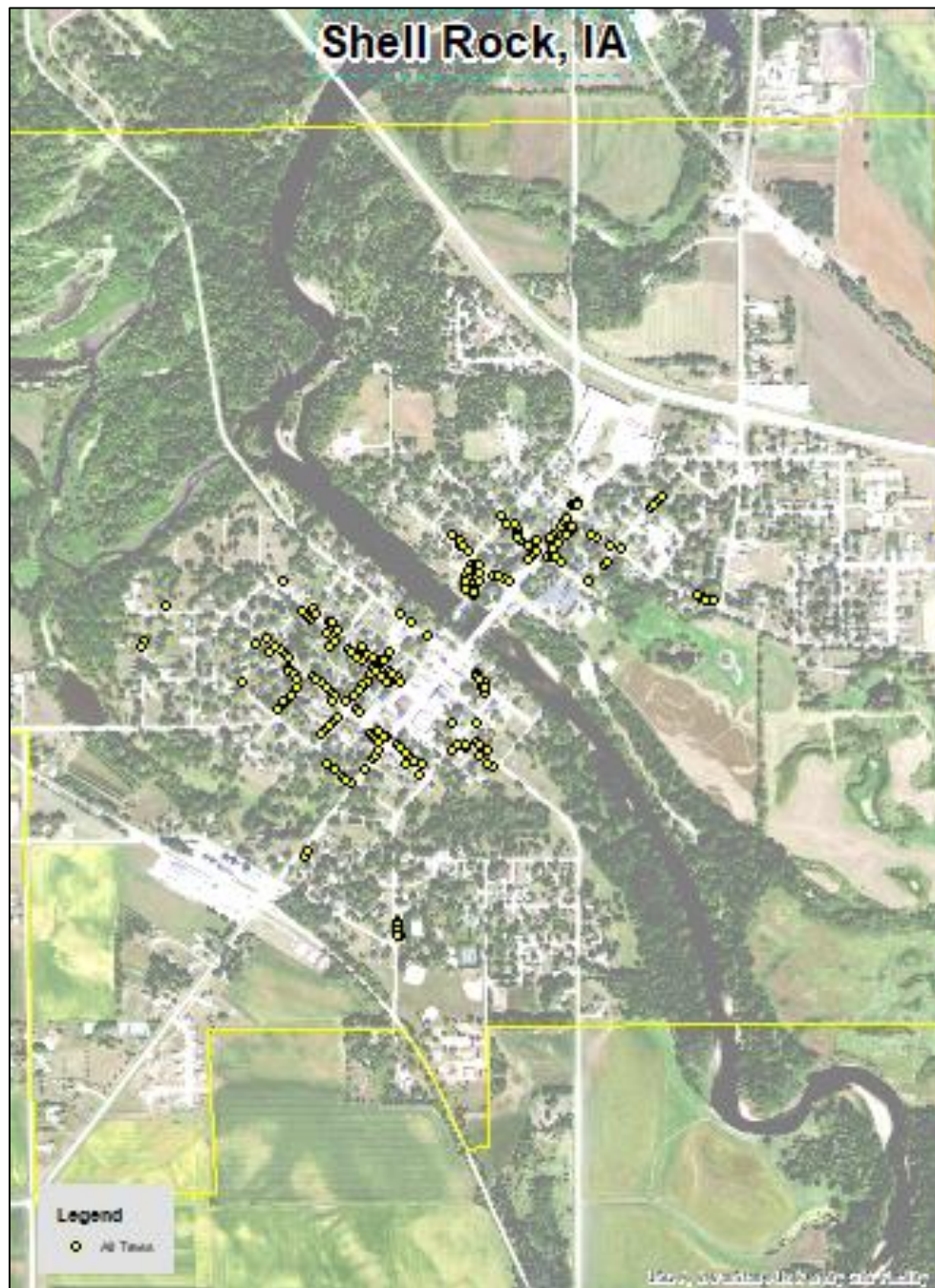# Shell Rock, IA

2020 Urban Forest Management Plan
Prepared by Iowa Department
of Natural Resources

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Executive Summary

Overview

This plan was developed to assist the City of Shell Rock 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) along with others such as Bur Oak Blight, Oak Wilt, Gypsy Moth, and Thousand Cankers Disease of black walnut. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues while maximizing the benefits of the urban tree canopy.

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 228 trees inventoried.

- Shell Rock's trees provide $40,963 of benefits annually, an average of $180 a tree
- There are at least 26 species of trees
- The top three genera are: Maple 49%, Crabapple 19%, N. Hackberry 8%, and Ash 8%
- 37% of trees are in need of some type of management
- 11 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 11 trees needing removal, 5 trees are of high priority and should be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- All ash trees should be carefully examined for the purpose of deciding whether any warrant preventative treatment from EAB. All others should be scheduled for removal as they will likely be dead within 5-10 years
- All trees should be pruned on a routine schedule- one third of the city every other year
- Plant a diverse mix of trees suited to the specific growing site that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut

Introduction

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

Trees are an important component of Shell Rock' 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 Shell Rock 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 Shell Rock'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.

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 228 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. Fin

Annual Benefits

Annual Energy Benefits
Trees conserve energy by shading buildings and blocking winds. Shell Rock's trees reduce energy related costs by approximately $11,318 annually (Appendix A, Table 1). These savings are both in Electricity (54.4 MWh) and in Natural Gas (7,336 Therms).

Annual Stormwater Benefits
Shell Rock's trees intercept about 551,147 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $14,936 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 Shell Rock, it is estimated that trees remove 681 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $1,907 (Appendix A, Table 3).

Annual Carbon Benefits
Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Shell Rock, trees sequester about 200,312 lbs of carbon a year with an associated value of $1,502 (Appendix A, Table 5). In addition, the trees store 2,075,768 lbs of carbon, with a yearly benefit of $15,568 (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. Shell Rock receives $11,300 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, Shell Rock's trees provide $40,963 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 228 trees in Shell Rock provide approximately $180 annually (Appendix A, Table 7).

Forest Structure

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

Maple	112	49%
Apple (Crab)	43	19%

N. Hackberry	18	8%
Ash	18	8%
Oak	12	5%

Age Class

Most of Shell Rock's trees (79%) are larger than 12 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. Shell Rock's size curve is on the larger side, indicating an older 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 Shell Rock indicate that 93% of the trees are in good health, with only 7% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 94% of Shell Rock's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3).

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees (Appendix B, Figure 5).

Needs	No. trees
Crown Cleaning	43
Crown Raising	7
Tree Staking	0
Tree Removal	11
Crown Reduction	20
Treat pest/disease	1

Canopy Cover

The total canopy with both private and public trees is 35%, or 370 acres. The canopy cover included in the Shell Rock inventory of public only trees includes approximately 6 acres (Appendix A, Figure 4).

