

# GRAND MOUND, IA



## 2011 Management Plan

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# Executive Summary

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## Overview

This plan was developed to assist the City of Grand Mound with managing its urban forest, including a snapshot of the current situation and future planning. Trees can provide a multitude of benefits to the community, and sound management should increase the benefits given by a healthy urban forest. Management is especially important considering the serious threats posed by current known forest pests and those that may arise in the future. One known threat is 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 6.1% of Grand Mound's city owned trees (ash) will die once EAB becomes established in the community. With proper planning, management and keeping current of the options, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

## Inventory, Results and Summary of Recommendations

In 2011, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street trees. Below are some key findings of the 65 trees inventoried.

- Grand Mound's trees provide \$13,144 of benefits annually, an average of \$202 a tree
- There are 20 species of trees
- The most common trees are: Silver Maple 22.7%, Norway Maple 9.1% and Pin oak 9.1%
- 28 trees are in need of some type of management
- 2 trees are recommended for removal. This does not mean immediate removal, but when action is taken, removal is recommended. [\\*City ownership of the trees recommended for removal should be verified prior to any removal\\*](#)
- All trees should be visited on a routine schedule
- Plant a diverse mix of trees that do not include: ash, maple, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven or willow.

## Introduction

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This plan was developed to assist Grand Mound with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of that money spent on tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal and replacement planting. With proper planning and management of the current canopy in Grand Mound, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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 Grand Mound 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 Grand Mound's urban forestry goals.

## Inventory

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In 2011, a tree inventory was conducted that included 100% of the city owned trees along the streets. 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 of 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

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The data collected for the 65 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

### **Annual Benefits**

#### **Annual Energy Benefits**

Trees conserve energy by shading buildings and blocking winds. Grand Mound's trees reduce energy related costs by approximately \$3,508 annually (Appendix A, Table 1). These savings are both in Electricity ( MWh) and in Natural Gas ( Therms).

#### **Annual Stormwater Benefits**

Grand Mound's trees intercept about 185,291 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$5,022 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 mater (ozone). In Grand Mound, it is estimated that trees remove 214 lbs. of air pollution (ozone (O<sub>3</sub>), particulate matter less than 1.5 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and sulfur dioxide (SO<sub>2</sub>)) per year with a net value of \$603 (Appendix A, Table 3).

#### **Annual Carbon Benefits**

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Grand Mound, trees sequester about 37,753 lbs of carbon a year with an associated value of \$283 (Appendix A, Table 5). In addition, the trees store 646,862 lbs of carbon, with a yearly benefit of \$4,851. (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. Grand Mound receives \$3,542 in annual social and aesthetic benefits from trees (Appendix A, Table 6).

#### **Financial Summary of all Benefits**

According to the USDA Forest Service i-Tree STRATUM analysis, Grand Mound's trees provide \$13,144 of benefits annually. Benefits of individual trees vary based on size, species, health and

location, but on average each of the 33 trees in Grand Mound provide approximately \$202 annually (Appendix A, Table 7).

## **Forest Structure**

### **Species Distribution**

Grand Mound has 20 different tree species along city streets (Appendix A, Figure 1). The distribution of trees by species is as follows:

<b><u>Species</u></b>	<b><u>% of Trees</u></b>
Silver Maple	22.7
Norway Maple	9.1
Pin Oak	9.1
Sugar Maple	6.1
Ash	6.1
Eastern Redcedar	6.1
Sycamore	6.1
Honeylocust	4.6
Black Walnut	4.6
Bur oak	4.6
Hackberry	3.0
Black Cherry	3.0
Sycamore	3.0
Siberian Elm	3.0
River Birch	1.5
Crabapple	1.5
Swamp white Oak	1.5
Pin Oak	1.5
Red Oak	1.5
American Elm	1.5

### **Size Class**

There are 6.0% city street tree 0-6 " at 4.5 feet above ground. 13.6% of the trees are between 6 and 12" in diameter, 16.7% are between 12 and 18 inches in diameter, 27.3 % are 18-24 inches in diameter, 13.6% are 24-30, 10.6% are 30-36, 12.1% are 36-42, and 0% are over 42 inches in diameter at breast height(Appendix A, Figure 2). For size, a Bell Curve is preferred and shows

the highest amount of trees around 10 inches in diameter at 4.5 ft. These figures suggest that there are not enough small diameter trees to replace the larger ones if the same number of trees is desired.

### **Condition: Wood and Foliage**

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage that was present on trees appeared moderately healthy with 36% ranked as fair and 59% ranked good (Appendix A, Figure 3 & Appendix B, Figure 3). 97% of Grand Mound's trees are in good or fair health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3) which is very good.

### **Management Needs**

The following outlines the specific management needs of the street trees by number of trees.

Crown Raising (3 trees)- Crown should be raised by removing lower branches from the tree trunk or main branches to eliminate obstructions or clearance issues. 4 trees

Tree Removal (2 tree)- Tree is dangerous, dead or dying, and no amount of maintenance will increase longevity or safety. Trees may also have a defect that is not repairable. Tree removal is not necessarily immediate.

