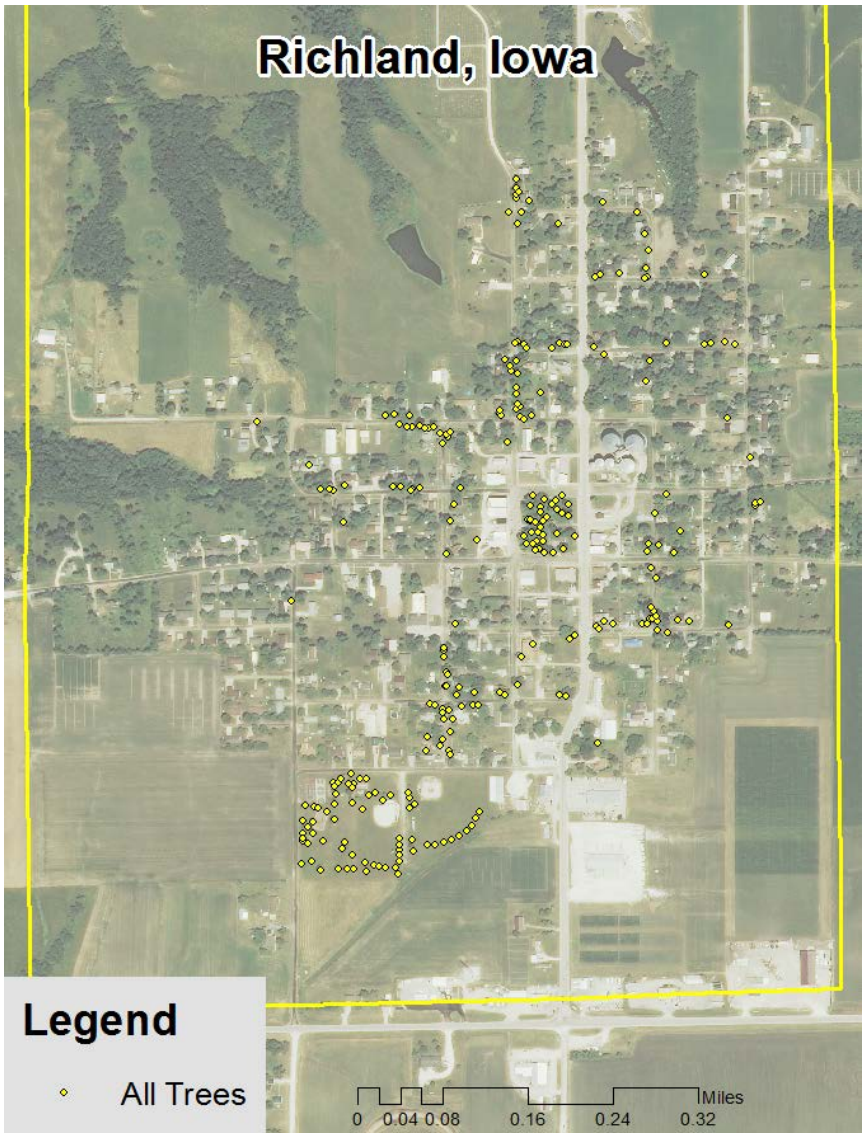
Richland, IA



2016 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Richland 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 14% of Richland'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 2015, a tree inventory was conducted by Matt Brewer, Iowa DNR, 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 262 trees inventoried.

- Richland's trees provide $49,975 of benefits annually, an average of $191 a tree
- There are over 33 species of trees
- The top three genera are: Maple 42%, Ash 14%, and Oak 14%
- 10% of trees are in need of some type of management
- 7 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 7 trees needing removal, 2 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- 8 of the 37 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
- Budget impacts from ash removal – Suggestion: request a budget increase to at least $2,600-$5,550 a year and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Richland 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 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 and replacement planting. With proper planning and management of the current canopy in Richland, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2015, a tree inventory was conducted by Matt Brewer, Iowa DNR, 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 262 city trees was entered into the USDA Forest Service program i-Tree Streets, 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. Richland's trees reduce energy related costs by approximately $12,605 annually (Appendix A, Table 1). These savings are both in Electricity (60.2 MWh) and in Natural Gas (8,196.3 Therms).

Annual Stormwater Benefits

Richland's trees intercept about 682,049 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $18,484 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 Richland, it is estimated that trees remove 768.8 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 $2,162 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Richland, trees sequester about 161,049 lbs of carbon a year with an associated value of $1,208 (Appendix A, Table 4). In addition, the trees store 2,493,166 lbs of carbon, with a yearly benefit of $18,699 (Appendix A, Table 5).

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. Richland receives $14,852 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, Richland's trees provide $49,975 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 262 trees in Richland provides approximately $191 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Richland has over 33 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	109	42%
Ash	37	14%
Oak	37	14%
Elm	13	5%
Spruce	11	4%
Aspen/Cottonwood	8	3%
Hackberry	7	3%
Honeylocust	7	3%
Black Walnut	7	3%
Apple/Crabapple	7	3%
American Sycamore	5	2%
Linden/Basswood	5	2%
Eastern Red Cedar	2	1%
Mulberry	2	1%
Birch	1	<1%
Tuliptree	1	<1%
Pine	1	<1%
Cherry/Plum	1	<1%
Pear	1	<1%

Age Class

Almost half of Richland's trees (47%) are between 18 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that a large number of trees are in the smallest size categories (a downward slope) to prepare for natural mortality and to maintain canopy cover. Richland will have an aging tree population as this 47% matures, and should consider new plantings (currently only 9% are under 6 inches in diameter) to develop the next generation of trees.

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 Richland indicate that 80% of the trees are in good health, with only 1% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Additionally, 67% of Richland'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 10% of the population. This 10% 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	19	7%
Tree Removal	7	3%

Canopy Cover

The total canopy with both private and public trees is 18% (89 acres). The canopy cover included in the Richland inventory includes approximately 7 acres (Appendix A, Figure 4).

Land Use and Location

The majority of Richland's city and park trees are in yard settings in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use	
Single family residential	60%
Park/vacant/other	39%
Small commercial	<1%

Location	
Front yard	57%
Planting strip	43%

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

Richland has 1 critical concern tree which needs immediate removal. This tree 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 the critical concern tree is addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 26 trees with these needs.

Poor tree species

After the removal of the critical concern tree, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 7 removals, 2 are ash trees. There are a total of 37 ash trees, and 8 of those have signs and symptoms that have been associated with EAB. In addition, there are 9 ash 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.

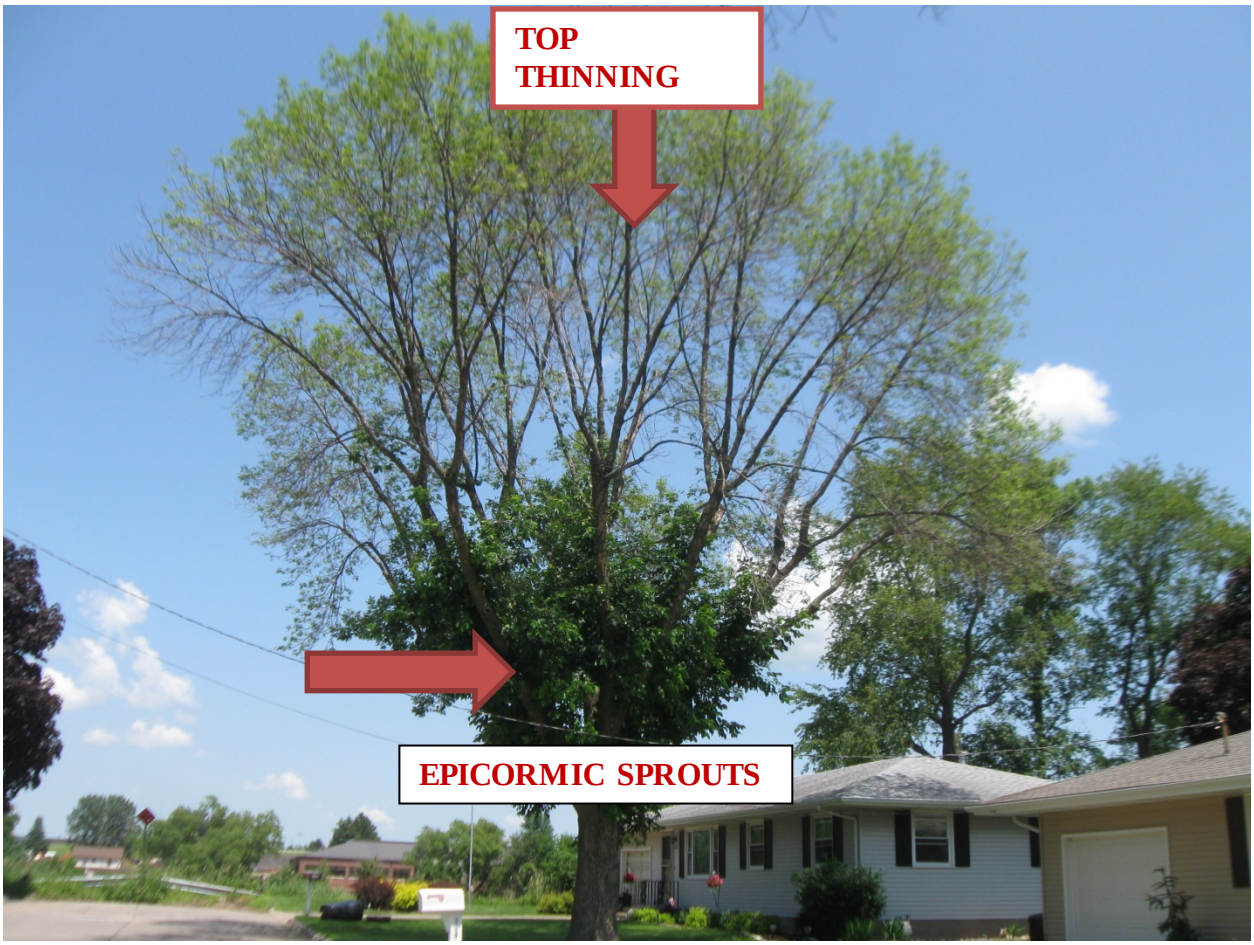
Planting

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant at least 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 or greater number of trees helps ensure continuation of the benefits of the existing forest in Richland.

