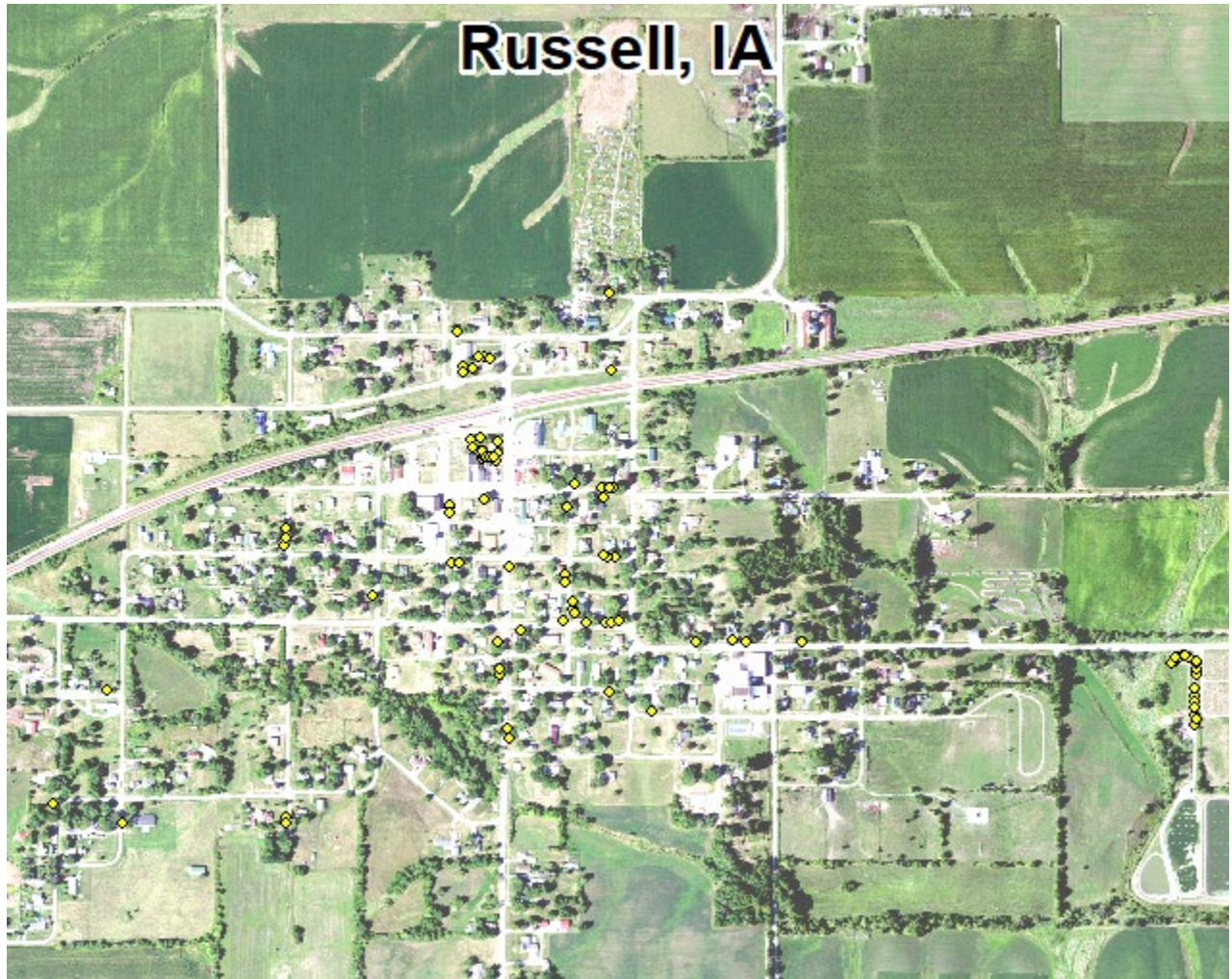


Russell



2020 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Russell 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 take best 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). Russell has already removed city owned ash trees so this plan will focus on the remaining city owned trees throughout the community. 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, 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 94 trees inventoried.

- Russell's trees provide \$17,100 of benefits annually, an average of \$182 a tree
- There are over 19 species of trees and NO ash
- The top three genera are: Maples 34%, Oaks 25%, and Pines 12%
- 22% of trees are in need of some type of management
- 11 trees are recommended for removal

Recommendations

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

- Of the 11 trees needing removal, 1 tree is over 24 inches in diameter at 4.5 feet and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- All trees should be pruned on a routine schedule- one third of the city every other year
- Continue planting trees throughout Russell. Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut

Introduction

This plan was developed to assist Russell 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 due to the Emerald Ash Borer (EAB), an invasive pest that kills native ash trees. With proper planning and management of the current canopy in Russell, the costs associated with tree maintenance and replacement may be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2019, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

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

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 feet, 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 94 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. Russell's trees reduce energy related costs by approximately \$4,062 annually and average \$43.21 per tree (Appendix A, Table 1). These savings are both in Electricity (19.3 MWh) and in Natural Gas (2,649 Therms).

Annual Stormwater Benefits

Russell's trees intercept about 229,064 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$6,208 of benefits to the city and average \$66.04 per tree.

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 Russell, it is estimated that trees remove 238 lbs. of air pollution (ozone (O₃), particulate matter less than 10 microns (PM₁₀), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂)) per year with a net value of \$653 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Russell, trees sequester about 92,677 lbs. of carbon a year with an associated value of \$695 (Appendix A, Table 5). In addition, the trees store 890,868 lbs. of carbon, with a yearly benefit of \$6,682 (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. Russell receives \$5,482 in annual social benefits from trees with an average \$58.32 per tree. (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Russell's trees provide \$17,100 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 94 trees in Russell provide approximately \$182 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Russell has over 19 different tree species along city streets and parks (Appendix A, Figure 1).

