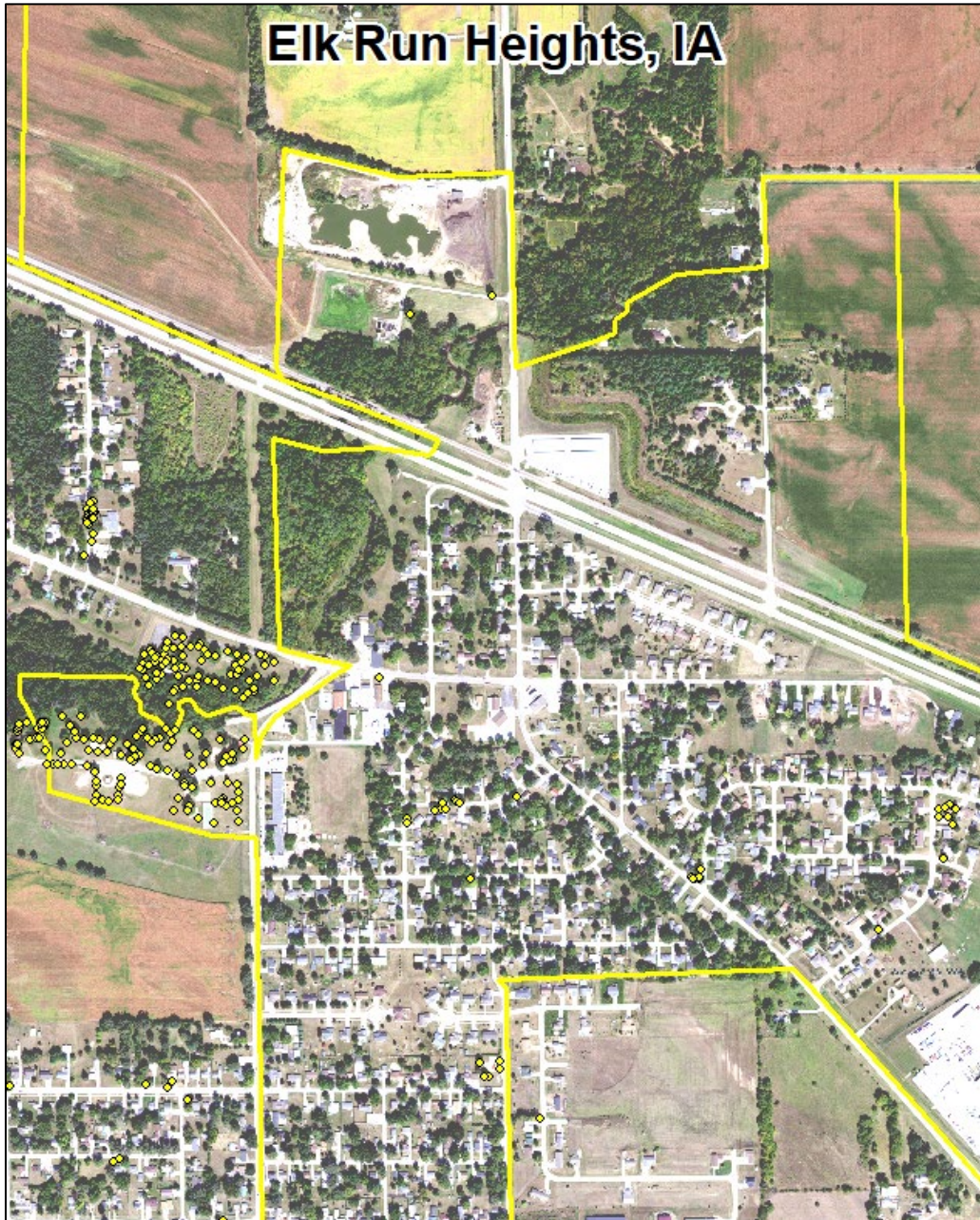# Elk Run Heights, IA

2021 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Elk Run Heights 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 20% of Elk Run Heights' 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 2020, 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 158 trees inventoried.

- Elk Run Heights' trees provide $29,120 of benefits annually, an average of $184 a tree
- There are over 25 species of trees
- The top three genera are: Maple 24%, Ash 20%, and Oak 14%
- 36% of trees are in need of some type of management
- 9 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 9 trees needing removal, 5 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*
- 3 of the 33 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 with a visual survey yearly
- With the current budget it could take 36 years to remove ash – Suggestion: request a budget increase to $3,805 annually and apply for grants to plant replacement trees

Introduction

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

Trees are an important component of Elk Run Heights' 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 Elk Run Heights 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 Elk Run Heights' urban forestry goals.

Inventory

In 2020, 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 158 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. Elk Run Heights' trees reduce energy related costs by approximately $7,946 annually (Appendix A, Table 1). These savings are both in Electricity (38.0 MWh) and in Natural Gas (5,163.4 Therms).

Annual Stormwater Benefits
Elk Run Heights' trees intercept about 404,797 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $10,970 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 Elk Run Heights, it is estimated that trees remove 495 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $1,405 (Appendix A, Table 3).

Annual Carbon Benefits
Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Elk Run Heights, trees sequester about 84,431 lbs of carbon a year with an associated value of $633 (Appendix A, Table 5). In addition, the trees store 1,660,161 lbs of carbon, with a yearly benefit of $12,451 (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. Elk Run Heights receives $7,751 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, Elk Run Heights' trees provide $29,120 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 158 trees in Elk Run Heights provide approximately $184 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Elk Run Heights has over 25 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	39	24%
Ash	33	20%
Oak	23	14%
Linden/Basswood	17	10%
Elm	15	9%
Hackberry	11	6%
Apple (Crab)	3	1%
Cedar	3	1%
Mulberry	3	1%
Walnut	2	1%
Cottonwood	2	1%
Pear	2	1%
Cherry	1	<1%
Birch	1	<1%
Locust	1	<1%
Spruce	1	<1%
Pine	1	<1%

Age Class

Most of Elk Run Heights' trees (53%) are over 18 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. Elk Run Heights' size curve is on the larger side, indicating an older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Elk Run Heights indicate that 74% of the trees are in good health, with only 6% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 78% of Elk Run Heights' 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 1% of the population. This 1% 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	46	29%
Tree Removal	9	5%
Treat pest/disease	2	1%
Crown Raising	1	<1%

Canopy Cover

The total canopy with both private and public trees is 24%, 160.3 acres. The canopy cover on city own properties included in the Elk Run Heights inventory includes approximately 4.39 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years on all lands. To achieve this goal it is estimated that 50 trees need to be planted annually on public and/or private lands.

Land Use and Location

The majority of Elk Run Heights' city and park trees are in within parks (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use	
Park/vacant/other	84%
Single family residential	13%
Small commercial	1%

Location	
Front yard	97%
Planting strip	2%

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

Elk Run Heights has 1 critical concern tree that needs immediate trimming. These trees can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). 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 57 trees with these needs.

<u>Poor tree species</u>
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 9 removals, 6 are ash trees. There are a total of 33 ash trees, and 3 of those have signs and symptoms that have been associated with EAB.. *City ownership of the trees recommended for removal should be verified prior to any removal*

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

Planting
Most of the planting over the next 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 Elk Run Heights.

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 (24%) (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.

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.