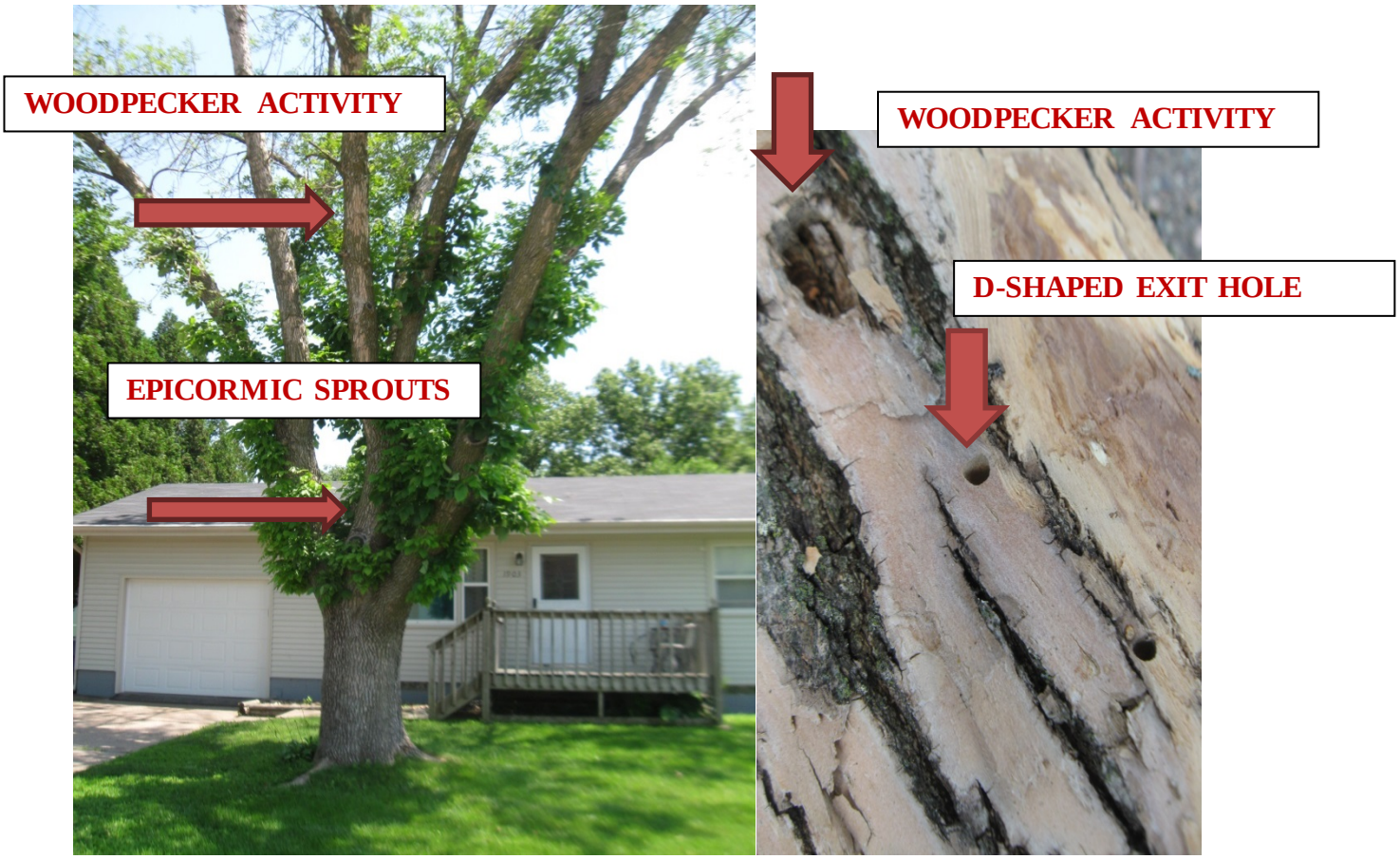
It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 10% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 5-10% of the total urban forest. Presently, the forest is heavily planted with maple (42%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut, as outlined in the city ordinance (Appendix C). All trees planted must meet the restrictions in the city ordinance (Appendix C).

Continual Monitoring For EAB

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 (See examples below). EAB could potentially kill all ash in Richland within 4 to 10 years.



EAB infested tree in Muscatine with top thinning and many new green epicormic sprouts



EAB infested tree in Muscatine with sprouting, wood pecker activity, and D-shaped exit holes

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 an 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.

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? The entire state of Iowa is under quarantine, so regulated articles may not be moved into non-quarantined states. For more information, please visit http://www.emeraldashborer.info/.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in the city ordinance (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

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

Monitoring

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

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB.

Six Year Maintenance Plan and Cost Estimates

Year 1 (FY 2016)

Remove 1 critical concern tree that needs immediate attention	$900
Remove 3 trees (marked for removal)	$2,700
Plant and Maintain 10 trees in open locations (pursue grants)	$1,000
Ash tree treatment (if elected), 3 trees in good condition, average 12–18"	avg. $225/tree
-$15 per inch, treated every two years, see note	
*Or saving for future ash removal	
Visual Survey for signs and symptoms of EAB	

Year 2 (FY 2017)

Remove 3 trees (marked for removal)	$2,700
Plant and Maintain 10 trees in open locations (pursue grants)	$1,000
Ash tree treatment (if elected) or saving for future ash removal	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

Year 3 (FY 2018)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected) or saving for future ash removal	
Visual Survey for signs and symptoms of EAB	

Year 4 (FY 2019)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected) or saving for future ash removal	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

Year 5 (FY 2020)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected) or saving for future ash removal	
Visual Survey for signs and symptoms of EAB	

Year 6 (FY 2021)

Remove any new critical concern trees and ash in poor health	$900/tree
Plant and Maintain 20 trees in open locations (pursue grants)	$2,000
Ash tree treatment (if elected) or saving for future ash removal	
Routine trimming: Contract to trim 1/3 of the city trees (~$300 per tree)	
Visual Survey for signs and symptoms of EAB	

*****Reduction of ash in poor health will reduce exposure to Emerald Ash Borer over time. EAB could potentially kill all ash within 4-15 years.
******Assuming a cost of $900 per tree for removal, the budget would need to be increased to $5,550 a year to remove all ash trees within 6 years.
*******Suggest a future (post ash removal and replacement) budget of at least $2 per capita (population 584). Currently, this amount would cover about 21% of what would be needed to remove EAB infested trees over a six year period. Suggest setting aside additional funds. Planting would be at least partially dependent on receiving grant funds annually.

Proposed Budget Increase

EAB could potentially kill all ash trees in Richland within 4-15 years. To remove all ash trees within 6 years the budget would need to be increased to $5,550 a year. If the budget were increased to $2,600 a year all ash could be removed within 13 years. Additionally, it is recommended that Richland 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 an example, if the average ash diameter is 20 inches and treatment costs $15 per inch, then treating 10 trees would cost about $3,000 (every other year treatment). This would be 10 trees selected for treatment, and Richland would still need to find $900 per tree for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $4,500 every two years for treatment and leave five less trees for removal (for at least two more years). 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. 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 Public Trees

1/15/2016

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	16.7	1,269	2,199.9	2,156	3,425	(N/A)	20.2	27.2	64.62
Sugar maple	7.3	558	985.0	965	1,523	(N/A)	10.7	12.1	54.39
Green ash	6.5	495	866.1	849	1,344	(N/A)	9.9	10.7	51.69
Pin oak	3.0	225	408.8	401	626	(N/A)	6.5	5.0	36.80
Maple	0.8	59	116.9	115	174	(N/A)	4.6	1.4	14.51
Norway maple	2.7	205	395.2	387	592	(N/A)	4.6	4.7	49.35
White ash	1.7	132	232.5	228	360	(N/A)	4.2	2.9	32.71
Northern red oak	1.1	86	159.0	156	242	(N/A)	3.8	1.9	24.18
Spruce	0.7	52	97.1	95	148	(N/A)	3.4	1.2	16.40
Siberian elm	3.2	239	414.4	406	645	(N/A)	3.4	5.1	71.71
Honeylocust	1.2	94	170.8	167	261	(N/A)	2.7	2.1	37.28
Black walnut	1.5	112	205.6	201	314	(N/A)	2.7	2.5	44.79
Cottonwood	2.9	217	391.6	384	601	(N/A)	2.7	4.8	85.88
Northern hackberry	2.3	172	331.8	325	497	(N/A)	2.7	3.9	71.05
Apple	0.3	19	44.2	43	63	(N/A)	2.7	0.5	8.94
Oak	1.3	100	178.5	175	275	(N/A)	2.3	2.2	45.76
American sycamore	1.6	123	223.5	219	342	(N/A)	1.9	2.7	68.40
Littleleaf linden	1.2	93	175.4	172	265	(N/A)	1.9	2.1	52.95
Elm	1.5	113	207.9	204	317	(N/A)	1.5	2.5	79.24
Bur oak	0.2	14	27.5	27	41	(N/A)	0.8	0.3	20.64
Mulberry	0.3	21	44.5	44	64	(N/A)	0.8	0.5	32.17
Red maple	0.4	28	46.6	46	74	(N/A)	0.8	0.6	36.76
Boxelder	0.5	39	71.5	70	109	(N/A)	0.8	0.9	54.38
Eastern red cedar	0.2	17	32.9	32	49	(N/A)	0.8	0.4	24.57
Blue spruce	0.1	10	20.4	20	30	(N/A)	0.8	0.2	14.80
Pear	0.0	0	0.6	1	1	(N/A)	0.4	0.0	0.87
Swamp white oak	0.1	8	16.9	17	24	(N/A)	0.4	0.2	24.47
River birch	0.2	18	29.5	29	47	(N/A)	0.4	0.4	46.78
Black cherry	0.1	6	12.8	13	18	(N/A)	0.4	0.1	18.19
White oak	0.1	7	13.7	13	21	(N/A)	0.4	0.2	20.64
Eastern white pine	0.1	10	14.6	14	24	(N/A)	0.4	0.2	24.14
Tulip tree	0.1	7	13.7	13	21	(N/A)	0.4	0.2	20.64
Eastern cottonwood	0.3	25	46.9	46	71	(N/A)	0.4	0.6	70.91
Total	60.2	4,573	8,196.3	8,032	12,605	(N/A)	100.0	100.0	48.11