Recommendations

Risk Management

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

Hazardous trees

Shell Rock has 16 trees that were flagged as critical concerns or in need of "immediate" attention (within 1-3 years). Five of these are situations where the entire tree should be removed, and eleven

need some form of trimming to remove a hazardous branch situation. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4).

Routine 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
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 Shell Rock.

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 (49%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut, as outlined in section 151 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151 (Appendix C).

Six Year Maintenance Plan
Year 1
    Removal: all 11 trees recommended for removal
    Pruning: address 11 trees flagged as needing immediate or critical concern pruning needs
    Ash trees: visit all 18 ash trees and designate for either treatment or removal

Year 2
    Address 30 of the 60 remaining trees flagged for routine maintenance needs
    Removal: any ash trees not designated for treatment
    Replacement plantings: Plant 10 new trees in open locations

Year 3
    Address the remaining 30 of the 60 trees flagged for routine maintenance needs
    Replacement plantings: Plant 10 new trees in open locations

Year 4

Initiate routine monitoring and pruning one third of the city every other year
Replacement plantings: Plant 10 new trees in open locations

Year 5
Replacement plantings: Plant 10 new trees in open locations

Year 6
Routine monitoring and pruning one third of the city every other year
Replacement plantings: Plant 10 new trees in open locations

Emerald Ash Borer Plan

Ash Tree Removal
Remove any ash trees that are dead or dying or in poor health as soon as possible. Any remaining healthy ash trees should be scheduled for removal if they are not designated for preventative treatment. *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. 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 151 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work
While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on 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 if preventative treatments are not being used. Dead ash trees will become brittle very quickly and may pose a serious hazard to life or property if not mitigated immediately.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

4/9/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	17.5	1,328	2,331.0	2,284	3,612	(N/A)	26.3	31.9	60.20
Apple	4.0	302	635.3	623	924	(N/A)	18.9	8.2	21.49
Silver maple	6.9	524	911.2	893	1,417	(N/A)	8.8	12.5	70.87
Northern hackberry	5.4	412	734.6	720	1,132	(N/A)	7.9	10.0	62.87
Norway maple	4.0	303	563.6	552	855	(N/A)	7.5	7.6	50.32
Green ash	4.1	314	535.1	524	838	(N/A)	6.6	7.4	55.89
Northern red oak	1.9	142	247.3	242	384	(N/A)	3.9	3.4	42.66
Black maple	2.5	190	339.4	333	523	(N/A)	3.9	4.6	58.08
Red maple	1.4	106	166.8	163	269	(N/A)	2.6	2.4	44.89
Spruce	0.5	39	58.5	57	97	(N/A)	1.8	0.9	24.14
American basswood	1.5	111	200.8	197	308	(N/A)	1.8	2.7	76.89
White ash	1.0	72	111.2	109	181	(N/A)	1.3	1.6	60.50
Black walnut	0.7	50	87.6	86	136	(N/A)	1.3	1.2	45.26
Eastern white pine	0.3	20	29.3	29	48	(N/A)	0.9	0.4	24.14
Bur oak	0.5	35	62.7	61	97	(N/A)	0.9	0.9	48.42
Kentucky coffeetree	0.2	14	27.5	27	41	(N/A)	0.9	0.4	20.64
Blue spruce	0.3	22	38.5	38	60	(N/A)	0.9	0.5	29.99
American elm	0.2	19	27.5	27	46	(N/A)	0.4	0.4	45.87
Ginkgo	0.1	5	9.9	10	15	(N/A)	0.4	0.1	14.72
Siberian elm	0.4	34	58.3	57	91	(N/A)	0.4	0.8	91.06
Broadleaf Deciduous Medium	0.0	3	6.2	6	9	(N/A)	0.4	0.1	8.99
River birch	0.3	24	47.4	46	71	(N/A)	0.4	0.6	70.84
Scotch pine	0.1	10	14.6	14	24	(N/A)	0.4	0.2	24.14
Norway spruce	0.1	10	14.6	14	24	(N/A)	0.4	0.2	24.14
Hickory	0.3	20	38.1	37	57	(N/A)	0.4	0.5	57.32
Northern pin oak	0.3	20	39.6	39	59	(N/A)	0.4	0.5	58.69
Total	54.4	4,129	7,336.4	7,190	11,318	(N/A)	100.0	100.0	49.64

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

4/9/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	194,890	5,282	(N/A)	26.3	35.4	88.03
Apple	14,705	399	(N/A)	18.9	2.7	9.27
Silver maple	97,300	2,637	(N/A)	8.8	17.7	131.84
Northern hackberry	40,011	1,084	(N/A)	7.9	7.3	60.24
Norway maple	34,798	943	(N/A)	7.5	6.3	55.47
Green ash	43,312	1,174	(N/A)	6.6	7.9	78.25
Northern red oak	16,432	445	(N/A)	3.9	3.0	49.48
Black maple	23,277	631	(N/A)	3.9	4.2	70.09
Red maple	8,645	234	(N/A)	2.6	1.6	39.04
Spruce	6,154	167	(N/A)	1.8	1.1	41.70
American basswood	21,138	573	(N/A)	1.8	3.8	143.21
White ash	8,624	234	(N/A)	1.3	1.6	77.91
Black walnut	6,016	163	(N/A)	1.3	1.1	54.35
Eastern white pine	3,077	83	(N/A)	0.9	0.6	41.70
Bur oak	7,411	201	(N/A)	0.9	1.3	100.41
Kentucky coffeetree	1,216	33	(N/A)	0.9	0.2	16.47
Blue spruce	4,469	121	(N/A)	0.9	0.8	60.55
American elm	1,391	38	(N/A)	0.4	0.3	37.69
Ginkgo	301	8	(N/A)	0.4	0.1	8.17
Siberian elm	5,904	160	(N/A)	0.4	1.1	159.99
Broadleaf Deciduous Medium	163	4	(N/A)	0.4	0.0	4.41
River birch	3,764	102	(N/A)	0.4	0.7	102.01
Scotch pine	1,539	42	(N/A)	0.4	0.3	41.70
Norway spruce	1,539	42	(N/A)	0.4	0.3	41.70
Hickory	2,591	70	(N/A)	0.4	0.5	70.21
Northern pin oak	2,479	67	(N/A)	0.4	0.4	67.19
Citywide total	551,147	14,936	(N/A)	100.0	100.0	65.51

