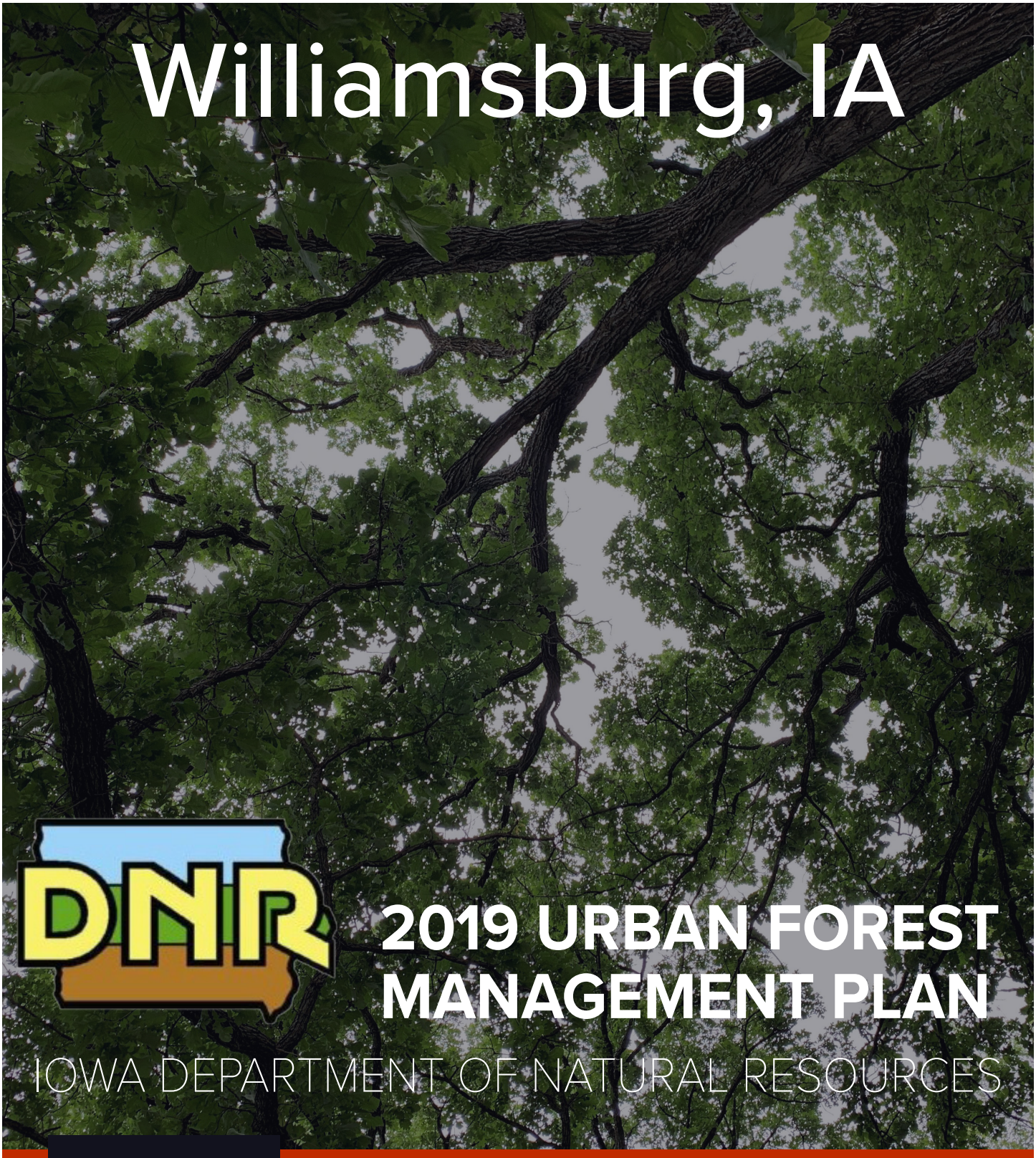

Williamsburg, IA

2019 URBAN FOREST MANAGEMENT PLAN

IOWA DEPARTMENT OF NATURAL RESOURCES

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Executive Summary

Overview

This plan was developed to assist the City of Williamsburg in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like 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 except mountain ash. There is a strong possibility that 10% of Williamsburg's city-owned trees will die once EAB becomes established in the community, unless local leaders begin preventative treatment. 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, JEO conducted a tree inventory 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 553 trees inventoried.

- Williamsburg's trees provide $102,625 of benefits annually, an average of $185.58 per tree
- There are over 21 species of trees
- The top three genera are: Maple 36%, Hackberry 15.5%, and Ash 10%
- 89% of trees need some type of management
- 11 trees should be removed

Recommendations

We detail our core recommendations in the Recommendations Section. In the Emerald Ash Borer Plan, we include management recommendations. Below are some key recommendations.

- Out of the 11 trees needing removal, 2 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately. *City ownership of the trees recommended for removal should be verified prior to any removal*
- 9 of the 53 ash trees should be carefully examined, as they have one or more symptoms that could be 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: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Check ash trees yearly with a visual survey.
- With the current budget it could take 4 years to remove ash. We suggest that city officials request a budget increase to $12,000 annually and apply for grants to plant replacement trees.

Introduction

This plan was developed to assist Williamsburg with managing, budgeting, and future planning of their urban forest. Across the state, forestry budgets continue to decrease as a higher percentage of the budgets are devoted to 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, treatment, and replacement planting. With proper planning and management of the current canopy in Williamsburg, these costs can be spread out over the years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important part of Williamsburg's infrastructure and one of the city's greatest assets. The benefits of trees are immense. Trees improve air quality, intercept stormwater runoff, conserve energy, lower traffic speeds, increase property values, reduce crime, improve mental health, and create a desirable place to live, to name just a few. Good urban forestry management will maintain these important benefits for the people of Williamsburg and future generations.

Urban forestry management sets goals and develops management strategies to achieve them. To develop management strategies, a comprehensive public tree inventory must be conducted. The inventory informs maintenance, removal schedules, tree planting, and budgeting. Aligning management actions with the tree inventory results will help meet Williamsburg's urban forestry goals.

Inventory

In 2019, JEO conducted a tree inventory that included 100% of the city-owned trees on both streets and parks. The team collected tree data 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 data collectors' programming 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, for all ash trees, the team notes signs and symptoms associated with EAB including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

JEO entered the data collected for the 553 city trees into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. Below are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Williamsburg's trees reduce energy-related costs by approximately $27,962 annually (Appendix A, Table 1). These savings are both in electricity (132.1 MWh) and in natural gas (18,301.2 Therms).

Annual Stormwater Benefits

Williamsburg's trees intercept about 1,443,525 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $39,120 in benefit 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 lessens emissions of volatile organic matter (ozone). In Williamsburg, it is estimated that trees remove 1,713.5 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $4,820 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Williamsburg, trees sequester about 256,391 lbs of carbon per year with an associated value of $1,923 (Appendix A, Table 5). In addition, the trees store 5,000,548 lbs of carbon, with a yearly benefit of $37,504 (Appendix A, Table 4).

Annual Aesthetics Benefits

The social benefits of trees are hard to capture. The i-Tree 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. Williamsburg receives $27,330 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, Williamsburg's trees provide $102,625 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 553 trees in Williamsburg provide approximately $185.58 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Williamsburg has over 21 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	199	36%
Hackberry	86	15.5%
Ash	53	10%
Oak	41	7.5%
Apple	40	7%
Spruce	24	4%
Locust	18	3%
Linden/Basswood	17	3%
Broadleaf Deciduous Small	14	2.5%
Elm	12	2%
Birch	6	1%
Conifer Evergreen	6	1%
Pear	6	1%
Sycamore	6	1%
Walnut	6	1%
Ginkgo	4	<1%
Buckeye	3	<1%
Cedar	3	<1%
Hemlock	3	<1%
Pine	3	<1%
Cottonwood	1	<1%
Magnolia	1	<1%
Sweetgum	1	<1%

Age Class

Most of Williamsburg's trees (34.72%) are between 18 and 30 inches in diameter at 4.5 ft (Appendix A, Figure 2). To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Williamsburg's size curve indicates a middle aged, very average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Williamsburg indicate that 96% of the trees are in good health, with only 4% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 93% of Williamsburg's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B,

Figure 3). Seven percent of the tree population's wood condition is in poor health, dead, or dying. This 7% is an estimate of trees that need management follow up.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3).

Crown Cleaning	373	67%
Crown Raising	15	3%
Tree Staking	14	2.5%
Tree Removal	11	2%
Crown Reduction	83	15%

Land Use and Location

The majority of Williamsburg'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	61%
Park/vacant/other	1.5%
Industrial/Large commercial	37.5%
Small commercial	0%
Multifamily residential	0%

Recommendations

Risk Management

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

Hazardous trees

Williamsburg has 11 trees that need immediate removal. These trees along with other trees needing maintenance can be seen on the Location of Trees with Recommended Maintenance Map (Appendix B, Figure 4). We recommend starting with the large-diameter, critical concern trees first. There are 2 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Proposed Work Schedule and Budget 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. There are a total of 496 trees with maintenance needs.

Poor tree species

After removing the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 11 removals, none are ash trees. There are a total of 53 ash trees, and 9 of those have signs and symptoms that have been associated with EAB. In

addition, there is 1 tree that is in poor health. *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 removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend 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 five years will replace the trees that are removed. We recommend planting 1.2 trees for every tree removed, since survival rates will not be 100%. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Williamsburg.

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 (36%) (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 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. We recommend 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.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized by first removing dead, dying, hazardous trees (Appendix B, Figure 4). Next will be all ash in poor condition that display EAB signs and symptoms (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 an effective tool for communities to spread removal costs out over several years while allowing trees to continue providing 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 normally disposed of 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 151.02 (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 EAB signs and symptoms including 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. City Code 151.06 states "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."