Pests commonly attack trees within a genus. A good guideline for healthy, diverse urban forests is to have $\leq 20\%$ of a genus and $\leq 10\%$ of any one species. The distribution of trees by genera is as follows:

Maples	32	34
Oaks	24	25
Pines	11	12
All others	27	29

Age Class

Russell’s age class and size distributions are on track. Continue planting new trees to replace the older trees. The largest representations (34%) are between 6 and 18 inches in diameter at 4.5 feet (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.

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 Russell indicate that 84% of the trees are in good or fair health, with 16% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 76% of Russell’s trees are in good or fair health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 25% of the population.

Management Needs

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

Tree Removal	11	12%
Crown Cleaning	9	10%
Crown Raising	1	1%
Tree Staking	0	
Crown Reduction	0	

Canopy Cover

The total canopy with both private and public trees is 19%, 124 acres. The canopy cover included in the Russell inventory includes approximately 2.3 acres (Appendix A, Figure 4). The City’s Canopy goal should be to increase canopy by 1%, in 30 years. To achieve this goal, it is estimated that 16 trees need to be planted annually on public and private lands.

Land Use and Location

The majority of Russell's city and park trees are in planting strips 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.

<u>Land Use</u>	
Single family residential	100%
Park/vacant/other	0
Industrial/Large commercial	0%
Small commercial	0%
Multifamily residential	0%

<u>Location</u>	
Planting strip	64%
Front yard	36%
Other maintained locations	0%
Cutout (surrounded by pavement)	0%

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

Russell has NO critical concern trees that need immediate removal. This shown 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.

Poor tree species

Because there are no critical concern or ash trees, poorest health trees should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). There are a total of 9 trees that are dead or dying and 2 more 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 Russell.

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 (34%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered below 30% for the entire family. 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.

Continual Monitoring

Due to the ongoing threat of insects and diseases, it is important to check the health of all trees. It is recommended that all trees be checked with a simple visual survey every year for tree decline, breakage, storm damage, or any other maintenance issues. Document your findings for any risks related to your trees. A simple report should include the address, tree issue (breakage, dying crown, etc.), likelihood of failure in 1 year, possible target or potential damage. Follow up and taking appropriate action is required.

Six Year Maintenance Plan

Year 1

Removal: 3 immediate removals
Planting and Replacement: 4 trees to be planted in open locations
Young Tree Pruning & Maintenance: 4
Visual Survey for risk trees

Year 2

Removal: 3 immediate removals
Planting and Replacement: 4 trees to be planted from previous removals
Young Tree Pruning & Maintenance: 4
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for risk trees

Year 3

Removal: 3 immediate removals
Planting and Replacement: 4 trees to be planted from previous removals
Young Tree Pruning & Maintenance: 4
Visual Survey for risk trees

Year 4

Removal: 2 routine removals
Planting and Replacement: 3 trees to be planted from previous removals
Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance: 3
Visual Survey for risk trees

Year 5

Removal: removal of any new critical concern trees
Planting and Replacement: 3 to increase tree canopy
Young Tree Pruning & Maintenance: 3
Visual Survey for risk trees

Year 6

Removal: removal of any new critical concern trees
Planting and Replacement: 3 to increase tree canopy
Young Tree Pruning & Maintenance: 3
Visual Survey for risk trees
Routine trimming: Contract to trim 1/3 of the city trees

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 because EAB is well established throughout the area. 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? Lucas County is within the statewide 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 must meet the restrictions in city ordinances. 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 sometimes 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 continue removing ash trees on their property if preventative treatments are not being used.

Suggested Budget

Total \$23,250 over 6 years (\$3,875/year)

Year 1 Budget

Removal: \$3,600

Planting: \$400

Watering & Maintenance: \$100

Year 2 Budget

Removal: \$3,600

Planting: \$400

Routine trimming: 28 trees, \$2,075

Watering & Maintenance: \$100

Year 3 Budget

Removal: \$3,600

Planting: \$400

Watering & Maintenance: \$100

Year 4 Budget

Removal: \$1,800

Planting: \$300

Routine trimming: \$2,075

Watering & Maintenance: \$75

Year 5 Budget

Removal: \$900 if needed

Planting: \$300

Watering & Maintenance: \$75

Year 6 Budget

Removal: \$900 if needed

Planting: \$300

Routine trimming: \$2,075

Watering & Maintenance: \$75

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Russell

Annual Energy Benefits of Public Trees

3/30/2020

Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	7.2	545	944.8	926	1,471	(N/A)	21.3	36.2	73.55
Pin oak	4.0	307	534.5	524	831	(N/A)	11.7	20.5	75.52
Eastern white pine	0.6	49	103.0	101	150	(N/A)	11.7	3.7	13.64
Conifer Evergreen Medium	0.6	43	91.8	90	133	(N/A)	9.6	3.3	14.80
Norway maple	1.9	148	281.5	276	424	(N/A)	8.5	10.4	52.95
Swamp white oak	0.5	40	77.3	76	116	(N/A)	7.4	2.9	16.60
Bur oak	0.1	5	8.8	9	14	(N/A)	5.3	0.3	2.72
Broadleaf Deciduous Small	0.2	11	26.3	26	37	(N/A)	3.2	0.9	12.42
Siberian elm	0.8	64	111.3	109	173	(N/A)	3.2	4.3	57.58
Sugar maple	0.0	1	2.1	2	3	(N/A)	3.2	0.1	1.00
Littleleaf linden	0.5	34	67.6	66	101	(N/A)	2.1	2.5	50.34
Catalpa	0.7	50	93.7	92	142	(N/A)	2.1	3.5	70.91
Northern hackberry	0.7	51	99.0	97	148	(N/A)	2.1	3.6	74.08
Black walnut	0.4	27	51.8	51	78	(N/A)	2.1	1.9	38.98
Honeylocust	0.3	21	33.4	33	54	(N/A)	1.1	1.3	53.77
Kentucky coffeetree	0.3	25	46.9	46	71	(N/A)	1.1	1.7	70.91
River birch	0.1	8	16.9	17	24	(N/A)	1.1	0.6	24.47
Northern red oak	0.2	15	23.3	23	38	(N/A)	1.1	0.9	37.72
Callery pear	0.2	18	29.5	29	47	(N/A)	1.1	1.2	46.78
Red maple	0.0	3	5.2	5	8	(N/A)	1.1	0.2	7.85
Total	19.3	1,466	2,648.7	2,596	4,062	(N/A)	100.0	100.0	43.21