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

4/9/2020

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							
Sugar maple	26.3	4.5	13.1	1.2	142	82.9	12.1	11.6	79.2	518	-20.7	-77	210.1	583 (N/A)	26.3	9.71
Apple	3.4	0.6	1.8	0.2	19	19.8	2.8	2.7	18.0	121	0.0	0	49.1	140 (N/A)	18.9	3.25
Silver maple	17.5	3.0	8.6	0.8	94	32.6	4.8	4.6	31.3	204	-9.5	-36	93.5	263 (N/A)	8.8	13.13
Northern hackberry	5.2	0.9	2.8	0.2	29	25.9	3.8	3.6	24.6	161	0.0	0	67.0	190 (N/A)	7.9	10.56
Norway maple	6.9	1.2	3.4	0.3	37	19.3	2.8	2.7	18.1	120	-1.6	-6	52.9	151 (N/A)	7.5	8.86
Green ash	5.8	0.9	2.8	0.3	31	19.5	2.9	2.7	18.8	122	0.0	0	53.6	153 (N/A)	6.6	10.20
Northern red oak	3.3	0.6	1.6	0.1	18	8.8	1.3	1.2	8.5	55	-4.7	-18	20.8	55 (N/A)	3.9	6.16
Black maple	5.9	1.0	2.7	0.3	31	11.9	1.7	1.7	11.3	74	-1.9	-7	34.6	98 (N/A)	3.9	10.92
Red maple	1.7	0.3	0.8	0.1	9	6.4	1.0	0.9	6.3	41	-0.6	-2	16.9	47 (N/A)	2.6	7.90
Spruce	0.7	0.1	0.6	0.1	5	2.4	0.4	0.3	2.3	15	-2.2	-8	4.7	11 (N/A)	1.8	2.82
American basswood	3.4	0.6	1.6	0.1	18	7.0	1.0	1.0	6.6	44	-2.7	-10	18.6	51 (N/A)	1.8	12.82
White ash	1.1	0.2	0.6	0.1	6	4.4	0.7	0.6	4.3	28	0.0	0	11.9	34 (N/A)	1.3	11.28
Black walnut	0.6	0.1	0.3	0.0	3	3.1	0.5	0.4	3.0	19	0.0	0	8.1	23 (N/A)	1.3	7.63
Eastern white pine	0.3	0.1	0.3	0.0	2	1.2	0.2	0.2	1.2	7	-1.1	-4	2.3	6 (N/A)	0.9	2.82
Bur oak	1.2	0.2	0.5	0.1	6	2.2	0.3	0.3	2.1	14	0.0	0	6.9	20 (N/A)	0.9	9.95
Kentucky coffeetree	0.0	0.0	0.0	0.0	0	0.9	0.1	0.1	0.9	6	0.0	0	2.1	6 (N/A)	0.9	2.99
Blue spruce	0.7	0.1	0.6	0.1	5	1.4	0.2	0.2	1.3	9	-1.7	-6	3.0	7 (N/A)	0.9	3.53
American elm	0.1	0.0	0.1	0.0	0	1.1	0.2	0.2	1.1	7	0.0	0	2.7	8 (N/A)	0.4	7.68
Ginkgo	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2 (N/A)	0.4	2.12
Siberian elm	1.2	0.2	0.6	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.8	20 (N/A)	0.4	19.64
Broadleaf Deciduous 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)	0.4	1.21
River birch	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14 (N/A)	0.4	13.58
Scotch pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3 (N/A)	0.4	2.82
Norway spruce	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3 (N/A)	0.4	2.82
Hickory	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.3	9 (N/A)	0.4	9.34
Northern pin oak	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)	0.4	10.16
Citywide total	87.4	14.9	43.8	4.0	474	258.6	37.7	36.0	246.5	1,614	-48.3	-181	680.6	1,907 (N/A)	100.0	8.36

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

4/9/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	760,621	5,705	(N/A)	26.3	36.6	95.08
Apple	58,319	437	(N/A)	18.9	2.8	10.17
Silver maple	428,441	3,213	(N/A)	8.8	20.6	160.67
Northern hackberry	72,567	544	(N/A)	7.9	3.5	30.24
Norway maple	112,492	844	(N/A)	7.5	5.4	49.63
Green ash	195,360	1,465	(N/A)	6.6	9.4	97.68
Northern red oak	69,339	520	(N/A)	3.9	3.3	57.78
Black maple	62,865	471	(N/A)	3.9	3.0	52.39
Red maple	19,221	144	(N/A)	2.6	0.9	24.03
Spruce	4,681	35	(N/A)	1.8	0.2	8.78
American basswood	132,293	992	(N/A)	1.8	6.4	248.05
White ash	23,116	173	(N/A)	1.3	1.1	57.79
Black walnut	20,479	154	(N/A)	1.3	1.0	51.20
Eastern white pine	2,340	18	(N/A)	0.9	0.1	8.78
Bur oak	39,444	296	(N/A)	0.9	1.9	147.91
Kentucky coffeetree	2,069	16	(N/A)	0.9	0.1	7.76
Blue spruce	6,012	45	(N/A)	0.9	0.3	22.54
American elm	3,037	23	(N/A)	0.4	0.1	22.78
Ginkgo	474	4	(N/A)	0.4	0.0	3.56
Siberian elm	29,353	220	(N/A)	0.4	1.4	220.15
Broadleaf Deciduous	218	2	(N/A)	0.4	0.0	1.64
River birch	14,280	107	(N/A)	0.4	0.7	107.10
Scotch pine	1,170	9	(N/A)	0.4	0.1	8.78
Norway spruce	1,170	9	(N/A)	0.4	0.1	8.78
Hickory	8,458	63	(N/A)	0.4	0.4	63.43
Northern pin oak	7,945	60	(N/A)	0.4	0.4	59.59
Citywide total	2,075,768	15,568	(N/A)	100.0	100.0	68.28