Proposed Work Schedule and Budget

Budget Allowance of $10,000/Year – (Based off Reported Yearly Tree Budget)

YEAR 1	**ESTIMATED COSTS**
Remove 10 trees recommended for immediate removal	$8,000
Plant 13 trees in open locations	$1,950
Visual Survey of EAB Signs/Symptoms	

YEAR 2	
Remove 1 tree recommended for immediate removal	$800
Remove 6 ash trees (prioritize largest diameter)	$4,800
Plant 10 trees in open locations	$1,500
Prune 1/3 of City Owned Trees	$2,760
Visual Survey of EAB Signs/Symptoms	

YEAR 3	
Remove 10 ash trees (prioritize largest diameter)	$8,000
Plant 13 trees in open locations	$1,950
Visual Survey of EAB Signs/Symptoms	

YEAR 4	
Remove 7 ash trees (prioritize largest diameter)	$5,600
Plant 10 trees in open locations	$1,500
Prune 1/3 of City Owned Trees	$2,760
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 10 ash trees (prioritize largest diameter)	$8,000
Plant 13 trees in open locations	$1,950
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 7 ash trees (prioritize largest diameter)	$5,600
Plant 10 trees in open locations	$1,500
Prune 1/3 of City Owned Trees	$2,760
Visual Survey of EAB Signs/Symptoms	

Estimated costs based on average $150/tree for planting and maintenance and $15/tree for pruning. Cost for removal reported: $800/tree.

**To remove all ash trees within 6 years alone, the budget would need to be $7,000 a year. If the budget were increased to $12,000 a year all ash could be removed in 3.5 years.

Proposed Work Schedule with Increased Budget

Budget Allowance of $12,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	**ESTIMATED COSTS**
Remove 11 trees recommended for immediate removal	$8,800
Remove 2 ash tree (prioritize largest diameter)	$1,600
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	

YEAR 2

Remove 8 ash trees (prioritize largest diameter)	$6,400
Plant 18 trees in open locations	$2,700
Prune 1/3 of City Owned Trees	$2,760
Visual Survey of EAB Signs/Symptoms	

YEAR 3

Remove 13 ash trees (prioritize largest diameter)	$10,400
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	

YEAR 4

Remove 8 ash trees (prioritize largest diameter)	$6,400
Plant 18 trees in open locations	$2,700
Prune 1/3 of City Owned Trees	$2,760
Visual Survey of EAB Signs/Symptoms	

YEAR 5

Remove 13 ash trees (prioritize largest diameter)	$10,400
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	

YEAR 6

Remove 8 ash trees (prioritize largest diameter)	$6,400
Plant 18 trees in open locations	$2,700
Prune 1/3 of City Owned Trees	$2,760
Visual Survey of EAB Signs/Symptoms	

Purposed Budget Increase

EAB could potentially kill all ash trees in Williamsburg within four years of its arrival. To remove all ash trees within six years, the budget would need to be $7,000 a year. If the budget were increased to $12,000 per year all ash could be removed within 3.5 years. Additionally, we recommend that Williamsburg 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 considered by many communities is treating 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 removal 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 20 inches and at $15 per inch, about 4 trees could be treated per year (every other year treatment). Eight trees would be selected for treatment, and Williamsburg would still need to find $36,000 for removal of the remaining ash. Alternatively, if there are 15 treatable trees, it would cost approximately $4,500 a year for treatment and leave $5,500 for removal. These are alternatives to straight removal of ash trees. However, whether the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Williamsburg. We suggest considering an increased budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

4/21/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	29.7	2,258	4,193.4	4,109	6,367	(N/A)	15.6	22.8	74.04
Norway maple	16.8	1,274	2,455.9	2,407	3,681	(N/A)	12.7	13.2	52.59
Sugar maple	13.5	1,026	1,830.5	1,794	2,820	(N/A)	9.6	10.1	53.20
Silver maple	14.2	1,078	1,871.9	1,834	2,912	(N/A)	9.2	10.4	57.10
Green ash	9.3	705	1,251.0	1,226	1,931	(N/A)	7.4	6.9	47.10
Apple	2.7	207	405.0	397	604	(N/A)	7.2	2.2	15.10
Northern pin oak	6.6	499	958.0	939	1,438	(N/A)	4.0	5.1	65.35
Red maple	2.8	211	384.8	377	588	(N/A)	3.3	2.1	32.67
Honeylocust	5.8	441	764.6	749	1,190	(N/A)	3.3	4.3	66.10
Blue spruce	1.7	129	237.2	232	362	(N/A)	2.9	1.3	22.60
Northern red oak	3.5	265	486.0	476	741	(N/A)	2.7	2.7	49.42
Littleleaf linden	2.0	151	277.8	272	423	(N/A)	2.2	1.5	35.25
Siberian elm	3.2	246	432.6	424	670	(N/A)	1.6	2.4	74.45
White ash	1.4	105	173.0	170	274	(N/A)	1.6	1.0	30.46
Black maple	2.0	151	279.3	274	425	(N/A)	1.3	1.5	60.68
Black walnut	1.9	141	255.9	251	392	(N/A)	1.1	1.4	65.29
American sycamore	2.5	188	336.8	330	518	(N/A)	1.1	1.9	86.29
Spruce	0.8	63	97.8	96	159	(N/A)	1.1	0.6	26.48
Callery pear	0.6	43	81.8	80	123	(N/A)	1.1	0.4	20.45
Conifer Evergreen Large	1.0	76	132.9	130	206	(N/A)	1.1	0.7	34.32
American basswood	2.0	150	279.6	274	424	(N/A)	0.9	1.5	84.88
Ginkgo	0.7	50	90.9	89	140	(N/A)	0.7	0.5	34.88
Black cherry	0.8	57	105.6	104	161	(N/A)	0.7	0.6	40.13
Cherry plum	0.4	27	54.1	53	80	(N/A)	0.7	0.3	19.98
River birch	0.9	66	125.5	123	189	(N/A)	0.7	0.7	47.16
Eastern hemlock	0.4	31	49.0	48	79	(N/A)	0.5	0.3	26.25
American elm	1.4	104	165.7	162	266	(N/A)	0.5	1.0	88.63
Eastern red cedar	0.3	25	49.3	48	74	(N/A)	0.5	0.3	24.57
Ash	0.1	9	18.6	18	27	(N/A)	0.5	0.1	8.99
Ohio buckeye	0.5	35	70.5	69	104	(N/A)	0.5	0.4	34.77
Mountain ash	0.1	7	16.6	16	24	(N/A)	0.4	0.1	11.80
Paper birch	0.5	36	54.0	53	88	(N/A)	0.4	0.3	44.23
Swamp white oak	0.1	6	12.4	12	18	(N/A)	0.4	0.1	8.99
Eastern white pine	0.4	28	49.2	48	76	(N/A)	0.4	0.3	38.17
Sweetgum	0.0	2	3.7	4	6	(N/A)	0.2	0.0	5.82
Norway spruce	0.2	14	24.6	24	38	(N/A)	0.2	0.1	38.17
White oak	0.3	25	46.9	46	71	(N/A)	0.2	0.3	70.91
Southern magnolia	0.2	18	24.2	24	41	(N/A)	0.2	0.1	41.29
Eastern cottonwood	0.4	33	59.0	58	91	(N/A)	0.2	0.3	91.02
Lilac	0.1	6	12.8	13	18	(N/A)	0.2	0.1	18.19
Broadleaf Deciduous Sms	0.0	2	3.8	4	5	(N/A)	0.2	0.0	5.40
Bur oak	0.3	25	46.9	46	71	(N/A)	0.2	0.3	70.91
Plum	0.0	2	3.8	4	5	(N/A)	0.2	0.0	5.40
Scotch pine	0.1	4	9.5	9	14	(N/A)	0.2	0.0	13.58
Black spruce	0.1	10	15.2	15	25	(N/A)	0.2	0.1	24.51
Amur maple	0.0	2	3.8	4	5	(N/A)	0.2	0.0	5.40
Total	132.1	10,027	18,301.2	17,935	27,962	(N/A)	100.0	100.0	50.56

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

4/21/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	293,878	7,964	(N/A)	15.6	20.4	92.61
Norway maple	161,364	4,373	(N/A)	12.7	11.2	62.47
Sugar maple	173,232	4,695	(N/A)	9.6	12.0	88.58
Silver maple	189,573	5,137	(N/A)	9.2	13.1	100.73
Green ash	100,961	2,736	(N/A)	7.4	7.0	66.73
Apple	10,919	296	(N/A)	7.2	0.8	7.40
Northern pin oak	70,610	1,914	(N/A)	4.0	4.9	86.98
Red maple	21,981	596	(N/A)	3.3	1.5	33.09
Honeylocust	65,965	1,788	(N/A)	3.3	4.6	99.31
Blue spruce	24,251	657	(N/A)	2.9	1.7	41.08
Northern red oak	37,296	1,011	(N/A)	2.7	2.6	67.38
Littleleaf linden	19,020	515	(N/A)	2.2	1.3	42.95
Siberian elm	36,016	976	(N/A)	1.6	2.5	108.45
White ash	11,042	299	(N/A)	1.6	0.8	33.25
Black maple	20,069	544	(N/A)	1.3	1.4	77.70
Black walnut	21,772	590	(N/A)	1.1	1.5	98.34
American sycamore	36,440	988	(N/A)	1.1	2.5	164.59
Spruce	12,298	333	(N/A)	1.1	0.9	55.54
Callery pear	3,069	83	(N/A)	1.1	0.2	13.86
Conifer Evergreen Large	22,722	616	(N/A)	1.1	1.6	102.63
American basswood	31,165	845	(N/A)	0.9	2.2	168.91
Ginkgo	4,961	134	(N/A)	0.7	0.3	33.61
Black cherry	3,174	86	(N/A)	0.7	0.2	21.50
Cherry plum	1,264	34	(N/A)	0.7	0.1	8.56
River birch	6,954	188	(N/A)	0.7	0.5	47.11
Eastern hemlock	6,046	164	(N/A)	0.5	0.4	54.62
American elm	10,493	284	(N/A)	0.5	0.7	94.79
Eastern red cedar	4,904	133	(N/A)	0.5	0.3	44.30
Ash	488	13	(N/A)	0.5	0.0	4.41
Ohio buckeye	4,513	122	(N/A)	0.5	0.3	40.77
Mountain ash	333	9	(N/A)	0.4	0.0	4.51
Paper birch	2,931	79	(N/A)	0.4	0.2	39.72
Swamp white oak	325	9	(N/A)	0.4	0.0	4.41
Eastern white pine	9,209	250	(N/A)	0.4	0.6	124.79
Sweetgum	172	5	(N/A)	0.2	0.0	4.65
Norway spruce	4,605	125	(N/A)	0.2	0.3	124.79
White oak	3,943	107	(N/A)	0.2	0.3	106.85
Southern magnolia	1,775	48	(N/A)	0.2	0.1	48.11
Eastern cottonwood	7,239	196	(N/A)	0.2	0.5	196.17
Lilac	264	7	(N/A)	0.2	0.0	7.17
Broadleaf Deciduous Small	69	2	(N/A)	0.2	0.0	1.86
Bur oak	3,943	107	(N/A)	0.2	0.3	106.85
Plum	69	2	(N/A)	0.2	0.0	1.86
Scotch pine	596	16	(N/A)	0.2	0.0	16.14
Black spruce	1,544	42	(N/A)	0.2	0.1	41.85
Amur maple	69	2	(N/A)	0.2	0.0	1.86
Citywide total	1,443,525	39,120	(N/A)	100.0	100.0	70.74