Crown Cleaning (13 trees) – Crown needs cleaning to remove dead, diseased, damaged, poorly attached, or crossing branches to increase the health or the longevity of tree. Most often this is the removal of dead interior branches.

Crown Reducing (11 trees)- Crown should be reduced/thinned by pruning to reduce tree height, spread, overcrowding, wind resistance, or an increase of light penetration. This is a typical recommendation when wires are nearby.

### **Canopy Cover**

The canopy cover of Grand Mound is about 1 acre.

## **Recommendations**

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## 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.

### Ash trees

There are 4 ash trees listed as a city street tree. If there are ash trees in a city park or private property it is recommended that they be looked at every year to check for symptoms associated with Emerald Ash Borer. Symptoms include splits in the back, "D" shaped exit holes, wood pecker activity, canopy dieback and epicormic sprouts. [\\*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. 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.

## Pruning Practices



**Two examples of improper cuts.**



**Consider the guidelines when pruning:**

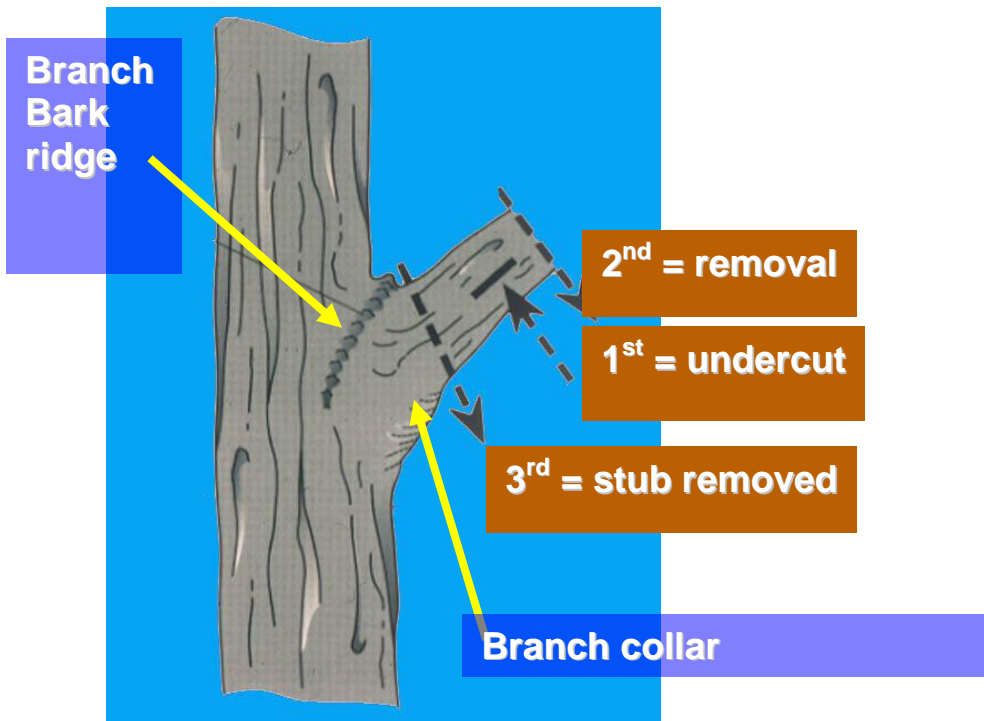
1. To avoid concerns related to the fungus that causes the disease oak wilt, all oak species should only be pruned between October 1 and February 28<sup>th</sup>.
2. All final cuts should be outside the branch collar.
3. Unless pruning broken oak branches between March 1 and September 30<sup>th</sup> pruning paints are not needed.



**Branch collar**

**Proper Pruning**

**Improper Pruning**



**Proper Pruning Cut**

**Planting**

There are locations where new trees could be planted. Select the appropriate species for the site to ensure a good fit for the tree and location. It is recommended to plant 1.2 trees for

every tree removed, since survival rates will not be 100%. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees or even increasing the number helps ensure continuation of the benefits of the existing forest in Grand Mound.

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) 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 Ash (Appendix A, Figure 1). 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: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

### **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 death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

## **Emerald Ash Borer Plan**

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### **Summary**

Follow the movements of EAB on <http://www.emeraldashborer.info/iowainfo.cfm>. This site coordinates efforts from many agencies working together for a common cause. Currently EAB is over 100 miles from Grand Mound. EAB could arrive in 1 year or 15 years. The proximity of the borer should dictate the rate at which ash is addressed.

Also follow developments as far as biologic controls and treatments. Research on insecticide injections of ash trees is just beginning. The early research shows repeated treatments could save ash trees, but more research is needed. Typically it is less expensive to cut and replace, but the option of tree injections may prove to be the best option in a small percentage of situations. Private homeowners may be more willing to incur the expense than a municipality if this proves effective.