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

1/15/2016

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	226,423	6,136	(N/A)	20.2	33.2	115.77
Sugar maple	78,090	2,116	(N/A)	10.7	11.4	75.58
Green ash	66,595	1,805	(N/A)	9.9	9.8	69.41
Pin oak	26,327	713	(N/A)	6.5	3.9	41.97
Maple	4,199	114	(N/A)	4.6	0.6	9.48
Norway maple	25,178	682	(N/A)	4.6	3.7	56.86
White ash	15,097	409	(N/A)	4.2	2.2	37.19
Northern red oak	8,731	237	(N/A)	3.8	1.3	23.66
Spruce	9,073	246	(N/A)	3.4	1.3	27.32
Siberian elm	33,900	919	(N/A)	3.4	5.0	102.08
Honeylocust	11,613	315	(N/A)	2.7	1.7	44.96
Black walnut	13,960	378	(N/A)	2.7	2.0	54.05
Cottonwood	43,679	1,184	(N/A)	2.7	6.4	169.10
Northern hackberry	21,323	578	(N/A)	2.7	3.1	82.55
Apple	884	24	(N/A)	2.7	0.1	3.42
Oak	15,031	407	(N/A)	2.3	2.2	67.89
American sycamore	23,167	628	(N/A)	1.9	3.4	125.56
Littleleaf linden	13,480	365	(N/A)	1.9	2.0	73.06
Elm	20,415	553	(N/A)	1.5	3.0	138.31
Bur oak	1,216	33	(N/A)	0.8	0.2	16.47
Mulberry	1,439	39	(N/A)	0.8	0.2	19.49
Red maple	2,229	60	(N/A)	0.8	0.3	30.21
Boxelder	6,257	170	(N/A)	0.8	0.9	84.78
Eastern red cedar	3,269	89	(N/A)	0.8	0.5	44.30
Blue spruce	1,511	41	(N/A)	0.8	0.2	20.47
Pear	7	0	(N/A)	0.4	0.0	0.20
Swamp white oak	586	16	(N/A)	0.4	0.1	15.88
River birch	1,409	38	(N/A)	0.4	0.2	38.19
Black cherry	264	7	(N/A)	0.4	0.0	7.17
White oak	608	16	(N/A)	0.4	0.1	16.47
Eastern white pine	1,539	42	(N/A)	0.4	0.2	41.70
Tulip tree	608	16	(N/A)	0.4	0.1	16.47
Eastern cottonwood	3,943	107	(N/A)	0.4	0.6	106.85
Citywide total	682,049	18,484	(N/A)	100.0	100.0	70.55

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

1/15/2016

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	37.1	6.3	18.5	1.6	201	78.8	11.5	11.0	75.6	493	-19.2	-72	221.3	622	(N/A)	20.2	11.74
Sugar maple	10.1	1.7	5.1	0.4	55	34.9	5.1	4.9	33.3	218	-8.0	-30	87.5	243	(N/A)	10.7	8.66
Green ash	7.8	1.3	3.8	0.4	42	30.9	4.5	4.3	29.6	193	0.0	0	82.6	235	(N/A)	9.9	9.04
Pin oak	4.0	0.7	2.2	0.2	22	14.2	2.1	2.0	13.4	88	-7.8	-29	30.8	81	(N/A)	6.5	4.77
Maple	0.5	0.1	0.3	0.0	3	3.8	0.6	0.5	3.5	24	-0.2	-1	9.1	26	(N/A)	4.6	2.13
Norway maple	5.1	0.9	2.5	0.2	28	13.1	1.9	1.8	12.2	81	-1.2	-5	36.6	104	(N/A)	4.6	8.70
White ash	1.6	0.2	0.8	0.1	8	8.2	1.2	1.1	7.9	51	0.0	0	21.2	60	(N/A)	4.2	5.45
Northern red oak	1.6	0.3	0.8	0.1	9	5.4	0.8	0.8	5.1	34	-2.3	-8	12.6	34	(N/A)	3.8	3.40
Spruce	0.9	0.2	0.8	0.1	6	3.3	0.5	0.5	3.1	21	-3.3	-12	6.1	15	(N/A)	3.4	1.61
Siberian elm	5.9	1.0	2.9	0.3	32	14.9	2.2	2.1	14.3	93	0.0	0	43.4	125	(N/A)	3.4	13.87
Honeylocust	2.1	0.3	1.0	0.1	11	5.9	0.9	0.8	5.6	37	-1.6	-6	15.0	42	(N/A)	2.7	5.96
Black walnut	1.4	0.2	0.7	0.1	8	7.1	1.0	1.0	6.7	44	0.0	0	18.2	52	(N/A)	2.7	7.40
Cottonwood	6.6	1.1	3.0	0.3	35	13.7	2.0	1.9	13.0	85	0.0	0	41.5	120	(N/A)	2.7	17.14
Northern hackberry	3.2	0.6	1.6	0.1	17	11.0	1.6	1.5	10.3	68	0.0	0	30.0	86	(N/A)	2.7	12.24
Apple	0.1	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.1	9	(N/A)	2.7	1.24
Oak	1.9	0.3	0.9	0.1	10	6.3	0.9	0.9	5.9	39	0.0	0	17.2	49	(N/A)	2.3	8.17
American sycamore	3.4	0.5	1.5	0.2	18	7.8	1.1	1.1	7.3	48	0.0	0	22.9	66	(N/A)	1.9	13.22
Littleleaf linden	2.4	0.4	1.2	0.1	13	5.9	0.9	0.8	5.6	37	-1.1	-4	16.1	45	(N/A)	1.9	9.06
Elm	2.9	0.5	1.3	0.1	15	7.2	1.0	1.0	6.8	44	0.0	0	20.7	60	(N/A)	1.5	14.90
Bur oak	0.0	0.0	0.0	0.0	0	0.9	0.1	0.1	0.9	6	0.0	0	2.1	6	(N/A)	0.8	2.99
Mulberry	0.5	0.1	0.2	0.0	3	1.4	0.2	0.2	1.2	8	0.0	0	3.8	11	(N/A)	0.8	5.45
Red maple	0.4	0.1	0.2	0.0	2	1.7	0.3	0.2	1.7	11	-0.2	-1	4.4	12	(N/A)	0.8	6.20
Boxelder	0.9	0.1	0.4	0.0	5	2.4	0.4	0.3	2.3	15	-0.3	-1	6.6	19	(N/A)	0.8	9.37
Eastern red cedar	0.7	0.1	0.5	0.1	4	1.1	0.2	0.1	1.0	7	-1.8	-7	2.0	4	(N/A)	0.8	2.19
Blue spruce	0.1	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3	(N/A)	0.8	1.53
Pear	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)	0.4	0.11
Swamp white oak	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)	0.4	3.47
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)	0.4	7.92
Black cherry	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)	0.4	2.55
White oak	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3	(N/A)	0.4	2.99
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)	0.4	2.82
Tulip tree	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3	(N/A)	0.4	2.99
Eastern cottonwood	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12	(N/A)	0.4	12.48
Citywide total	102.3	17.2	51.2	4.7	554	286.9	41.8	39.9	272.9	1,789	-48.1	-180	768.8	2,162	(N/A)	100.0	8.25

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

1/15/2016

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	796,547	5,974	(N/A)	20.2	31.9	112.72
Sugar maple	289,068	2,168	(N/A)	10.7	11.6	77.43
Green ash	256,291	1,922	(N/A)	9.9	10.3	73.93
Pin oak	105,147	789	(N/A)	6.5	4.2	46.39
Maple	7,310	55	(N/A)	4.6	0.3	4.57
Norway maple	84,662	635	(N/A)	4.6	3.4	52.91
White ash	36,179	271	(N/A)	4.2	1.5	24.67
Northern red oak	31,536	237	(N/A)	3.8	1.3	23.65
Spruce	6,969	52	(N/A)	3.4	0.3	5.81
Siberian elm	142,952	1,072	(N/A)	3.4	5.7	119.13
Honeylocust	27,569	207	(N/A)	2.7	1.1	29.54
Black walnut	46,038	345	(N/A)	2.7	1.8	49.33
Cottonwood	221,548	1,662	(N/A)	2.7	8.9	237.37
Northern hackberry	46,359	348	(N/A)	2.7	1.9	49.67
Apple	2,943	22	(N/A)	2.7	0.1	3.15
Oak	61,358	460	(N/A)	2.3	2.5	76.70
American sycamore	113,952	855	(N/A)	1.9	4.6	170.93
Littleleaf linden	50,509	379	(N/A)	1.9	2.0	75.76
Elm	93,602	702	(N/A)	1.5	3.8	175.50
Bur oak	2,069	16	(N/A)	0.8	0.1	7.76
Mulberry	7,651	57	(N/A)	0.8	0.3	28.69
Red maple	4,725	35	(N/A)	0.8	0.2	17.72
Boxelder	30,751	231	(N/A)	0.8	1.2	115.32
Eastern red cedar	2,204	17	(N/A)	0.8	0.1	8.27
Blue spruce	568	4	(N/A)	0.8	0.0	2.13
Pear	14	0	(N/A)	0.4	0.0	0.10
Swamp white oak	1,101	8	(N/A)	0.4	0.0	8.26
River birch	3,624	27	(N/A)	0.4	0.1	27.18
Black cherry	908	7	(N/A)	0.4	0.0	6.81
White oak	1,035	8	(N/A)	0.4	0.0	7.76
Eastern white pine	1,170	9	(N/A)	0.4	0.0	8.78
Tulip tree	1,035	8	(N/A)	0.4	0.0	7.76
Eastern cottonwood	15,773	118	(N/A)	0.4	0.6	118.30
Citywide total	2,493,166	18,699	(N/A)	100.0	100.0	71.37