Budget and Emerald Ash Borer Plan

Six Year Maintenance Plan with Additional Funding: $3,805 average annually
Current Budget: $1,000 annually

FY 2021: $3,080

Removal: 2 recommended removal trees	$1,400
Trim: 1 critical concern tree	$30
Treat 3 Ash for EAB (1st batch, 1st dose)	$900
Planting and Replacement: 5 trees to be planted in open locations	$500
Young Tree Pruning & Maintenance:	$250
Visual Survey for signs and symptoms of EAB	

FY 2022: $4,550

Removal: 2 recommended removal trees	$1,400
Treat 3 ash for EAB (2nd batch, 1st dose)	$900
Planting and Replacement: 5 trees in open locations	$500
Young Tree Pruning & Maintenance:	$250
Routine trimming: Contract to trim 1/3 of the city trees	$1,500
Visual Survey for signs and symptoms of EAB	

FY 2023: $3,050

Removal: 2 recommended removal trees	$1,400
Treat 3 ash for EAB (1st batch, 2nd dose)	$900
Planting and Replacement: 5 trees in open locations	$500
Young Tree Pruning & Maintenance:	$250
Visual Survey for signs and symptoms of EAB	

FY 2024: $4,550

Removal: 2 recommended removal trees	$1,400
Treat 3 ash for EAB (2nd batch, 2nd dose)	$900
Planting and Replacement: 5 trees in open locations	$500
Routine trimming: Contract to trim 1/3 of the city trees	$1,500
Young Tree Pruning & Maintenance:	$250
Visual Survey for signs and symptoms of EAB	

FY 2025: $3,050

Removal: 1 recommended removal tree, 1 large ash tree	$1,400
Treat 3 ash for EAB (1st batch, 3rd dose)	$900
Planting and Replacement: 5 trees in open locations	$500
Young Tree Pruning & Maintenance:	$250
Visual Survey for signs and symptoms of EAB	

FY 2026: $4,550

Removal: 2 ash trees	$1,400
Treat 3 ash for EAB (2nd batch, 3rd dose)	$900
Planting and Replacement: 5 trees in open locations	$500
Routine trimming: Contract to trim 1/3 of the city trees	$1,500
Young Tree Pruning & Maintenance:	$250
Visual Survey for signs and symptoms of EAB	

*Reduction of ash over 6 years: Approximately 9 ash trees removed (approximately 27% of ash). It will take approximately 12 years to remove all ash with the proposed 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 $4,200 a year. If the budget were increased to $2,000 a year, all ash could be removed in 13 years.

Estimates based on the following costs: tree removal $700/tree, planting and replacement $100/tree, young tree pruning and maintenance $50/tree, routine trimming $30/tree. Actual costs could be different.

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. The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

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

Monitoring

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

Private Ash Trees

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

Proposed Budget Increase

EAB could potentially kill all ash trees in Elk Run Heights within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $5,275 (total ash + all other removals *removal cost + (planting and maintenance *1.2 of removals) /6) a year. Additionally, it is recommended that Elk Run Heights 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 $15 per inch, about 4 trees could be treated per year (every other year treatment) would be $1,200. This would be 6 trees selected for treatment, and Elk Run

Heights would still need to find $18,900 (total ash - 6 *removal cost) for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $2,250 a year for treatment and leave $12,600 (total ash- 15 *removal cost) 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 if EAB is found in Elk Run Heights. 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

Elk Run Heights

Annual Energy Benefits of Public Trees

3/25/2021

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	7.2	547	963.6	944	1,491	(N/A)	16.5	18.8	57.34
Bur oak	5.7	436	788.1	772	1,208	(N/A)	12.7	15.2	60.40
American basswood	3.6	270	507.2	497	767	(N/A)	10.8	9.7	45.13
American elm	5.8	439	770.2	755	1,194	(N/A)	9.5	15.0	79.57
Silver maple	4.7	357	629.9	617	974	(N/A)	8.2	12.3	74.93
Red maple	0.7	49	80.9	79	129	(N/A)	7.6	1.6	10.72
Northern hackberry	2.4	185	356.9	350	534	(N/A)	7.0	6.7	48.59
Norway maple	1.4	106	193.1	189	295	(N/A)	4.4	3.7	42.20
White ash	1.3	102	153.5	150	253	(N/A)	4.4	3.2	36.11
Sugar maple	0.7	54	100.3	98	153	(N/A)	2.5	1.9	38.13
Apple	0.1	5	11.4	11	16	(N/A)	1.9	0.2	5.40
Eastern red cedar	0.1	6	12.9	13	19	(N/A)	1.9	0.2	6.24
Mulberry	0.5	35	69.1	68	102	(N/A)	1.9	1.3	34.15
Black walnut	0.6	43	73.8	72	115	(N/A)	1.3	1.4	57.57
Boxelder	0.4	33	61.6	60	94	(N/A)	1.3	1.2	46.76
Eastern cottonwood	0.9	66	118.0	116	182	(N/A)	1.3	2.3	91.02
Northern red oak	0.5	36	67.0	66	102	(N/A)	1.3	1.3	50.75
Callery pear	0.5	36	59.0	58	94	(N/A)	1.3	1.2	46.78
Black cherry	0.2	15	31.6	31	46	(N/A)	0.6	0.6	46.14
Swamp white oak	0.0	0	0.8	1	1	(N/A)	0.6	0.0	1.10
Amur maple	0.1	6	12.8	13	18	(N/A)	0.6	0.2	18.19
River birch	0.2	18	29.5	29	47	(N/A)	0.6	0.6	46.78
Honeylocust	0.3	23	42.3	41	65	(N/A)	0.6	0.8	64.79
Eastern white pine	0.1	10	14.6	14	24	(N/A)	0.6	0.3	24.14
Blue spruce	0.1	10	15.2	15	25	(N/A)	0.6	0.3	24.51
Total	38.0	2,886	5,163.4	5,060	7,946	(N/A)	100.0	100.0	50.29

Table 2: Annual Stormwater Benefits

Elk Run Heights

Annual Stormwater Benefits of Public Trees

3/25/2021

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	74,597	2,022	(N/A)	16.5	18.4	77.75
Bur oak	78,859	2,137	(N/A)	12.7	19.5	106.85
American basswood	32,169	872	(N/A)	10.8	7.9	51.28
American elm	56,630	1,535	(N/A)	9.5	14.0	102.31
Silver maple	69,242	1,876	(N/A)	8.2	17.1	144.34
Red maple	3,701	100	(N/A)	7.6	0.9	8.36
Northern hackberry	18,665	506	(N/A)	7.0	4.6	45.98
Norway maple	11,069	300	(N/A)	4.4	2.7	42.85
White ash	8,491	230	(N/A)	4.4	2.1	32.87
Sugar maple	6,949	188	(N/A)	2.5	1.7	47.08
Apple	206	6	(N/A)	1.9	0.1	1.86
Eastern red cedar	1,026	28	(N/A)	1.9	0.3	9.27
Mulberry	2,105	57	(N/A)	1.9	0.5	19.02
Black walnut	5,409	147	(N/A)	1.3	1.3	73.29
Boxelder	4,466	121	(N/A)	1.3	1.1	60.52
Eastern cottonwood	14,478	392	(N/A)	1.3	3.6	196.17
Northern red oak	5,069	137	(N/A)	1.3	1.3	68.69
Callery pear	2,818	76	(N/A)	1.3	0.7	38.19
Black cherry	1,174	32	(N/A)	0.6	0.3	31.82
Swamp white oak	12	0	(N/A)	0.6	0.0	0.33
Amur maple	264	7	(N/A)	0.6	0.1	7.17
River birch	1,409	38	(N/A)	0.6	0.3	38.19
Honeylocust	2,905	79	(N/A)	0.6	0.7	78.73
Eastern white pine	1,539	42	(N/A)	0.6	0.4	41.70
Blue spruce	1,544	42	(N/A)	0.6	0.4	41.85
Citywide total	404,797	10,970	(N/A)	100.0	100.0	69.43

