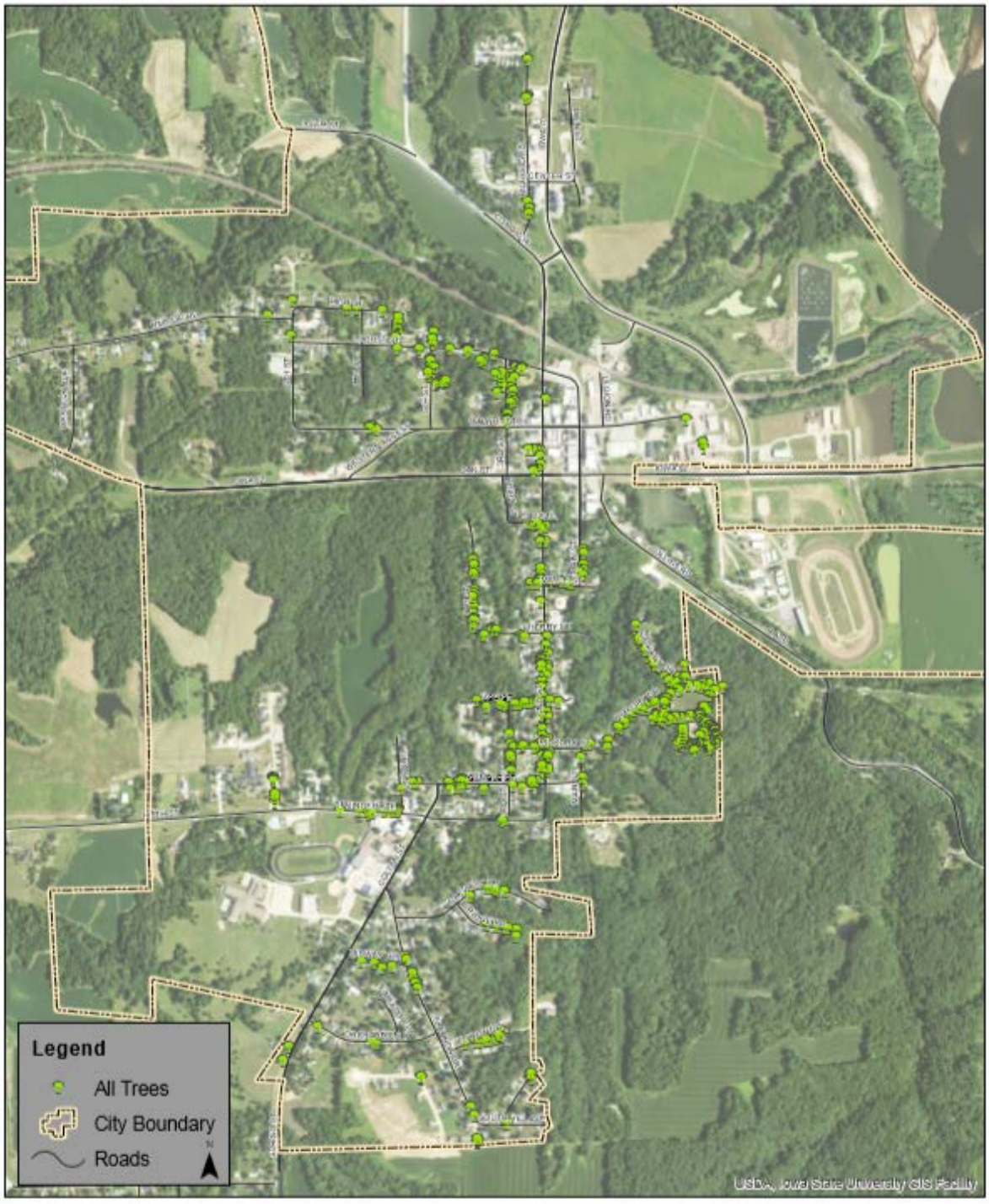
Columbus Junction, IA



2018 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Columbus Junction 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 8.4% of Columbus Junction'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 450 trees inventoried.

- Columbus Junction's trees provide $73,838 of benefits annually, an average of $164 a tree
- There are over 30 species of trees
- The top three genera are: Oak 26.2%, Maples 19.3%, and Ash 8.4%
- 42% of trees are in need of some type of management
- 66 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 66 trees needing removal, 27 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*
- 31 of the 38 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation (9 with woodpecker activity)
- 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 the current budget it could take 46 years to remove ash – Suggestion: request a budget increase to $6,000 annually and apply for grants to plant replacement trees

Introduction

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

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

Inventory

In 2018, 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 450 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. Columbus Junction's trees reduce energy related costs by approximately $20,337.47 annually (Appendix A, Table 1). These savings are both in Electricity (96.43 MWh) and in Natural Gas (13,284.46 Therms).

Annual Stormwater Benefits

Columbus Junction's trees intercept about 1,034,688 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $28,040 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 Columbus Junction it is estimated that trees remove 1,229.31 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $3,470.88 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Columbus Junction, trees sequester about 211,308.92 lbs of carbon a year with an associated value of $1,584.82 (Appendix A, Table 5). In addition, the trees store 3,938,455.58 lbs of carbon, with a yearly benefit of $29,538.42 (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. Columbus Junction receives $19,341.31 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, Columbus Junction's trees provide $73,838 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 450 trees in Columbus Junction provide approximately $164 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Columbus Junction has over 30 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

Oak	118	26.2%
Maple	87	19.3%
Ash	38	8.4%
Walnut	33	7.3%
Catalpa	23	5.1%
Apple (Crab)	20	4.4%
Spruce	18	4%
Redbud	14	3.1%
Cedars	12	2.6%
Elms	9	2%
Others	78	17.3%

Age Class

Most of Columbus Junction's trees (70%) are less than 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. Columbus Junction's size curve is on the smaller 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 Columbus Junction indicate that 93% of the trees are in fair to good health, with only 7% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 84% of Columbus Junction's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 8% of the population. This 16% 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	91	20.22%
Crown Raising	18	4%
Tree Staking	0	0%
Tree Removal	66	14.67%
Crown Reduction	8	1.78%

Treat ash for EAB	4	0.89%

Canopy Cover

The total canopy with both private and public trees is 49%, 685 acres. The canopy cover included in the Columbus Junction inventory includes approximately 11 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years. To achieve this goal it is estimated that 102 trees need to be planted annually.

Land Use and Location

The majority of Columbus Junction's city and park trees are in planting strips or 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	62.44%
Park/vacant/other	35.33%
Industrial/Large commercial	.22%
Small commercial	2.0%
Multifamily residential	0.0%

Location	
Planting strip	34.89%
Other maintained locations	13.56%
Median	1.33%
Front yard	50.22%

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

Columbus Junction has 13 critical concern trees that need immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large diameter critical concern trees first. Eleven trees are over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the six year maintenance plan at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 121 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 66 removals, 33 are ash trees. There are a total of

38 ash trees, and 31 of those have signs and symptoms that have been associated with EAB. In addition, there are 27 trees that are 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 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 Columbus Junction.

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 slightly heavily planted with oaks (26.2%) (Appendix A, Figure 1). Oaks 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. All trees planted must meet the restrictions in city ordinance Chapter 24.03 (Appendix C).

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 with <u>No Additional Funding</u>

Year 1

Removal: 1 largest critical concern tree
Planting and Replacement: 4 trees to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 1 largest critical concern tree

*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 0 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 largest critical concern tree
Planting and Replacement: 4 trees to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 4
Removal: 1 largest critical concern tree
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 0 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: 1 largest critical concern tree
Planting and Replacement: 4 trees to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 6
Removal: 1 largest critical concern tree
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 0 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 0 ash trees removed (0% of ash). It will take approximately 46 years to remove all ash with the current budget. 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 $6,000 a year. If the budget were increased to $3,500 a year all ash could be removed in 13 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. All trees will meet the restrictions in city ordinance Chapter 24.03 (Appendix C). The new plantings will be a diverse mix and should not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work
While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on 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. City Code Chapter 24.03 states:

> **24.03 DUTIES AND RESPONSIBILITIES.** It is the responsibility of the board to study, investigate, counsel and develop a written plan for the care, preservation, trimming, planting, replanting, removal or disposition of trees and shrubs in public areas. Such a plan will be presented to the Council and upon its acceptance and approval shall constitute the official comprehensive tree plan for the City. The Board shall review annually and update if needed the City Tree Plan. The Board, when requested by the Council, shall consider, investigate, make findings, report and recommend upon any special matter or question within the scope of its work.