Table 5: Annual Carbon Sequestered

Annual CO Benefits of Public Trees

1/15/2016

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	64,465	483	-3,823	-178	-30	28,041	210	88,504	664 (N/A)	20.2	35.5	12.52
Sugar maple	15,842	119	-1,388	-78	-11	12,325	92	26,701	200 (N/A)	10.7	10.7	7.15
Green ash	15,003	113	-1,230	-66	-10	10,941	82	24,647	185 (N/A)	9.9	9.9	7.11
Pin oak	10,400	78	-505	-32	-4	4,970	37	14,834	111 (N/A)	6.5	5.9	6.54
Maple	1,116	8	-35	-9	0	1,315	10	2,387	18 (N/A)	4.6	1.0	1.49
Norway maple	4,088	31	-406	-28	-3	4,528	34	8,181	61 (N/A)	4.6	3.3	5.11
White ash	4,111	31	-174	-18	-1	2,916	22	6,835	51 (N/A)	4.2	2.7	4.66
Northern red oak	1,738	13	-151	-14	-1	1,900	14	3,472	26 (N/A)	3.8	1.4	2.60
Spruce	685	5	-33	-13	0	1,157	9	1,796	13 (N/A)	3.4	0.7	1.50
Siberian elm	5,964	45	-686	-33	-5	5,288	40	10,533	79 (N/A)	3.4	4.2	8.78
Honeylocust	3,665	27	-133	-10	-1	2,069	16	5,590	42 (N/A)	2.7	2.2	5.99
Black walnut	3,564	27	-221	-15	-2	2,477	19	5,805	44 (N/A)	2.7	2.3	6.22
Cottonwood	6,575	49	-1,063	-32	-8	4,803	36	10,282	77 (N/A)	2.7	4.1	11.02
Northern hackberry	2,901	22	-223	-21	-2	3,806	29	6,463	48 (N/A)	2.7	2.6	6.92
Apple	406	3	-14	-5	0	426	3	813	6 (N/A)	2.7	0.3	0.87
Oak	3,195	24	-295	-14	-2	2,200	17	5,087	38 (N/A)	2.3	2.0	6.36
American sycamore	3,652	27	-547	-18	-4	2,719	20	5,806	44 (N/A)	1.9	2.3	8.71
Littleleaf linden	4,329	32	-242	-14	-2	2,052	15	6,125	46 (N/A)	1.9	2.5	9.19
Elm	3,736	28	-449	-16	-3	2,502	19	5,772	43 (N/A)	1.5	2.3	10.82
Bur oak	418	3	-10	-2	0	318	2	723	5 (N/A)	0.8	0.3	2.71
Mulberry	114	1	-37	-5	0	459	3	531	4 (N/A)	0.8	0.2	1.99
Red maple	648	5	-23	-3	0	616	5	1,239	9 (N/A)	0.8	0.5	4.65
Boxelder	2,149	16	-148	-7	-1	856	6	2,850	21 (N/A)	0.8	1.1	10.69
Eastern red cedar	86	1	-11	-4	0	374	3	445	3 (N/A)	0.8	0.2	1.67
Blue spruce	77	1	-3	-2	0	212	2	285	2 (N/A)	0.8	0.1	1.07
Pear	9	0	0	0	0	6	0	14	0 (N/A)	0.4	0.0	0.10
Swamp white oak	224	2	-5	-1	0	176	1	393	3 (N/A)	0.4	0.2	2.95
River birch	386	3	-17	-2	0	395	3	762	6 (N/A)	0.4	0.3	5.71
Black cherry	114	1	-4	-1	0	124	1	232	2 (N/A)	0.4	0.1	1.74
White oak	209	2	-5	-1	0	159	1	361	3 (N/A)	0.4	0.1	2.71
Eastern white pine	116	1	-6	-2	0	216	2	324	2 (N/A)	0.4	0.1	2.43
Tulip tree	209	2	-5	-1	0	159	1	361	3 (N/A)	0.4	0.1	2.71
Eastern cottonwood	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	0.4	0.5	9.97
Citywide total	161,049	1,208	-11,969	-652	-95	101,057	758	249,485	1,871 (N/A)	100.0	100.0	7.14

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

1/15/2016

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	5,181	(N/A)	20.2	34.9	97.75
Sugar maple	1,672	(N/A)	10.7	11.3	59.71
Green ash	1,303	(N/A)	9.9	8.8	50.10
Pin oak	897	(N/A)	6.5	6.0	52.79
Maple	201	(N/A)	4.6	1.4	16.75
Norway maple	395	(N/A)	4.6	2.7	32.93
White ash	559	(N/A)	4.2	3.8	50.80
Northern red oak	156	(N/A)	3.8	1.1	15.63
Spruce	195	(N/A)	3.4	1.3	21.62
Siberian elm	409	(N/A)	3.4	2.8	45.44
Honeylocust	888	(N/A)	2.7	6.0	126.79
Black walnut	328	(N/A)	2.7	2.2	46.83
Cottonwood	441	(N/A)	2.7	3.0	63.06
Northern hackberry	392	(N/A)	2.7	2.6	56.02
Apple	21	(N/A)	2.7	0.1	3.05
Oak	264	(N/A)	2.3	1.8	43.94
American sycamore	270	(N/A)	1.9	1.8	53.90
Littleleaf linden	430	(N/A)	1.9	2.9	86.02
Elm	265	(N/A)	1.5	1.8	66.35
Bur oak	57	(N/A)	0.8	0.4	28.56
Mulberry	6	(N/A)	0.8	0.0	3.20
Red maple	96	(N/A)	0.8	0.6	47.86
Boxelder	130	(N/A)	0.8	0.9	65.08
Eastern red cedar	27	(N/A)	0.8	0.2	13.68
Blue spruce	42	(N/A)	0.8	0.3	21.08
Pear	0	(N/A)	0.4	0.0	0.03
Swamp white oak	26	(N/A)	0.4	0.2	26.22
River birch	39	(N/A)	0.4	0.3	39.16
Black cherry	6	(N/A)	0.4	0.0	6.40
White oak	29	(N/A)	0.4	0.2	28.56
Eastern white pine	32	(N/A)	0.4	0.2	32.32
Tulip tree	29	(N/A)	0.4	0.2	28.56
Eastern cottonwood	66	(N/A)	0.4	0.4	65.59
Citywide total	14,852	(N/A)	100.0	100.0	56.69

Table 7: Summary of Benefits in Dollars

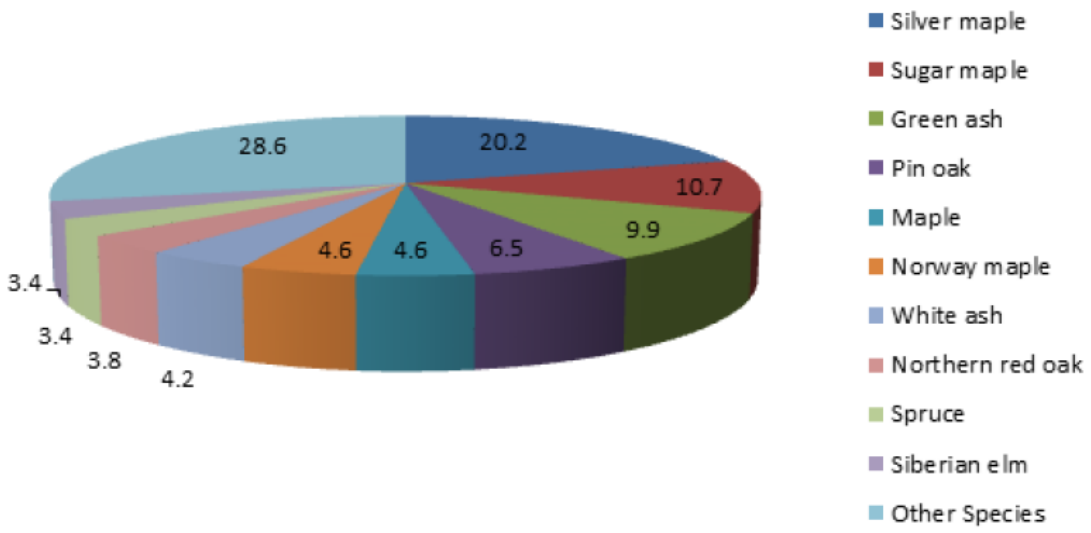
Total Annual Benefits of Public Trees by Species ($)

1/15/2016

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	3,425	664	622	6,136	5,181	16,027	(N/A)	32.1
Sugar maple	1,523	200	243	2,116	1,672	5,754	(N/A)	11.5
Green ash	1,344	185	235	1,805	1,303	4,871	(N/A)	9.7
Pin oak	626	111	81	713	897	2,429	(N/A)	4.9
Maple	174	18	26	114	201	532	(N/A)	1.1
Norway maple	592	61	104	682	395	1,835	(N/A)	3.7
White ash	360	51	60	409	559	1,439	(N/A)	2.9
Northern red oak	242	26	34	237	156	695	(N/A)	1.4
Spruce	148	13	15	246	195	616	(N/A)	1.2
Siberian elm	645	79	125	919	409	2,177	(N/A)	4.4
Honeylocust	261	42	42	315	888	1,547	(N/A)	3.1
Black walnut	314	44	52	378	328	1,115	(N/A)	2.2
Cottonwood	601	77	120	1,184	441	2,423	(N/A)	4.8
Northern hackberry	497	48	86	578	392	1,602	(N/A)	3.2
Apple	63	6	9	24	21	123	(N/A)	0.2
Oak	275	38	49	407	264	1,033	(N/A)	2.1
American sycamore	342	44	66	628	270	1,349	(N/A)	2.7
Littleleaf linden	265	46	45	365	430	1,151	(N/A)	2.3
Elm	317	43	60	553	265	1,238	(N/A)	2.5
Bur oak	41	5	6	33	57	143	(N/A)	0.3
Mulberry	64	4	11	39	6	125	(N/A)	0.2
Red maple	74	9	12	60	96	251	(N/A)	0.5
Boxelder	109	21	19	170	130	449	(N/A)	0.9
Eastern red cedar	49	3	4	89	27	173	(N/A)	0.3
Blue spruce	30	2	3	41	42	118	(N/A)	0.2
Pear	1	0	0	0	0	1	(N/A)	0.0
Swamp white oak	24	3	3	16	26	73	(N/A)	0.1
River birch	47	6	8	38	39	138	(N/A)	0.3
Black cherry	18	2	3	7	6	36	(N/A)	0.1
White oak	21	3	3	16	29	71	(N/A)	0.1
Eastern white pine	24	2	3	42	32	103	(N/A)	0.2
Tulip tree	21	3	3	16	29	71	(N/A)	0.1
Eastern cottonwood	71	10	12	107	66	266	(N/A)	0.5
Citywide Total	12,605	1,871	2,162	18,484	14,852	49,975	(N/A)	100.0