Table 5: Annual Carbon Sequestered

Annual CO₂ Benefits of Public Trees

4/9/2020

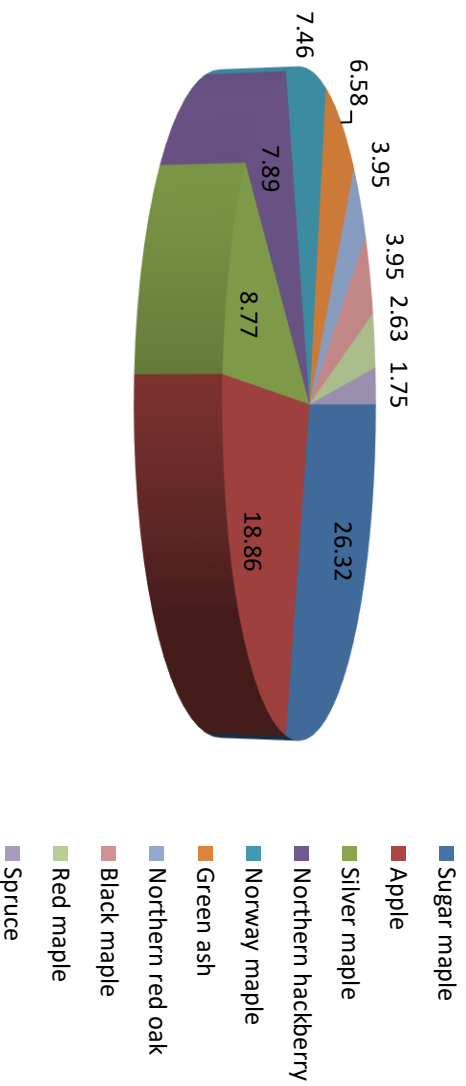| Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	39,144	294	-3,651	-186	-29	29,341	220	64,647	485 (N/A)	26.3	32.3	8.08
Apple	6,186	46	-280	-56	-3	6,666	50	12,515	94 (N/A)	18.9	6.2	2.18
Silver maple	30,176	226	-2,057	-77	-16	11,588	87	39,630	297 (N/A)	8.8	19.8	14.86
Northern hackberry	5,499	41	-348	-45	-3	9,099	68	14,205	107 (N/A)	7.9	7.1	5.92
Norway maple	6,346	48	-541	-39	-4	6,698	50	12,464	93 (N/A)	7.5	6.2	5.50
Green ash	8,504	64	-938	-42	-7	6,939	52	14,463	108 (N/A)	6.6	7.2	7.23
Northern red oak	2,024	15	-333	-22	-3	3,130	23	4,800	36 (N/A)	3.9	2.4	4.00
Black maple	3,736	28	-302	-23	-2	4,200	32	7,612	57 (N/A)	3.9	3.8	6.34
Red maple	2,581	19	-92	-11	-1	2,340	18	4,818	36 (N/A)	2.6	2.4	6.02
Spruce	462	3	-22	-8	0	866	6	1,298	10 (N/A)	1.8	0.6	2.43
American basswood	6,770	51	-635	-18	-5	2,449	18	8,566	64 (N/A)	1.8	4.3	16.06
White ash	2,302	17	-111	-7	-1	1,602	12	3,786	28 (N/A)	1.3	1.9	9.47
Black walnut	1,511	11	-98	-7	-1	1,104	8	2,510	19 (N/A)	1.3	1.3	6.27
Eastern white pine	231	2	-11	-4	0	433	3	649	5 (N/A)	0.9	0.3	2.43
Bur oak	986	7	-189	-6	-1	783	6	1,574	12 (N/A)	0.9	0.8	5.90
Kentucky coffeetree	418	3	-10	-2	0	318	2	723	5 (N/A)	0.9	0.4	2.71
Blue spruce	91	1	-29	-5	0	493	4	549	4 (N/A)	0.9	0.3	2.06
American elm	222	2	-15	-2	0	418	3	623	5 (N/A)	0.4	0.3	4.67
Ginkgo	58	0	-2	-1	0	111	1	165	1 (N/A)	0.4	0.1	1.24
Siberian elm	911	7	-141	-5	-1	749	6	1,514	11 (N/A)	0.4	0.8	11.36
Broadleaf Deciduous Medi	96	1	-2	-1	0	65	0	158	1 (N/A)	0.4	0.1	1.18
River birch	0	0	-69	-4	-1	539	4	466	3 (N/A)	0.4	0.2	3.49
Scotch pine	116	1	-6	-2	0	216	2	324	2 (N/A)	0.4	0.2	2.43
Norway spruce	116	1	-6	-2	0	216	2	324	2 (N/A)	0.4	0.2	2.43
Hickory	660	5	-41	-3	0	441	3	1,058	8 (N/A)	0.4	0.5	7.93
Northern pin oak	470	4	-38	-3	0	440	3	869	7 (N/A)	0.4	0.4	6.52
Citywide total	119,615	897	-9,965	-582	-79	91,244	684	200,312	1,502 (N/A)	100.0	100.0	6.59

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

4/9/2020

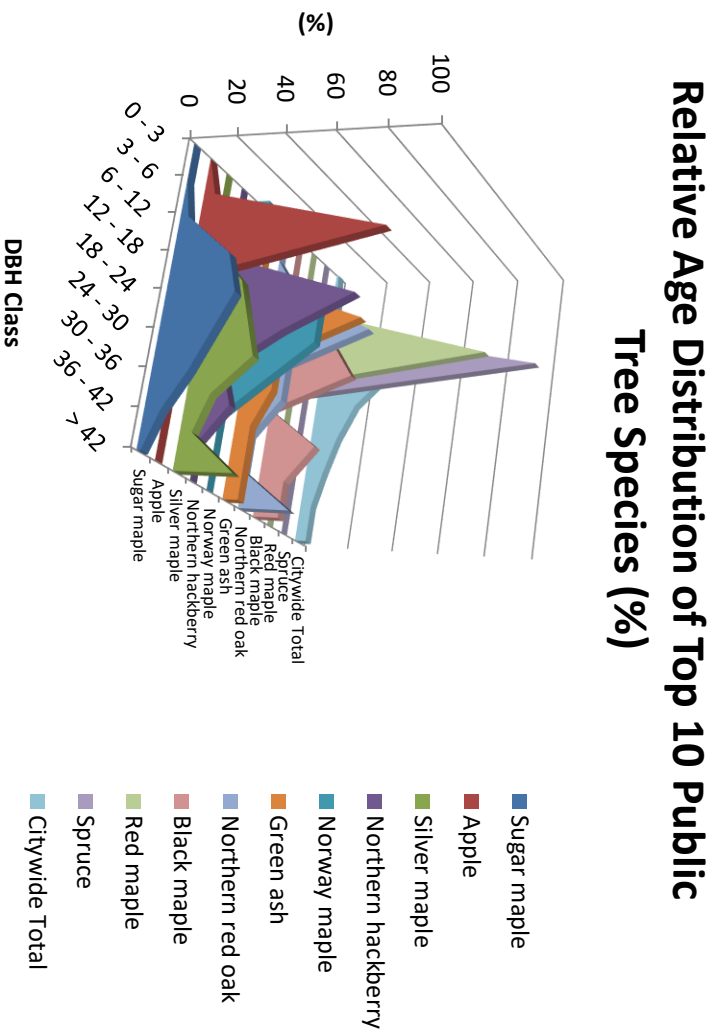| Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	4,061	(N/A)	26.3	35.9	67.68
Apple	353	(N/A)	18.9	3.1	8.20
Silver maple	2,269	(N/A)	8.8	20.1	113.47
Northern hackberry	866	(N/A)	7.9	7.7	48.11
Norway maple	603	(N/A)	7.5	5.3	35.49
Green ash	726	(N/A)	6.6	6.4	48.42
Northern red oak	164	(N/A)	3.9	1.5	18.21
Black maple	459	(N/A)	3.9	4.1	51.00
Red maple	359	(N/A)	2.6	3.2	59.88
Spruce	129	(N/A)	1.8	1.1	32.32
American basswood	421	(N/A)	1.8	3.7	105.20
White ash	254	(N/A)	1.3	2.2	84.61
Black walnut	140	(N/A)	1.3	1.2	46.67
Eastern white pine	65	(N/A)	0.9	0.6	32.32
Bur oak	73	(N/A)	0.9	0.6	36.54
Kentucky coffeetree	57	(N/A)	0.9	0.5	28.56
Blue spruce	25	(N/A)	0.9	0.2	12.61
American elm	37	(N/A)	0.4	0.3	36.79
Ginkgo	7	(N/A)	0.4	0.1	6.77
Siberian elm	54	(N/A)	0.4	0.5	53.50
Broadleaf Deciduous Medium	13	(N/A)	0.4	0.1	12.89
River birch	0	(N/A)	0.4	0.0	0.00
Scotch pine	32	(N/A)	0.4	0.3	32.32
Norway spruce	32	(N/A)	0.4	0.3	32.32
Hickory	58	(N/A)	0.4	0.5	57.69
Northern pin oak	43	(N/A)	0.4	0.4	43.05
Citywide total	11,300	(N/A)	100.0	100.0	49.56