## **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 trees in poor condition that develop into dead, dying and hazardous trees (Appendix B, Figure 2 & Appendix B, Figure 3). [\\*City ownership of the tree recommended for removal should be verified prior to any removal\\*](#)

## **EAB Quarantines**

EAB is an extremely destructive plant pest and it is responsible for the death and decline of over 25 million 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](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 the budget permits, all removed trees will be replaced. All trees will meet the restrictions of any city ordinances. The new plantings should be a diverse mix and will not include ash, maple,

Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow. There are many places in Grand Mound where trees could be planted.

### **Postponed Work**

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genus 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 as trees are infested with Emerald Ash Borer. Trees that are on private property are part of Grand Mound's urban forest. Private property owners should be given direction to the proper species to plant, spacing, and location.

## **Six Year Work Plan and Estimated Costs**

### **Year 1:**

Inspect all trees scheduled for maintenance

### **Year 2:**

Inspect all trees scheduled for maintenance	
Remove 1 tree	\$500/tree
Plant trees in open locations (2)	\$100/tree

**Year 3:**

Inspect all trees scheduled for maintenance	
Plant trees in open locations (2)	\$100/tree

**Year 4:**

Inspect all trees scheduled for maintenance	
Plant trees in open locations (1)	\$100/tree
Remove 1 tree	\$500/tree

**Year 5:**

Inspect all trees scheduled for maintenance	
Plant trees in open locations (1)	\$100/tree

**Year 6:**

Inspect all trees scheduled for maintenance	
Plant trees in open locations (1)	\$100/tree

**Funding**

Depending on how the removals, maintenance and replanting are completed, this may be above the current budget. Grand Mound can 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.

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## Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

<b>Annual Energy Benefits of Public Trees by Species</b>									
9/29/2011									
Species	Total Electricity (MWh)	Electricity (\$)	Total Natural Gas (Therms)	Natural Gas (\$)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Blue spruce	0.5	38	81.6	80	118	(N/A)	24.2	9.9	14.80
Ash	1.0	77	152.0	149	226	(N/A)	15.2	18.9	45.19
Sugar maple	1.1	80	145.7	143	223	(N/A)	12.1	18.6	55.65
Northern hackberry	1.0	74	144.0	141	215	(N/A)	9.1	18.0	71.73
Conifer Evergreen Small	0.0	1	1.3	1	2	(N/A)	6.1	0.2	0.93
Mulberry	0.1	6	13.5	13	19	(N/A)	6.1	1.6	9.53
Eastern white pine	0.3	22	39.4	39	61	(N/A)	6.1	5.1	30.47
Norway maple	0.3	20	39.6	39	59	(N/A)	3.0	4.9	58.69
Ohio buckeye	0.3	24	47.4	46	71	(N/A)	3.0	5.9	70.84
Broadleaf Deciduous	0.0	2	3.8	4	5	(N/A)	3.0	0.5	5.40
Catalpa	0.4	29	53.7	53	82	(N/A)	3.0	6.9	82.02
Honeylocust	0.4	28	47.4	46	74	(N/A)	3.0	6.2	74.28
Eastern red cedar	0.1	8	16.4	16	25	(N/A)	3.0	2.1	24.57
Apple	0.1	6	12.8	13	18	(N/A)	3.0	1.5	18.19
Other street trees	0.0	0	0.0	0	0	(N/A)	0.0	0.0	0.00
Citywide total	5.5	415	798.7	783	1,198	(N/A)	100.0	100.0	36.30

Table 2: Annual Stormwater Benefits

<b>Annual Stormwater Benefits of Public Trees by Species</b>						
9/29/2011						
Species	Total rainfall interception (Gal)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Blue spruce	6,043	164	(N/A)	24.2	9.8	20.47
Ash	10,605	287	(N/A)	15.2	17.1	57.49
Sugar maple	12,138	329	(N/A)	12.1	19.6	82.24
Northern hackberry	8,482	230	(N/A)	9.1	13.7	76.63
Conifer Evergreen Small	49	1	(N/A)	6.1	0.1	0.66
Mulberry	272	7	(N/A)	6.1	0.4	3.68
Eastern white pine	5,938	161	(N/A)	6.1	9.6	80.47
Norway maple	2,479	67	(N/A)	3.0	4.0	67.19
Ohio buckeye	3,764	102	(N/A)	3.0	6.1	102.01
Broadleaf Deciduous	69	2	(N/A)	3.0	0.1	1.86
Catalpa	5,490	149	(N/A)	3.0	8.9	148.79
Honeylocust	4,684	127	(N/A)	3.0	7.6	126.96
Eastern red cedar	1,634	44	(N/A)	3.0	2.6	44.30
Apple	264	7	(N/A)	3.0	0.4	7.17
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	61,912	1,678	(N/A)	100.0	100.0	50.85