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

4/21/2020

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
Northern hackberry	47.2	8.2	23.9	2.1	257	143.3	20.8	19.8	134.9	890	0.0	0	400.2	1,147	(N/A)	15.6	13.34
Norway maple	33.3	5.7	16.3	1.5	180	81.7	11.8	11.2	76.2	505	-7.8	-29	229.9	656	(N/A)	12.7	9.37
Sugar maple	25.6	4.4	12.3	1.1	137	64.3	9.4	8.9	61.2	401	-19.8	-74	167.4	464	(N/A)	9.6	8.75
Silver maple	31.2	5.3	15.6	1.4	169	67.0	9.8	9.4	64.2	419	-17.0	-64	186.9	524	(N/A)	9.2	10.28
Green ash	12.4	2.0	6.0	0.6	66	44.2	6.4	6.1	42.1	276	0.0	0	119.7	342	(N/A)	7.4	8.33
Apple	3.1	0.5	1.5	0.1	17	13.3	1.9	1.8	12.4	82	0.0	0	34.6	99	(N/A)	7.2	2.47
Northern pin oak	15.6	2.7	7.5	0.7	84	32.0	4.6	4.4	29.8	198	-3.6	-13	93.7	268	(N/A)	4.0	12.19
Red maple	4.9	0.8	2.3	0.2	26	13.3	1.9	1.8	12.6	83	-1.7	-6	36.3	103	(N/A)	3.3	5.70
Honeylocust	12.9	2.1	5.9	0.6	68	27.4	4.0	3.8	26.3	171	-10.1	-38	72.9	202	(N/A)	3.3	11.20
Blue spruce	3.4	0.7	2.8	0.4	22	8.1	1.2	1.1	7.7	51	-8.8	-33	16.6	40	(N/A)	2.9	2.49
Northern red oak	8.1	1.4	3.9	0.4	43	16.7	2.4	2.3	15.8	104	-11.6	-43	39.4	104	(N/A)	2.7	6.93
Littleleaf linden	3.1	0.5	1.6	0.1	17	9.6	1.4	1.3	9.0	59	-1.5	-6	25.1	71	(N/A)	2.2	5.88
Siberian elm	6.4	1.1	3.1	0.3	34	15.4	2.2	2.1	14.7	96	0.0	0	45.2	130	(N/A)	1.6	14.46
White ash	1.0	0.2	0.5	0.0	5	6.4	0.9	0.9	6.2	40	0.0	0	16.3	46	(N/A)	1.6	5.10
Black maple	5.2	0.9	2.4	0.2	28	9.5	1.4	1.3	9.0	59	-1.7	-6	28.3	81	(N/A)	1.3	11.54
Black walnut	2.8	0.4	1.3	0.1	15	8.9	1.3	1.2	8.4	55	0.0	0	24.5	70	(N/A)	1.1	11.68
American sycamore	5.9	0.9	2.6	0.3	31	11.8	1.7	1.6	11.2	73	0.0	0	36.1	104	(N/A)	1.1	17.41
Spruce	1.4	0.3	1.2	0.2	9	3.8	0.6	0.5	3.8	24	-5.6	-21	6.1	13	(N/A)	1.1	2.09
Callery pear	0.4	0.1	0.2	0.0	2	2.7	0.4	0.4	2.5	17	-0.1	0	6.6	18	(N/A)	1.1	3.08
Conifer Evergreen Large	2.7	0.5	2.2	0.3	18	4.7	0.7	0.7	4.5	29	-12.7	-48	3.7	0	(N/A)	1.1	-0.06
American basswood	5.1	0.9	2.4	0.2	27	9.6	1.4	1.3	9.0	59	-4.1	-15	25.7	71	(N/A)	0.9	14.21
Ginkgo	1.4	0.2	0.7	0.1	7	3.2	0.5	0.4	3.0	20	-0.4	-2	9.0	26	(N/A)	0.7	6.39
Black cherry	1.1	0.2	0.5	0.0	6	3.6	0.5	0.5	3.4	22	0.0	0	9.8	28	(N/A)	0.7	7.00
Cherry plum	0.3	0.0	0.2	0.0	2	1.7	0.2	0.2	1.6	11	0.0	0	4.4	12	(N/A)	0.7	3.09
River birch	1.3	0.2	0.6	0.1	7	4.2	0.6	0.6	3.9	26	-0.3	-1	11.2	32	(N/A)	0.7	7.93
Eastern hemlock	0.7	0.1	0.6	0.1	5	1.9	0.3	0.3	1.8	12	-2.5	-9	3.3	7	(N/A)	0.5	2.36
American elm	3.8	0.6	1.8	0.2	20	6.3	0.9	0.9	6.2	40	0.0	0	20.7	60	(N/A)	0.5	20.01
Eastern red cedar	1.0	0.2	0.8	0.1	7	1.6	0.2	0.2	1.5	10	-2.7	-10	3.1	7	(N/A)	0.5	2.19
Ash	0.0	0.0	0.0	0.0	0	0.6	0.1	0.1	0.5	4	0.0	0	1.3	4	(N/A)	0.5	1.21
Ohio buckeye	0.9	0.2	0.5	0.0	5	2.3	0.3	0.3	2.1	14	-0.2	-1	6.4	18	(N/A)	0.5	6.09
Mountain ash	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)	0.4	1.63
Paper birch	0.2	0.0	0.1	0.0	1	2.1	0.3	0.3	2.1	14	0.0	0	5.3	15	(N/A)	0.4	7.42
Swamp white oak	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	2	(N/A)	0.4	1.21
Eastern white pine	1.1	0.2	0.9	0.1	7	1.8	0.3	0.2	1.7	11	-5.7	-21	0.6	-3	(N/A)	0.4	-1.58
Sweetgum	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)	0.2	0.87
Norway spruce	0.6	0.1	0.4	0.1	4	0.9	0.1	0.1	0.8	5	-2.9	-11	0.3	-2	(N/A)	0.2	-1.58
White oak	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)	0.2	12.48
Southern magnolia	0.1	0.0	0.1	0.0	1	1.0	0.2	0.1	1.0	7	-0.5	-2	2.1	5	(N/A)	0.2	5.49
Eastern cottonwood	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.2	19.04
Lilac	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3	(N/A)	0.2	2.55
Broadleaf Deciduous Smal	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)	0.2	0.71
Bur oak	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)	0.2	12.48
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)	0.2	0.71
Scotch pine	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)	0.2	1.48
Black spruce	0.2	0.0	0.2	0.0	1	0.6	0.1	0.1	0.6	4	-0.6	-2	1.2	3	(N/A)	0.2	2.89
Amur maple	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)	0.2	0.71
Citywide total	246.6	42.2	123.9	11.9	1,341	632.6	92.0	87.7	598.7	3,936	-122.1	-458	1,713.5	4,820	(N/A)	100.0	8.72

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

4/21/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	722,105	5,416	(N/A)	15.6	14.4	62.97
Norway maple	548,620	4,115	(N/A)	12.7	11.0	58.78
Sugar maple	754,761	5,661	(N/A)	9.6	15.1	106.81
Silver maple	722,339	5,418	(N/A)	9.2	14.4	106.23
Green ash	409,524	3,071	(N/A)	7.4	8.2	74.91
Apple	50,083	376	(N/A)	7.2	1.0	9.39
Northern pin oak	256,856	1,926	(N/A)	4.0	5.1	87.56
Red maple	54,671	410	(N/A)	3.3	1.1	22.78
Honeylocust	166,517	1,249	(N/A)	3.3	3.3	69.38
Blue spruce	24,233	182	(N/A)	2.9	0.5	11.36
Northern red oak	177,040	1,328	(N/A)	2.7	3.5	88.52
Littleleaf linden	67,327	505	(N/A)	2.2	1.3	42.08
Siberian elm	154,302	1,157	(N/A)	1.6	3.1	128.58
White ash	26,035	195	(N/A)	1.6	0.5	21.70
Black maple	55,617	417	(N/A)	1.3	1.1	59.59
Black walnut	91,391	685	(N/A)	1.1	1.8	114.24
American sycamore	199,013	1,493	(N/A)	1.1	4.0	248.77
Spruce	13,341	100	(N/A)	1.1	0.3	16.68
Callery pear	6,481	49	(N/A)	1.1	0.1	8.10
Conifer Evergreen	32,499	244	(N/A)	1.1	0.6	40.62
American basswood	200,590	1,504	(N/A)	0.9	4.0	300.89
Ginkgo	19,808	149	(N/A)	0.7	0.4	37.14
Black cherry	15,854	119	(N/A)	0.7	0.3	29.73
Cherry plum	5,031	38	(N/A)	0.7	0.1	9.43
River birch	20,615	155	(N/A)	0.7	0.4	38.65
Eastern hemlock	5,683	43	(N/A)	0.5	0.1	14.21
American elm	73,655	552	(N/A)	0.5	1.5	184.14
Eastern red cedar	3,306	25	(N/A)	0.5	0.1	8.27
Ash	655	5	(N/A)	0.5	0.0	1.64
Ohio buckeye	15,599	117	(N/A)	0.5	0.3	39.00
Mountain ash	1,086	8	(N/A)	0.4	0.0	4.07
Paper birch	7,344	55	(N/A)	0.4	0.1	27.54
Swamp white oak	437	3	(N/A)	0.4	0.0	1.64
Eastern white pine	14,981	112	(N/A)	0.4	0.3	56.18
Sweetgum	185	1	(N/A)	0.2	0.0	1.39
Norway spruce	7,490	56	(N/A)	0.2	0.1	56.18
White oak	15,773	118	(N/A)	0.2	0.3	118.30
Southern magnolia	1,851	14	(N/A)	0.2	0.0	13.88
Eastern cottonwood	39,259	294	(N/A)	0.2	0.8	294.44
Lilac	908	7	(N/A)	0.2	0.0	6.81
Broadleaf Deciduo	178	1	(N/A)	0.2	0.0	1.33
Bur oak	15,773	118	(N/A)	0.2	0.3	118.30
Plum	178	1	(N/A)	0.2	0.0	1.33
Scotch pine	257	2	(N/A)	0.2	0.0	1.93
Black spruce	1,118	8	(N/A)	0.2	0.0	8.39
Amur maple	178	1	(N/A)	0.2	0.0	1.33
Citywide total	5,000,548	37,504	(N/A)	100.0	100.0	67.82