Budget

Current Budget
Total $6,000 over 6 years ($6,000/year)

FY 2018 Budget
Removal: $600
*Or saving for ash tree treatment and/or future ash removal
Planting: $400

Watering & Maintenance: $0

FY 2019 Budget
Removal: $600
*Or saving for ash tree treatment and/or future ash removal
Planting: $0
Routine trimming: $400
Watering & Maintenance: $0

FY 2020 Budget
Removal: $600
*Or saving for ash tree treatment and/or future ash removal
Planting: $400
Watering & Maintenance: $0

FY 2021 Budget
Removal: $600
*Or saving for ash tree treatment and/or future ash removal
Planting: $0
Routine trimming: $400
Watering & Maintenance: $0

FY 2022 Budget
Removal: $600
*Or saving for ash tree treatment and/or future ash removal
Planting: $400
Watering & Maintenance: $0

FY 2023 Budget
Removal: $600
*Or saving for ash tree treatment and/or future ash removal
Planting: $0
Routine trimming: $400
Watering & Maintenance: $0

*Reduction of ash over 6 years: 0 ash trees removed (0% of ash). **It will take approximately 46 years to remove all ash with the current budget.**

<u>Purposed Budget Increase</u>
EAB could potentially kill all ash trees in Columbus Junction within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $6,000 a year. If the budget were increased to $3,500 a year all ash could be removed within 13 years. Additionally, it is recommended that Columbus Junction 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 20 inches and at $12 per inch, 2 trees could be treated per year (every other year treatment). This would be 4 trees selected for treatment, and Columbus Junction would still need to find $1000 for removal. Alternatively, if there are 4 treatable trees treated every other year, it would cost approximately $480 a year for treatment and leave $560 for removal. 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 as EAB is in Columbus Junction. 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

Annual Energy Benefits of All Trees by Species					12/14/2018				
Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
White oak	25.46	1,932.08	3,512.91	3,442.65	5,374.73	(N/A)	18.22	26.43	65.55
Green ash	11.18	848.50	1,513.01	1,482.75	2,331.25	(N/A)	8.00	11.46	64.76
Black walnut	4.14	314.52	568.78	557.40	871.93	(N/A)	7.33	4.29	26.42
Silver maple	7.69	583.59	993.53	973.66	1,557.25	(N/A)	6.00	7.66	57.68
Norway maple	5.41	410.54	775.07	759.57	1,170.11	(N/A)	6.00	5.75	43.34
Sugar maple	6.36	482.83	854.19	837.11	1,319.94	(N/A)	5.33	6.49	55.00
Catalpa	6.80	516.49	933.74	915.07	1,431.56	(N/A)	5.11	7.04	62.24
Apple	1.12	85.05	179.96	176.36	261.41	(N/A)	4.44	1.29	13.07
Northern pin oak	4.44	336.80	652.17	639.12	975.92	(N/A)	3.56	4.80	61.00
Northern red oak	1.99	151.30	284.44	278.75	430.04	(N/A)	3.33	2.11	28.67
Eastern redbud	0.82	62.42	129.19	126.61	189.02	(N/A)	3.11	0.93	13.50
Red maple	1.31	99.56	174.40	170.91	270.48	(N/A)	1.78	1.33	33.81
Blue spruce	0.84	63.46	110.85	108.63	172.09	(N/A)	1.78	0.85	21.51
Chinese elm	2.20	167.09	300.08	294.07	461.17	(N/A)	1.78	2.27	57.65
Honeylocust	2.02	153.66	273.54	268.07	421.74	(N/A)	1.78	2.07	52.72
American sycamore	0.02	1.59	3.73	3.65	5.24	(N/A)	1.78	0.03	0.66
Norway spruce	0.37	27.71	54.61	53.52	81.23	(N/A)	1.78	0.40	10.15
Eastern red cedar	0.47	35.45	72.51	71.06	106.51	(N/A)	1.56	0.52	15.22
Northern hackberry	1.56	118.68	206.61	202.48	321.16	(N/A)	1.33	1.58	53.53
Mulberry	0.32	24.39	52.67	51.62	76.00	(N/A)	1.11	0.37	15.20
Others	11.90	902.98	1,638.47	1,605.70	2,508.68		14.89	12.34	37.01
Total	96.43	7,318.70	13,284.46	13,018.77	20,337.47	(N/A)	100.00	100.00	45.19

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of All Trees by Species				12/14/2018		
Species	Total Rainfall Interception (Gal)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
White oak	299,602.53	8,119.23	(N/A)	18.22	28.96	99.01
Green ash	131,231.73	3,556.38	(N/A)	8.00	12.68	98.79
Black walnut	32,747.70	887.46	(N/A)	7.33	3.16	26.89
Silver maple	103,958.36	2,817.27	(N/A)	6.00	10.05	104.34
Norway maple	42,050.52	1,139.57	(N/A)	6.00	4.06	42.21
Sugar maple	66,961.72	1,814.66	(N/A)	5.33	6.47	75.61
Catalpa	87,091.61	2,360.18	(N/A)	5.11	8.42	102.62
Apple	3,964.14	107.43	(N/A)	4.44	0.38	5.37
Northern pin oak	43,953.45	1,191.14	(N/A)	3.56	4.25	74.45
Northern red oak	15,265.76	413.70	(N/A)	3.33	1.48	27.58
Eastern redbud	3,782.05	102.49	(N/A)	3.11	0.37	7.32
Red maple	10,215.64	276.84	(N/A)	1.78	0.99	34.61
Blue spruce	10,755.92	291.49	(N/A)	1.78	1.04	36.44
Chinese elm	23,449.02	635.47	(N/A)	1.78	2.27	79.43
Honeylocust	18,618.45	504.56	(N/A)	1.78	1.80	63.07
American sycamore	143.08	3.88	(N/A)	1.78	0.01	0.48
Norway spruce	4,066.93	110.21	(N/A)	1.78	0.39	13.78
Eastern red cedar	6,565.15	177.92	(N/A)	1.56	0.63	25.42
Northern hackberry	9,942.86	269.45	(N/A)	1.33	0.96	44.91
Mulberry	1,583.29	42.91	(N/A)	1.11	0.15	8.58
Others	118,737.79	3,217.79		14.89	11.48	44.34
Citywide total	1,034,687.69	28,040.04	(N/A)	100.00	100.00	62.31

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of All Trees by Species					12/14/2018												
Species	Deposition O3 (lb)	Deposition NO2 (lb)	Deposition PM10 (lb)	Deposition SO2 (lb)	Total Deposition ($)	Avoided NO2 (lb)	Avoided PM10 (lb)	Avoided VOC (lb)	Avoided SO2 (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Stand. Error	% of Total Trees	Avg. $/tree
White oak	39.32	6.29	18.49	1.76	208.48	121.80	17.71	16.89	115.37	758.11	0.00	0.00	337.63	966.59	(N/A)	18.22	11.79
Green ash	17.51	2.80	8.19	0.78	92.70	53.23	7.76	7.40	50.67	331.95	0.00	0.00	148.34	424.65	(N/A)	8.00	11.80
Black walnut	2.65	0.42	1.53	0.12	14.84	19.78	2.88	2.75	18.78	123.22	0.00	0.00	48.90	138.06	(N/A)	7.33	4.18
Silver maple	17.25	2.92	8.55	0.76	93.23	36.08	5.29	5.06	34.79	226.18	- 9.04	- 33.89	101.67	285.52	(N/A)	6.00	10.57
Norway maple	7.48	1.29	3.83	0.33	40.86	26.18	3.79	3.61	24.55	162.30	- 1.85	- 6.94	69.21	196.22	(N/A)	6.00	7.27
Sugar maple	8.60	1.46	4.35	0.38	46.75	30.19	4.41	4.21	28.81	188.48	- 6.79	- 25.47	75.62	209.75	(N/A)	5.33	8.74
Catalpa	12.83	2.05	5.86	0.58	67.55	32.51	4.73	4.51	30.84	202.48	0.00	0.00	93.92	270.03	(N/A)	5.11	11.74
Apple	0.84	0.14	0.45	0.04	4.60	5.59	0.80	0.76	5.08	34.21	0.00	- 0.02	13.67	38.79	(N/A)	4.44	1.94
Northern pin oak	9.18	1.58	4.47	0.41	49.48	21.62	3.12	2.97	20.13	133.66	- 2.13	- 7.99	61.35	175.16	(N/A)	3.56	10.95
Northern red oak	2.75	0.48	1.43	0.12	15.10	9.60	1.39	1.33	9.03	59.59	- 3.89	- 14.58	22.24	60.10	(N/A)	3.33	4.01
Eastern redbud	1.15	0.19	0.54	0.05	6.13	4.07	0.58	0.55	3.72	24.99	- 0.01	- 0.02	10.86	31.09	(N/A)	3.11	2.22
Red maple	2.30	0.39	1.09	0.10	12.29	6.21	0.91	0.87	5.94	38.81	- 0.79	- 2.98	17.02	48.12	(N/A)	1.78	6.02
Blue spruce	1.32	0.26	1.13	0.16	8.86	3.95	0.58	0.55	3.79	24.69	- 3.81	- 14.29	7.94	19.26	(N/A)	1.78	2.41
Chinese elm	2.79	0.45	1.35	0.13	14.88	10.50	1.53	1.46	9.98	65.44	0.00	0.00	28.17	80.32	(N/A)	1.78	10.04
Honeylocust	3.44	0.57	1.61	0.16	18.27	9.62	1.40	1.34	9.17	60.00	- 2.55	- 9.56	24.75	68.72	(N/A)	1.78	8.59
American sycamore	0.00	0.00	0.00	0.00	0.01	0.11	0.02	0.01	0.10	0.65	0.00	0.00	0.24	0.66	(N/A)	1.78	0.08
Norway spruce	0.37	0.07	0.37	0.05	2.63	1.78	0.26	0.24	1.65	11.00	- 1.27	- 4.75	3.53	8.88	(N/A)	1.78	1.11
Eastern red cedar	1.00	0.20	0.83	0.12	6.63	2.30	0.33	0.31	2.11	14.14	- 3.55	- 13.33	3.66	7.45	(N/A)	1.56	1.06
Northern hackberry	1.12	0.19	0.65	0.05	6.37	7.41	1.08	1.03	7.09	46.33	0.00	0.00	18.65	52.69	(N/A)	1.33	8.78
Mulberry	0.49	0.08	0.23	0.02	2.60	1.61	0.23	0.22	1.46	9.83	0.00	- 0.01	4.33	12.42	(N/A)	1.11	2.48
Others	15.94	2.75	9.26	1.03	90.83	56.88	8.27	7.89	53.90	354.10	- 18.28	- 68.54	137.64	376.38		14.89	5.64
Citywide Total	148.32	24.59	74.22	7.16	803.08	461.02	67.07	63.94	436.95	2,870.16	- 53.96	- 202.37	1,229.31	3,470.88	(N/A)	100.00	7.71