**Table 3: Annual Air Quality Benefits**

**Annual Air Quality Benefits of Public Trees by Species**

9/29/2011

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 <sub>3</sub>	NO <sub>2</sub>	PM <sub>10</sub>	SO <sub>2</sub>		NO <sub>2</sub>	PM <sub>10</sub>	VOC	SO <sub>2</sub>								
Blue spruce	0.6	0.1	0.5	0.1	4	2.5	0.4	0.3	2.3	15	-1.9	-7	4.9	12 (N/A)	24.2	1.53	
Ash	2.3	0.4	1.1	0.1	12	5.0	0.7	0.7	4.6	31	-0.5	-2	14.3	41 (N/A)	15.2	8.18	
Sugar maple	1.6	0.3	0.8	0.1	9	5.0	0.7	0.7	4.8	31	-1.3	-5	12.7	35 (N/A)	12.1	8.82	
Northern hackberry	1.2	0.2	0.6	0.1	6	4.8	0.7	0.7	4.4	29	0.0	0	12.6	36 (N/A)	9.1	11.97	
Conifer Evergreen Small	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	6.1	0.09	
Mulberry	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	2	0.0	0	0.9	3 (N/A)	6.1	1.33	
Eastern white pine	0.7	0.1	0.6	0.1	5	1.4	0.2	0.2	1.3	9	-2.8	-10	1.8	3 (N/A)	6.1	1.45	
Norway maple	0.5	0.1	0.2	0.0	3	1.3	0.2	0.2	1.2	8	-0.1	0	3.6	10 (N/A)	3.0	10.16	
Ohio buckeye	0.9	0.1	0.4	0.0	5	1.6	0.2	0.2	1.5	10	-0.2	-1	4.7	14 (N/A)	3.0	13.58	
Broadleaf Deciduous	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	3.0	0.71	
Catalpa	0.8	0.1	0.4	0.0	4	1.9	0.3	0.3	1.8	12	0.0	0	5.5	16 (N/A)	3.0	15.71	
Honeylocust	0.9	0.2	0.4	0.0	5	1.7	0.3	0.2	1.7	11	-0.8	-3	4.7	13 (N/A)	3.0	12.87	
Eastern red cedar	0.3	0.1	0.3	0.0	2	0.5	0.1	0.1	0.5	3	-0.9	-3	1.0	2 (N/A)	3.0	2.19	
Apple	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)	3.0	2.55	
Other street trees	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)	0.0	0.00	
Citywide total	9.8	1.7	5.4	0.6	55	26.6	3.8	3.6	24.8	164	-8.4	-32	67.9	188 (N/A)	100.0	5.69	

**Table 4: Annual Carbon Stored**

**Stored CO2 Benefits of Public Trees by Species**

9/29/2011

Species	Total Stored CO2 (lbs)	Total (\$)	Standard Error	% of Total Trees	% of Total \$	Avg. \$/tree
Blue spruce	2,273	17	(N/A)	24.2	1.3	2.13
Ash	37,623	282	(N/A)	15.2	21.8	56.43
Sugar maple	46,132	346	(N/A)	12.1	26.7	86.50
Northern	16,331	122	(N/A)	9.1	9.5	40.83
Conifer Evergreen	5	0	(N/A)	6.1	0.0	0.02
Mulberry	922	7	(N/A)	6.1	0.5	3.46
Eastern white pine	6,685	50	(N/A)	6.1	3.9	25.07
Norway maple	7,945	60	(N/A)	3.0	4.6	59.59
Ohio buckeye	14,280	107	(N/A)	3.0	8.3	107.10
Broadleaf	178	1	(N/A)	3.0	0.1	1.33
Catalpa	25,943	195	(N/A)	3.0	15.0	194.57
Honeylocust	12,245	92	(N/A)	3.0	7.1	91.84
Eastern red cedar	1,102	8	(N/A)	3.0	0.6	8.27
Apple	908	7	(N/A)	3.0	0.5	6.81
Other street trees	0	0	(N/A)	0.0	0.0	0.00
Citywide total	172,573	1,294	(N/A)	100.0	100.0	39.22

**Table 5: Annual Carbon Sequestered**

## Annual CO<sub>2</sub> Benefits of Public Trees by Species

9/29/2011

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
Blue spruce	309	2	-11	-2	0	850	6	1,146	9 (N/A)	24.2	6.6	1.07
Ash	1,069	8	-181	-1	-1	1,700	13	2,588	19 (N/A)	15.2	14.9	3.88
Sugar maple	2,424	18	-221	-1	-2	1,764	13	3,965	30 (N/A)	12.1	22.9	7.44
Northern hackberry	1,208	9	-78	-1	-1	1,637	12	2,766	21 (N/A)	9.1	16.0	6.92
Conifer Evergreen	1	0	0	0	0	12	0	13	0 (N/A)	6.1	0.1	0.05
Mulberry	123	1	-4	0	0	130	1	248	2 (N/A)	6.1	1.4	0.93
Eastern white pine	375	3	-32	0	0	493	4	835	6 (N/A)	6.1	4.8	3.13
Norway maple	470	4	-38	0	0	440	3	872	7 (N/A)	3.0	5.0	6.54
Ohio buckeye	370	3	-69	0	-1	539	4	840	6 (N/A)	3.0	4.9	6.30
Broadleaf Deciduous	38	0	-1	0	0	37	0	74	1 (N/A)	3.0	0.4	0.56
Catalpa	960	7	-125	0	-1	650	5	1,485	11 (N/A)	3.0	8.6	11.14
Honeylocust	1,486	11	-59	0	0	615	5	2,042	15 (N/A)	3.0	11.8	15.31
Eastern red cedar	43	0	-5	0	0	187	1	224	2 (N/A)	3.0	1.3	1.68
Apple	114	1	-4	0	0	124	1	233	2 (N/A)	3.0	1.4	1.75
Other street trees	0	0	0	0	0	0	0	0	0 (N/A)	0.0	0.0	0.00
Citywide total	8,988	67	-828	-6	-6	9,178	69	17,331	130 (N/A)	100.0	100.0	3.94