Species Distribution of Public Trees

1/15/2016

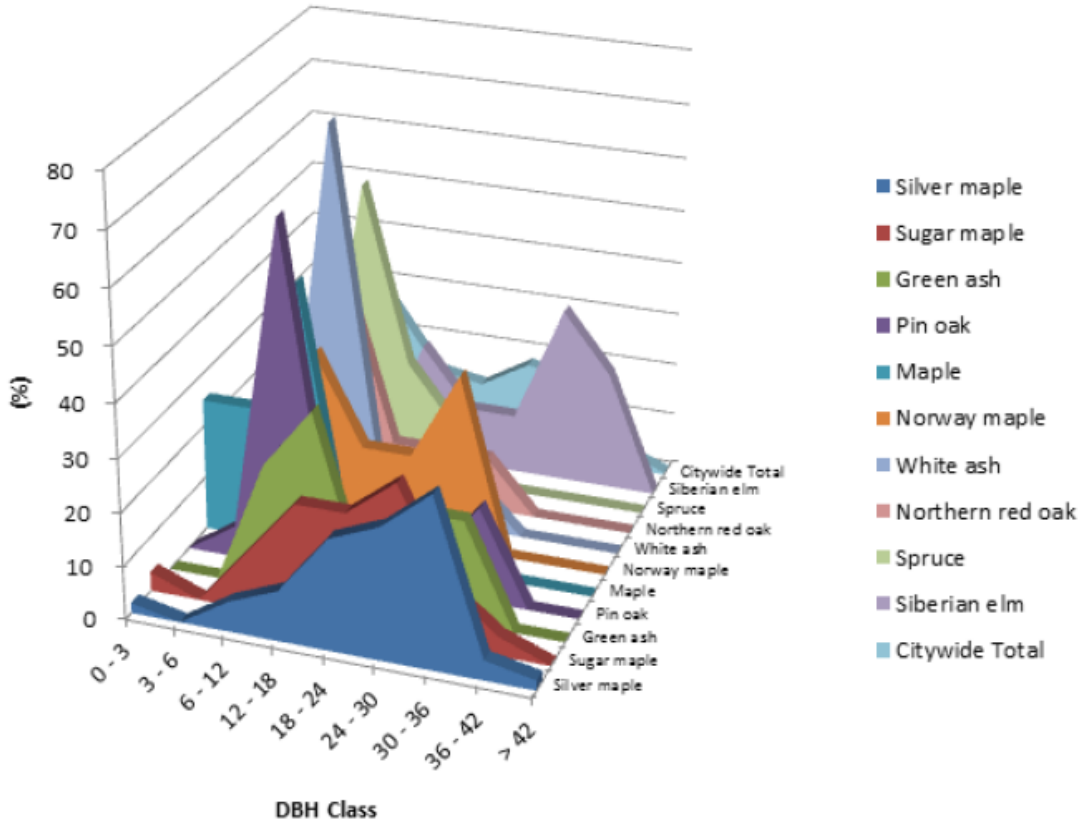


Species	Percent
Silver maple	20.2
Sugar maple	10.7
Green ash	9.9
Pin oak	6.5
Maple	4.6
Norway maple	4.6
White ash	4.2
Northern red oak	3.8
Spruce	3.4
Siberian elm	3.4
Other Species	28.6
Total	100.0

Figure 1: Species Distribution

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

1/15/2016



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Silver maple	1.89	0.00	5.66	9.43	20.75	24.53	32.08	3.77	1.89
Sugar maple	3.57	0.00	10.71	21.43	21.43	28.57	10.71	3.57	0.00
Green ash	0.00	0.00	23.08	34.62	3.85	19.23	19.23	0.00	0.00
Pin oak	0.00	5.88	64.71	5.88	0.00	5.88	17.65	0.00	0.00
Maple	25.00	25.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway maple	0.00	0.00	33.33	16.67	16.67	33.33	0.00	0.00	0.00
White ash	0.00	0.00	72.73	9.09	9.09	9.09	0.00	0.00	0.00
Northern red oak	10.00	20.00	40.00	10.00	10.00	10.00	0.00	0.00	0.00
Spruce	11.11	0.00	55.56	22.22	11.11	0.00	0.00	0.00	0.00
Siberian elm	0.00	0.00	0.00	22.22	11.11	11.11	33.33	22.22	0.00
Citywide Total	4.58	4.20	26.34	14.12	12.60	17.94	16.03	3.82	0.38

Figure 2: Relative Age Class

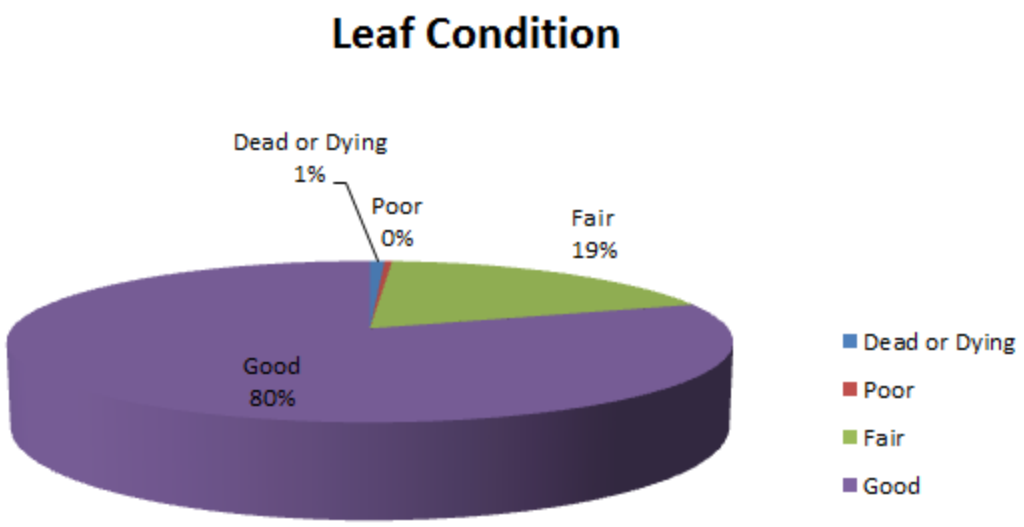


Figure 3: Foliage Condition

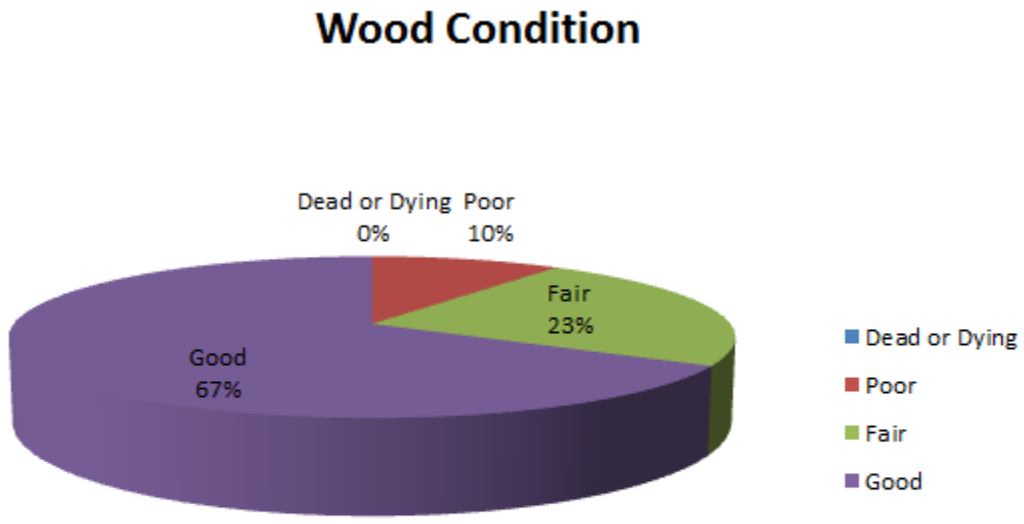
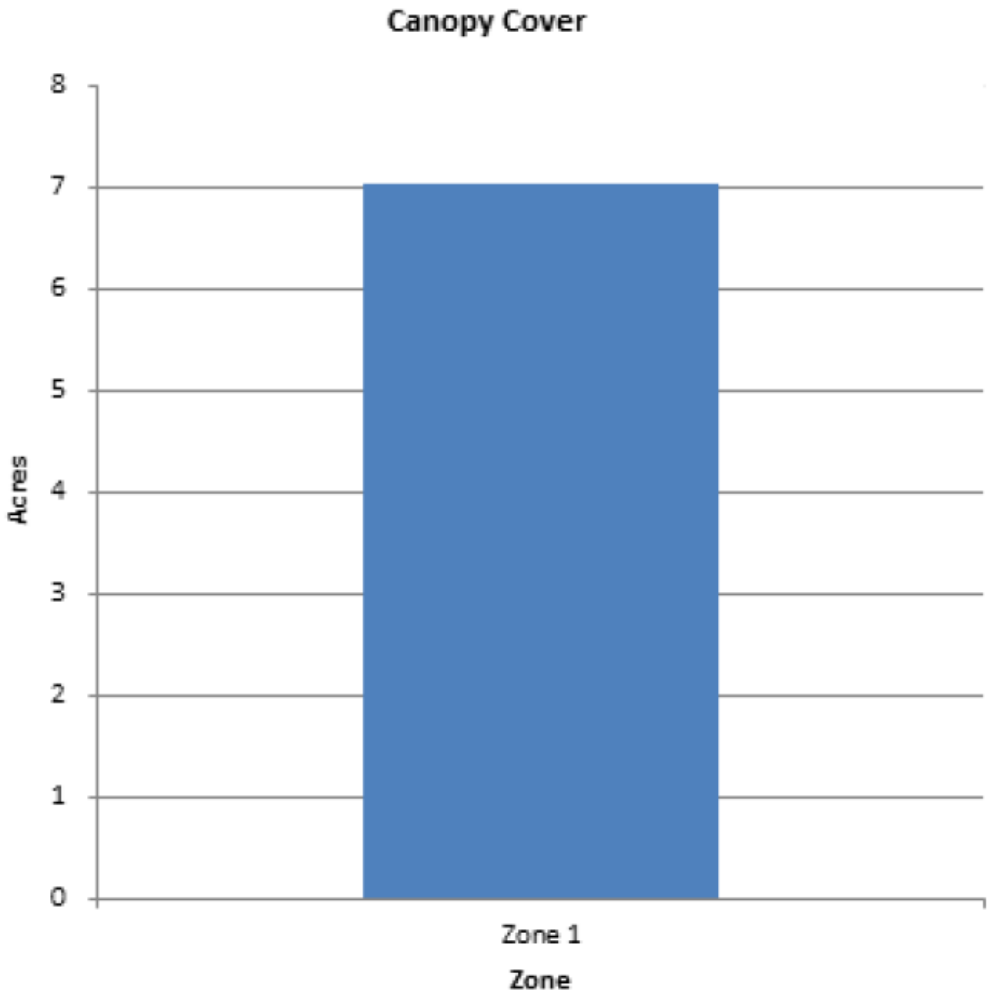