Table 3: Annual Air Quality Benefits

Elk Run Heights

Annual Air Quality Benefits of Public Trees

3/25/2021

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2								
Green ash	8.9	1.4	4.3	0.4	47	34.2	5.0	4.8	32.6	213	0.0	0	91.6	261	(N/A)	16.5	10.03
Bur oak	12.2	2.0	5.5	0.5	64	27.4	4.0	3.8	26.0	171	0.0	0	81.5	235	(N/A)	12.7	11.75
American basswood	3.8	0.6	2.0	0.2	21	17.2	2.5	2.4	16.2	107	-3.4	-13	41.4	115	(N/A)	10.8	6.75
American elm	10.7	1.8	5.3	0.5	58	27.4	4.0	3.8	26.2	171	0.0	0	79.8	229	(N/A)	9.5	15.28
Silver maple	12.6	2.1	6.1	0.6	68	22.3	3.3	3.1	21.3	139	-6.6	-25	64.6	182	(N/A)	8.2	13.98
Red maple	0.7	0.1	0.3	0.0	4	3.0	0.4	0.4	2.9	19	-0.2	-1	7.8	22	(N/A)	7.6	1.81
Northern hackberry	2.3	0.4	1.3	0.1	13	11.8	1.7	1.6	11.0	73	0.0	0	30.3	86	(N/A)	7.0	7.83
Norway maple	2.1	0.4	1.0	0.1	11	6.7	1.0	0.9	6.3	42	-0.5	-2	18.0	51	(N/A)	4.4	7.30
White ash	0.5	0.1	0.3	0.0	3	6.2	0.9	0.9	6.1	39	0.0	0	15.0	42	(N/A)	4.4	6.00
Sugar maple	0.8	0.1	0.4	0.0	5	3.4	0.5	0.5	3.2	21	-0.7	-2	8.4	23	(N/A)	2.5	5.84
Apple	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2	(N/A)	1.9	0.71
Eastern red cedar	0.1	0.0	0.1	0.0	1	0.4	0.1	0.1	0.4	2	-0.5	-2	0.5	1	(N/A)	1.9	0.34
Mulberry	0.7	0.1	0.3	0.0	4	2.2	0.3	0.3	2.1	14	0.0	0	6.1	17	(N/A)	1.9	5.82
Black walnut	0.6	0.1	0.3	0.0	3	2.7	0.4	0.4	2.6	17	0.0	0	7.0	20	(N/A)	1.3	9.95
Boxelder	0.6	0.1	0.3	0.0	3	2.1	0.3	0.3	2.0	13	-0.2	-1	5.4	15	(N/A)	1.3	7.54
Eastern cottonwood	2.3	0.4	1.0	0.1	12	4.2	0.6	0.6	4.0	26	0.0	0	13.1	38	(N/A)	1.3	19.04
Northern red oak	1.1	0.2	0.5	0.0	6	2.3	0.3	0.3	2.1	14	-1.6	-6	5.4	14	(N/A)	1.3	7.07
Callery pear	0.4	0.1	0.2	0.0	2	2.2	0.3	0.3	2.1	14	-0.1	0	5.6	16	(N/A)	1.3	7.92
Black cherry	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.6	8.35
Swamp white oak	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.6	0.14
Amur maple	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)	0.6	2.55
River birch	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8	(N/A)	0.6	7.92
Honeylocust	0.5	0.1	0.3	0.0	3	1.5	0.2	0.2	1.4	9	-0.4	-1	3.8	11	(N/A)	0.6	10.61
Eastern white pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3	(N/A)	0.6	2.82
Blue 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)	0.6	2.89
Citywide total	61.9	10.3	30.3	2.8	333	181.2	26.4	25.2	172.3	1,130	-15.5	-58	495.0	1,405	(N/A)	100.0	8.89

Table 4: Annual Carbon Stored

Elk Run Heights

Stored CO2 Benefits of Public Trees

3/25/2021

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	290,777	2,181	(N/A)	16.5	17.5	83.88
Bur oak	412,317	3,092	(N/A)	12.7	24.8	154.62
American basswood	137,926	1,034	(N/A)	10.8	8.3	60.85
American elm	229,240	1,719	(N/A)	9.5	13.8	114.62
Silver maple	299,112	2,243	(N/A)	8.2	18.0	172.56
Red maple	8,022	60	(N/A)	7.6	0.5	5.01
Northern hackberry	30,752	231	(N/A)	7.0	1.9	20.97
Norway maple	34,215	257	(N/A)	4.4	2.1	36.66
White ash	17,791	133	(N/A)	4.4	1.1	19.06
Sugar maple	23,545	177	(N/A)	2.5	1.4	44.15
Apple	533	4	(N/A)	1.9	0.0	1.33
Eastern red cedar	363	3	(N/A)	1.9	0.0	0.91
Mulberry	10,688	80	(N/A)	1.9	0.6	26.72
Black walnut	19,445	146	(N/A)	1.3	1.2	72.92
Boxelder	15,891	119	(N/A)	1.3	1.0	59.59
Eastern cottonwood	78,517	589	(N/A)	1.3	4.7	294.44
Northern red oak	23,457	176	(N/A)	1.3	1.4	87.96
Callery pear	7,248	54	(N/A)	1.3	0.4	27.18
Black cherry	6,743	51	(N/A)	0.6	0.4	50.57
Swamp white oak	17	0	(N/A)	0.6	0.0	0.13
Amur maple	908	7	(N/A)	0.6	0.1	6.81
River birch	3,624	27	(N/A)	0.6	0.2	27.18
Honeylocust	6,743	51	(N/A)	0.6	0.4	50.57
Eastern white pine	1,170	9	(N/A)	0.6	0.1	8.78
Blue spruce	1,118	8	(N/A)	0.6	0.1	8.39
Citywide total	1,660,161	12,451	(N/A)	100.0	100.0	78.81

Table 5: Annual Carbon Sequestered

Annual CO$_2$ Benefits of Public Trees

3/25/2021

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	16,374	123	-1,396	-73	-11	12,079	91	26,985	202 (N/A)	16.5	19.3	7.78
Bur oak	12,255	92	-1,979	-66	-15	9,627	72	19,837	149 (N/A)	12.7	14.2	7.44
American basswood	9,076	68	-662	-40	-5	5,971	45	14,344	108 (N/A)	10.8	10.3	6.33
American elm	6,887	52	-1,100	-54	-9	9,698	73	15,431	116 (N/A)	9.5	11.0	7.72
Silver maple	20,956	157	-1,436	-53	-11	7,884	59	27,351	205 (N/A)	8.2	19.6	15.78
Red maple	1,102	8	-39	-7	0	1,090	8	2,147	16 (N/A)	7.6	1.5	1.34
Northern hackberry	2,711	20	-148	-22	-1	4,082	31	6,623	50 (N/A)	7.0	4.7	4.52
Norway maple	2,227	17	-164	-13	-1	2,347	18	4,396	33 (N/A)	4.4	3.1	4.71
White ash	2,521	19	-85	-11	-1	2,262	17	4,686	35 (N/A)	4.4	3.4	5.02
Sugar maple	1,486	11	-114	-8	-1	1,198	9	2,563	19 (N/A)	2.5	1.8	4.80
Apple	114	1	-3	-2	0	112	1	221	2 (N/A)	1.9	0.2	0.55
Eastern red cedar	67	0	-2	-2	0	135	1	197	1 (N/A)	1.9	0.1	0.49
Mulberry	860	6	-51	-6	0	767	6	1,570	12 (N/A)	1.9	1.1	3.93
Black walnut	1,302	10	-93	-5	-1	945	7	2,149	16 (N/A)	1.3	1.5	8.06
Boxelder	1,389	10	-76	-5	-1	732	5	2,039	15 (N/A)	1.3	1.5	7.65
Eastern cottonwood	1,824	14	-377	-10	-3	1,469	11	2,906	22 (N/A)	1.3	2.1	10.90
Northern red oak	382	3	-113	-6	-1	792	6	1,055	8 (N/A)	1.3	0.8	3.96
Callery pear	772	6	-35	-4	0	790	6	1,523	11 (N/A)	1.3	1.1	5.71
Black cherry	478	4	-32	-3	0	335	3	778	6 (N/A)	0.6	0.6	5.84
Swamp white oak	5	0	0	0	0	7	0	12	0 (N/A)	0.6	0.0	0.09
Amur maple	114	1	-4	-1	0	124	1	232	2 (N/A)	0.6	0.2	1.74
River birch	386	3	-17	-2	0	395	3	762	6 (N/A)	0.6	0.5	5.71
Honeylocust	936	7	-32	-3	0	515	4	1,417	11 (N/A)	0.6	1.0	10.62
Eastern white pine	116	1	-6	-2	0	216	2	324	2 (N/A)	0.6	0.2	2.43
Blue spruce	91	1	-5	-2	0	213	2	296	2 (N/A)	0.6	0.2	2.22
Citywide total	84,431	633	-7,970	-402	-63	63,785	478	139,845	1,049 (N/A)	100.0	100.0	6.64