Table 6: Annual Social and Aesthetic Benefits

## Annual Aesthetic/Other Benefits of Public Trees by Species

9/29/2011

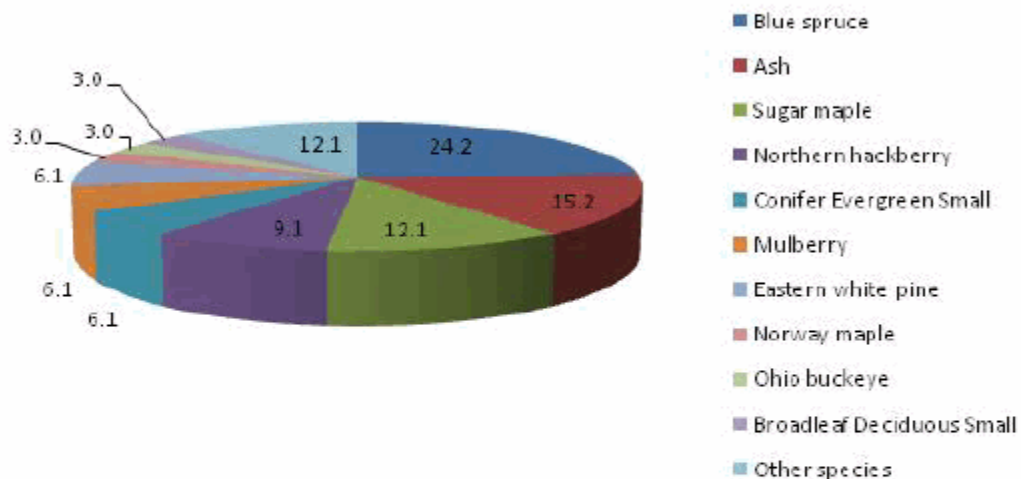
Species	Standard Error (\$)	% of Total Trees	% of Total \$	Avg. \$/tree
Blue spruce	169 (N/A)	24.2	12.5	21.08
Ash	103 (N/A)	15.2	7.6	20.69
Sugar maple	253 (N/A)	12.1	18.7	63.34
Northern hackberry	168 (N/A)	9.1	12.4	56.03
Conifer Evergreen Small	9 (N/A)	6.1	0.6	4.27
Mulberry	6 (N/A)	6.1	0.5	3.22
Eastern white pine	94 (N/A)	6.1	7.0	47.08
Norway maple	43 (N/A)	3.0	3.2	43.05
Ohio buckeye	31 (N/A)	3.0	2.3	31.46
Broadleaf Deciduous	2 (N/A)	3.0	0.2	2.06
Catalpa	67 (N/A)	3.0	4.9	66.60
Honeylocust	389 (N/A)	3.0	28.7	388.90
Eastern red cedar	14 (N/A)	3.0	1.0	13.68
Apple	6 (N/A)	3.0	0.5	6.40
Other street trees	0 (±NaN)	0.0	0.0	0.00
Citywide total	1,355 (N/A)	100.0	100.0	41.06

**Table 7: Summary of Benefits in Dollars**

<b>Total Annual Benefits of Public Trees by Species (\$)</b>								
9/29/201								
Species	Energy	CO <sub>2</sub>	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Blue spruce	118	9	12	164	169	472	(±0)	10.4
Ash	226	19	41	287	103	677	(±0)	14.9
Sugar maple	223	30	35	329	253	870	(±0)	19.1
Northern hackberry	215	21	36	230	168	670	(±0)	14.7
Conifer Evergreen	2	0	0	1	9	12	(±0)	0.3
Mulberry	19	2	3	7	6	37	(±0)	0.8
Eastern white pine	61	6	3	161	94	325	(±0)	7.1
Norway maple	59	7	10	67	43	186	(±0)	4.1
Ohio buckeye	71	6	14	102	31	224	(±0)	4.9
Broadleaf Deciduous	5	1	1	2	2	11	(±0)	0.2
Catalpa	82	11	16	149	67	324	(±0)	7.1
Honeylocust	74	15	13	127	389	618	(±0)	13.6
Eastern red cedar	25	2	2	44	14	86	(±0)	1.9
Apple	18	2	3	7	6	36	(±0)	0.8
Other street trees	0	0	0	0	0	0	(±0)	0.0
<b>Citywide Total</b>	<b>1,198</b>	<b>130</b>	<b>188</b>	<b>1,678</b>	<b>1,355</b>	<b>4,549</b>	<b>(±0)</b>	<b>100.0</b>