Table 2: Annual Stormwater Benefits

Russell

Annual Stormwater Benefits of Public Trees

3/30/2020

Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	104,317	2,827	(N/A)	21.3	45.5	141.35
Pin oak	49,963	1,354	(N/A)	11.7	21.8	123.09
Eastern white pine	9,412	255	(N/A)	11.7	4.1	23.19
Conifer Evergreen Medium	6,799	184	(N/A)	9.6	3.0	20.47
Norway maple	17,086	463	(N/A)	8.5	7.5	57.88
Swamp white oak	2,809	76	(N/A)	7.4	1.2	10.87
Bur oak	397	11	(N/A)	5.3	0.2	2.15
Broadleaf Deciduous Small	536	15	(N/A)	3.2	0.2	4.85
Siberian elm	7,020	190	(N/A)	3.2	3.1	63.41
Sugar maple	33	1	(N/A)	3.2	0.0	0.29
Littleleaf linden	4,733	128	(N/A)	2.1	2.1	64.13
Catalpa	7,886	214	(N/A)	2.1	3.4	106.85
Northern hackberry	6,051	164	(N/A)	2.1	2.6	81.99
Black walnut	3,199	87	(N/A)	2.1	1.4	43.34
Honeylocust	1,557	42	(N/A)	1.1	0.7	42.19
Kentucky coffeetree	3,943	107	(N/A)	1.1	1.7	106.85
River birch	586	16	(N/A)	1.1	0.3	15.88
Northern red oak	1,193	32	(N/A)	1.1	0.5	32.34
Gallery pear	1,409	38	(N/A)	1.1	0.6	38.19
Red maple	137	4	(N/A)	1.1	0.1	3.72
Citywide total	229,064	6,208	(N/A)	100.0	100.0	66.04

Table 3: Annual Air Quality Benefits

Russell

Annual Air Quality Benefits of Public Trees

3/30/2020

Species	Deposition (lb)				Total Depos. (\$)	Avoided (lb)				Total Avoided (\$)	BVOC Emissions (lb)	BVOC Emissions (\$)	Total (lb)	Total (\$)	Standard Error	% of Total Trees	Avg. \$/tree
	O ₃	NO ₂	PM ₁₀	SO ₂		NO ₂	PM ₁₀	VOC	SO ₂								
Silver maple	18.8	3.2	9.2	0.8	101	33.9	5.0	4.7	32.5	212	-9.9	-37	98.2	276	(N/A)	21.3	13.81
Pin oak	9.4	1.6	4.7	0.4	51	19.1	2.8	2.7	18.3	120	-17.3	-65	41.9	106	(N/A)	11.7	9.64
Eastern white pine	0.9	0.2	0.9	0.1	6	3.2	0.5	0.4	2.9	20	-4.2	-16	5.0	10	(N/A)	11.7	0.95
Conifer Evergreen Medium	0.6	0.1	0.6	0.1	4	2.8	0.4	0.4	2.6	17	-2.1	-8	5.5	14	(N/A)	9.6	1.53
Norway maple	3.3	0.6	1.7	0.1	18	9.4	1.4	1.3	8.8	58	-0.8	-3	25.8	74	(N/A)	8.5	9.19
Swamp white oak	0.3	0.1	0.2	0.0	2	2.6	0.4	0.4	2.4	16	-0.1	0	6.2	17	(N/A)	7.4	2.49
Bur oak	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.7	2	(N/A)	5.3	0.40
Broadleaf Deciduous Small	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.7	5	0.0	0	1.8	5	(N/A)	3.2	1.73
Siberian elm	0.9	0.2	0.5	0.0	5	4.0	0.6	0.6	3.8	25	0.0	0	10.5	30	(N/A)	3.2	9.90
Sugar maple	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	0.0	0	0.1	0	(N/A)	3.2	0.13
Littleleaf linden	0.8	0.1	0.4	0.0	4	2.2	0.3	0.3	2.1	14	-0.4	-1	5.8	16	(N/A)	2.1	8.23
Catalpa	1.0	0.2	0.5	0.0	5	3.2	0.5	0.4	3.0	20	0.0	0	8.7	25	(N/A)	2.1	12.48
Northern hackberry	0.9	0.1	0.5	0.0	5	3.3	0.5	0.5	3.1	20	0.0	0	8.8	25	(N/A)	2.1	12.53
Black walnut	0.3	0.0	0.2	0.0	2	1.7	0.3	0.2	1.6	11	0.0	0	4.4	12	(N/A)	2.1	6.17
Honeylocust	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.3	8	-0.2	-1	3.2	9	(N/A)	1.1	8.90
Kentucky coffeetree	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12	(N/A)	1.1	12.48
River birch	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3	(N/A)	1.1	3.47
Northern red oak	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.9	6	-0.3	-1	2.1	6	(N/A)	1.1	5.79
Gallery pear	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)	1.1	7.92
Red maple	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1	(N/A)	1.1	1.12
Citywide total	38.6	6.6	19.9	1.8	211	92.2	13.4	12.8	87.5	574	-35.3	-132	237.5	653	(N/A)	100.0	6.95