Table 4: Annual Carbon Stored

Stored CO2 Benefits of All Trees by Species				12/14/2018		
Species	Total stored CO2 (lbs)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
White oak	1,289,349.94	9,670.12	(N/A)	18.22	32.74	117.93
Green ash	575,118.95	4,313.39	(N/A)	8.00	14.60	119.82
Black walnut	90,144.51	676.08	(N/A)	7.33	2.29	20.49
Silver maple	382,076.56	2,865.57	(N/A)	6.00	9.70	106.13
Norway maple	123,603.19	927.02	(N/A)	6.00	3.14	34.33
Sugar maple	245,116.41	1,838.37	(N/A)	5.33	6.22	76.60
Catalpa	426,848.04	3,201.36	(N/A)	5.11	10.84	139.19
Apple	14,861.55	111.46	(N/A)	4.44	0.38	5.57
Northern pin oak	150,156.63	1,126.17	(N/A)	3.56	3.81	70.39
Northern red oak	52,896.26	396.72	(N/A)	3.33	1.34	26.45
Eastern redbud	18,716.38	140.37	(N/A)	3.11	0.48	10.03
Red maple	25,373.91	190.30	(N/A)	1.78	0.64	23.79
Blue spruce	7,986.71	59.90	(N/A)	1.78	0.20	7.49
Chinese elm	90,097.32	675.73	(N/A)	1.78	2.29	84.47
Honeylocust	43,735.99	328.02	(N/A)	1.78	1.11	41.00
American sycamore	97.31	0.73	(N/A)	1.78	0.00	0.09
Norway spruce	2,204.42	16.53	(N/A)	1.78	0.06	2.07
Eastern red cedar	3,589.72	26.92	(N/A)	1.56	0.09	3.85
Northern hackberry	15,190.80	113.93	(N/A)	1.33	0.39	18.99
Mulberry	8,019.99	60.15	(N/A)	1.11	0.20	12.03
Others	373,270.99	2,799.53		14.89	9.48	38.63
Citywide total	3,938,455.58	29,538.42	(N/A)	100.00	100.00	65.64

Table 5: Annual Carbon Sequestered

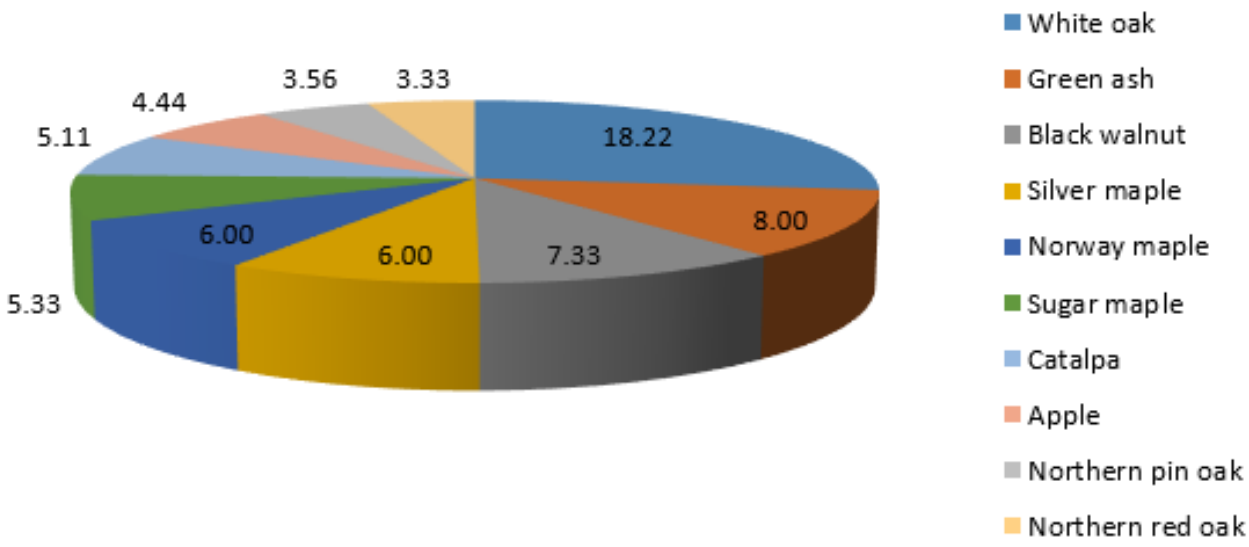
Annual CO2 Benefits of All Trees by Species				12/14/2018									
Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maint. Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
White oak	60,010.25	450.08	- 6,188.88	- 269.10	- 48.43	42,698.44	320.24	96,250.71	721.88	(N/A)	18.22	27.26	8.80
Green ash	25,857.63	193.93	- 2,760.61	- 116.81	- 21.58	18,751.55	140.64	41,731.77	312.99	(N/A)	8.00	11.82	8.69
Black walnut	9,399.78	70.50	- 432.77	- 46.22	- 3.59	6,950.90	52.13	15,871.69	119.04	(N/A)	7.33	4.50	3.61
Silver maple	29,889.05	224.17	- 1,835.42	- 82.49	- 14.38	12,897.18	96.73	40,868.33	306.51	(N/A)	6.00	11.57	11.35
Norway maple	9,483.86	71.13	- 593.35	- 53.24	- 4.85	9,072.89	68.05	17,910.17	134.33	(N/A)	6.00	5.07	4.98
Sugar maple	13,606.25	102.05	- 1,177.26	- 67.28	- 9.33	10,670.46	80.03	23,032.18	172.74	(N/A)	5.33	6.52	7.20
Catalpa	15,195.26	113.96	- 2,048.99	- 74.69	- 15.93	11,414.37	85.61	24,485.96	183.64	(N/A)	5.11	6.93	7.98
Apple	1,726.06	12.95	- 71.60	- 17.36	- 0.67	1,879.61	14.10	3,516.72	26.38	(N/A)	4.44	1.00	1.32
Northern pin oak	5,741.21	43.06	- 720.75	- 48.36	- 5.77	7,443.16	55.82	12,415.25	93.11	(N/A)	3.56	3.52	5.82
Northern red oak	2,808.41	21.06	- 253.90	- 24.77	- 2.09	3,343.59	25.08	5,873.33	44.05	(N/A)	3.33	1.66	2.94
Eastern redbud	1,630.04	12.23	- 89.97	- 13.26	- 0.77	1,379.37	10.35	2,906.18	21.80	(N/A)	3.11	0.82	1.56
Red maple	1,302.56	9.77	- 121.90	- 12.09	- 1.00	2,200.34	16.50	3,368.91	25.27	(N/A)	1.78	0.95	3.16
Blue spruce	625.71	4.69	- 38.34	- 14.04	- 0.39	1,402.54	10.52	1,975.87	14.82	(N/A)	1.78	0.56	1.85
Chinese elm	5,289.37	39.67	- 432.47	- 22.62	- 3.41	3,692.68	27.70	8,526.96	63.95	(N/A)	1.78	2.41	7.99
Honeylocust	4,436.98	33.28	- 209.93	- 16.38	- 1.70	3,395.95	25.47	7,606.62	57.05	(N/A)	1.78	2.15	7.13
American sycamore	20.75	0.16	- 0.78	- 1.56	- 0.02	35.17	0.26	53.57	0.40	(N/A)	1.78	0.02	0.05
Norway spruce	336.65	2.52	- 10.60	- 7.22	- 0.13	612.36	4.59	931.19	6.98	(N/A)	1.78	0.26	0.87
Eastern red cedar	242.17	1.82	- 17.23	- 9.75	- 0.20	783.39	5.88	998.58	7.49	(N/A)	1.56	0.28	1.07
Northern hackberry	1,376.19	10.32	- 72.92	- 12.48	- 0.64	2,622.88	19.67	3,913.68	29.35	(N/A)	1.33	1.11	4.89
Mulberry	198.44	1.49	- 38.54	- 6.05	- 0.33	538.92	4.04	692.77	5.20	(N/A)	1.11	0.20	1.04
Others	22,132.30	165.99	- 1,791.83	- 139.04	- 14.48	19,955.56	149.67	40,157.00	301.18		14.89	11.37	4.41
Citywide Total	211,308.92	1,584.82	- 18,908.04	- 1,054.76	- 149.72	161,741.31	1,213.06	353,087.43	2,648.16	(N/A)	100.00	100.00	5.88

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefit of All Trees by Species				12/14/2018	
Species	Total ($)	Stand. Error	% of Total Trees	% of Total $	Avg. $/tree
White oak	4,765.54	(N/A)	18.22	24.64	58.12
Green ash	2,040.36	(N/A)	8.00	10.55	56.68
Black walnut	1,057.32	(N/A)	7.33	5.47	32.04
Silver maple	2,422.65	(N/A)	6.00	12.53	89.73
Norway maple	944.72	(N/A)	6.00	4.88	34.99
Sugar maple	1,445.85	(N/A)	5.33	7.48	60.24
Catalpa	1,160.05	(N/A)	5.11	6.00	50.44
Apple	94.96	(N/A)	4.44	0.49	4.75
Northern pin oak	528.72	(N/A)	3.56	2.73	33.04
Northern red oak	259.87	(N/A)	3.33	1.34	17.32
Eastern redbud	93.99	(N/A)	3.11	0.49	6.71
Red maple	191.53	(N/A)	1.78	0.99	23.94
Blue spruce	184.13	(N/A)	1.78	0.95	23.02
Chinese elm	441.33	(N/A)	1.78	2.28	55.17
Honeylocust	975.27	(N/A)	1.78	5.04	121.91
American sycamore	42.10	(N/A)	1.78	0.22	5.26
Norway spruce	111.28	(N/A)	1.78	0.58	13.91
Eastern red cedar	120.39	(N/A)	1.56	0.62	17.20
Northern hackberry	246.11	(N/A)	1.33	1.27	41.02
Mulberry	10.55	(N/A)	1.11	0.05	2.11
Others	2,204.59		14.89	11.40	32.98
Citywide Total	19,341.32	(N/A)	100.00	100.00	42.98