## Species Distribution of Public Trees (%)

9/29/2011

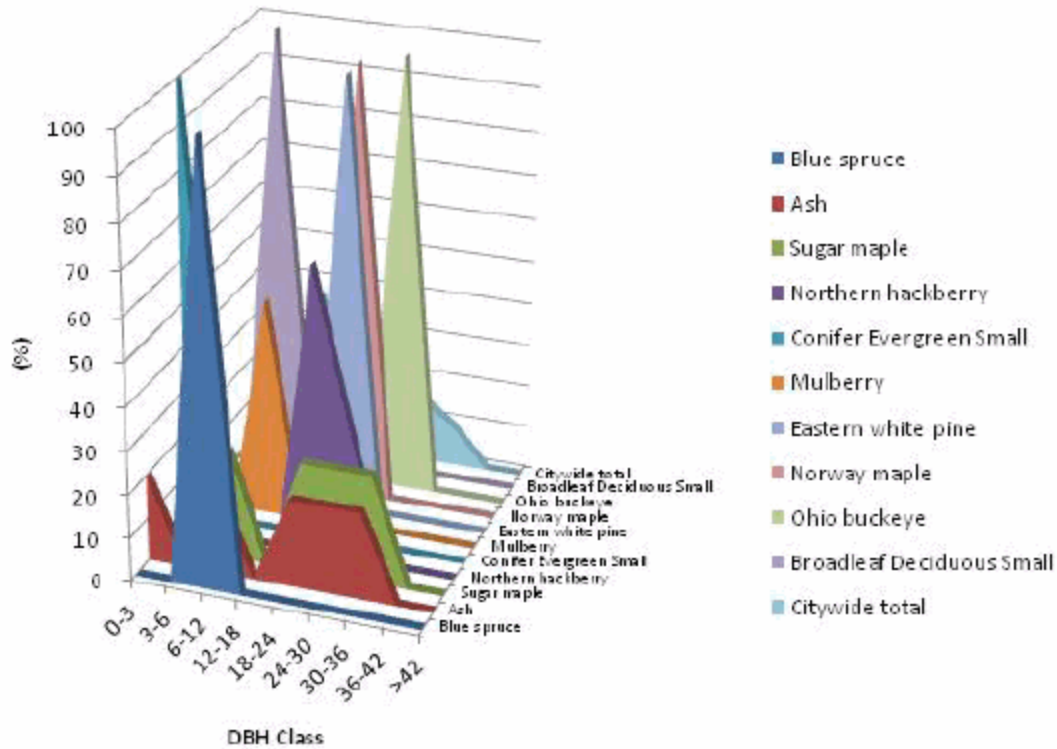


Species	Percent
Blue spruce	24.2
Ash	15.2
Sugar maple	12.1
Northern hackberry	9.1
Conifer Evergreen	6.1
Mulberry	6.1
Eastern white pine	6.1
Norway maple	3.0
Ohio buckeye	3.0
Broadleaf Deciduous	3.0
Other species	12.1
<b>Total</b>	<b>100.0</b>

Figure 1: Species Distribution

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

9/29/2011



Species	DBH class (in)								
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Blue spruce	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Ash	20.0	0.0	20.0	0.0	20.0	20.0	20.0	0.0	0.0
Sugar maple	0.0	0.0	25.0	0.0	25.0	25.0	25.0	0.0	0.0
Northern hackberry	0.0	0.0	0.0	0.0	66.7	33.3	0.0	0.0	0.0
Conifer Evergreen Small	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mulberry	50.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern white pine	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Norway maple	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Ohio buckeye	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Broadleaf Deciduous	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Citywide total	12.1	3.0	36.4	3.0	21.2	15.2	9.1	0.0	0.0