Table 6: Annual Social and Aesthetic Benefits

Elk Run Heights

Annual Aesthetic/Other Benefits of Public Trees

3/25/2021

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,400	(N/A)	16.5	18.1	53.85
Bur oak	934	(N/A)	12.7	12.1	46.71
American basswood	710	(N/A)	10.8	9.2	41.76
American elm	945	(N/A)	9.5	12.2	63.01
Silver maple	1,572	(N/A)	8.2	20.3	120.94
Red maple	154	(N/A)	7.6	2.0	12.82
Northern hackberry	424	(N/A)	7.0	5.5	38.52
Norway maple	221	(N/A)	4.4	2.9	31.56
White ash	355	(N/A)	4.4	4.6	50.75
Sugar maple	164	(N/A)	2.5	2.1	40.91
Apple	6	(N/A)	1.9	0.1	2.06
Eastern red cedar	48	(N/A)	1.9	0.6	16.03
Mulberry	51	(N/A)	1.9	0.7	16.89
Black walnut	111	(N/A)	1.3	1.4	55.72
Boxelder	103	(N/A)	1.3	1.3	51.63
Eastern cottonwood	117	(N/A)	1.3	1.5	58.34
Northern red oak	27	(N/A)	1.3	0.4	13.73
Callery pear	78	(N/A)	1.3	1.0	39.16
Black cherry	29	(N/A)	0.6	0.4	28.80
Swamp white oak	3	(N/A)	0.6	0.0	2.74
Amur maple	6	(N/A)	0.6	0.1	6.40
River birch	39	(N/A)	0.6	0.5	39.16
Honeylocust	195	(N/A)	0.6	2.5	194.60
Eastern white pine	32	(N/A)	0.6	0.4	32.32
Blue spruce	25	(N/A)	0.6	0.3	25.23
Citywide total	7,751	(N/A)	100.0	100.0	49.05

Table 7: Summary of Benefits in Dollars

Elk Run Heights

Total Annual Benefits of Public Trees by Species ($)

3/25/2021

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Green ash	1,491	202	261	2,022	1,400	5,376	(N/A)	18.5
Bur oak	1,208	149	235	2,137	934	4,663	(N/A)	16.0
American basswood	767	108	115	872	710	2,571	(N/A)	8.8
American elm	1,194	116	229	1,535	945	4,018	(N/A)	13.8
Silver maple	974	205	182	1,876	1,572	4,810	(N/A)	16.5
Red maple	129	16	22	100	154	421	(N/A)	1.4
Northern hackberry	534	50	86	506	424	1,600	(N/A)	5.5
Norway maple	295	33	51	300	221	900	(N/A)	3.1
White ash	253	35	42	230	355	915	(N/A)	3.1
Sugar maple	153	19	23	188	164	547	(N/A)	1.9
Apple	16	2	2	6	6	32	(N/A)	0.1
Eastern red cedar	19	1	1	28	48	97	(N/A)	0.3
Mulberry	102	12	17	57	51	239	(N/A)	0.8
Black walnut	115	16	20	147	111	409	(N/A)	1.4
Boxelder	94	15	15	121	103	348	(N/A)	1.2
Eastern cottonwood	182	22	38	392	117	751	(N/A)	2.6
Northern red oak	102	8	14	137	27	288	(N/A)	1.0
Callery pear	94	11	16	76	78	276	(N/A)	0.9
Black cherry	46	6	8	32	29	121	(N/A)	0.4
Swamp white oak	1	0	0	0	3	4	(N/A)	0.0
Amur maple	18	2	3	7	6	36	(N/A)	0.1
River birch	47	6	8	38	39	138	(N/A)	0.5
Honeylocust	65	11	11	79	195	359	(N/A)	1.2
Eastern white pine	24	2	3	42	32	103	(N/A)	0.4
Blue spruce	25	2	3	42	25	97	(N/A)	0.3
Citywide Total	7,946	1,049	1,405	10,970	7,751	29,120	(N/A)	100.0

Species Distribution of Public Trees

Legend:
- Green ash
- Bur oak
- American basswood
- American elm
- Silver maple
- Red maple
- Northern hackberry
- Norway maple
- White ash
- Sugar maple

Values: 16.46, 12.66, 10.76, 9.49, 8.23, 7.59, 6.96, 4.43, 4.43, 2.53
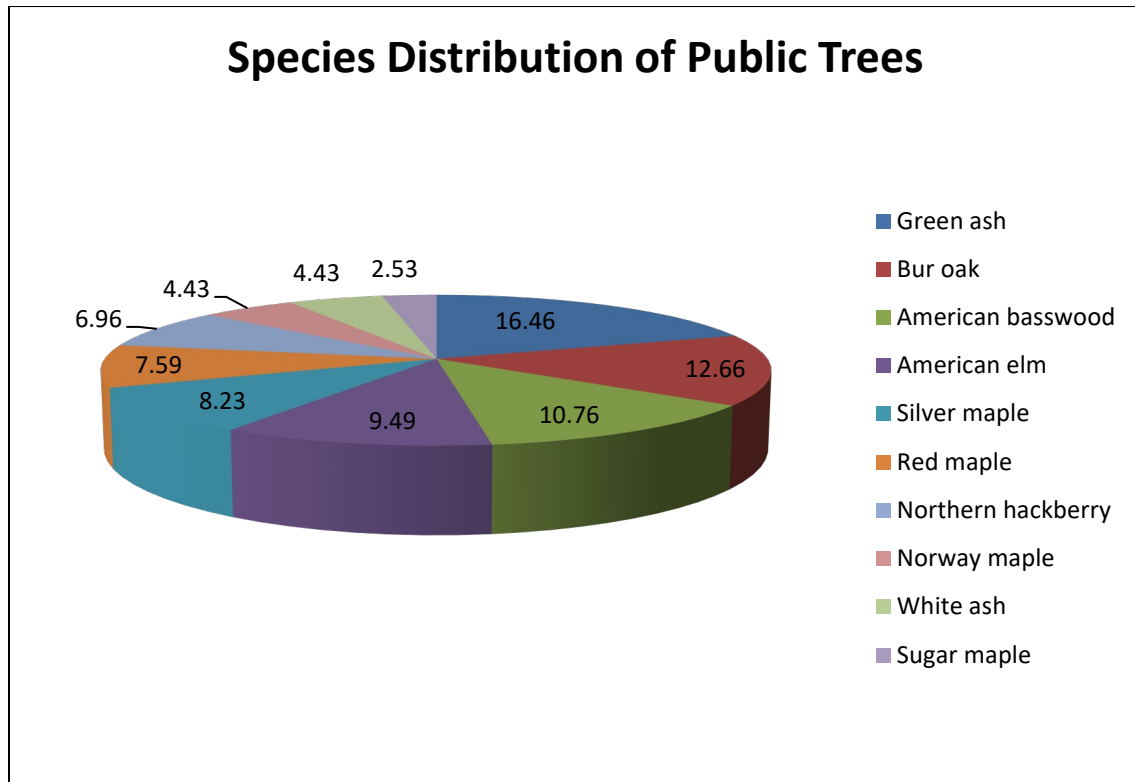
Figure 1: Species Distribution