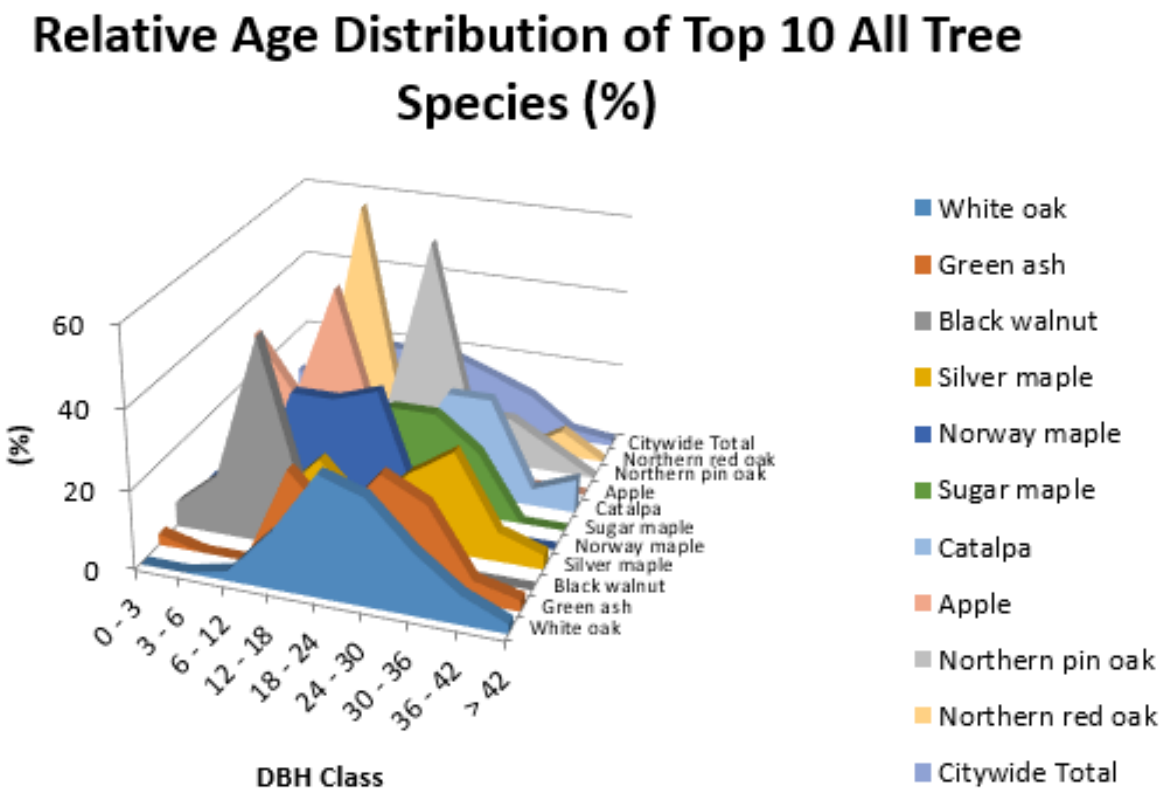
Table 7: Summary of Benefits in Dollars

Average Annual Benefits of All Tree by Species ($/tree)					12/14/2018		
Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total	Stand.
White oak	65.55	8.80	11.79	99.01	58.12	243.27	(N/A)
Green ash	64.76	8.69	11.80	98.79	56.68	240.71	(N/A)
Black walnut	26.42	3.61	4.18	26.89	32.04	93.15	(N/A)
Silver maple	57.68	11.35	10.57	104.34	89.73	273.67	(N/A)
Norway maple	43.34	4.98	7.27	42.21	34.99	132.78	(N/A)
Sugar maple	55.00	7.20	8.74	75.61	60.24	206.79	(N/A)
Catalpa	62.24	7.98	11.74	102.62	50.44	235.02	(N/A)
Apple	13.07	1.32	1.94	5.37	4.75	26.45	(N/A)
Northern pin oak	61.00	5.82	10.95	74.45	33.04	185.25	(N/A)
Northern red oak	28.67	2.94	4.01	27.58	17.32	80.52	(N/A)
Eastern redbud	13.50	1.56	2.22	7.32	6.71	31.31	(N/A)
Red maple	33.81	3.16	6.02	34.61	23.94	101.53	(N/A)
Blue spruce	21.51	1.85	2.41	36.44	23.02	85.22	(N/A)
Chinese elm	57.65	7.99	10.04	79.43	55.17	210.28	(N/A)
Honeylocust	52.72	7.13	8.59	63.07	121.91	253.42	(N/A)
American sycamore	0.66	0.05	0.08	0.48	5.26	6.53	(N/A)
Norway spruce	10.15	0.87	1.11	13.78	13.91	39.82	(N/A)
Eastern red cedar	15.22	1.07	1.06	25.42	17.20	59.97	(N/A)
Northern hackberry	53.53	4.89	8.78	44.91	41.02	153.13	(N/A)
Mulberry	15.20	1.04	2.48	8.58	2.11	29.42	(N/A)
Others	37.01	4.41	5.64	44.34	32.98	124.37	
Citywide Total	45.19	5.88	7.71	62.31	42.98	164.08	(N/A)



Species Distribution of All Trees for :	
12/14/2018	
Species	Percent
White oak	18.22
Green ash	8.00
Black walnut	7.33
Silver maple	6.00
Norway maple	6.00
Sugar maple	5.33
Catalpa	5.11
Apple	4.44
Northern pin oak	3.56
Northern red oak	3.33
Other Species	32.67

Figure 1: Species Distribution



Relative Age Distribution of Top 10 All Tree Species (%)	12/14/2018						DBH class (in)		
Species	0 - 3	3 - 6	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	> 42
White oak	0.00	0.00	2.44	14.63	30.49	26.83	15.85	7.32	2.44
Green ash	2.78	0.00	0.00	25.00	13.89	27.78	22.22	5.56	2.78
Black walnut	6.06	15.15	51.52	12.12	9.09	6.06	0.00	0.00	0.00
Silver maple	3.70	7.41	7.41	18.52	7.41	18.52	25.93	7.41	3.70
Norway maple	3.70	0.00	29.63	29.63	33.33	3.70	0.00	0.00	0.00
Sugar maple	0.00	4.17	8.33	20.83	25.00	25.00	16.67	0.00	0.00
Catalpa	13.04	0.00	4.35	8.70	8.70	26.09	26.09	4.35	8.70
Apple	30.00	15.00	45.00	10.00	0.00	0.00	0.00	0.00	0.00
Northern pin oak	0.00	0.00	0.00	12.50	56.25	12.50	12.50	6.25	0.00
Northern red oak	0.00	6.67	60.00	6.67	20.00	0.00	0.00	6.67	0.00
Citywide Total	8.44	5.11	18.89	18.67	18.89	14.89	10.67	2.89	1.56