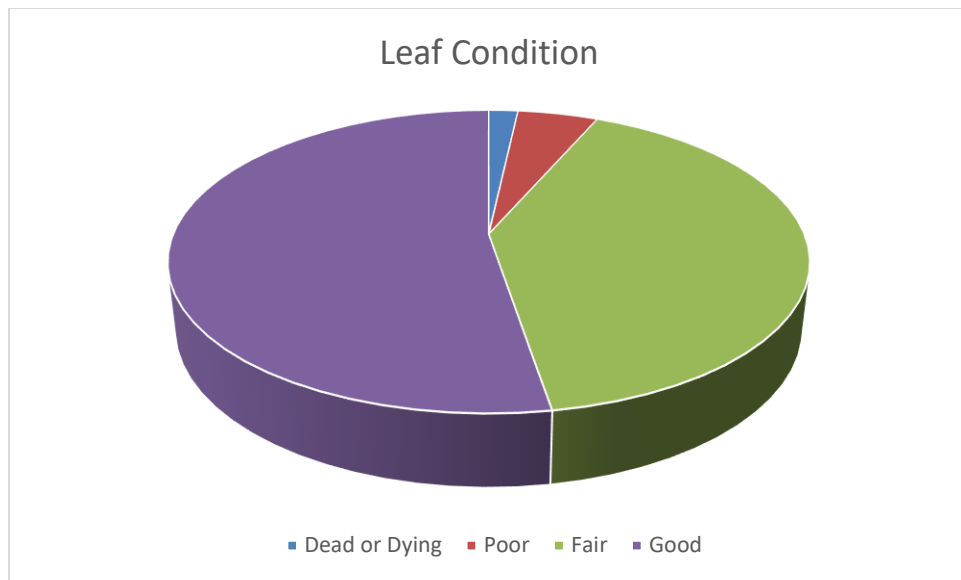**Table 7: Summary of Benefits in Dollars**

Total Annual Benefits of Public Trees by Species ($)

4/9/2020

Species	Energy	CO$_2$	Air Quality	Stormwater	Aesthetic/Other	Total ($) Standard Error	% of Total $
Sugar maple	3,612	485	583	5,282	4,061	14,022 (N/A)	34.2
Apple	924	94	140	399	353	1,909 (N/A)	4.7
Silver maple	1,417	297	263	2,637	2,269	6,883 (N/A)	16.8
Northern hackberry	1,132	107	190	1,084	866	3,379 (N/A)	8.2
Norway maple	855	93	151	943	603	2,646 (N/A)	6.5
Green ash	838	108	153	1,174	726	3,000 (N/A)	7.3
Northern red oak	384	36	55	445	164	1,085 (N/A)	2.6
Black maple	523	57	98	631	459	1,768 (N/A)	4.3
Red maple	269	36	47	234	359	946 (N/A)	2.3
Spruce	97	10	11	167	129	414 (N/A)	1.0
American basswood	308	64	51	573	421	1,417 (N/A)	3.5
White ash	181	28	34	234	254	731 (N/A)	1.8
Black walnut	136	19	23	163	140	481 (N/A)	1.2
Eastern white pine	48	5	6	83	65	207 (N/A)	0.5
Bur oak	97	12	20	201	73	402 (N/A)	1.0
Kentucky coffeetree	41	5	6	33	57	143 (N/A)	0.3
Blue spruce	60	4	7	121	25	217 (N/A)	0.5
American elm	46	5	8	38	37	133 (N/A)	0.3
Ginkgo	15	1	2	8	7	33 (N/A)	0.1
Siberian elm	91	11	20	160	54	336 (N/A)	0.8
Broadleaf Deciduous M(	9	1	1	4	13	29 (N/A)	0.1
River birch	71	3	14	102	0	190 (N/A)	0.5
Scotch pine	24	2	3	42	32	103 (N/A)	0.3
Norway spruce	24	2	3	42	32	103 (N/A)	0.3
Hickory	57	8	9	70	58	202 (N/A)	0.5
Northern pin oak	59	7	10	67	43	186 (N/A)	0.5
Citywide Total	11,318	1,502	1,907	14,936	11,300	40,963 (N/A)	100.0

Figure 1: Species Distribution

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

Sugar maple
Apple
Silver maple
Northern hackberry
Norway maple
Green ash
Northern red oak
Black maple
Red maple
Spruce

Figure 2: Relative Age Class

DBH Class

(%)

0 - 3
3 - 6
6 - 12
12 - 18
18 - 24
24 - 30
30 - 36
36 - 42
> 42

Sugar maple
Apple
Silver maple
Northern hackberry
Norway maple
Green ash
Northern red oak
Black maple
Red maple
Spruce
Citywide Total