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

Y-axis: (%) — 0, 20, 40, 60, 80

DBH Class (x-axis): 0 - 3, 3 - 6, 6 - 12, 12 - 18, 18 - 24, 24 - 30, 30 - 36, 36 - 42, > 42

Series (depth axis): Green ash, Bur oak, American basswood, American elm, Silver maple, Red maple, Northern hackberry, Norway maple, White ash, Sugar maple, Citywide Total

Legend:
- Green ash
- Bur oak
- American basswood
- American elm
- Silver maple
- Red maple
- Northern hackberry
- Norway maple
- White ash
- Sugar maple
- Citywide Total

Figure 2: Relative Age Class
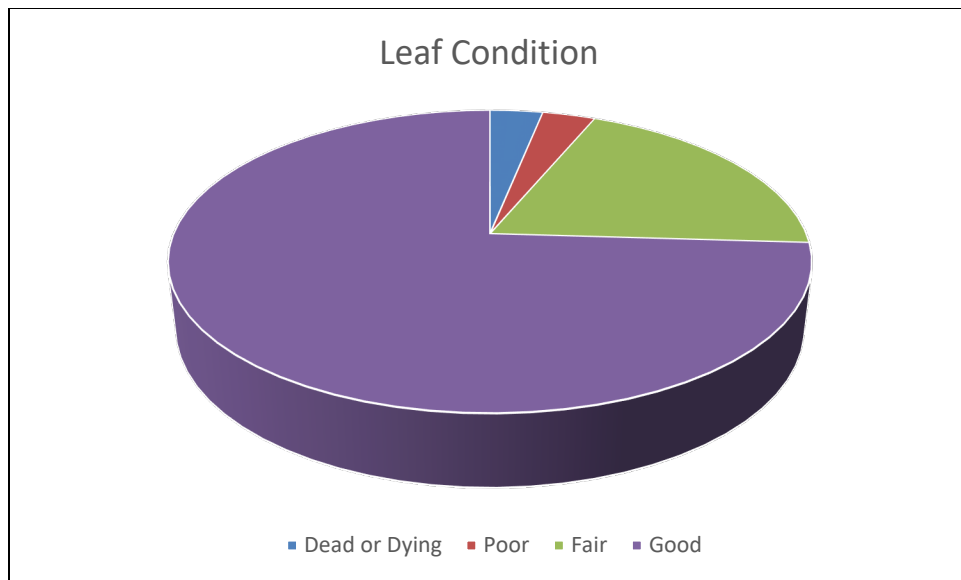
Figure 3: Foliage Condition
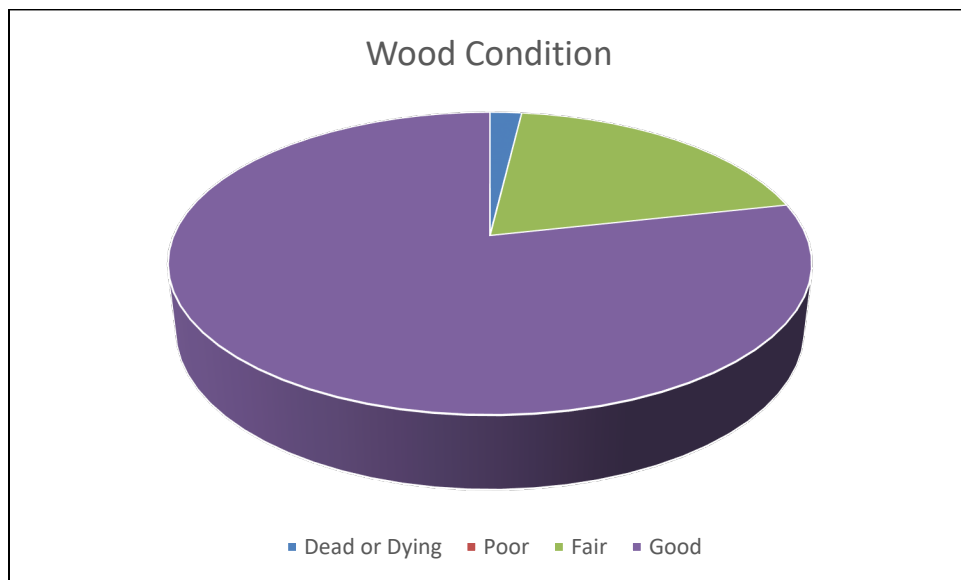
Figure 4: Wood Condition
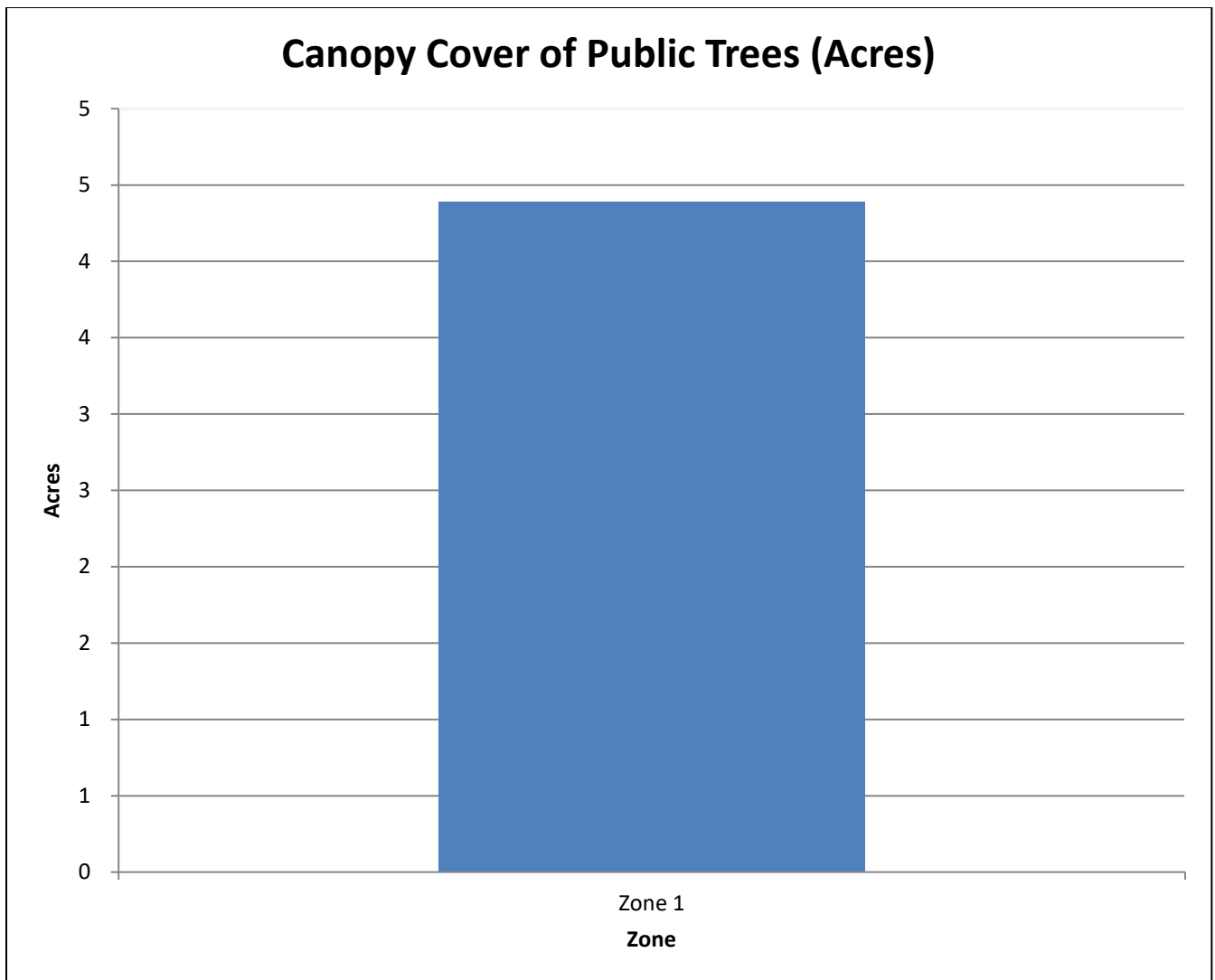
Figure 5: Canopy Cover in Acres
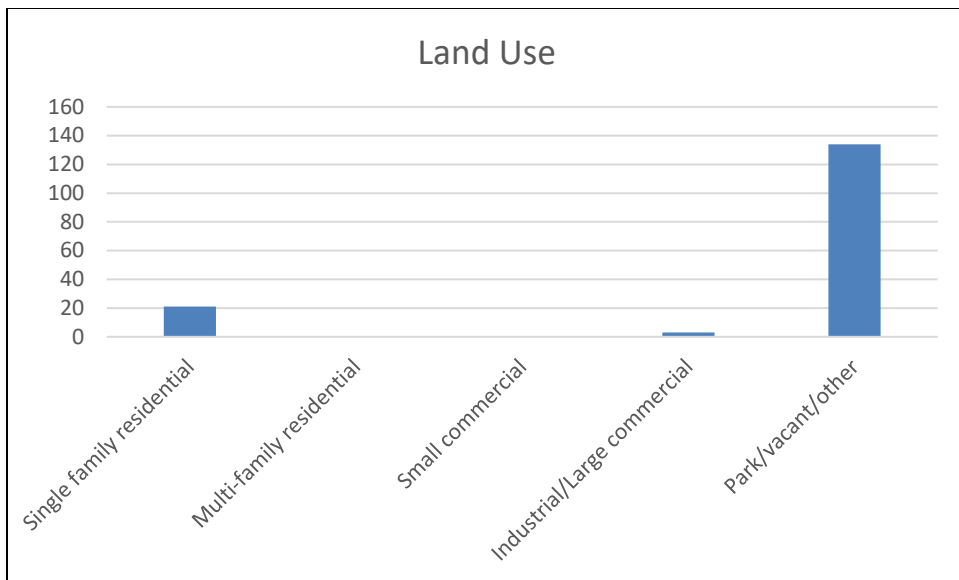
Figure 6: Land Use of city/park trees
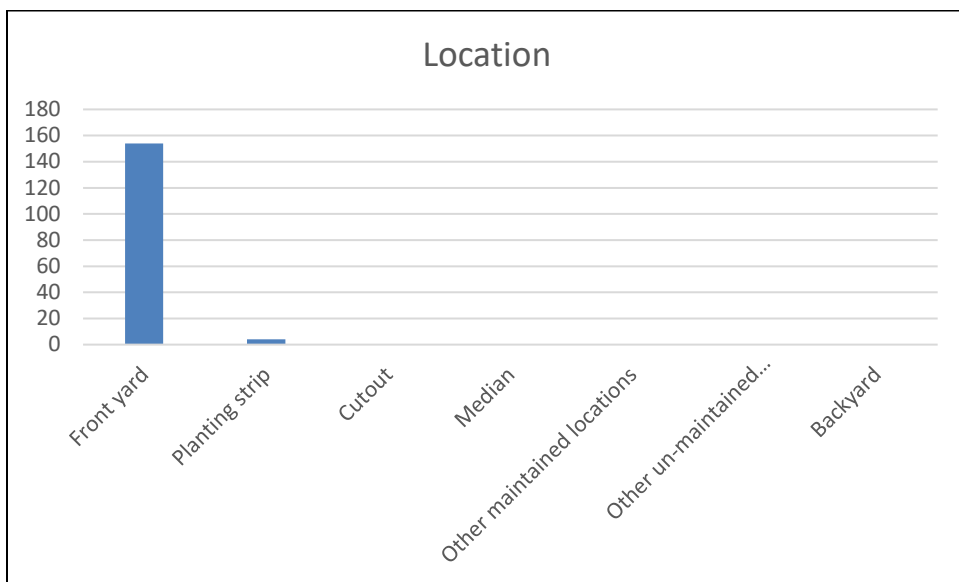
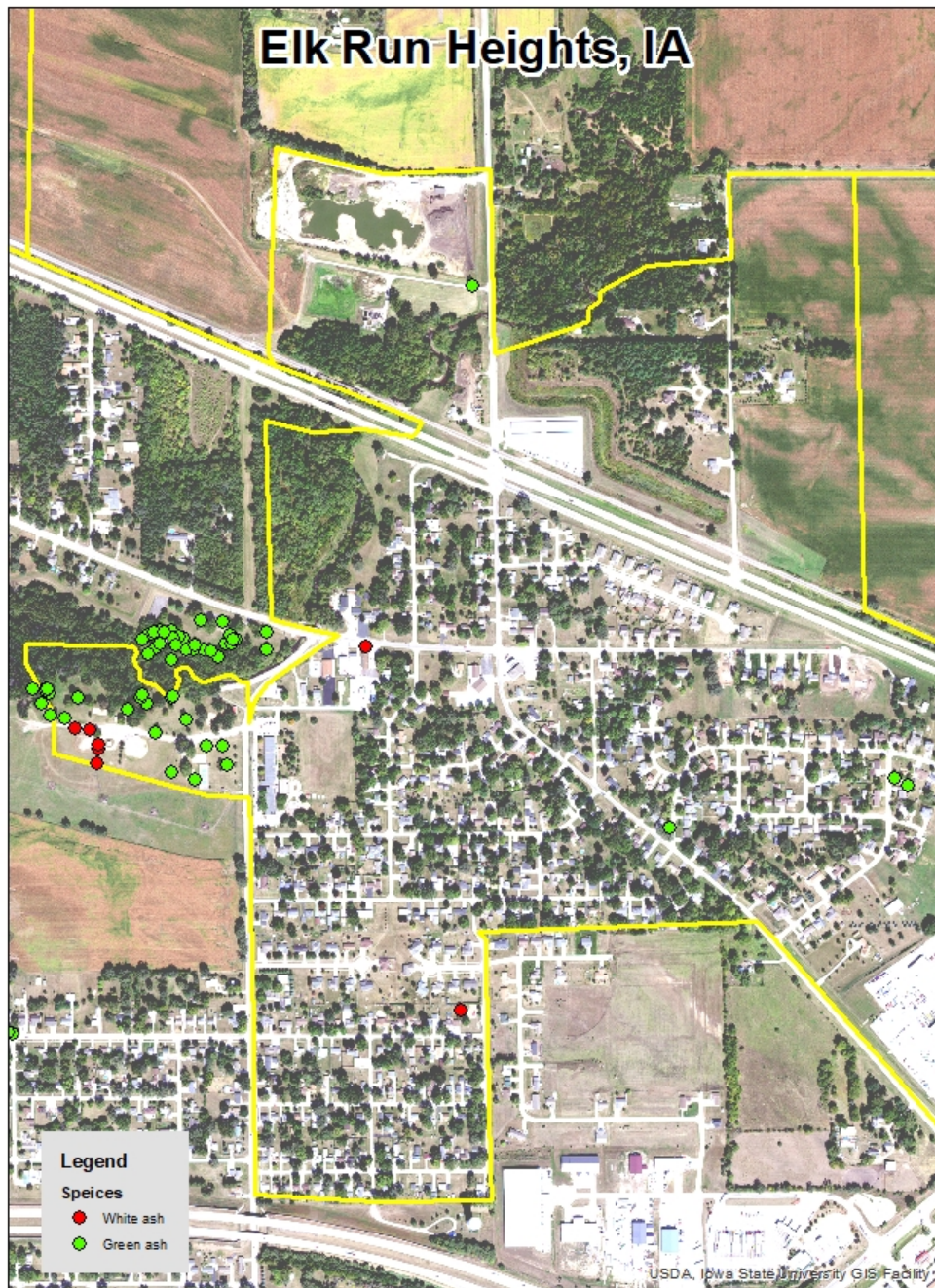**Figure 7: Location of city/park trees**