Figure 4: Wood Condition

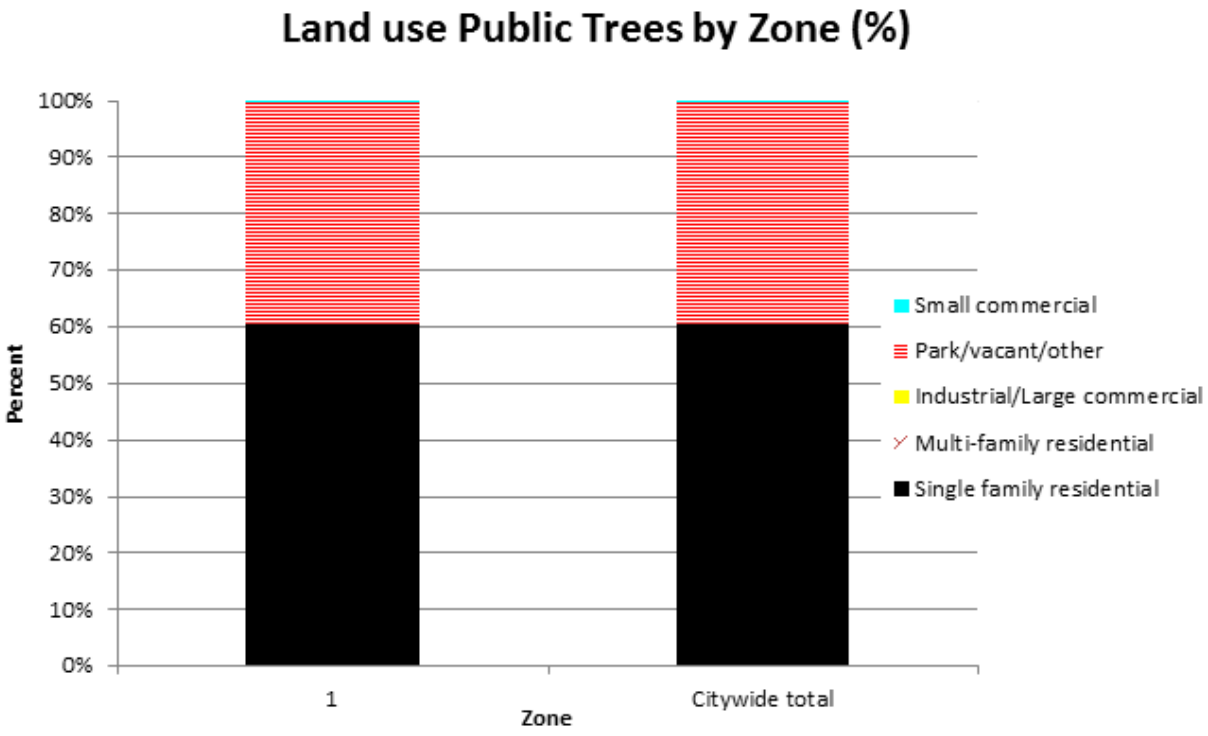
Canopy Cover of Public Trees (Acres)

1/15/2016



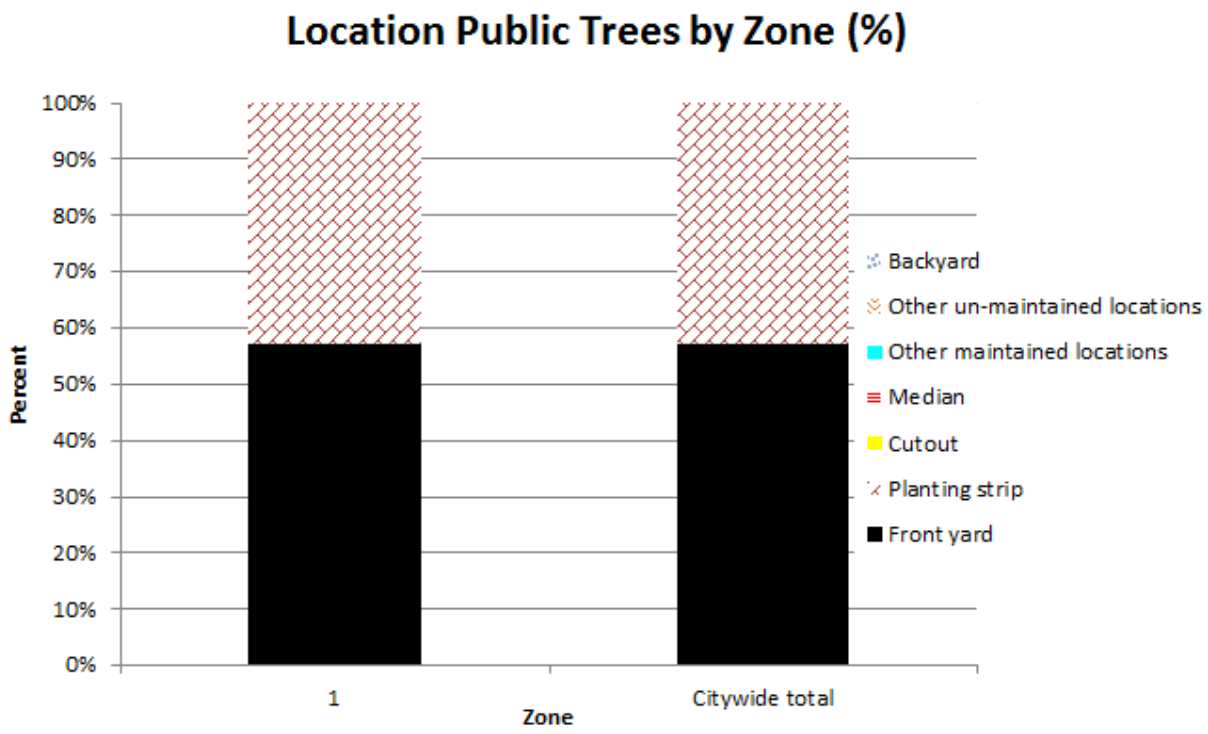
Zone	Acres	% of Total Canopy Cover
Zone 1	7	100.0
Citywide total	7	100.0

Figure 5: Canopy Cover in Acres



Zone	Single family residential	Multi-family residential	Industrial/Large commercial	Park/vacant /other	Small commercial
1	60.31	0.00	0.00	39.31	0.38
Citywide total	60.31	0.00	0.00	39.31	0.38

Figure 6: Land Use of city/park trees



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	57.25	42.75	0.00	0.00	0.00	0.00	0.00
Citywide total	57.25	42.75	0.00	0.00	0.00	0.00	0.00