Table 4: Annual Carbon Stored

Russell

Stored CO₂ Benefits of Public Trees

3/30/2020

Species	Total Stored CO ₂ (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	442,413	3,318	(N/A)	21.3	49.7	165.90
Pin oak	254,945	1,912	(N/A)	11.7	28.6	173.83
Eastern white pine	9,402	71	(N/A)	11.7	1.1	6.41
Conifer Evergreen Medium	2,558	19	(N/A)	9.6	0.3	2.13
Norway maple	54,410	408	(N/A)	8.5	6.1	51.01
Swamp white oak	5,817	44	(N/A)	7.4	0.7	6.23
Bur oak	407	3	(N/A)	5.3	0.0	0.61
Broadleaf Deciduous Small	1,830	14	(N/A)	3.2	0.2	4.57
Siberian elm	22,025	165	(N/A)	3.2	2.5	55.06
Sugar maple	51	0	(N/A)	3.2	0.0	0.13
Littleleaf linden	16,436	123	(N/A)	2.1	1.8	61.63
Catalpa	31,546	237	(N/A)	2.1	3.5	118.30
Northern hackberry	12,189	91	(N/A)	2.1	1.4	45.71
Black walnut	9,492	71	(N/A)	2.1	1.1	35.60
Honeylocust	3,037	23	(N/A)	1.1	0.3	22.78
Kentucky coffeetree	15,773	118	(N/A)	1.1	1.8	118.30
River birch	1,101	8	(N/A)	1.1	0.1	8.26
Northern red oak	3,595	27	(N/A)	1.1	0.4	26.96
Callery pear	3,624	27	(N/A)	1.1	0.4	27.18
Red maple	218	2	(N/A)	1.1	0.0	1.64
Citywide total	890,868	6,682	(N/A)	100.0	100.0	71.08

Table 5: Annual Carbon Sequestered

Russell

Annual CO₂ Benefits of Public Trees

3/30/2020

Species	Sequestered (lb)	Sequestered (\$)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released (\$)	Avoided (lb)	Avoided (\$)	Net Total (lb)	Total Standard (\$ Error)	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	31,320	235	-2,124	-80	-17	12,049	90	41,164	309 (N/A)	21.3	44.4	15.44
Pin oak	18,942	142	-1,224	-44	-10	6,783	51	24,457	183 (N/A)	11.7	26.4	16.68
Eastern white pine	678	5	-45	-13	0	1,085	8	1,705	13 (N/A)	11.7	1.8	1.16
Conifer Evergreen Medium	348	3	-12	-11	0	956	7	1,281	10 (N/A)	9.6	1.4	1.07
Norway maple	3,246	24	-261	-20	-2	3,265	24	6,229	47 (N/A)	8.5	6.7	5.84
Swamp white oak	1,088	8	-31	-6	0	893	7	1,944	15 (N/A)	7.4	2.1	2.08
Bur oak	156	1	-2	-2	0	110	1	263	2 (N/A)	5.3	0.3	0.39
Broadleaf Deciduous Small	236	2	-9	-3	0	254	2	479	4 (N/A)	3.2	0.5	1.20
Siberian elm	1,439	11	-106	-8	-1	1,406	11	2,731	20 (N/A)	3.2	2.9	6.83
Sugar maple	56	0	0	-1	0	20	0	75	1 (N/A)	3.2	0.1	0.19
Littleleaf linden	1,579	12	-79	-5	-1	760	6	2,254	17 (N/A)	2.1	2.4	8.45
Catalpa	1,714	13	-151	-7	-1	1,105	8	2,660	20 (N/A)	2.1	2.9	9.97
Northern hackberry	853	6	-59	-6	0	1,131	8	1,919	14 (N/A)	2.1	2.1	7.20
Black walnut	868	7	-46	-4	0	600	5	1,419	11 (N/A)	2.1	1.5	5.32
Honeylocust	474	4	-15	-2	0	466	3	924	7 (N/A)	1.1	1.0	6.93
Kentucky coffeetree	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	1.1	1.4	9.97
River birch	224	2	-5	-1	0	176	1	393	3 (N/A)	1.1	0.4	2.95
Northern red oak	281	2	-17	-2	0	329	2	591	4 (N/A)	1.1	0.6	4.43
Callery pear	386	3	-17	-2	0	395	3	762	6 (N/A)	1.1	0.8	5.71
Red maple	39	0	-1	-1	0	60	0	97	1 (N/A)	1.1	0.1	0.73
Citywide total	64,783	486	-4,280	-221	-34	32,394	243	92,677	695 (N/A)	100.0	100.0	7.39

Table 6: Annual Social and Aesthetic Benefits**Russell****Annual Aesthetic/Other Benefits of Public Trees**