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees

4/21/2020

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($) Error	Standard	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	37,649	282	-3,466	-281	-28	49,893	374	83,795	628	(N/A)	15.6	18.5	7.31
Norway maple	22,088	166	-2,634	-182	-21	28,162	211	47,435	356	(N/A)	12.7	10.5	5.08
Sugar maple	34,531	259	-3,630	-156	-28	22,672	170	53,417	401	(N/A)	9.6	11.8	7.56
Silver maple	56,265	422	-3,468	-155	-27	23,818	179	76,460	573	(N/A)	9.2	16.9	11.24
Green ash	21,406	161	-1,966	-99	-15	15,581	117	34,923	262	(N/A)	7.4	7.7	6.39
Apple	4,694	35	-240	-41	-2	4,575	34	8,988	67	(N/A)	7.2	2.0	1.69
Northern pin oak	4,518	34	-1,233	-78	-10	11,024	83	14,231	107	(N/A)	4.0	3.1	4.85
Red maple	4,922	37	-262	-27	-2	4,662	35	9,294	70	(N/A)	3.3	2.1	3.87
Honeylocust	16,509	124	-799	-45	-6	9,736	73	25,400	191	(N/A)	3.3	5.6	10.58
Blue spruce	1,451	11	-116	-31	-1	2,852	21	4,156	31	(N/A)	2.9	0.9	1.95
Northern red oak	2,214	17	-850	-46	-7	5,858	44	7,176	54	(N/A)	2.7	1.6	3.59
Littleleaf linden	6,508	49	-324	-24	-3	3,330	25	9,490	71	(N/A)	2.2	2.1	5.93
Siberian elm	6,247	47	-741	-35	-6	5,438	41	10,910	82	(N/A)	1.6	2.4	9.09
White ash	3,121	23	-127	-13	-1	2,311	17	5,291	40	(N/A)	1.6	1.2	4.41
Black maple	0	0	-267	-19	-2	3,339	25	3,053	23	(N/A)	1.3	0.7	3.27
Black walnut	4,391	33	-439	-20	-3	3,114	23	7,047	53	(N/A)	1.1	1.6	8.81
American sycamore	5,229	39	-955	-28	-7	4,147	31	8,393	63	(N/A)	1.1	1.9	10.49
Spruce	578	4	-64	-14	-1	1,393	10	1,893	14	(N/A)	1.1	0.4	2.37
Callery pear	1,121	8	-33	-6	0	940	7	2,022	15	(N/A)	1.1	0.4	2.53
Conifer Evergreen Larg	1,330	10	-156	-19	-1	1,672	13	2,828	21	(N/A)	1.1	0.6	3.53
American basswood	10,010	75	-963	-25	-7	3,324	25	12,346	93	(N/A)	0.9	2.7	18.52
Ginkgo	547	4	-95	-10	-1	1,115	8	1,556	12	(N/A)	0.7	0.3	2.92
Black cherry	1,281	10	-76	-9	-1	1,260	9	2,457	18	(N/A)	0.7	0.5	4.61
Cherry plum	533	4	-24	-5	0	594	4	1,098	8	(N/A)	0.7	0.2	2.06
River birch	1,550	12	-99	-9	-1	1,451	11	2,893	22	(N/A)	0.7	0.6	5.42
Eastern hemlock	418	3	-27	-7	0	679	5	1,064	8	(N/A)	0.5	0.2	2.66
American elm	1,601	12	-354	-13	-3	2,288	17	3,522	26	(N/A)	0.5	0.8	8.81
Eastern red cedar	0	0	-16	-6	0	561	4	539	4	(N/A)	0.5	0.1	1.35
Ash	287	2	-5	-2	0	194	1	473	4	(N/A)	0.5	0.1	1.18
Ohio buckeye	690	5	-76	-5	-1	779	6	1,388	10	(N/A)	0.5	0.3	3.47
Mountain ash	152	1	-5	-2	0	161	1	306	2	(N/A)	0.4	0.1	1.15
Paper birch	891	7	-35	-4	0	786	6	1,637	12	(N/A)	0.4	0.4	6.14
Swamp white oak	191	1	-3	-1	0	129	1	316	2	(N/A)	0.4	0.1	1.18
Eastern white pine	256	2	-72	-9	-1	622	5	797	6	(N/A)	0.4	0.2	2.99
Sweetgum	74	1	-1	-1	0	49	0	121	1	(N/A)	0.2	0.0	0.91
Norway spruce	0	0	-36	-5	0	311	2	270	2	(N/A)	0.2	0.1	2.02
White oak	857	6	-76	-4	-1	552	4	1,330	10	(N/A)	0.2	0.3	9.97
Southern magnolia	143	1	-9	-2	0	388	3	520	4	(N/A)	0.2	0.1	3.90
Eastern cottonwood	912	7	-188	-5	-1	734	6	1,453	11	(N/A)	0.2	0.3	10.90
Lilac	114	1	-4	-1	0	124	1	232	2	(N/A)	0.2	0.1	1.74
Broadleaf Deciduous St	38	0	-1	-1	0	37	0	74	1	(N/A)	0.2	0.0	0.55
Bur oak	857	6	-76	-4	-1	552	4	1,330	10	(N/A)	0.2	0.3	9.97
Plum	38	0	-1	-1	0	37	0	74	1	(N/A)	0.2	0.0	0.55
Scotch pine	53	0	-1	-1	0	94	1	145	1	(N/A)	0.2	0.0	1.08
Black spruce	91	1	-5	-2	0	213	2	296	2	(N/A)	0.2	0.1	2.22
Amur maple	38	0	-1	-1	0	37	0	74	1	(N/A)	0.2	0.0	0.55
Citywide total	256,391	1,923	-24,022	-1,448	-191	221,590	1,662	452,511	3,394	(N/A)	100.0	100.0	6.14

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

4/21/2020

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Northern hackberry	4,962	(N/A)	15.6	18.2	57.70
Norway maple	2,108	(N/A)	12.7	7.7	30.12
Sugar maple	3,408	(N/A)	9.6	12.5	64.30
Silver maple	4,544	(N/A)	9.2	16.6	89.10
Green ash	1,870	(N/A)	7.4	6.8	45.60
Apple	270	(N/A)	7.2	1.0	6.76
Northern pin oak	416	(N/A)	4.0	1.5	18.89
Red maple	674	(N/A)	3.3	2.5	37.47
Honeylocust	4,055	(N/A)	3.3	14.8	225.29
Blue spruce	334	(N/A)	2.9	1.2	20.88
Northern red oak	167	(N/A)	2.7	0.6	11.14
Littleleaf linden	677	(N/A)	2.2	2.5	56.40
Siberian elm	421	(N/A)	1.6	1.5	46.79
White ash	415	(N/A)	1.6	1.5	46.07
Black maple	0	(N/A)	1.3	0.0	0.00
Black walnut	351	(N/A)	1.1	1.3	58.46
American sycamore	353	(N/A)	1.1	1.3	58.88
Spruce	162	(N/A)	1.1	0.6	26.93
Callery pear	130	(N/A)	1.1	0.5	21.71
Conifer Evergreen Large	220	(N/A)	1.1	0.8	36.67
American basswood	624	(N/A)	0.9	2.3	124.71
Ginkgo	41	(N/A)	0.7	0.1	10.19
Black cherry	75	(N/A)	0.7	0.3	18.81
Cherry plum	30	(N/A)	0.7	0.1	7.59
River birch	151	(N/A)	0.7	0.6	37.87
Eastern hemlock	112	(N/A)	0.5	0.4	37.24
American elm	206	(N/A)	0.5	0.8	68.60
Eastern red cedar	0	(N/A)	0.5	0.0	0.00
Ash	39	(N/A)	0.5	0.1	12.89
Ohio buckeye	71	(N/A)	0.5	0.3	23.52
Mountain ash	8	(N/A)	0.4	0.0	4.23
Paper birch	92	(N/A)	0.4	0.3	45.86
Swamp white oak	26	(N/A)	0.4	0.1	12.89
Eastern white pine	26	(N/A)	0.4	0.1	13.13
Sweetgum	15	(N/A)	0.2	0.1	14.73
Norway spruce	0	(N/A)	0.2	0.0	0.00
White oak	66	(N/A)	0.2	0.2	65.59
Southern magnolia	35	(N/A)	0.2	0.1	34.98
Eastern cottonwood	58	(N/A)	0.2	0.2	58.34
Lilac	6	(N/A)	0.2	0.0	6.40
Broadleaf Deciduous Smal	2	(N/A)	0.2	0.0	2.06
Bur oak	66	(N/A)	0.2	0.2	65.59
Plum	2	(N/A)	0.2	0.0	2.06
Scotch pine	15	(N/A)	0.2	0.1	15.42
Black spruce	25	(N/A)	0.2	0.1	25.23
Amur maple	2	(N/A)	0.2	0.0	2.06
Citywide total	27,330	(N/A)	100.0	100.0	49.42