Figure 3: Foliage Condition
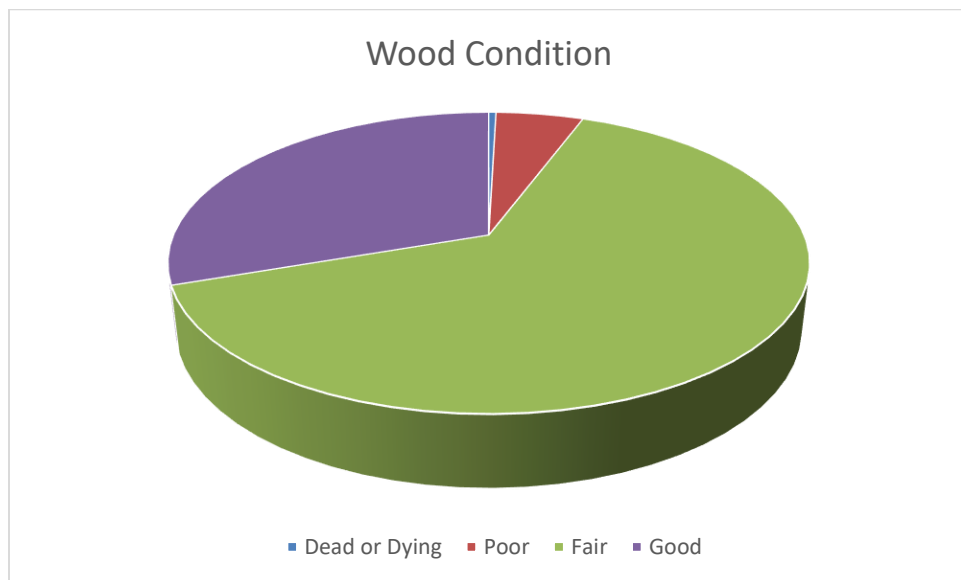
Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)
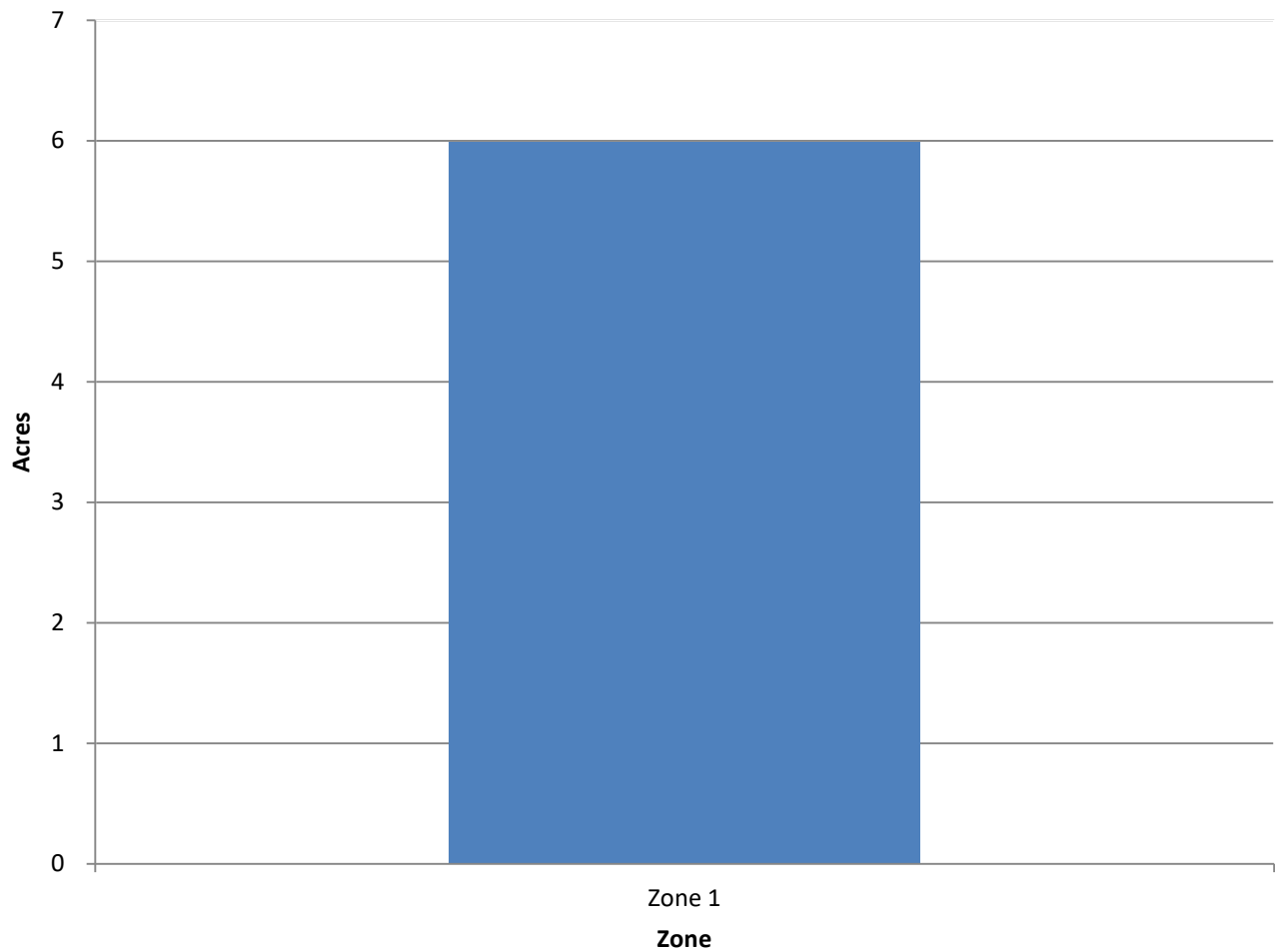
Figure 5: Canopy Cover in Acres
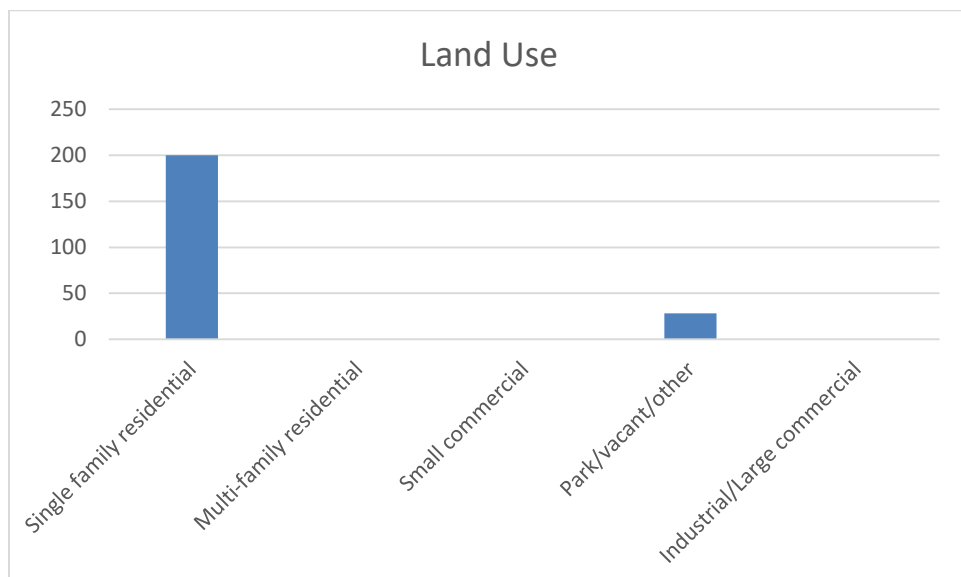
Figure 6: Land Use of city/park trees

Location

(Bar chart showing tree counts by location with y-axis from 0 to 250 in increments of 50)