3/30/2020

Species	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Silver maple	2,358	(N/A)	21.3	43.0	117.90
Pin oak	1,403	(N/A)	11.7	25.6	127.54
Eastern white pine	155	(N/A)	11.7	2.8	14.06
Conifer Evergreen Medium	190	(N/A)	9.6	3.5	21.08
Norway maple	308	(N/A)	8.5	5.6	38.53
Swamp white oak	130	(N/A)	7.4	2.4	18.54
Bur oak	45	(N/A)	5.3	0.8	9.05
Broadleaf Deciduous Small	13	(N/A)	3.2	0.2	4.28
Siberian elm	118	(N/A)	3.2	2.2	39.32
Sugar maple	1	(N/A)	3.2	0.0	0.49
Littleleaf linden	163	(N/A)	2.1	3.0	81.48
Catalpa	131	(N/A)	2.1	2.4	65.59
Northern hackberry	116	(N/A)	2.1	2.1	57.91
Black walnut	86	(N/A)	2.1	1.6	43.12
Honeylocust	103	(N/A)	1.1	1.9	102.70
Kentucky coffeetree	66	(N/A)	1.1	1.2	65.59
River birch	26	(N/A)	1.1	0.5	26.22
Northern red oak	24	(N/A)	1.1	0.4	24.08
Callery pear	39	(N/A)	1.1	0.7	39.16
Red maple	7	(N/A)	1.1	0.1	7.28
Citywide total	5,482	(N/A)	100.0	100.0	58.32

Table 7: Summary of Benefits in Dollars**Russell****Total Annual Benefits of Public Trees by Species (\$)**

3/30/2020

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Silver maple	1,471	309	276	2,827	2,358	7,241	(N/A)	42.3
Pin oak	831	183	106	1,354	1,403	3,877	(N/A)	22.7
Eastern white pine	150	13	10	255	155	583	(N/A)	3.4
Conifer Evergreen Medi	133	10	14	184	190	531	(N/A)	3.1
Norway maple	424	47	74	463	308	1,315	(N/A)	7.7
Swamp white oak	116	15	17	76	130	354	(N/A)	2.1
Bur oak	14	2	2	11	45	74	(N/A)	0.4
Broadleaf Deciduous Sm	37	4	5	15	13	73	(N/A)	0.4
Siberian elm	173	20	30	190	118	531	(N/A)	3.1
Sugar maple	3	1	0	1	1	6	(N/A)	0.0
Littleleaf linden	101	17	16	128	163	425	(N/A)	2.5
Catalpa	142	20	25	214	131	532	(N/A)	3.1
Northern hackberry	148	14	25	164	116	467	(N/A)	2.7
Black walnut	78	11	12	87	86	274	(N/A)	1.6
Honeylocust	54	7	9	42	103	214	(N/A)	1.3
Kentucky coffeetree	71	10	12	107	66	266	(N/A)	1.6
River birch	24	3	3	16	26	73	(N/A)	0.4
Northern red oak	38	4	6	32	24	104	(N/A)	0.6
Callery pear	47	6	8	38	39	138	(N/A)	0.8
Red maple	8	1	1	4	7	21	(N/A)	0.1
Citywide Total	4,062	695	653	6,208	5,482	17,100	(N/A)	100.0