Table 7: Summary of Benefits in Dollars

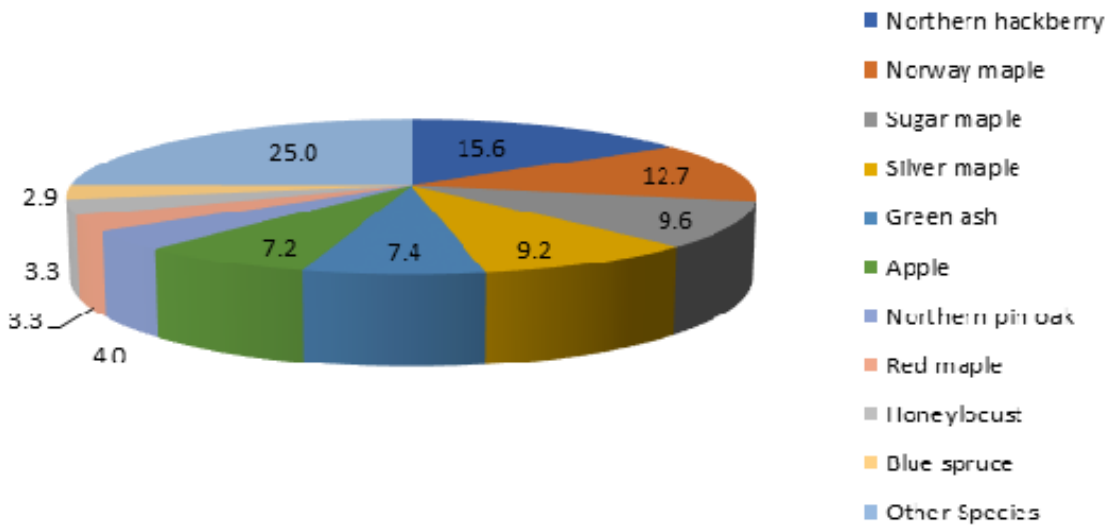
Annual Benefits of Public Trees by Species ($/tree)

4/21/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Northern hackberry	74.04	7.31	13.34	92.61	57.70	244.99	(N/A)
Norway maple	52.59	5.08	9.37	62.47	30.12	159.63	(N/A)
Sugar maple	53.20	7.56	8.75	88.58	64.30	222.39	(N/A)
Silver maple	57.10	11.24	10.28	100.73	89.10	268.46	(N/A)
Green ash	47.10	6.39	8.33	66.73	45.60	174.15	(N/A)
Apple	15.10	1.69	2.47	7.40	6.76	33.40	(N/A)
Northern pin oak	65.35	4.85	12.19	86.98	18.89	188.25	(N/A)
Red maple	32.67	3.87	5.70	33.09	37.47	112.81	(N/A)
Honeylocust	66.10	10.58	11.20	99.31	225.29	412.49	(N/A)
Blue spruce	22.60	1.95	2.49	41.08	20.88	88.99	(N/A)
Northern red oak	49.42	3.59	6.93	67.38	11.14	138.46	(N/A)
Littleleaf linden	35.25	5.93	5.88	42.95	56.40	146.41	(N/A)
Siberian elm	74.45	9.09	14.46	108.45	46.79	253.25	(N/A)
White ash	30.46	4.41	5.10	33.25	46.07	119.29	(N/A)
Black maple	60.68	3.27	11.54	77.70	0.00	153.19	(N/A)
Black walnut	65.29	8.81	11.68	98.34	58.46	242.57	(N/A)
American sycamore	86.29	10.49	17.41	164.59	58.88	337.66	(N/A)
Spruce	26.48	2.37	2.09	55.54	26.93	113.40	(N/A)
Callery pear	20.45	2.53	3.08	13.86	21.71	61.63	(N/A)
Conifer Evergreen L	34.32	3.53	-0.06	102.63	36.67	177.09	(N/A)
American basswood	84.88	18.52	14.21	168.91	124.71	411.22	(N/A)
Ginkgo	34.88	2.92	6.39	33.61	10.19	88.00	(N/A)
Black cherry	40.13	4.61	7.00	21.50	18.81	92.06	(N/A)
Cherry plum	19.98	2.06	3.09	8.56	7.59	41.28	(N/A)
River birch	47.16	5.42	7.93	47.11	37.87	145.49	(N/A)
Eastern hemlock	26.25	2.66	2.36	54.62	37.24	123.13	(N/A)
American elm	88.63	8.81	20.01	94.79	68.60	280.84	(N/A)
Eastern red cedar	24.57	1.35	2.19	44.30	0.00	72.40	(N/A)
Ash	8.99	1.18	1.21	4.41	12.89	28.68	(N/A)
Ohio buckeye	34.77	3.47	6.09	40.77	23.52	108.61	(N/A)
Mountain ash	11.80	1.15	1.63	4.51	4.23	23.32	(N/A)
Paper birch	44.23	6.14	7.42	39.72	45.86	143.36	(N/A)
Swamp white oak	8.99	1.18	1.21	4.41	12.89	28.68	(N/A)
Eastern white pine	38.17	2.99	-1.58	124.79	13.13	177.50	(N/A)
Sweetgum	5.82	0.91	0.87	4.65	14.73	26.98	(N/A)
Norway spruce	38.17	2.02	-1.58	124.79	0.00	163.41	(N/A)
White oak	70.91	9.97	12.48	106.85	65.59	265.81	(N/A)
Southern magnolia	41.29	3.90	5.49	48.11	34.98	133.78	(N/A)
Eastern cottonwood	91.02	10.90	19.04	196.17	58.34	375.47	(N/A)
Lilac	18.19	1.74	2.55	7.17	6.40	36.05	(N/A)
Broadleaf Deciduous	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Bur oak	70.91	9.97	12.48	106.85	65.59	265.81	(N/A)
Plum	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Scotch pine	13.58	1.08	1.48	16.14	15.42	47.70	(N/A)
Black spruce	24.51	2.22	2.89	41.85	25.23	96.70	(N/A)
Amur maple	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Citywide Total	50.56	6.14	8.72	70.74	49.42	185.58	(N/A)

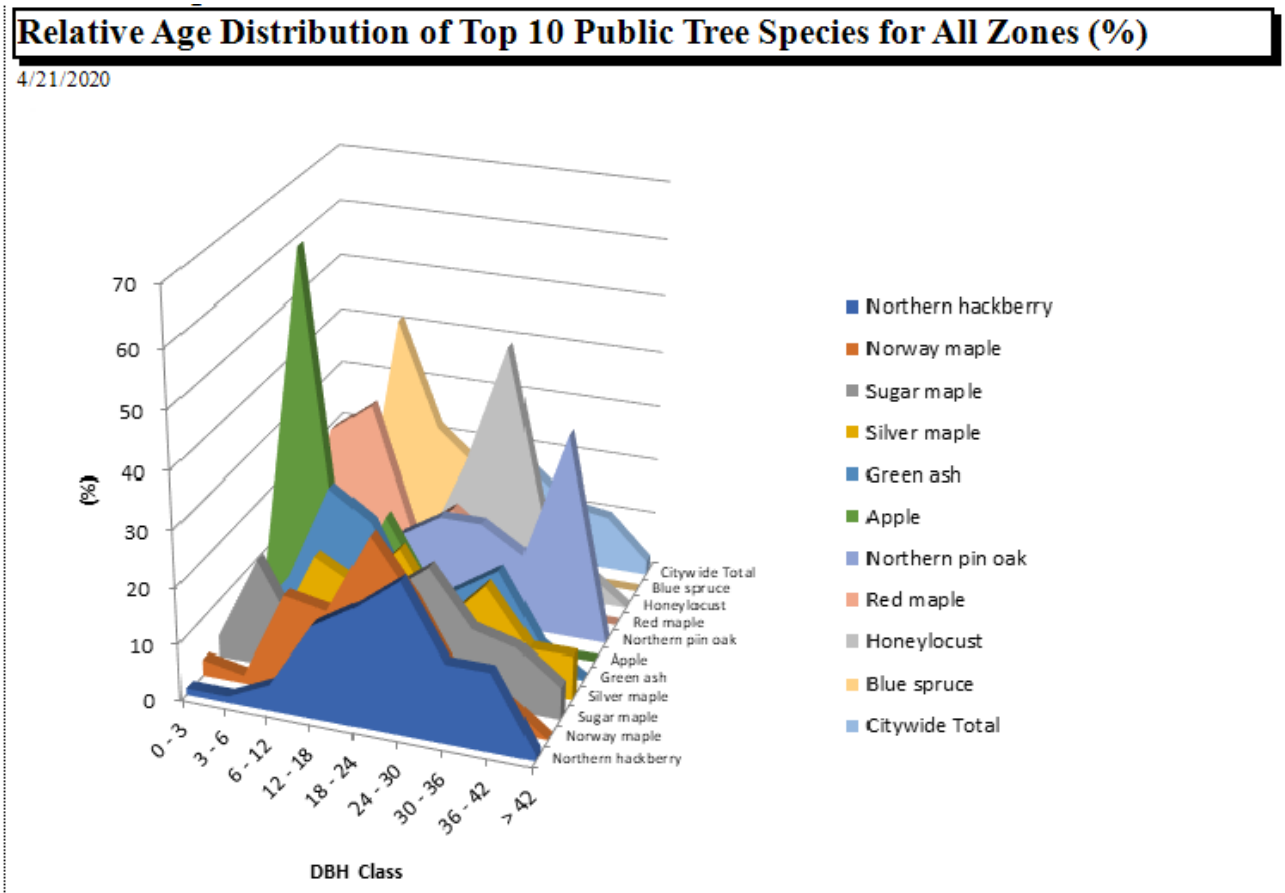
Species Distribution of Public Trees

4/21/2020



Species	Percent
Northern hackberry	15.6
Norway maple	12.7
Sugar maple	9.6
Silver maple	9.2
Green ash	7.4
Apple	7.2
Northern pin oak	4.0
Red maple	3.3
Honeylocust	3.3
Blue spruce	2.9
Other Species	25.0
Total	100.0