Categories: Front yard (~25), Planting strip (~205), Cutout (0), Median (0), Other maintained locations (0), Other un-maintained… (0), Backyard (0)
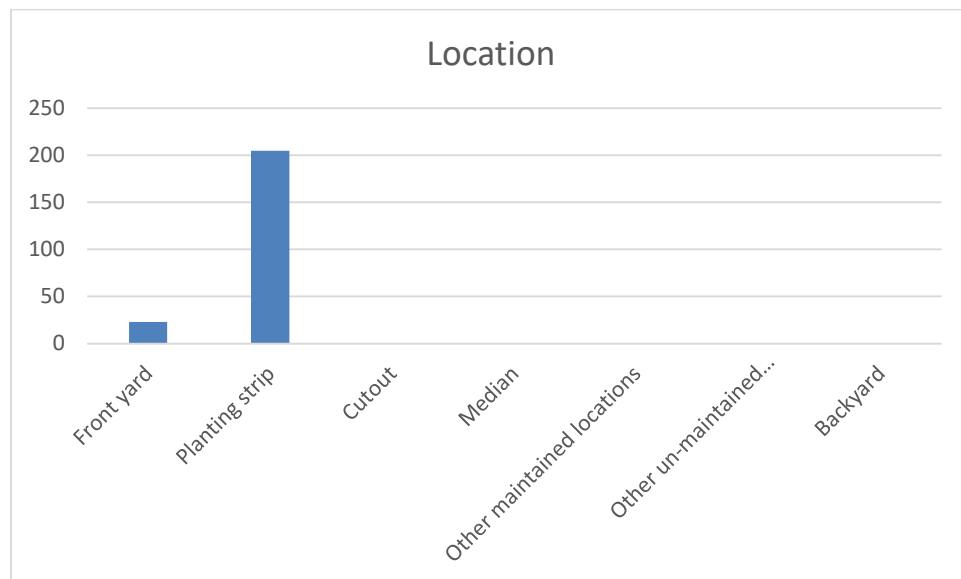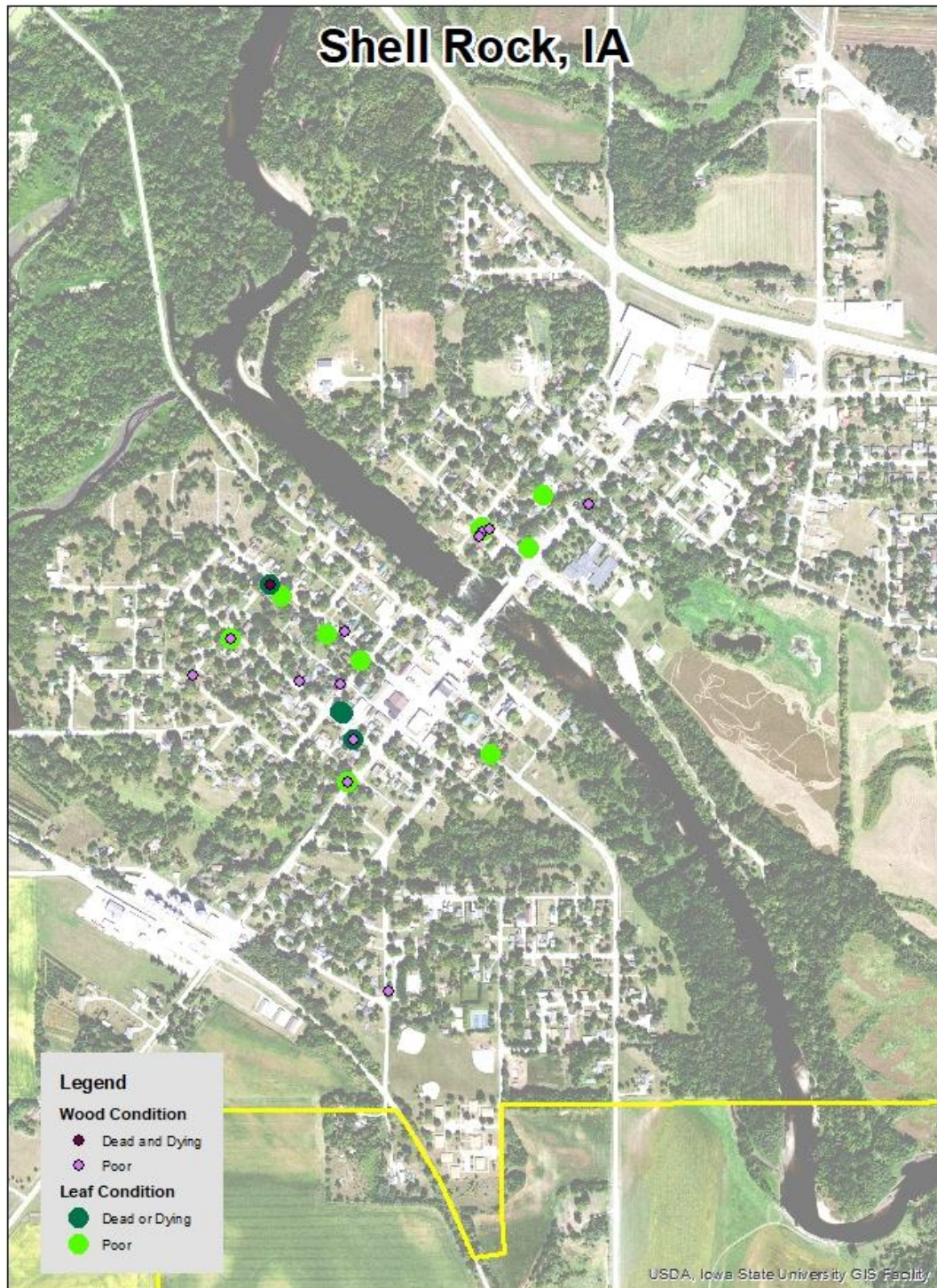
Figure 7: Location of city/park trees