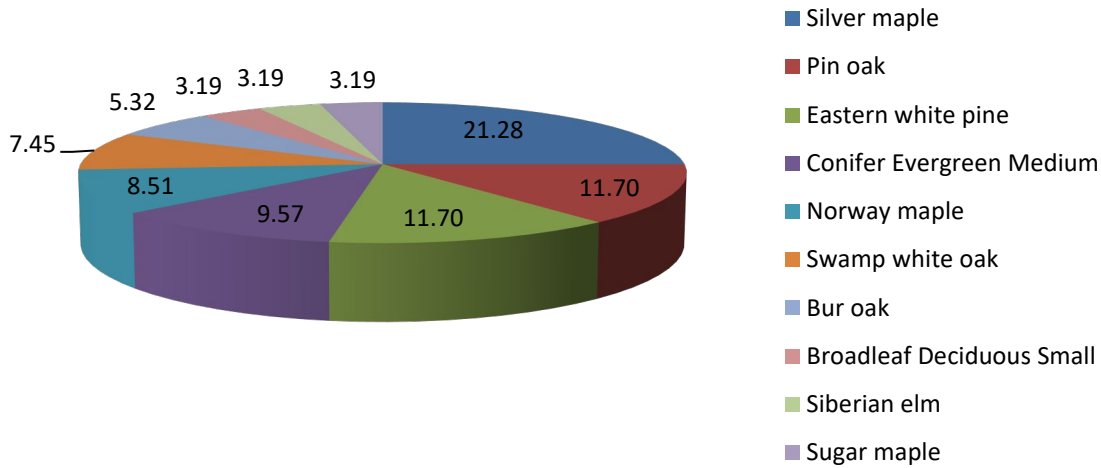


Figure 1: Species Distribution

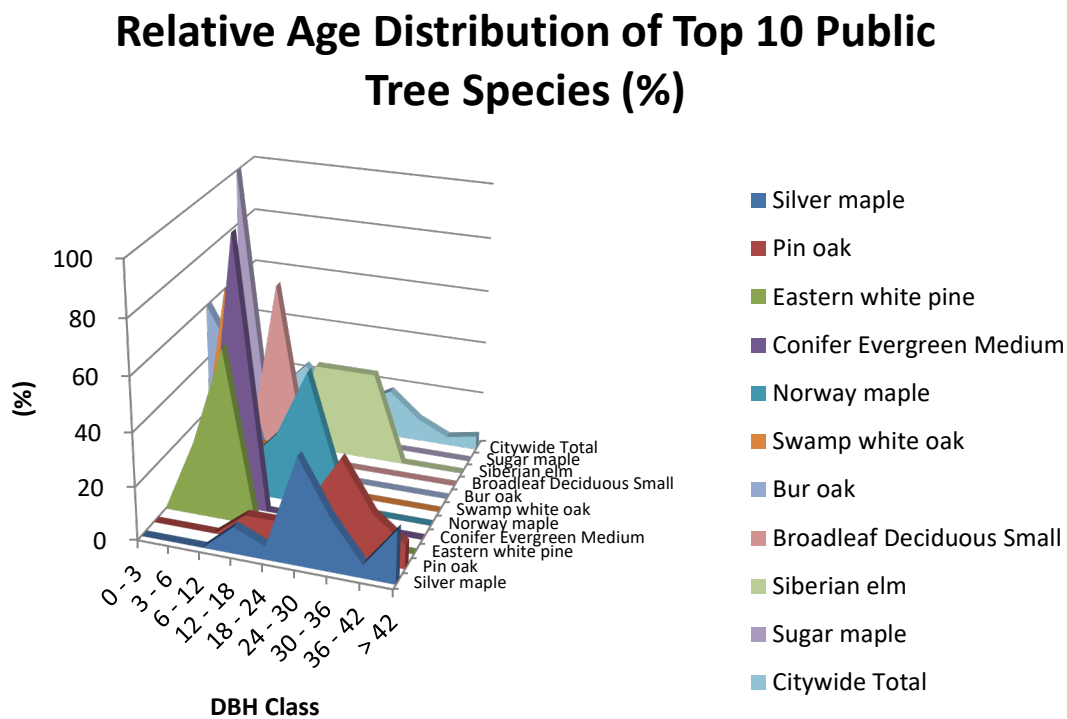


Figure 2: Relative Age Class

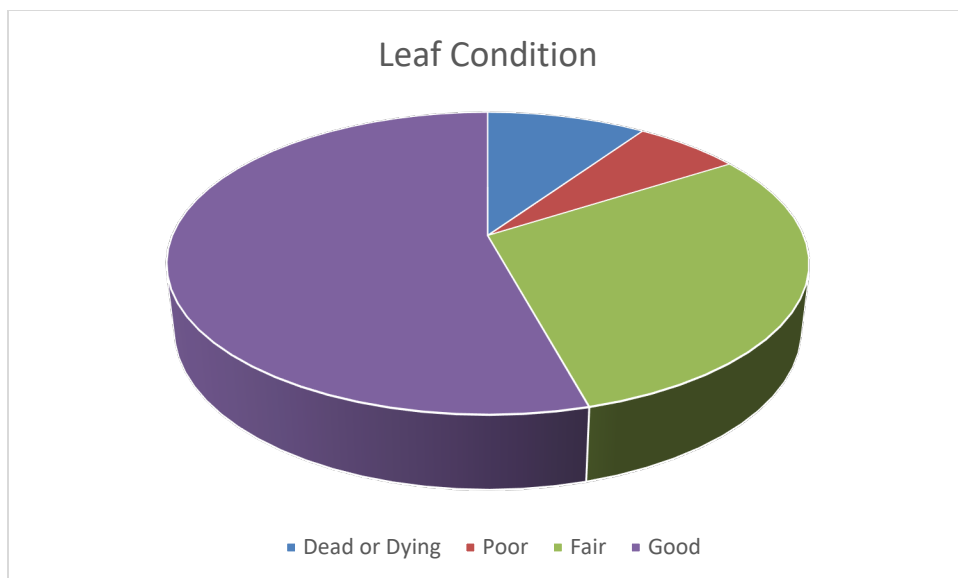


Figure 3: Foliage Condition

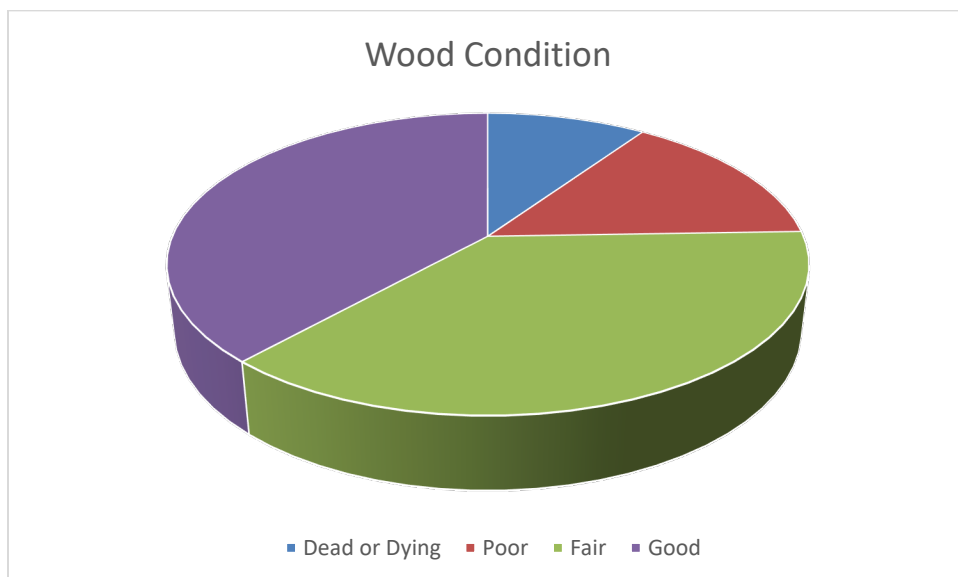


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