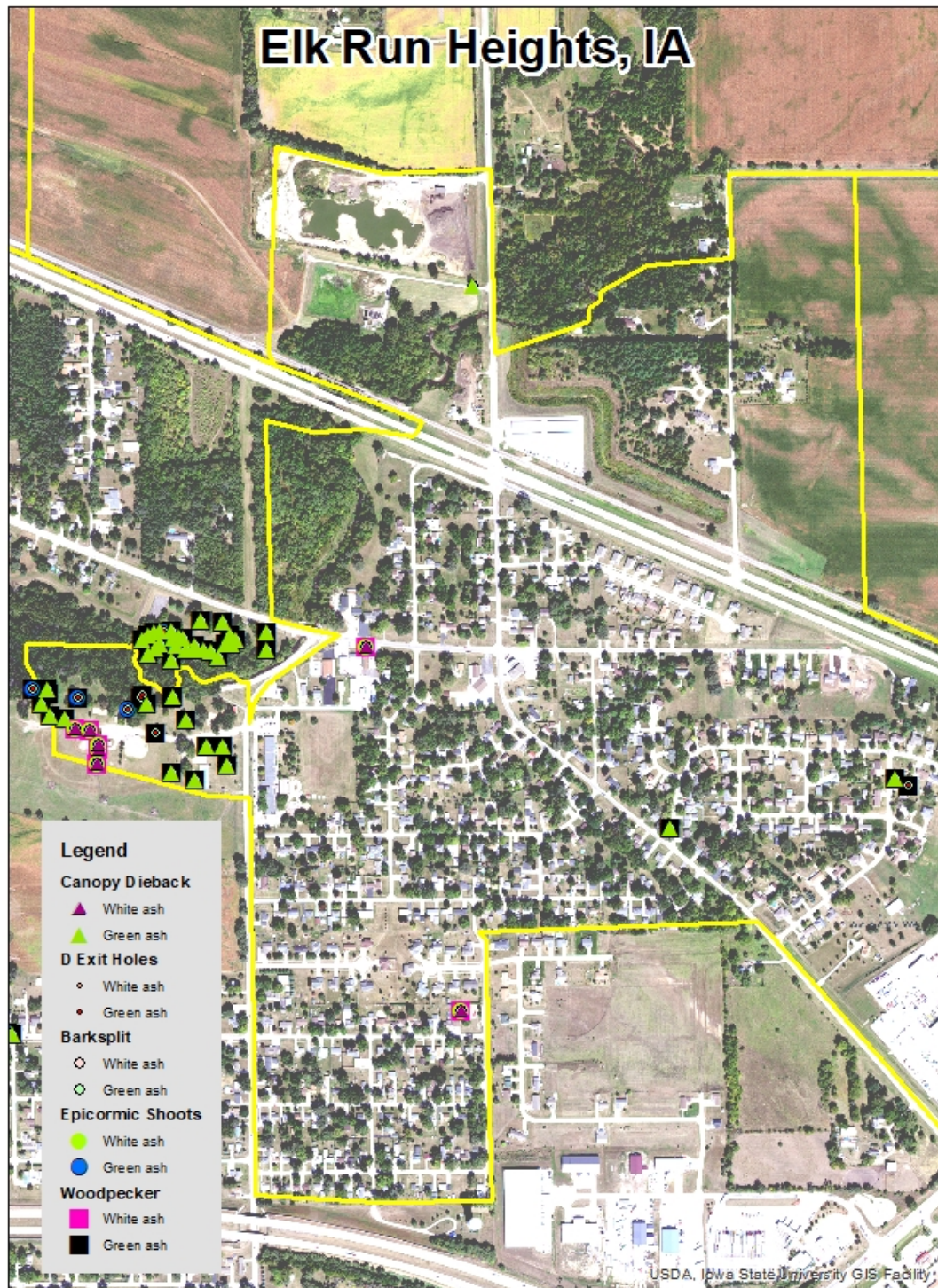**Figure 1: Location of Ash Trees**
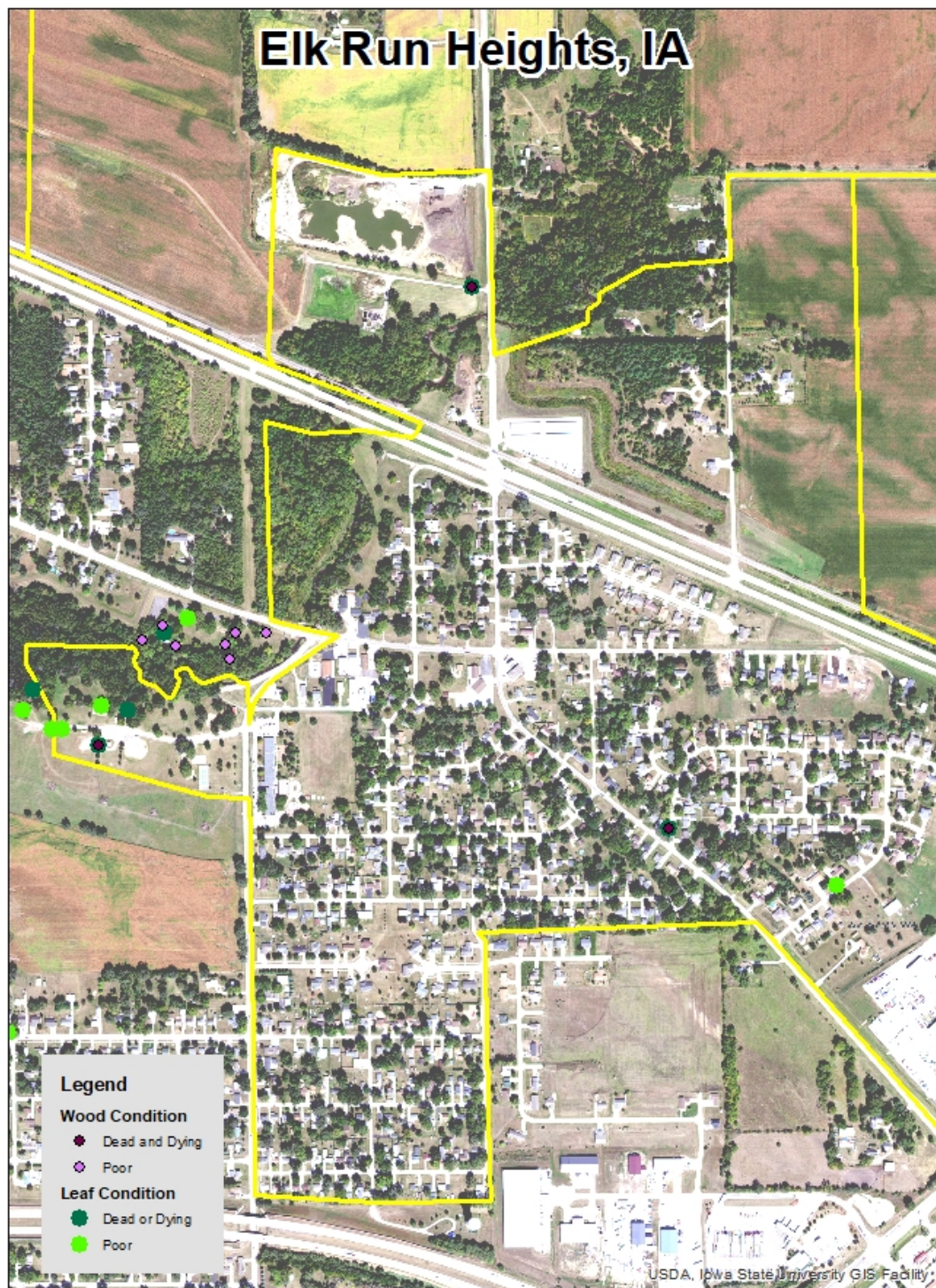
Figure 2: Location of EAB symptoms
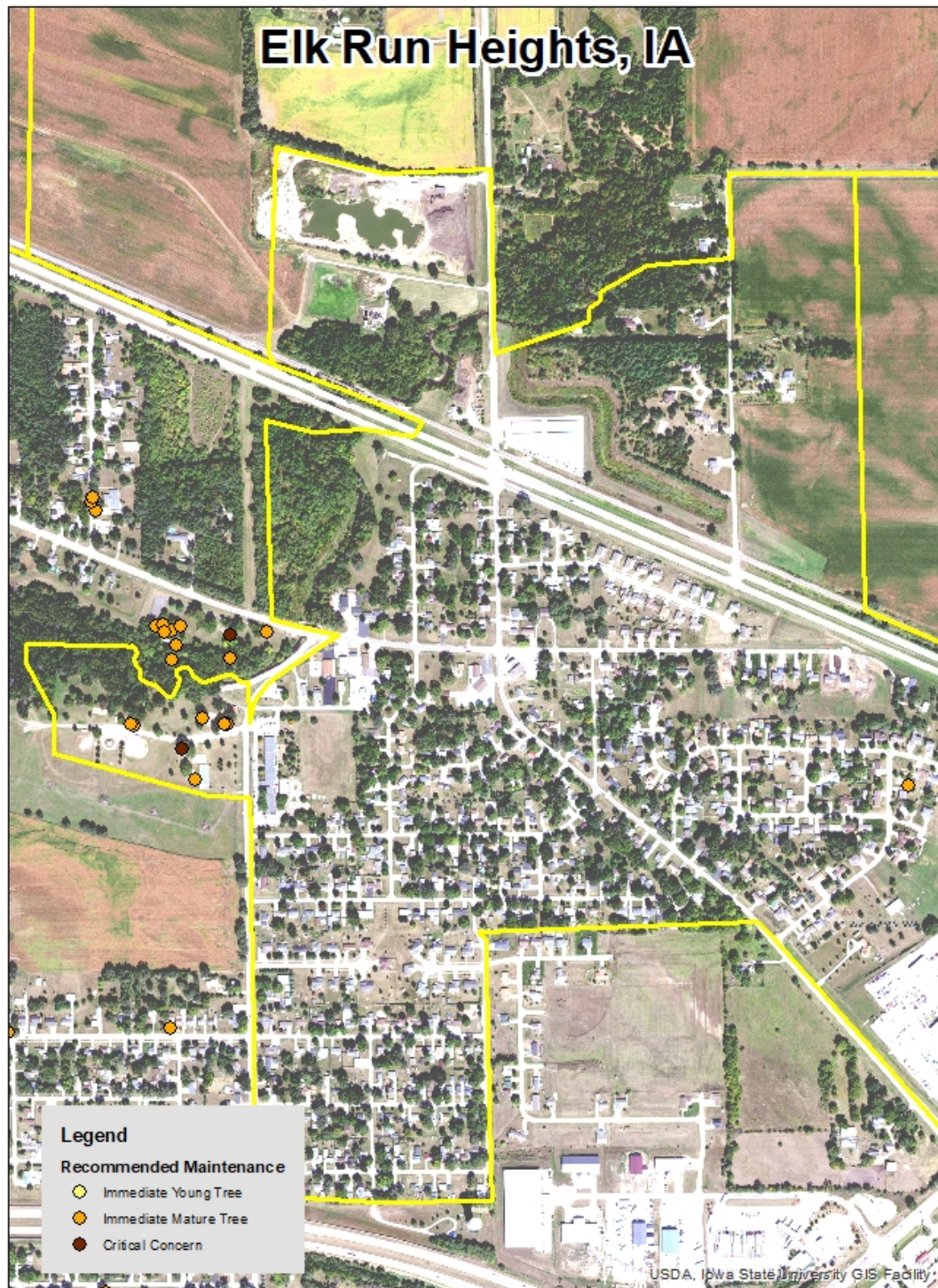
Figure 3: Location of Poor Condition Trees