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

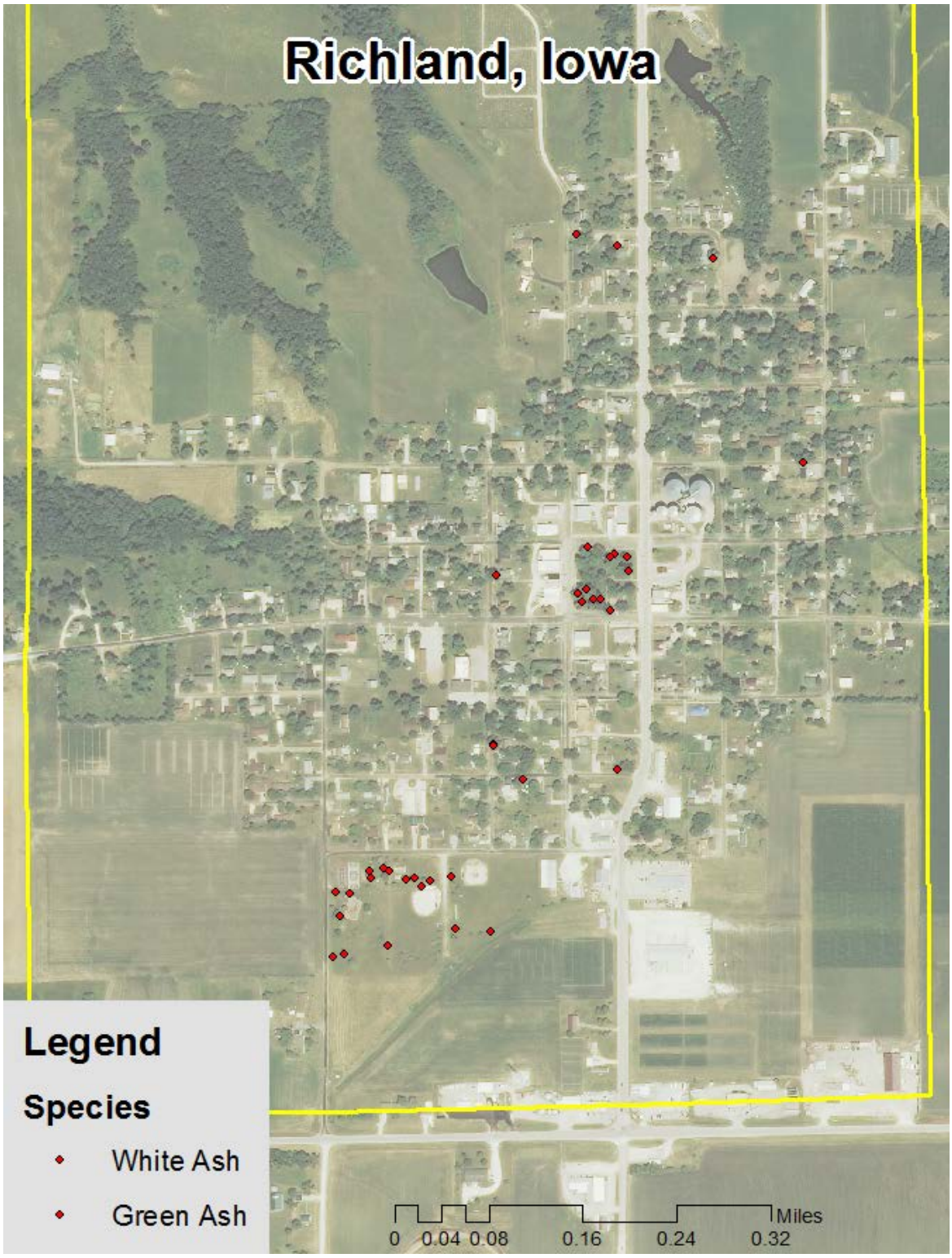


Figure 1: Location of Ash Trees

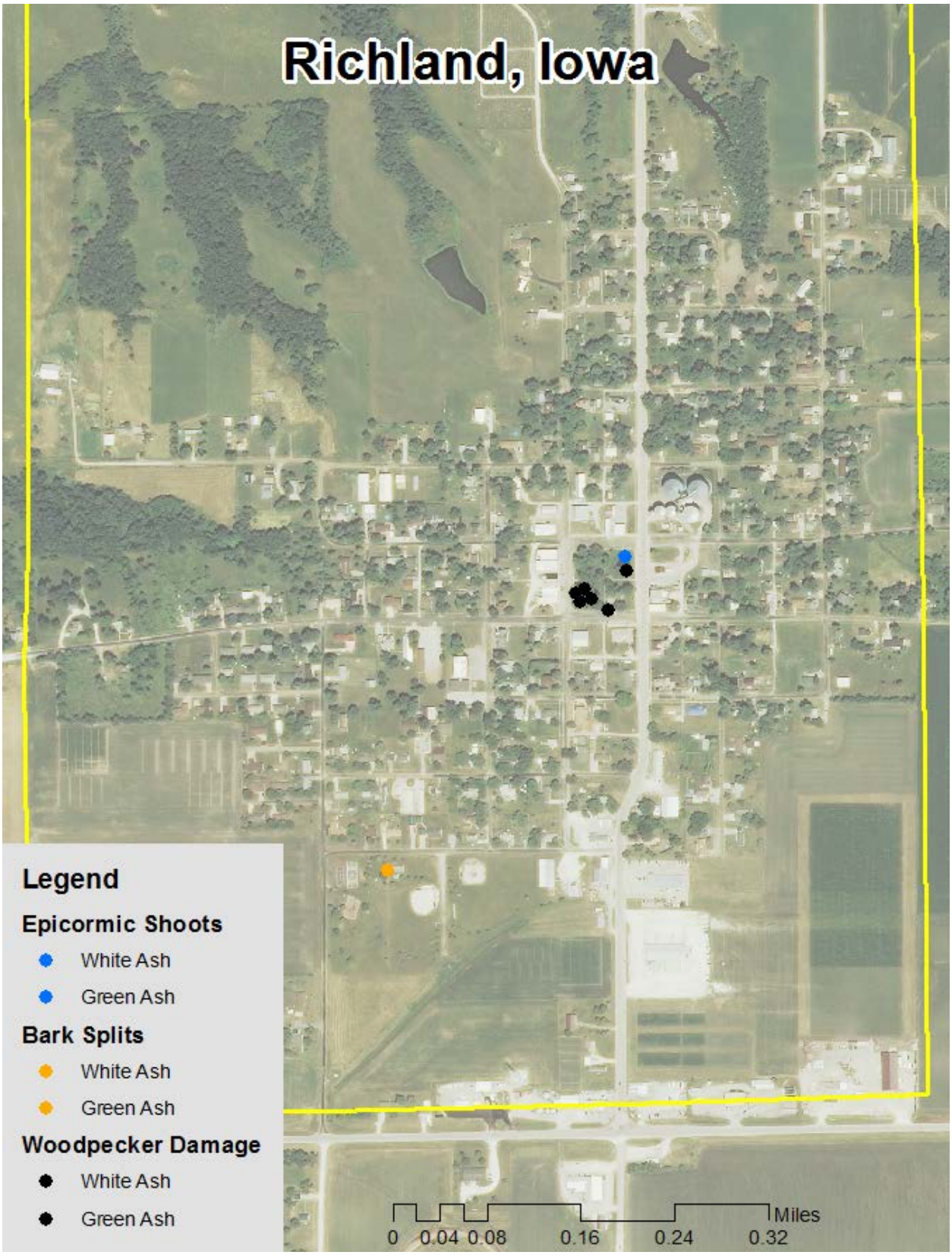


Figure 2: Location of EAB symptoms

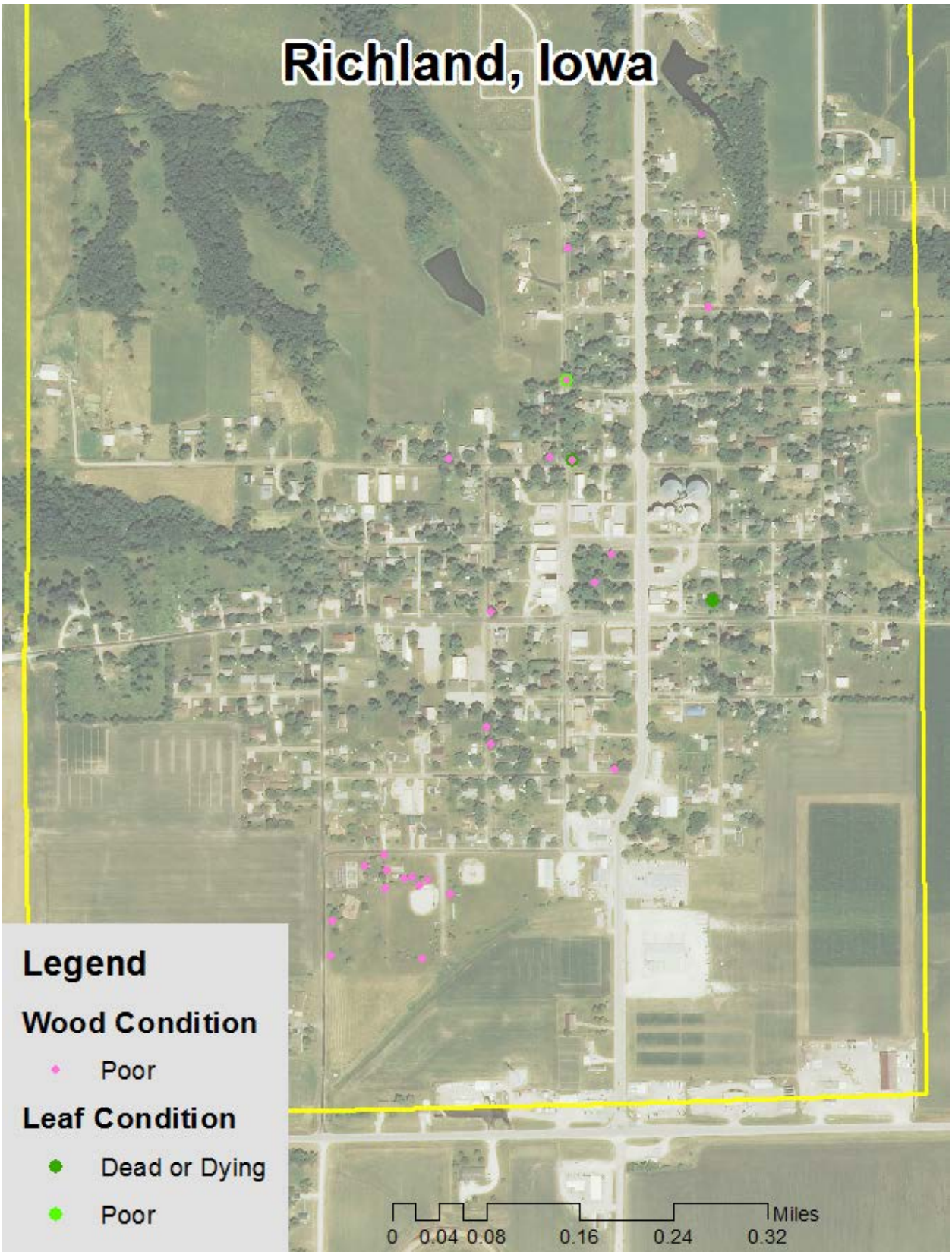


Figure 3: Location of Poor Condition Trees

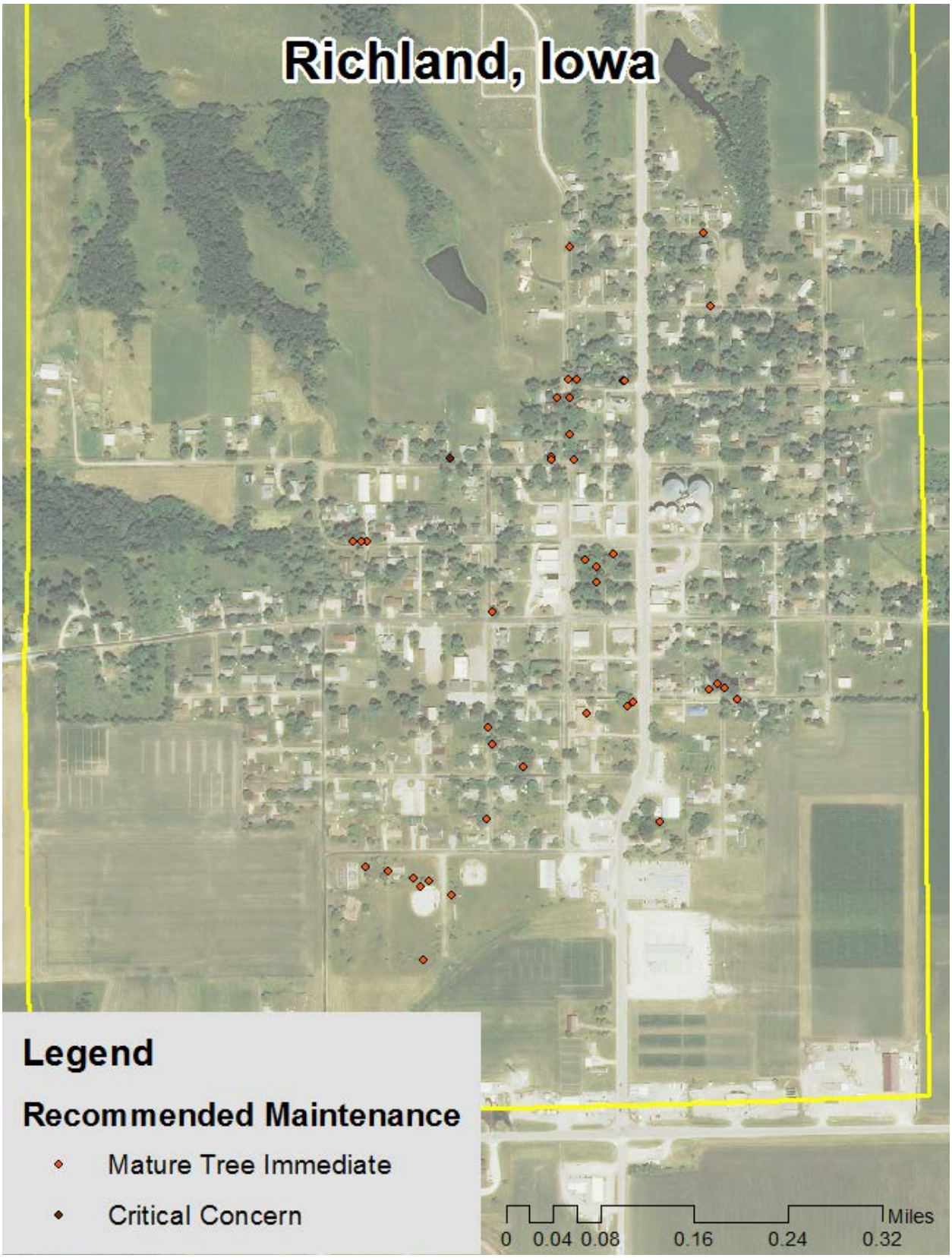


Figure 4: Location of Trees with Recommended Maintenance

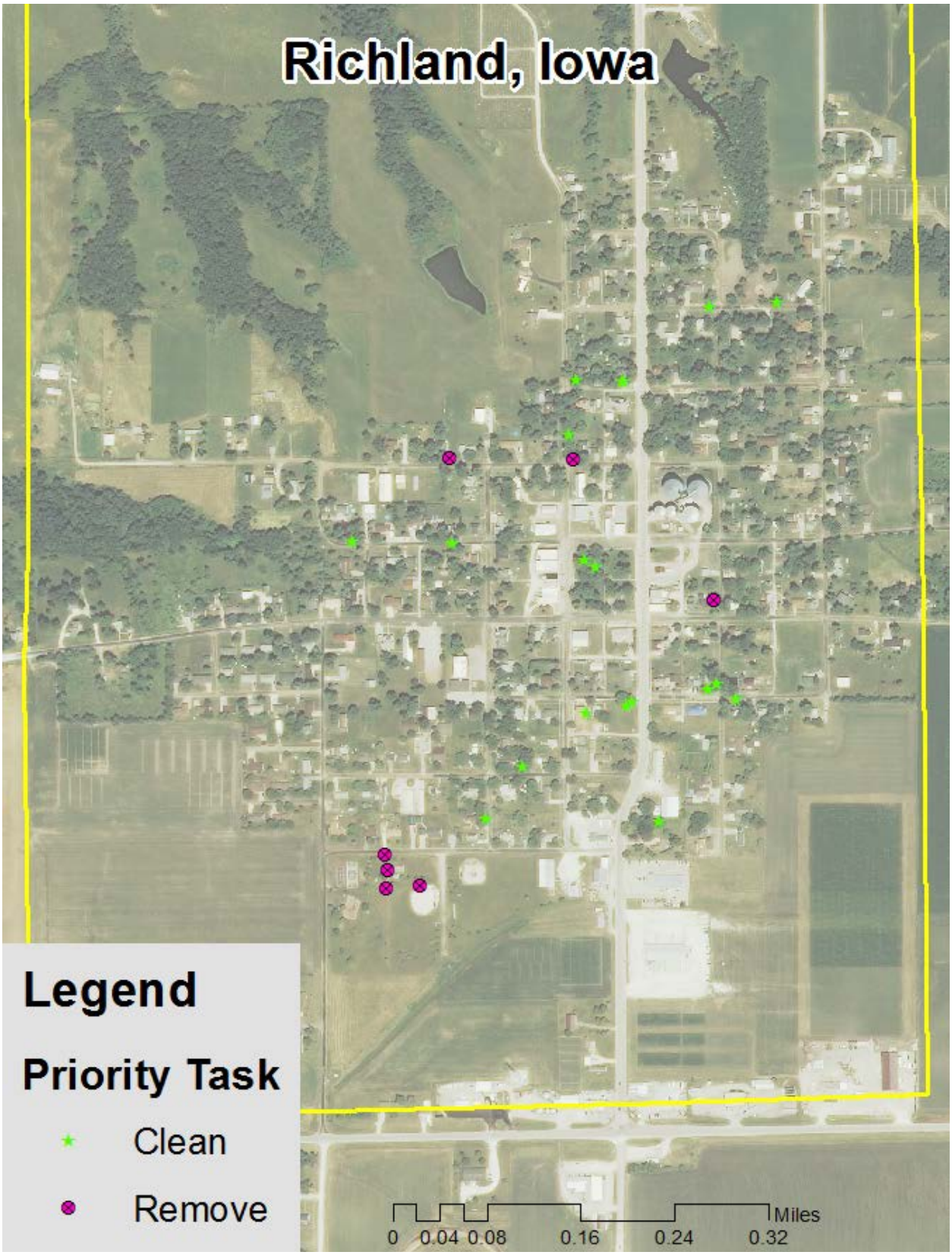


Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Richland Tree Ordinances

3-2-2 NUISANCES ENUMERATED

The following subsections include, but do not limit, the conditions which are deemed to be nuisances in the City:

1. **Offensive Smells**. Erecting, continuing or using any building or other place from the exercise of trade, employment or manufacture, which, by occasioning noxious exhalations, offensive smells or other annoyances, becomes injurious and dangerous to the health, comfort or property of individuals or the public. (Code of Iowa, Sec. 657.2(1))

2. **Filth or Noisome Substance**. Causing or suffering any offal, filth or noisome substance to be collected or to remain in any place to the prejudice of others. (Code of Iowa, Sec. 657.2(2))

3. **Impeding Passage of Navigable River.** Obstructing or impeding without legal authority the passage of any navigable river, harbor or collection of water. (Code of Iowa, Sec. 657.2(3))

4. **Water Pollution.** Corrupting or rendering unwholesome or impure the water of any river, stream or pond, or unlawfully diverting the sane from its natural course or state, to the injure or prejudice of others. (Code of Iowa, Sec. 657.2(4))

5. **Blocking Public and Private Ways.** Obstructing or encumbering, by fences, buildings, or otherwise, the public roads, private ways, streets, alleys, commons, landing places, or burying grounds. (Code of Iowa, Sec. 657.2(5))