Figure 2: Relative Age Class

## Functional (Foliage) Condition of Public Trees by Species (%)

9/29/2011

### Citywide total

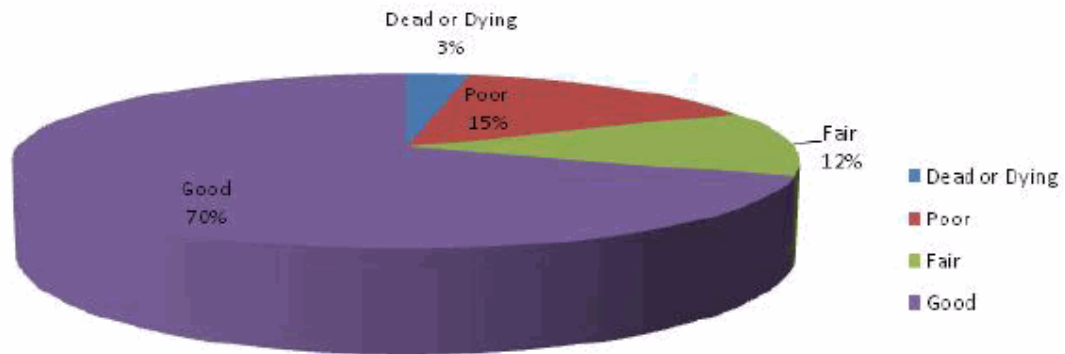


Figure 3: Foliage Condition

## Structural (Woody) Condition of Public Trees by Species (%)

9/29/2011

### Citywide total

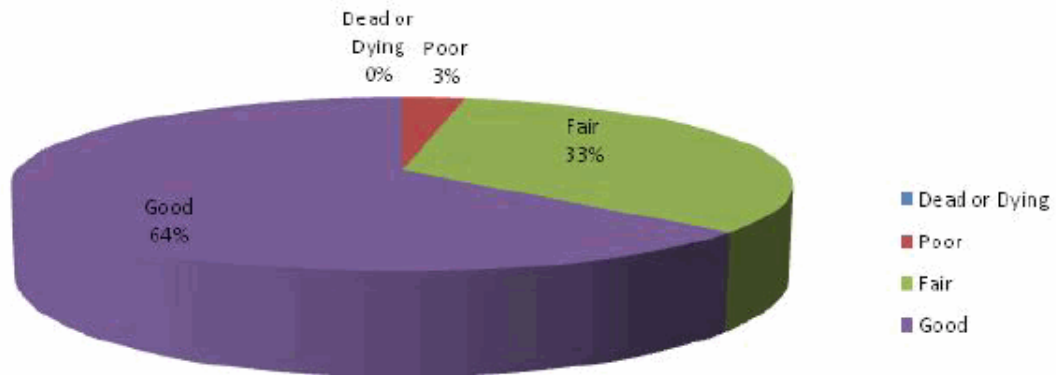
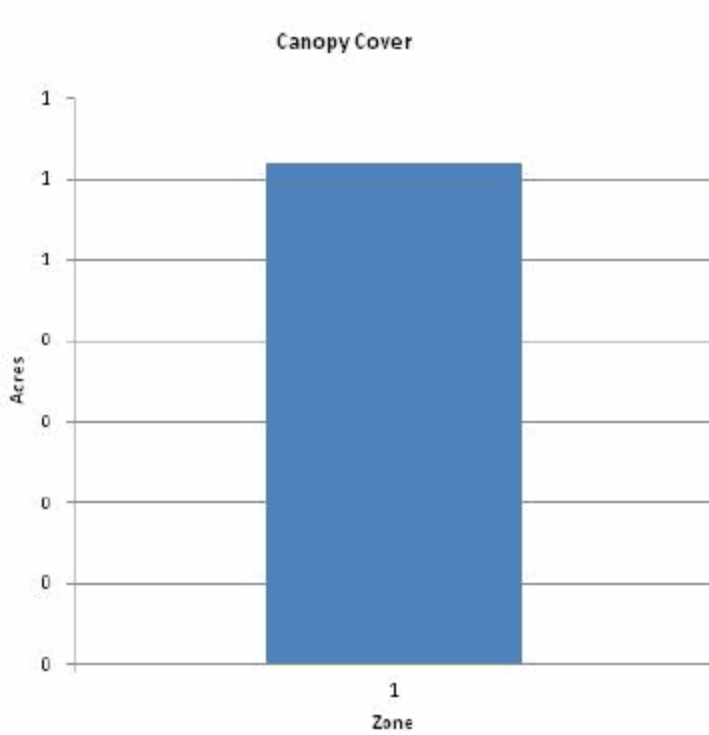