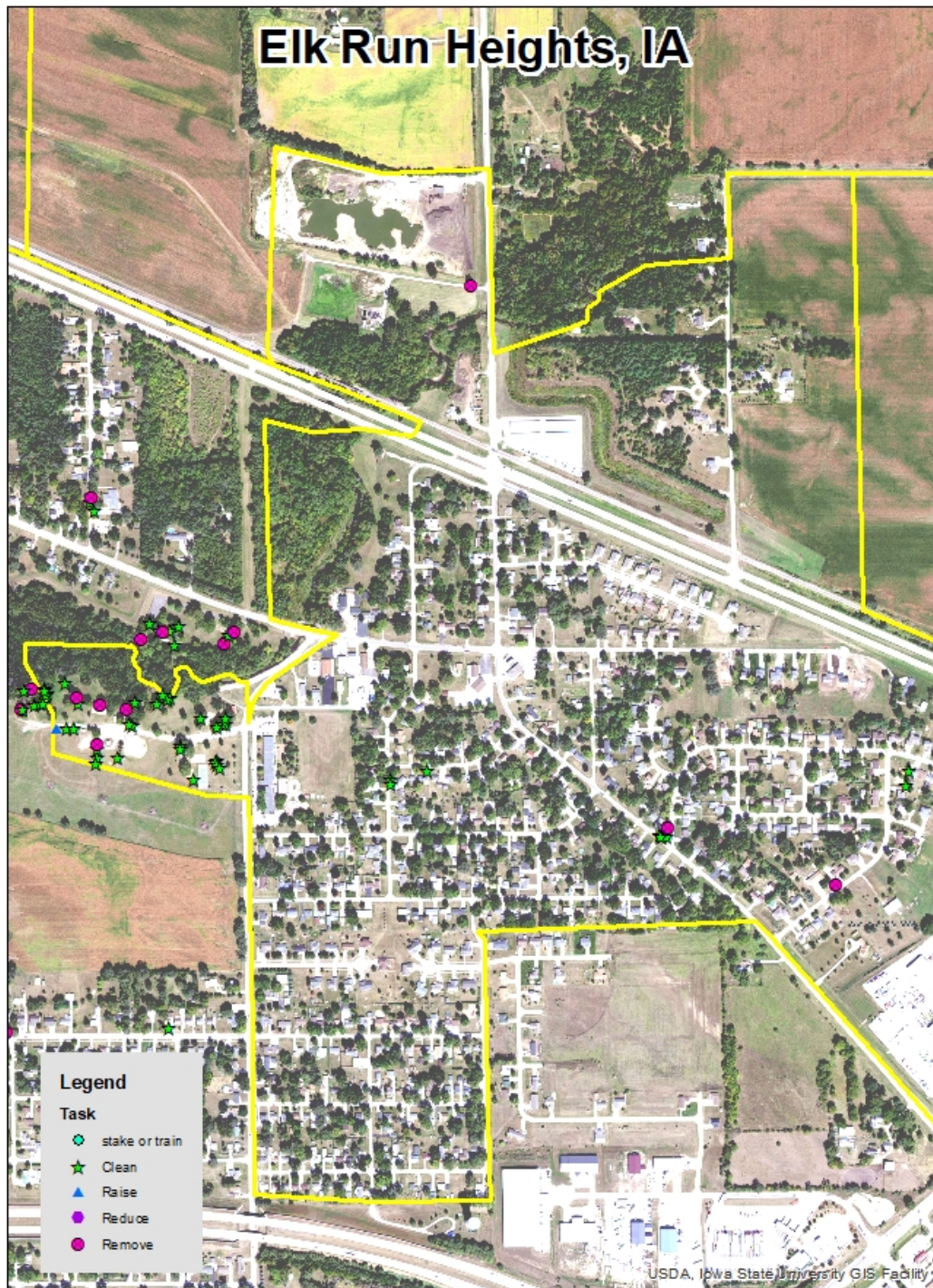**Figure 4: Location of Trees with Recommended Maintenance**

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

Appendix C: Elk Run Heights Tree Ordinances

None

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