Figure 1: Species Distribution



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Northern hackberry	1.16	1.16	4.65	16.28	20.93	26.74	13.95	13.95	1.16
Norway maple	2.86	1.43	17.14	15.71	30.00	20.00	7.14	5.71	0.00
Sugar maple	3.77	18.87	5.66	1.89	16.98	22.64	13.21	11.32	5.66
Silver maple	1.96	1.96	17.65	13.73	21.57	9.80	17.65	7.84	7.84
Green ash	0.00	9.76	26.83	21.95	7.32	12.20	17.07	4.88	0.00
Apple	5.00	65.00	2.50	20.00	7.50	0.00	0.00	0.00	0.00
Northern pin oak	0.00	0.00	0.00	13.64	18.18	18.18	13.64	36.36	0.00
Red maple	0.00	27.78	33.33	11.11	16.67	11.11	0.00	0.00	0.00
Honeylocust	0.00	0.00	11.11	5.56	22.22	44.44	11.11	5.56	0.00
Blue spruce	0.00	0.00	43.75	25.00	18.75	12.50	0.00	0.00	0.00
Citywide Total	1.81	12.48	12.12	15.73	17.72	17.00	10.85	9.76	2.53

Figure 2: Relative Age Class

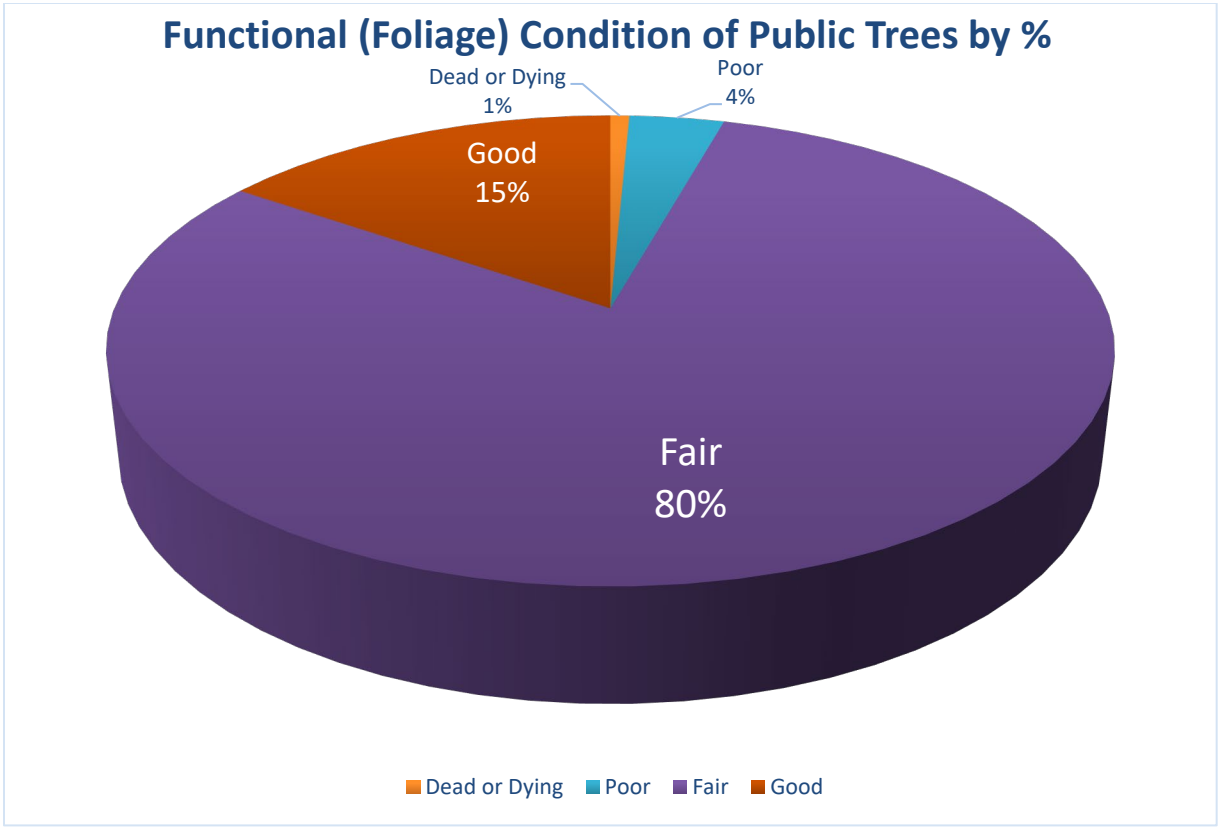


Figure 3: Foliage Condition

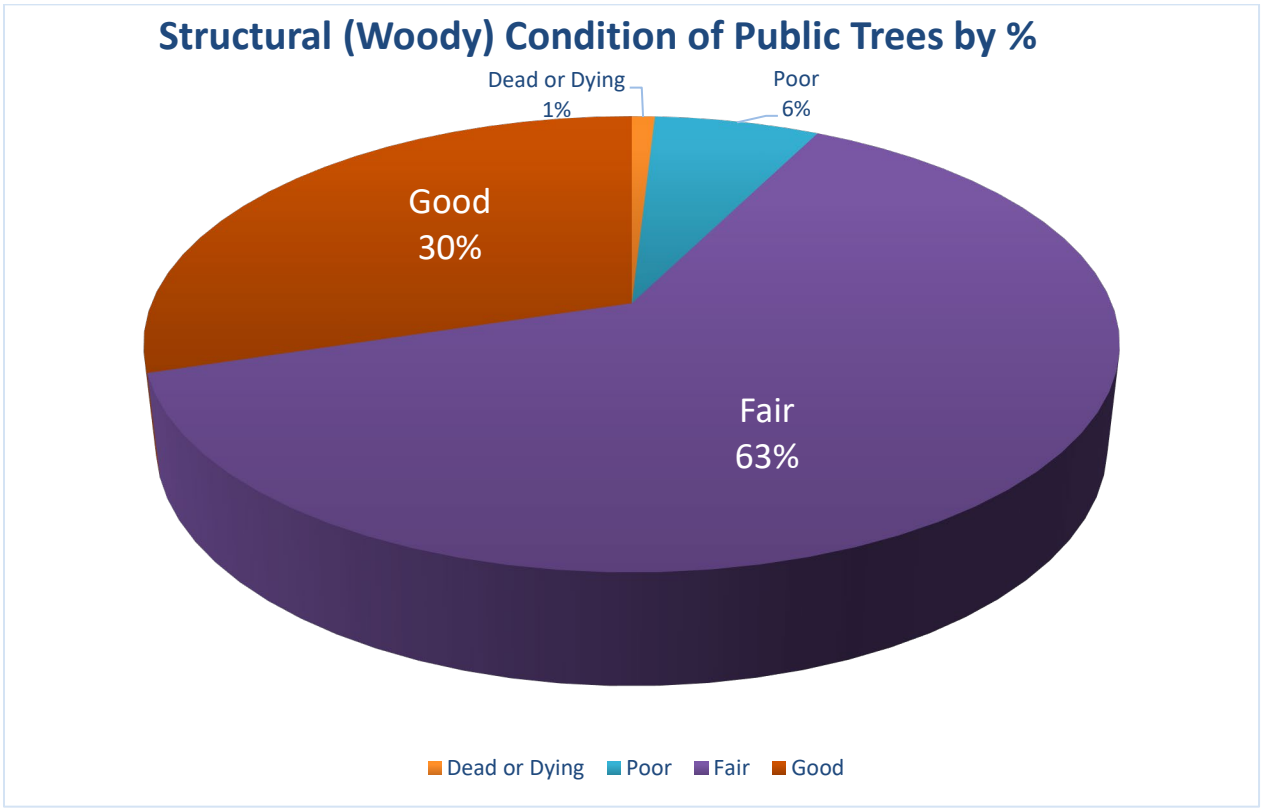
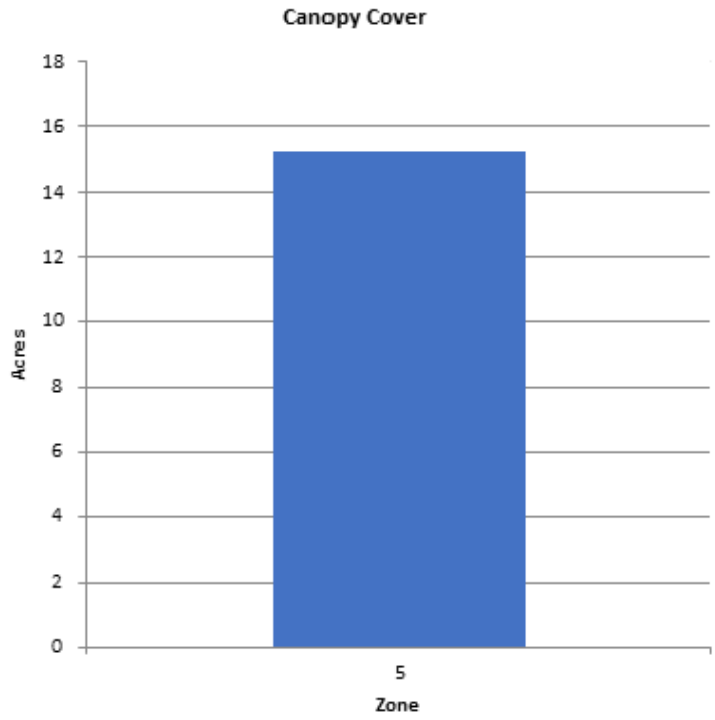


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

4/21/2020



Zone	Acres	% of Total Canopy Cover
5	15	100.0
Citywide total	15	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide Total	0	0	15	0.00	0.00