6. **Billboards.** Billboards, signboards, and advertising signs, whether erected and constructed on public or private property, which so obstruct and impair the view of any portion or part of a public street, avenue, highway, boulevard, or alley or of a railroad or street railway track as to render dangerous the use thereof. (Code of Iowa, Sec. 657.2(7))

7. **Cottonwood Trees.** Cotton-bearing cottonwood trees and all other cotton-bearing poplar trees. (Code of Iowa, Sec. 657.2(9))

8. **Storing of Flammable Junk.** Depositing or storing of flammable junk, such as old rags, rope, cordage, rubber, bones and paper, by dealers in such articles within the fire limits of the City, unless in a building of fireproof construction. (Code of Iowa, Sec. 657.2(10))

9. **Air Pollution.** Air pollution, emission of dense smoke, noxious fumes or fly ash. (Code of Iowa, Sec. 657.2(11))

10. **Weeds, Brush.** Dense growth of all weeds, vines, brush or other vegetation in the City so as to constitute a health, safety, or fire hazard. (Code of Iowa, Sec. 657.2(12))

11. **Dutch Elm Disease.** Trees infected with Dutch elm disease. (Code of Iowa, Sec. 657.2(13))

12. **Airport, Air Space.** Any object or structure hereafter erected within one thousand (1,000) feet of the limits of any municipal or regularly established airport or landing place, which may endanger or obstruct aerial navigation including take-off and landing, unless such object or structure constitutes a proper use or enjoyment of the land on which the same is located. (Code of Iowa, Sec. 657.2(9))

13. **House of Ill Fame.** Houses of ill fame, kept for the purpose of prostitution and lewdness; gambling housed, places resorted to by persons participating in criminal gang activity prohibited by chapter 723A of the Code of Iowa or places resorted to by persons using controlled substances, as defined in Section 124.101 of the Code of Iowa, in violation of law, or houses where drunkenness, quarreling, fighting, or breaches of the peace are carried on or permitted to the disturbance of others. (Code of Iowa, Sec. 657.2(6))

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