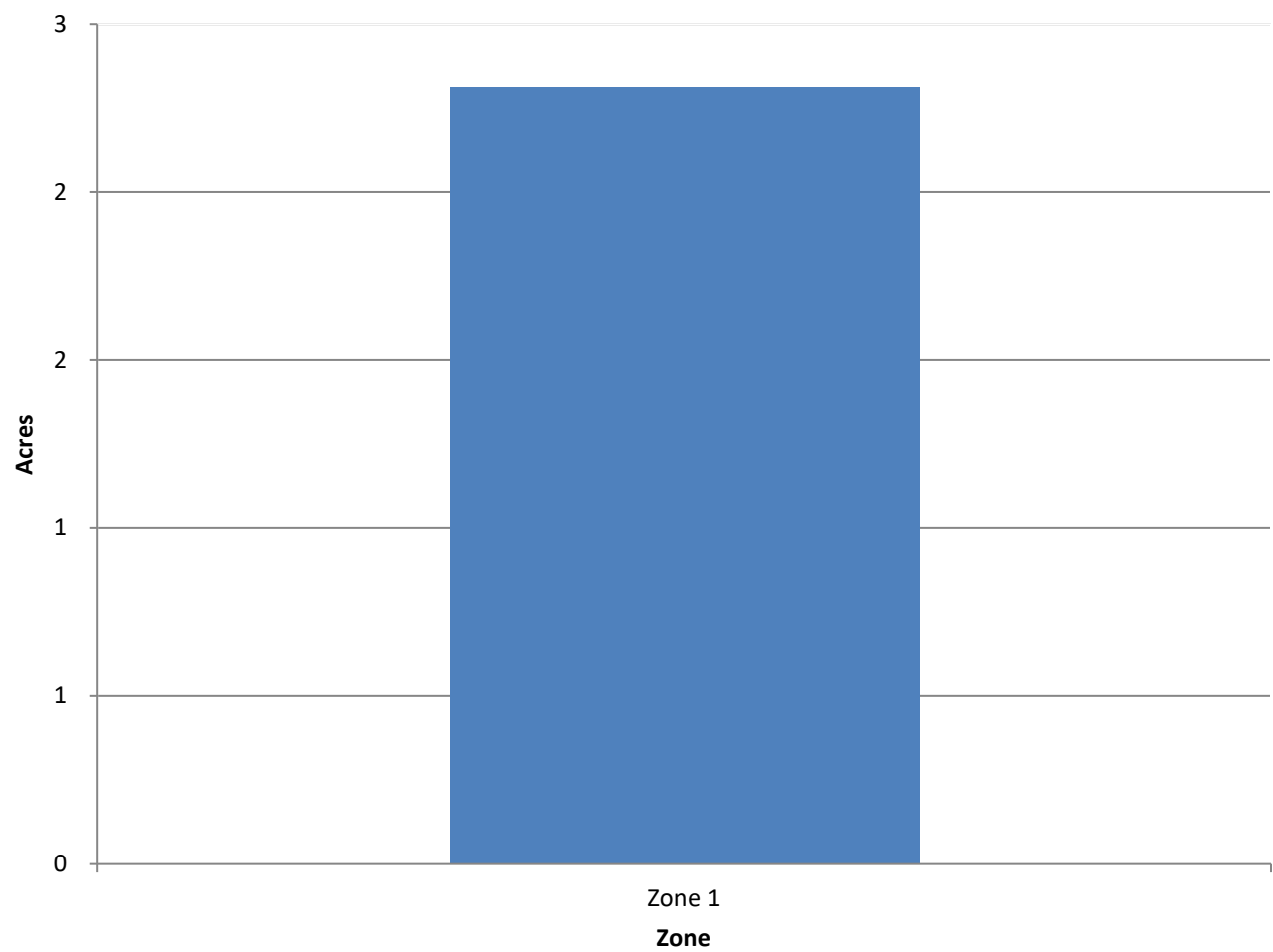


Figure 5: Canopy Cover in Acres

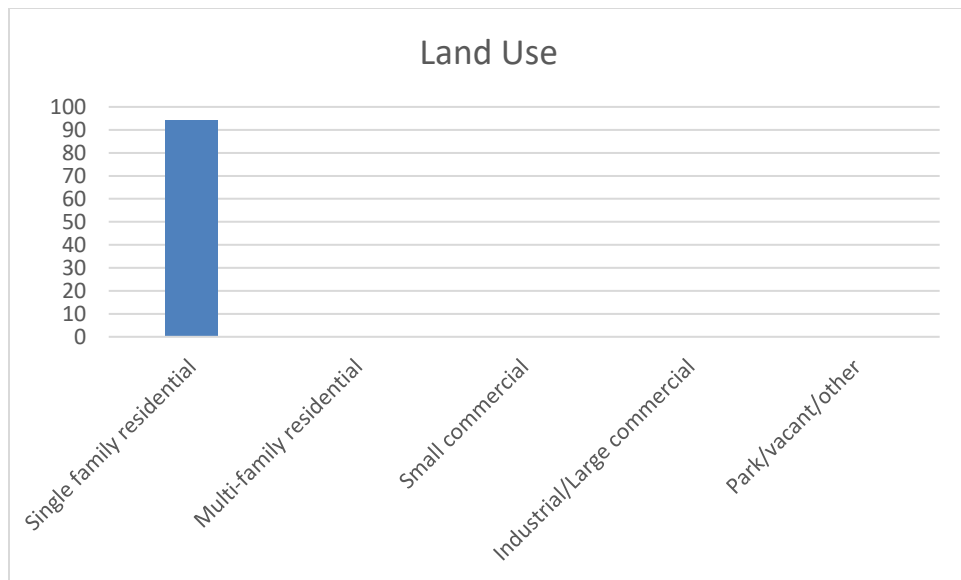


Figure 6: Land Use of city/park trees

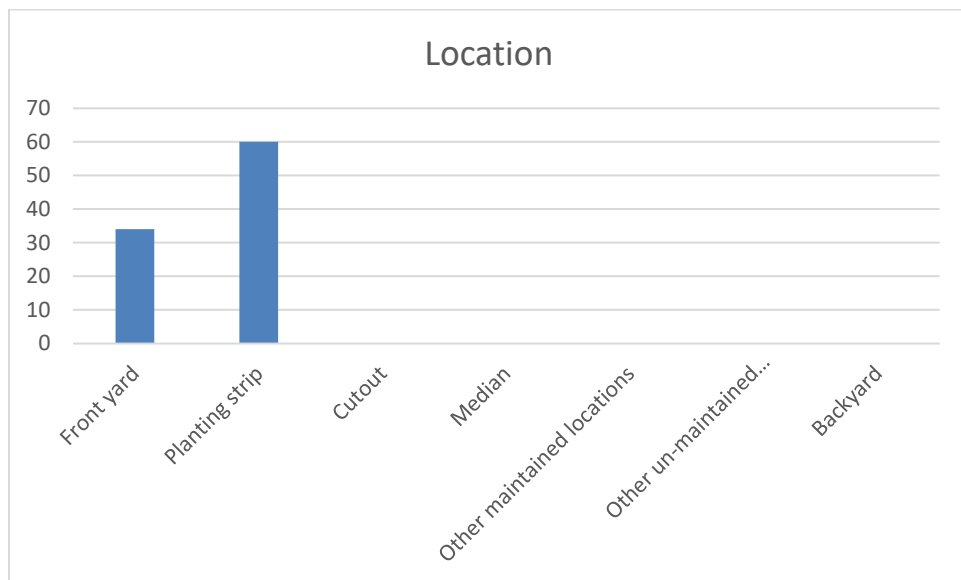


Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

No ASH

Figure 1: Location of Ash Trees

No ASH

Figure 2: Location of EAB symptoms