Figure 2: Relative Age Class

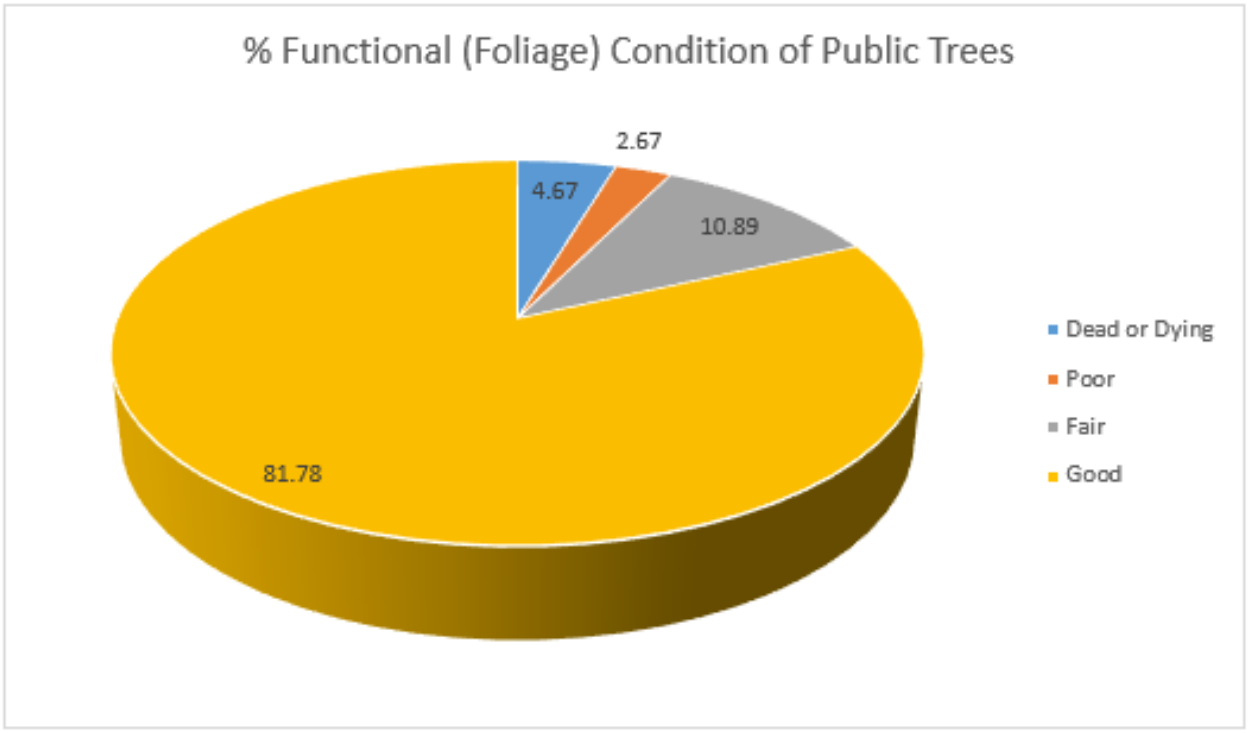


Figure 3: Foliage Condition

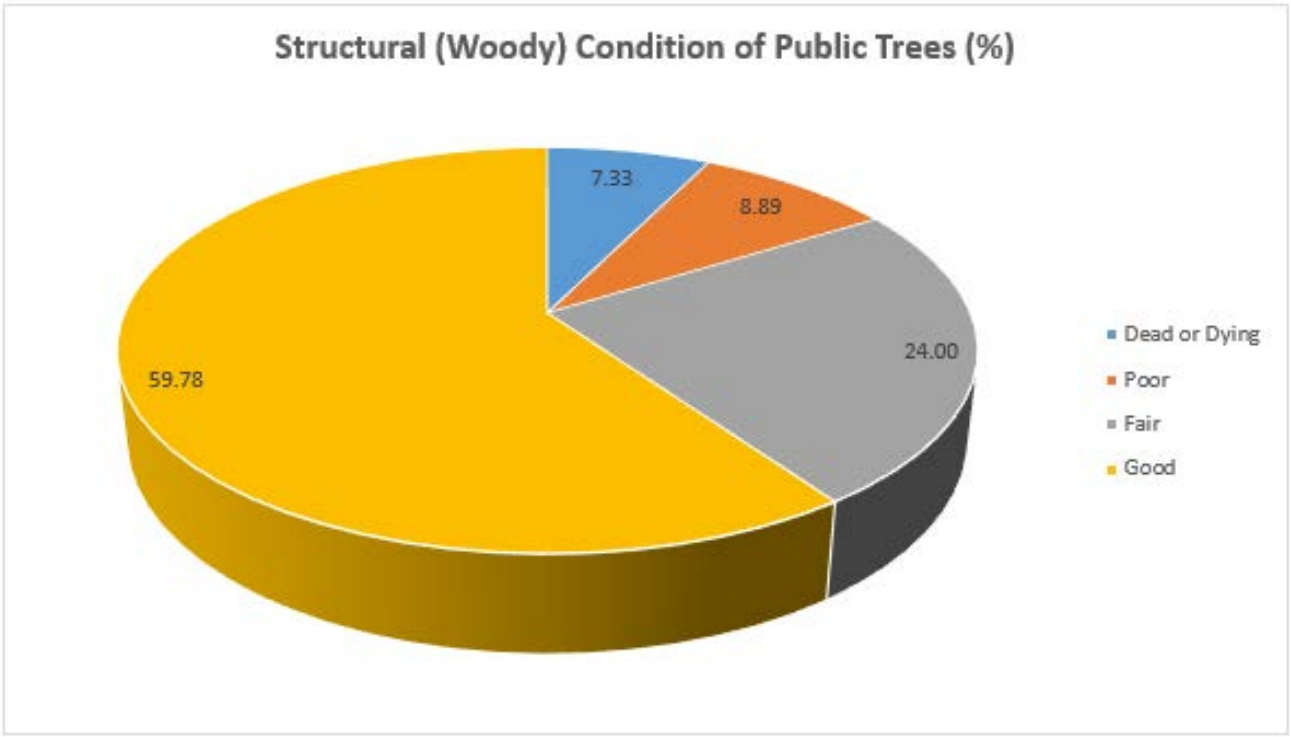
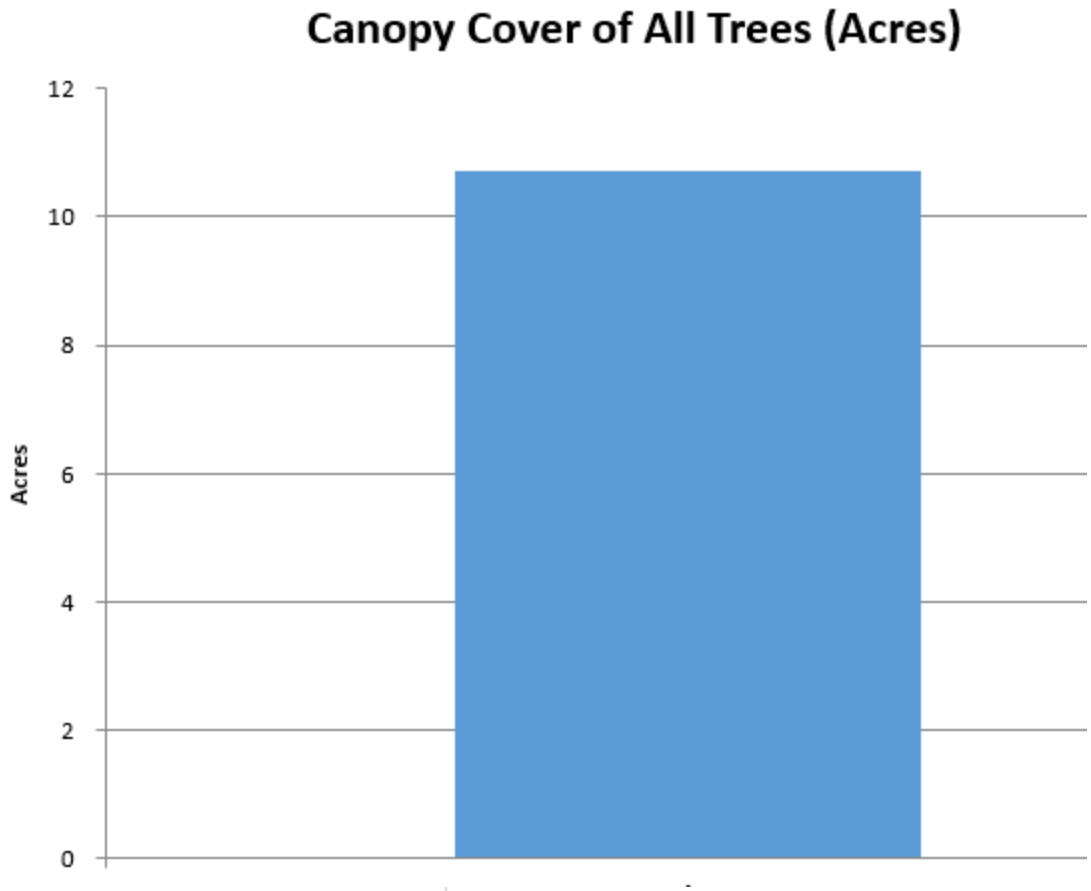
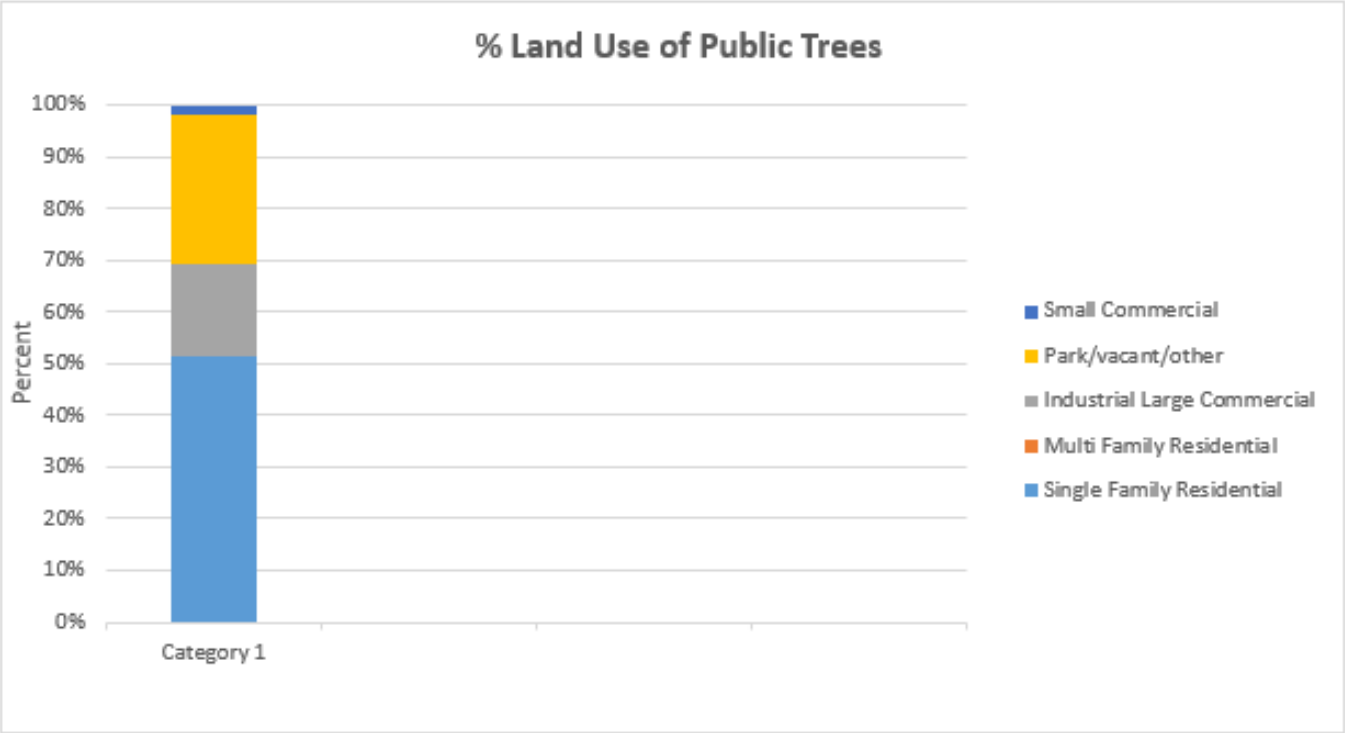