Figure 1: Location of Ash Trees
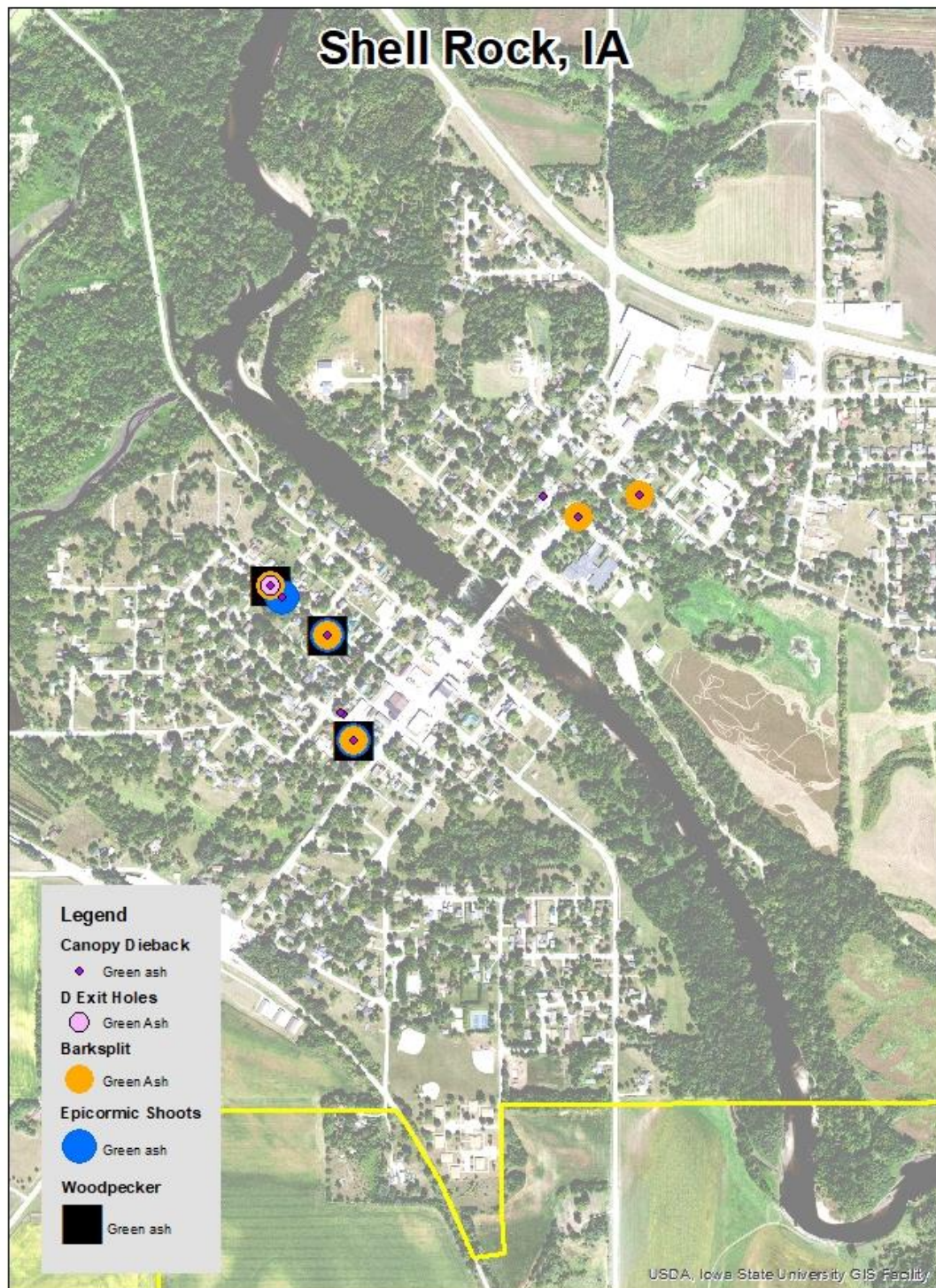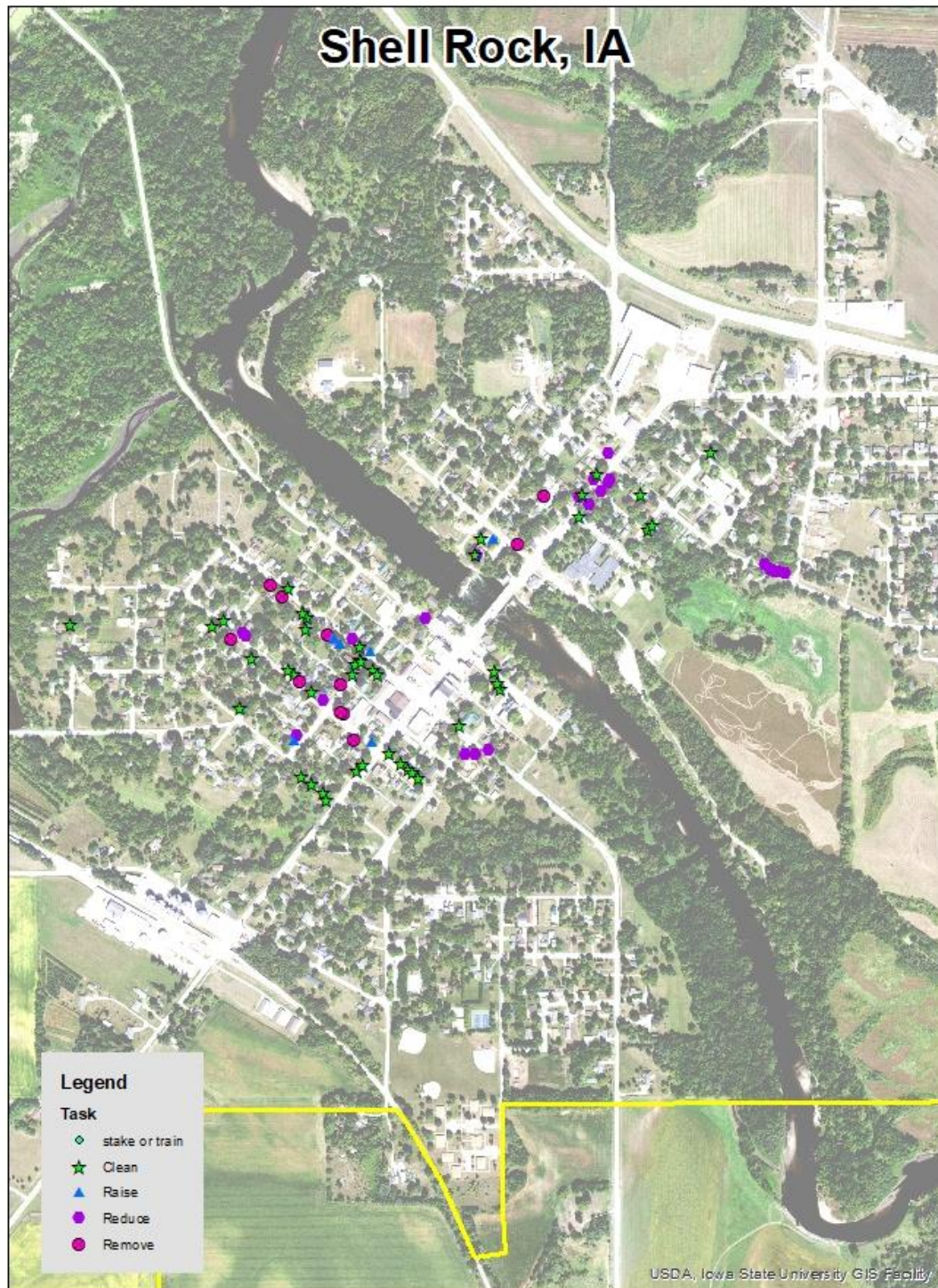
Figure 2: Location of EAB symptoms

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: Shell Rock Tree Ordinance

(See enclosed document)

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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.