Figure 5: Canopy Cover in Acres

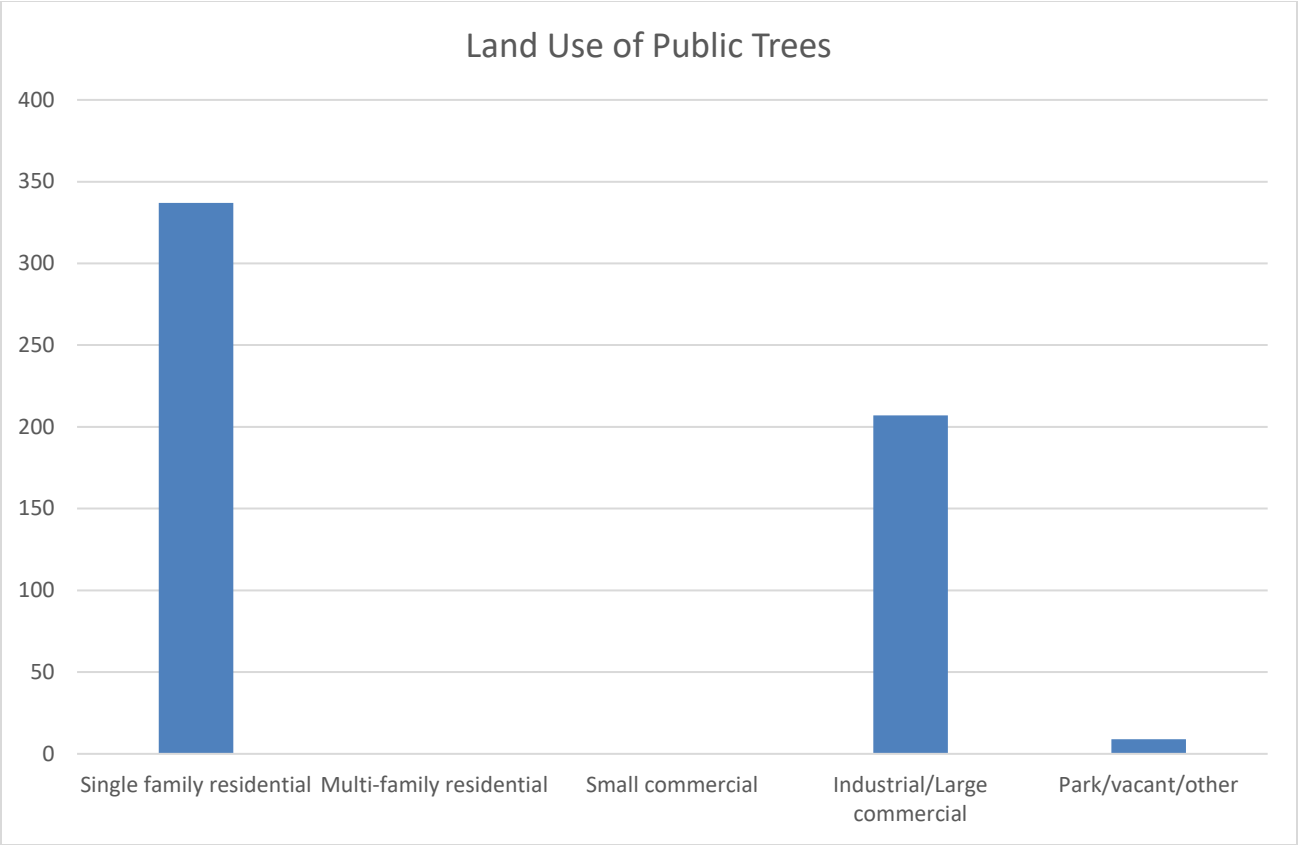


Figure 6: Land Use of city/park trees

Appendix B: ArcGIS Mapping

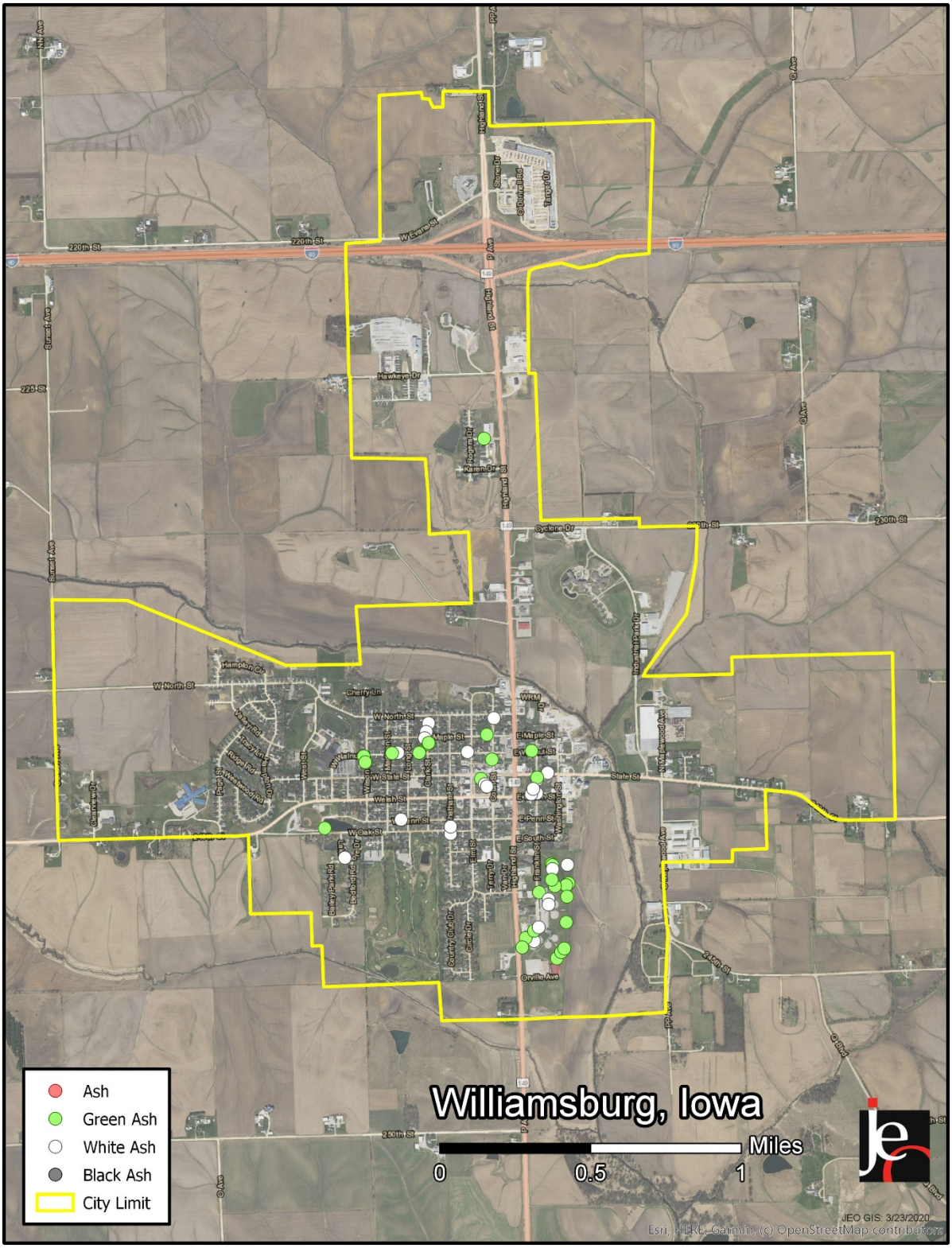


Figure 1: Location of Ash Trees

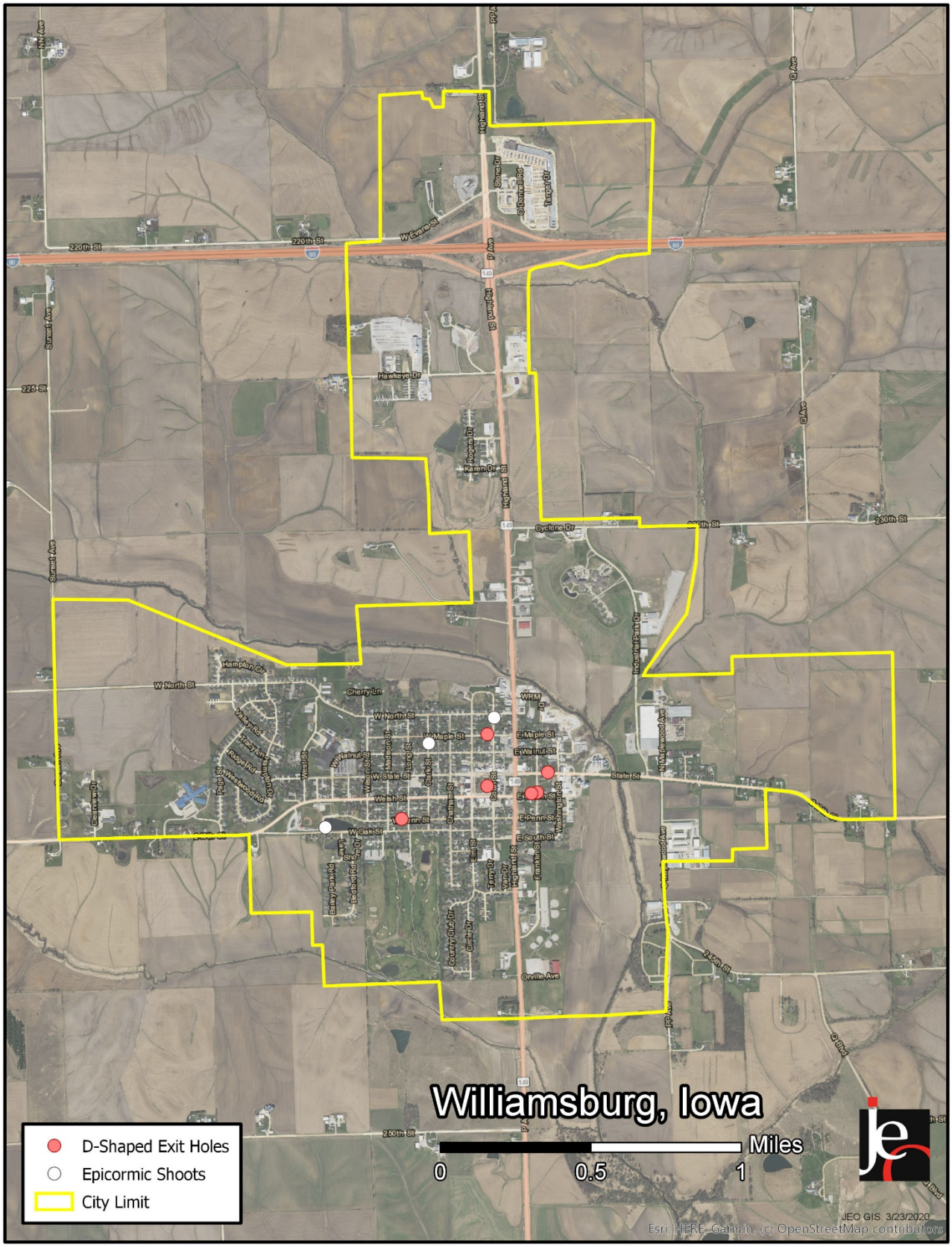


Figure 2: Location of EAB symptoms

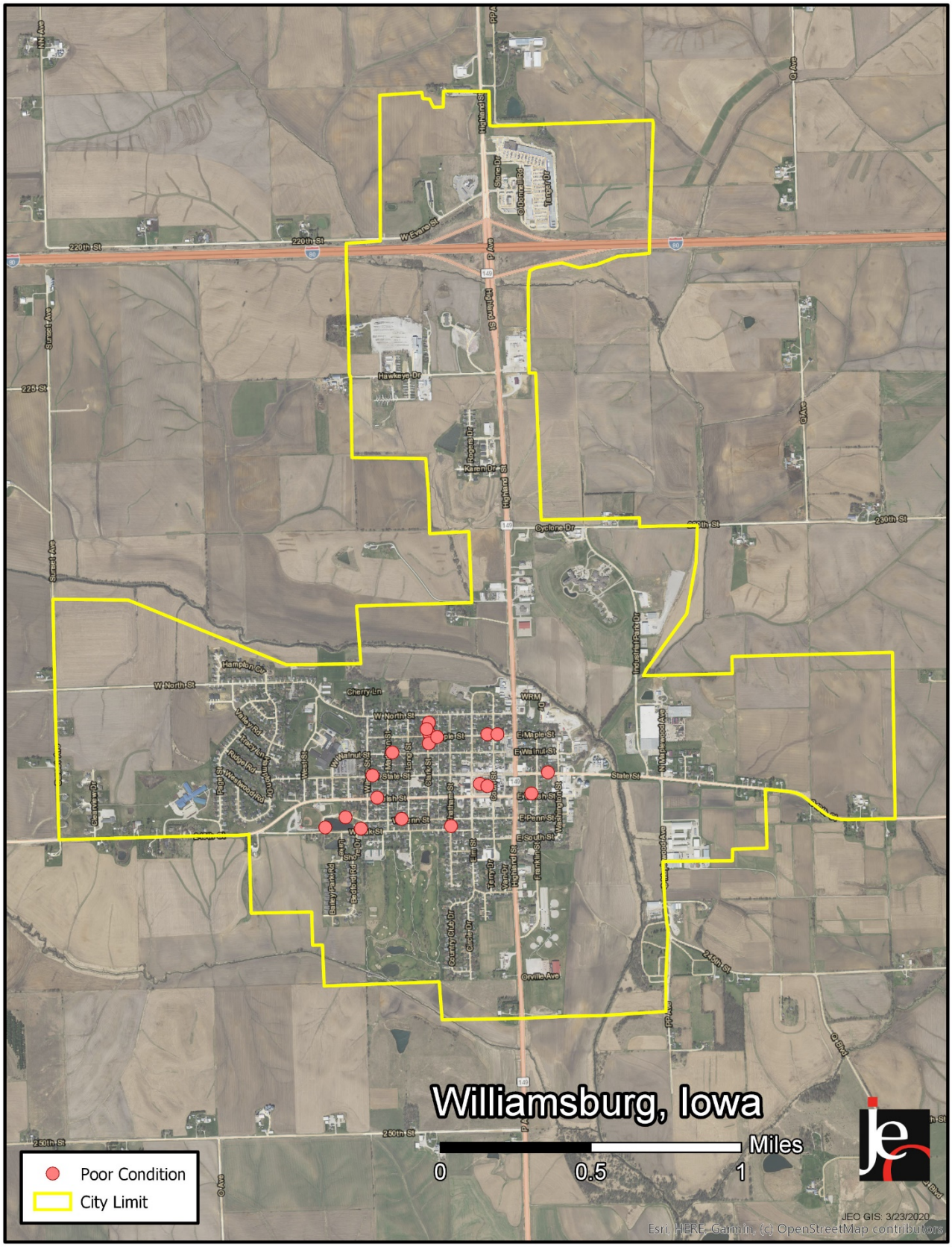


Figure 3: Location of Poor Condition Trees

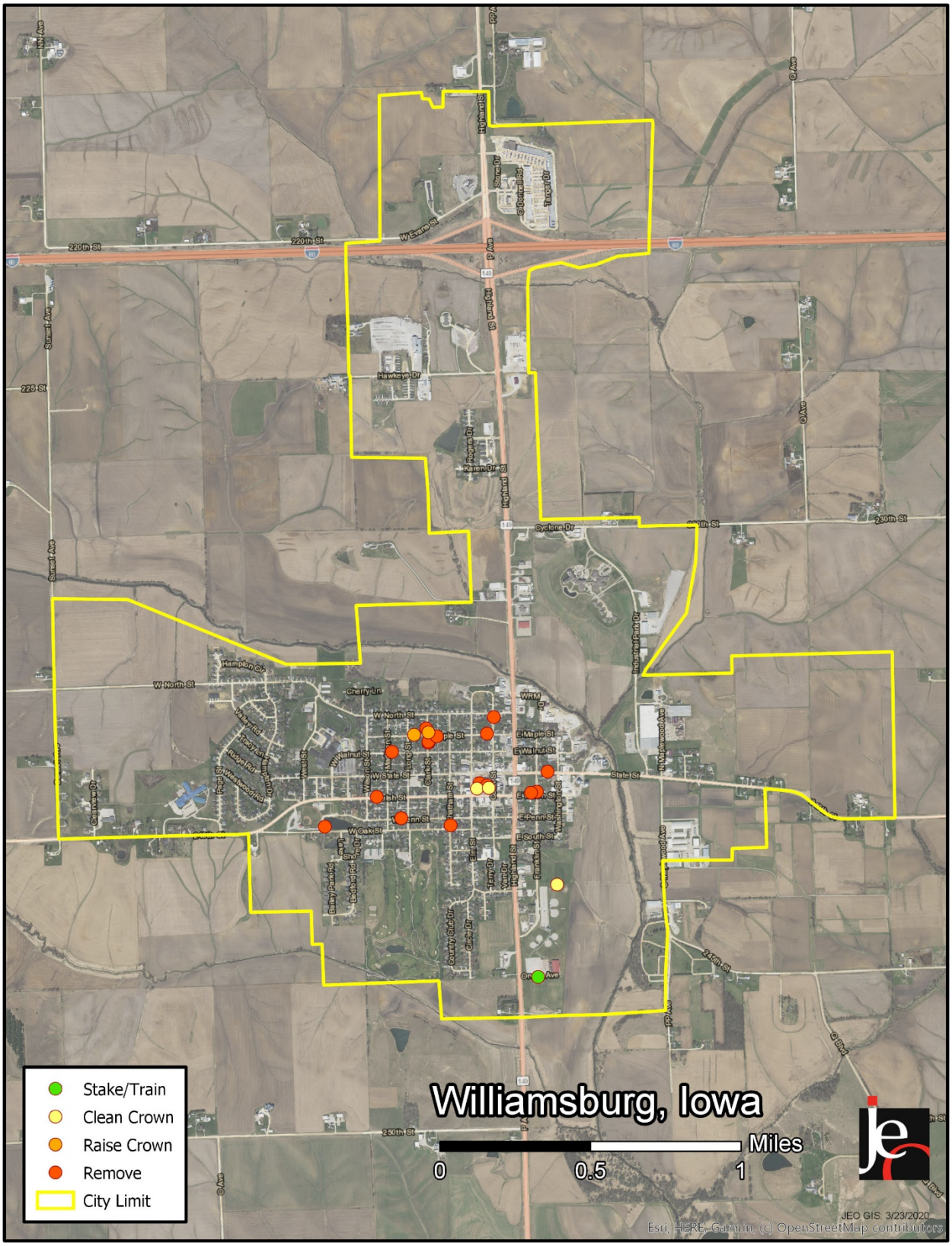


Figure 4: Location of Trees with Recommended Maintenance ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Williamsburg Tree Ordinances

CHAPTER 151
TREES AND GRASS

151.01 DEFINITION.
For use in this chapter, "parking" means that part of the street, avenue, or highway in the City not covered by sidewalk and lying between the lot line and the curb line or, on unpaved streets, that part of the street, avenue, or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

151.02 PLANTING RESTRICTIONS.
No tree shall be planted in any parking or street except in accordance with the following:
1. Alignment. All trees planted in any street shall be planted in the parking midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.
2. Spacing. Trees shall not be planted on any parking which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.
3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut.

151.03 DUTY TO TRIM TREES.
The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax.

151.04 TRIMMING TREES TO BE SUPERVISED.
Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

151.05 DISEASE CONTROL.
Any dead, diseased, or damaged tree or shrub which may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

151.06 INSPECTION AND REMOVAL.
The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.
2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that 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. (Code of Iowa, Sec. 364.12[3b & h])

The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

Federal law prohibits employment discrimination on the basis of race, color, age, religion, national origin, sex or disability. State law prohibits employment discrimination on the basis of race, color, creed, age, sex, sexual orientation, gender identity, national origin, religion, pregnancy, or disability. State law also prohibits public accommodation (such as access to services or physical facilities) discrimination on the basis of race, color, creed, religion, sex, sexual orientation, gender identity, religion, national origin, or disability. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please contact the Iowa Civil Rights Commission, 1-800-457-4416, or write to the Iowa Department of Natural Resources, Wallace State Office Bldg., 502 E 9th St, Des Moines IA 50319.

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