Figure 3: Location of Poor Condition Trees

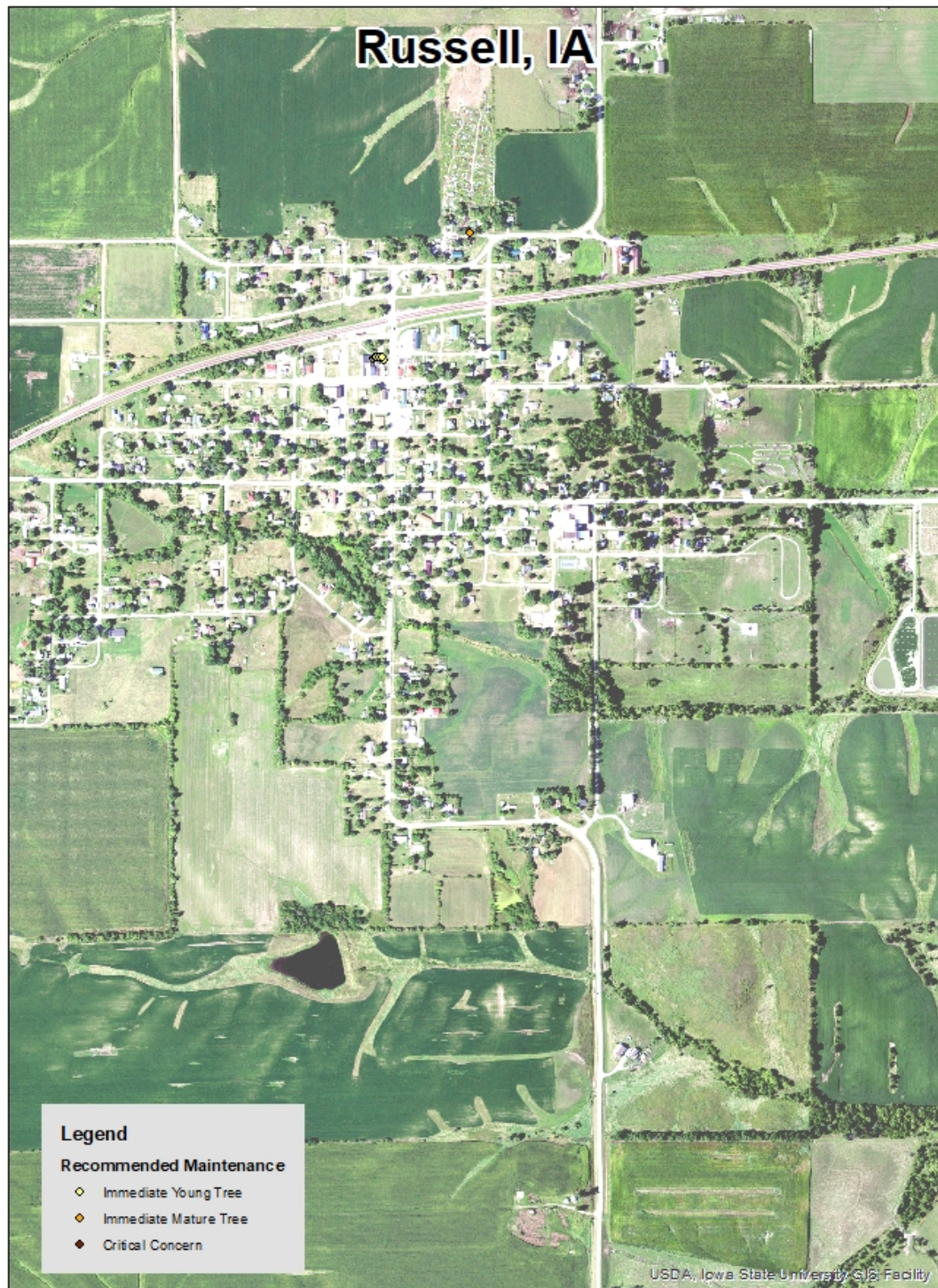


Figure 4: Location of Trees with Recommended Maintenance



Figure 5: Maintenance Tasks

City ownership of the trees recommended for removal should be verified prior to any removal

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