Figure 4: Wood Condition



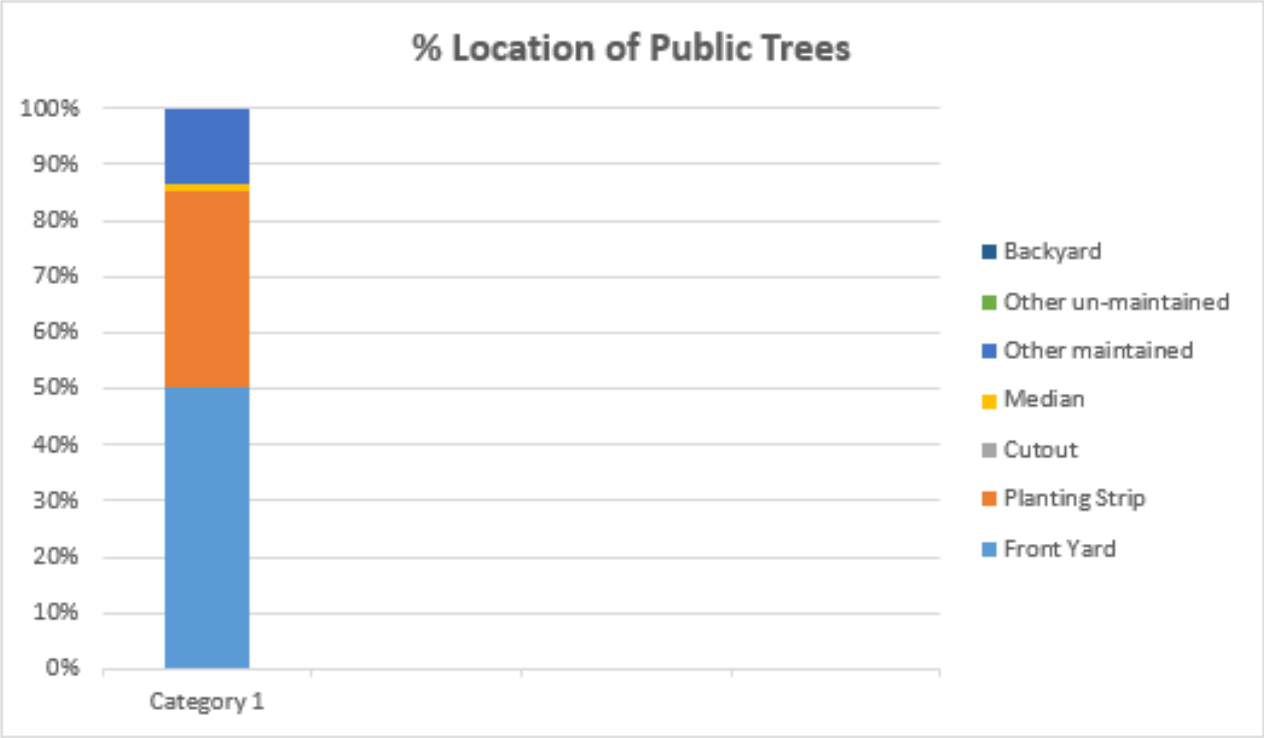
Canopy Cover of All Trees (Acres)		12/14/2018
Zone	Acres	% of Total Canopy
1	10.72	1.60
Citywide Total	685.00	100.00

Figure 5: Canopy Cover in Acres



Land Use of All Trees by Zone		12/14/80		
Zone	**Land Use**	**Tree Count**	**Standard Error**	**% of Zone**
1	Single family residential	281	(N/A)	62.44
	Multi-family residential	0	(N/A)	0.00
	Industrial/Large commercial	1	(N/A)	0.22
	Park/vacant/other	159	(N/A)	35.33
	Small commercial	9	(N/A)	2.00
	Total	450	(N/A)	100.00

Figure 6: Land Use of city/park trees



Site Type of All Trees by Zone		12/14/18		
Zone	**Site Type**	**Tree Count**	**Standard Error**	**% of Zone**
1	Front yard	226	(N/A)	50.22
	Planting strip	157	(N/A)	34.89
	Cutout	0	(N/A)	0.00
	Median	6	(N/A)	1.33
	Other maintained locations	61	(N/A)	13.56
	Other un-maintained locations	0	(N/A)	0.00
	Backyard	0	(N/A)	0.00
	Total	450	(N/A)	100.00

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1:

Location of Ash Trees
2018 Community Tree Inventory
Columbus Junction, IA

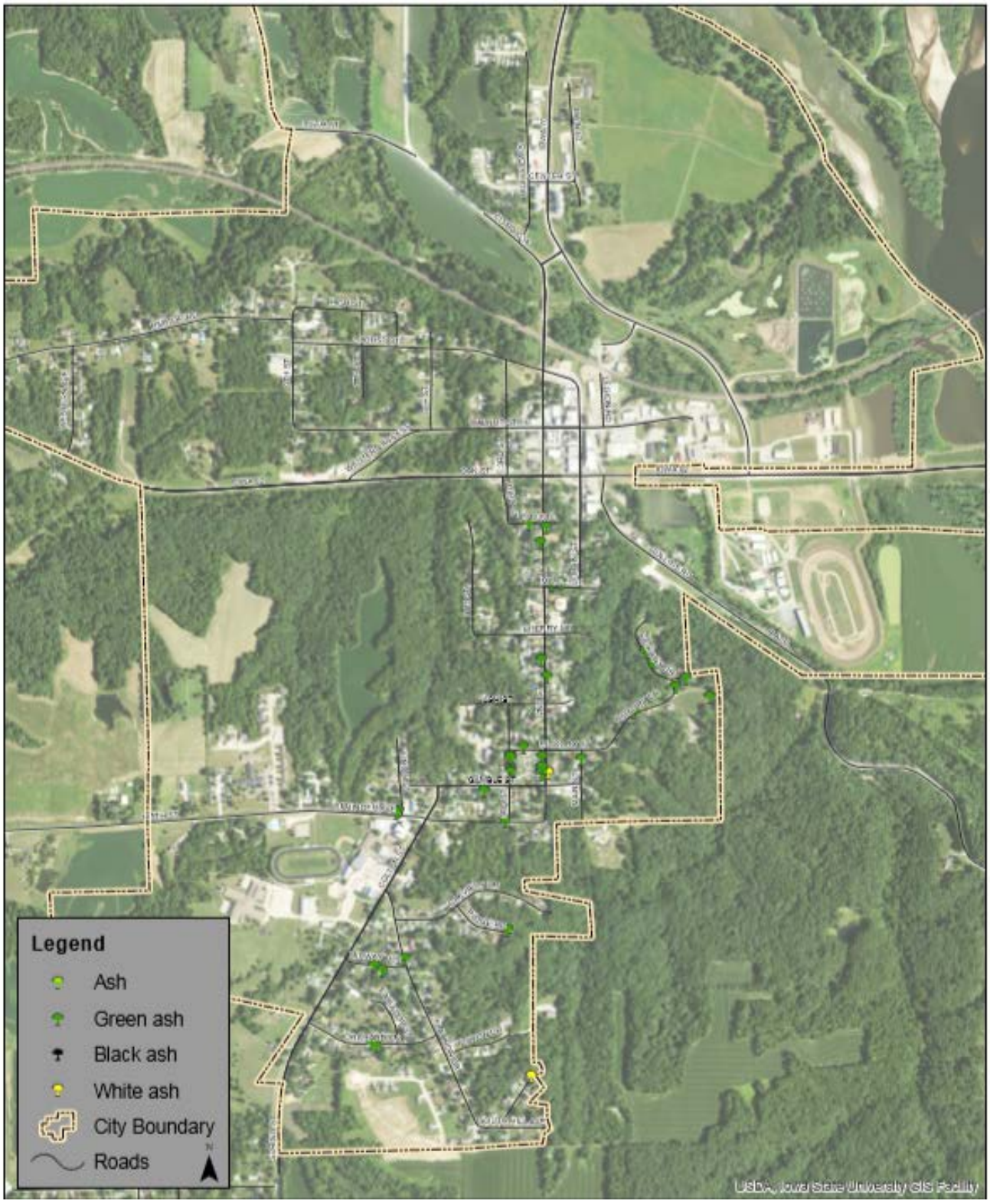


Figure 2:

Location of EAB Symptoms
2018 Community Tree Inventory
Columbus Junction, IA

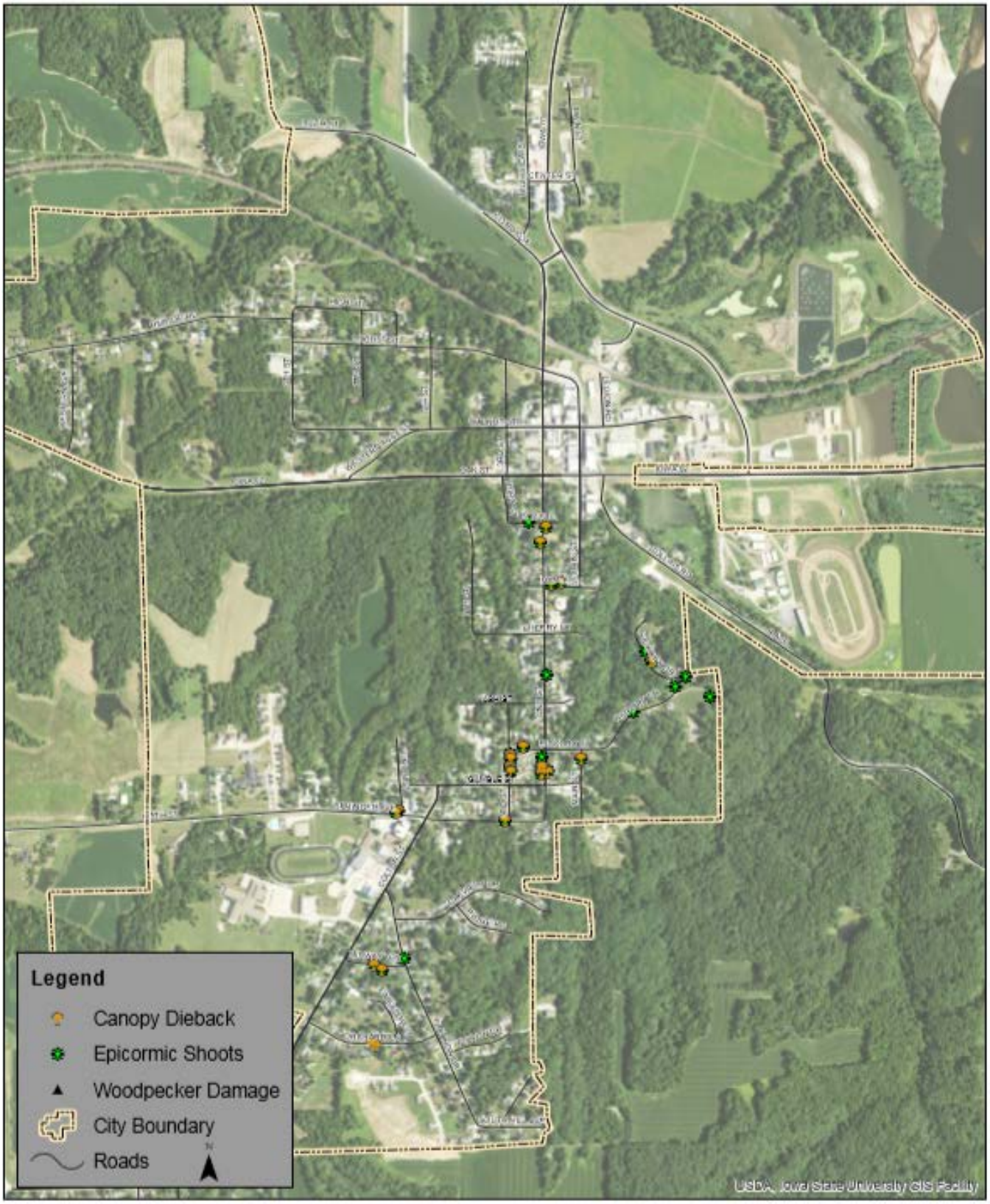


Figure 3:

Location of Poor Condition Trees
2018 Community Tree Inventory
Columbus Junction, IA

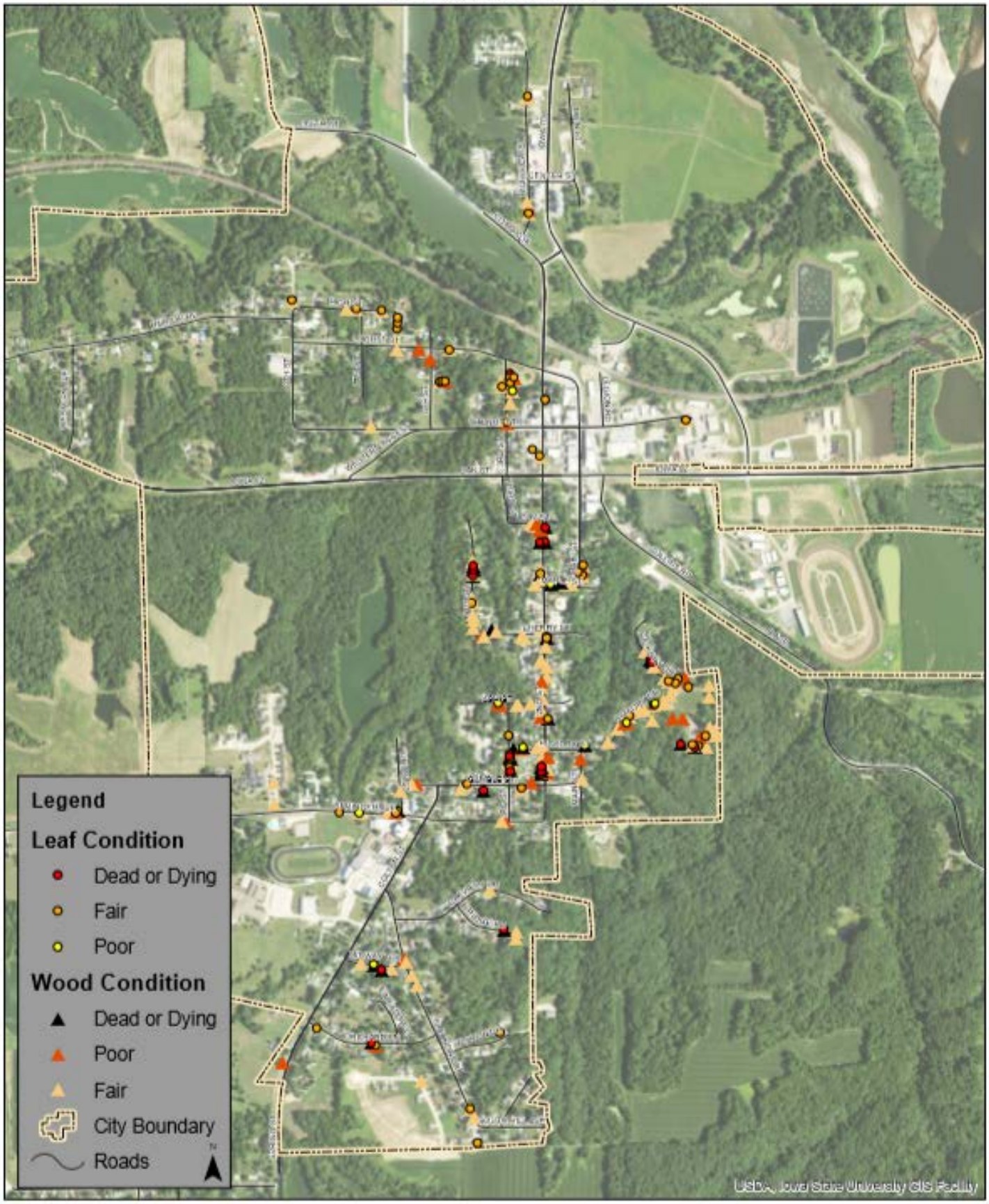


Figure 4:

Location of Trees with Recommended Maintenance
2018 Community Tree Inventory
Columbus Junction, IA

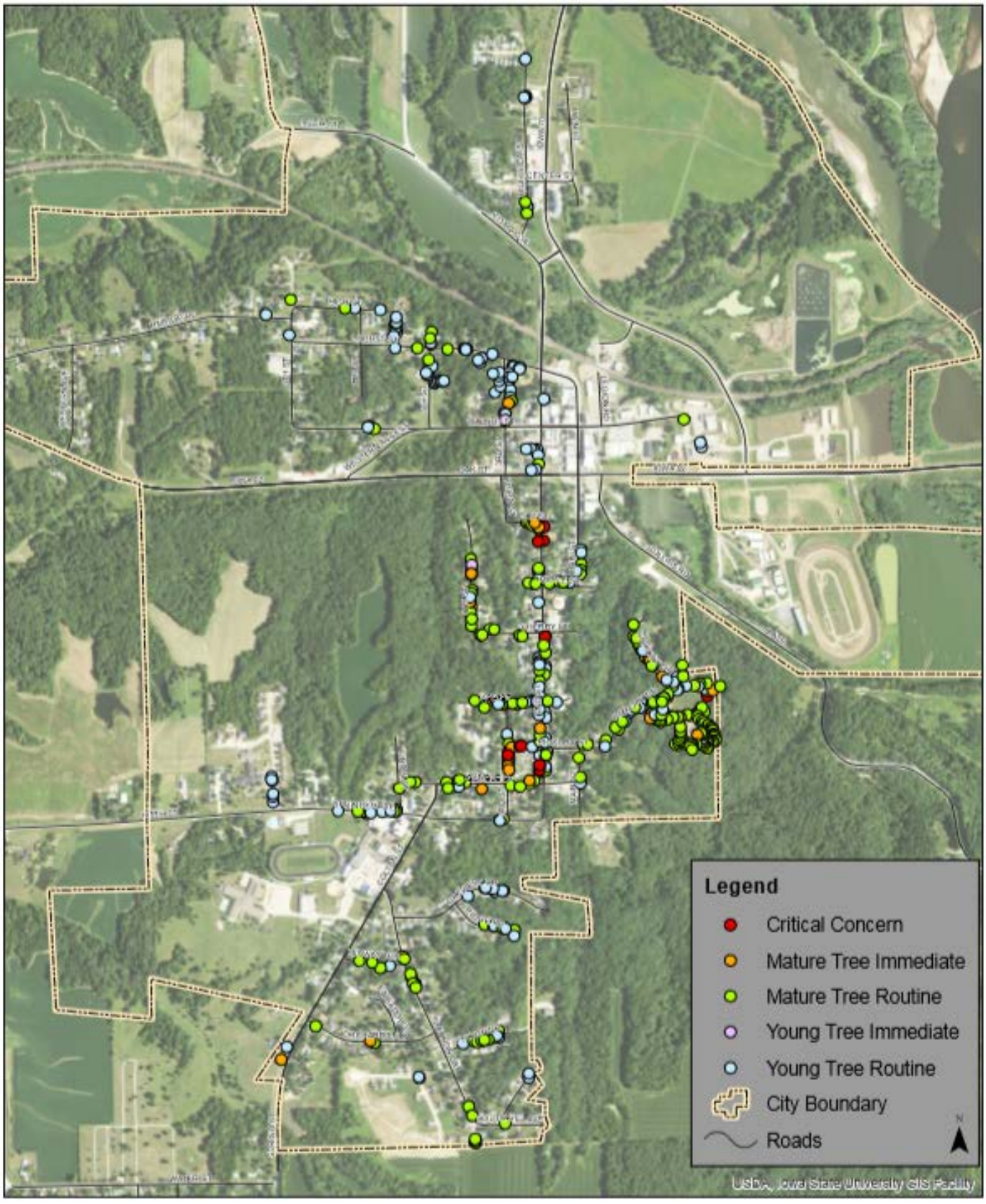


Figure 5:

Maintenance Tasks
2018 Community Tree Inventory
Columbus Junction, IA

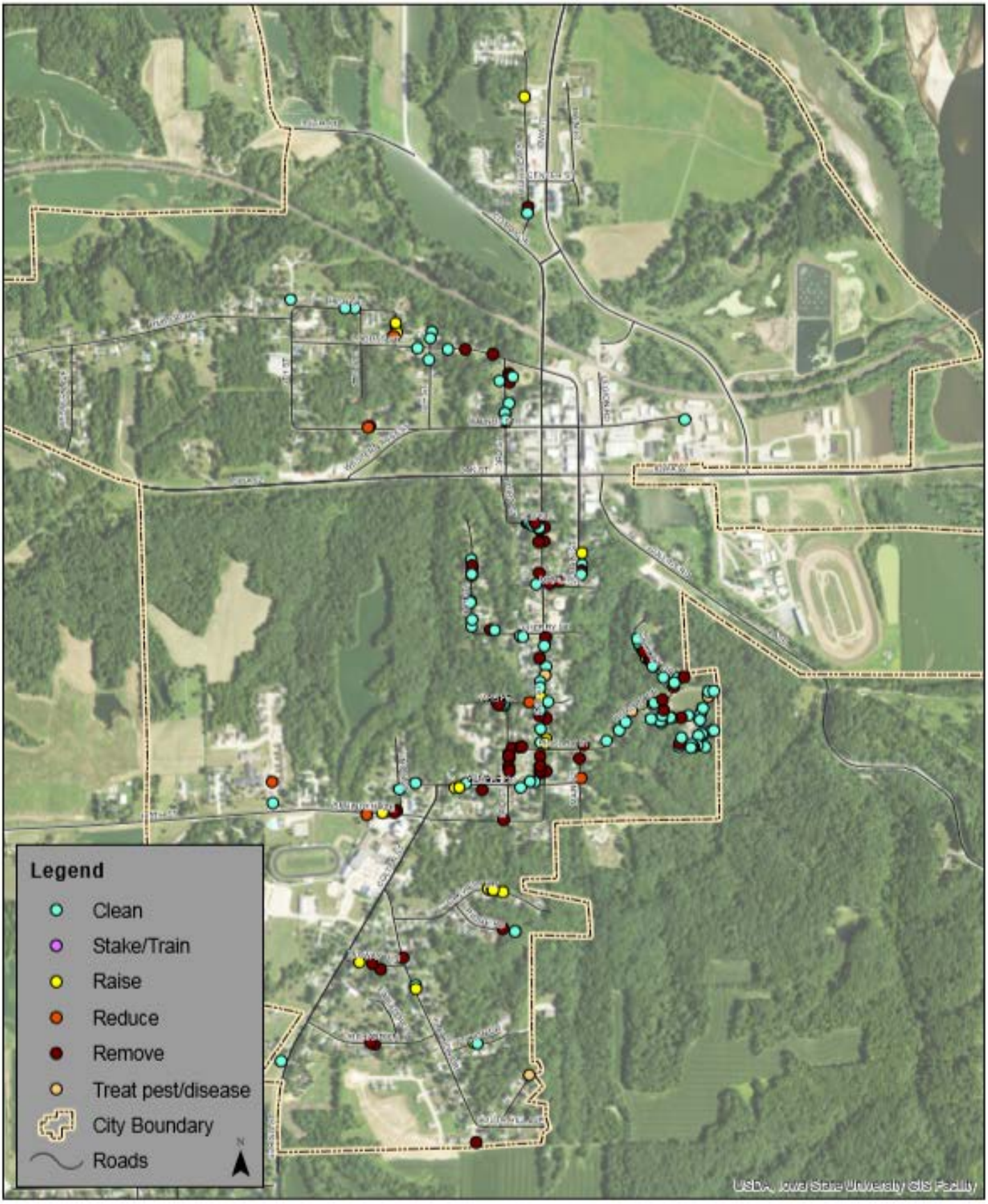
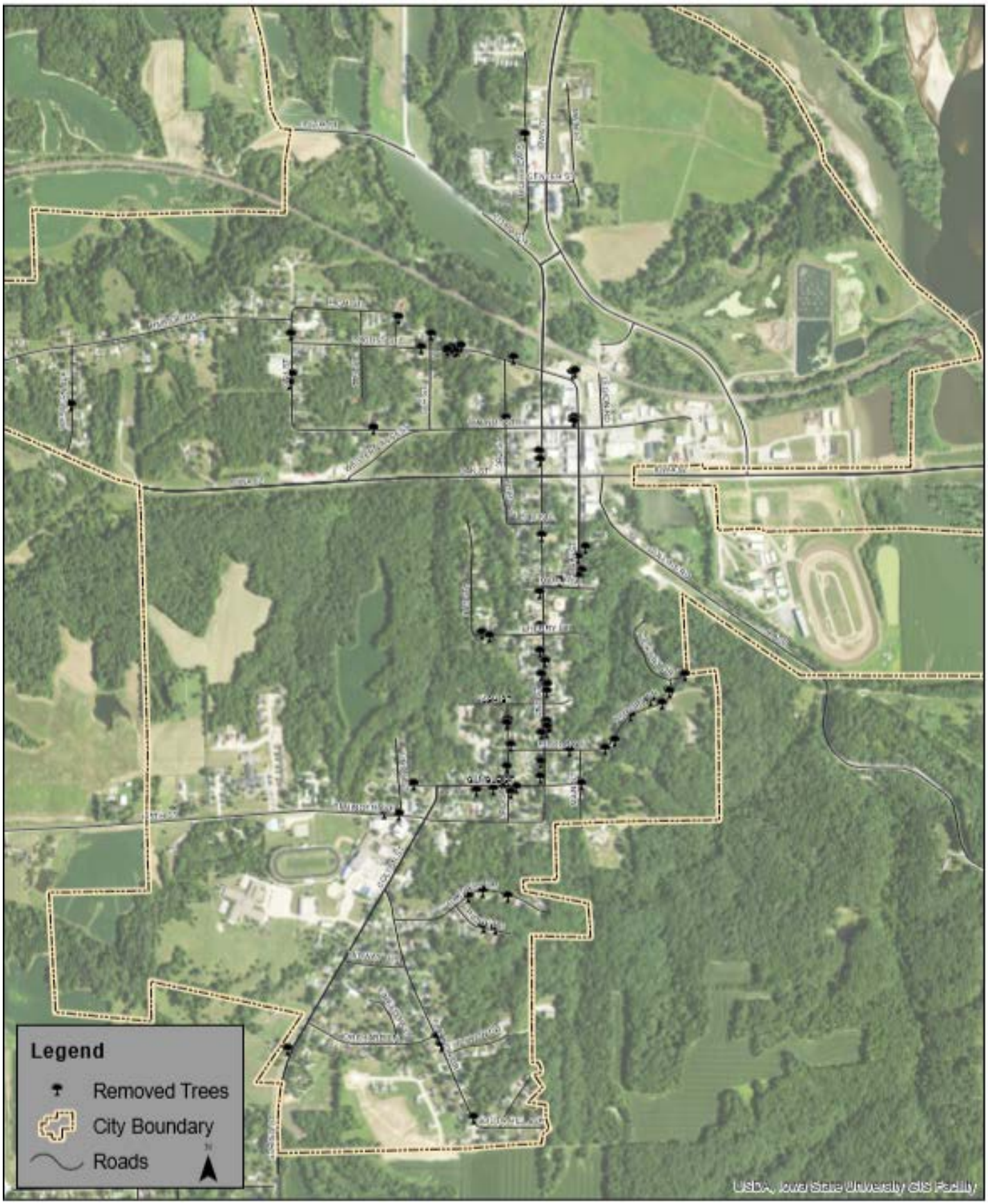


Figure 6:

Location of Treatable Ash Trees
2018 Community Tree Inventory
Columbus Junction, IA

Figure 7:

Removed Trees
2018 Community Tree Inventory
Columbus Junction, IA



Appendix C: Columbus Junction Tree Ordinances

CHAPTER 24

TREE BOARD

24.01 CREATION AND ESTABLISHMENT. There is hereby created and established a City Tree Board for the City, which shall consist of four (4) members and one Council representative, chosen by the Mayor and confirmed by the Council.

24.02 COMPENSATION. Members of the Board shall serve without compensation.

24.03 DUTIES AND RESPONSIBILITIES. It is the responsibility of the board to study, investigate, counsel and develop a written plan for the care, preservation, trimming, planting, replanting, removal or disposition of trees and shrubs in public areas. Such a plan will be presented to the Council and upon its acceptance and approval shall constitute the official comprehensive tree plan for the City. The Board shall review annually and update if needed the City Tree Plan. The Board, when requested by the Council, shall consider, investigate, make findings, report and recommend upon any special matter or question within the scope of its work.

24.04 OPERATION. The Board shall choose its own officers, make its own rules and regulations, and keep a journal of its proceedings. A majority of the members shall be a quorum for the transaction of business.

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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.