Figure 4: Wood Condition

# Canopy Cover of Public Trees (Acres)

9/29/2011



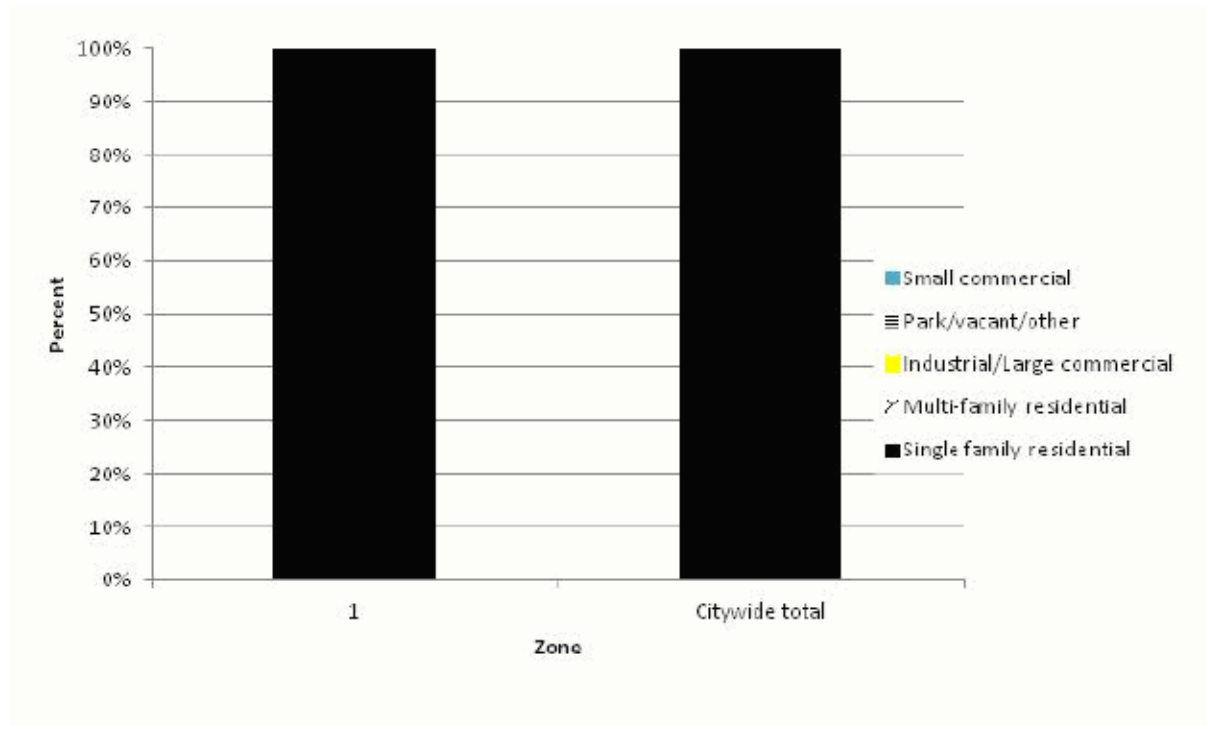
Zone	Acres	% of Total Canopy Cover
1	1	100.0
Citywide total	1	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	1		

Figure 5: Canopy Cover in Acres

## Land Use of Public Trees by Zone (%)

9/29/2011



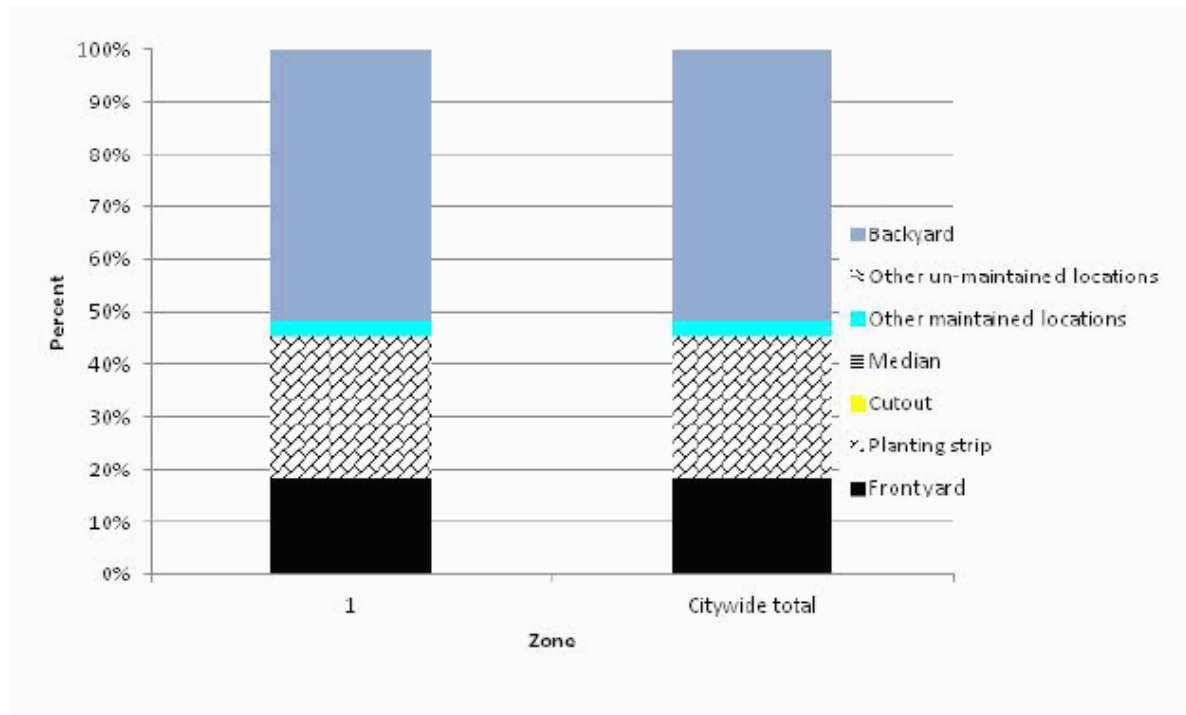
Zone	Single family residential	Multi-family residential	Industrial/Large commercial	Park/vacant/other	Small commercial
1	100.0	0.0	0.0	0.0	0.0
Citywide total	100.0	0.0	0.0	0.0	0.0

Figure 6: Land Use of city/park trees



## Location of Public Trees by Zone (%)

9/29/2011



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	18.2	27.3	0.0	0.0	3.0	0.0	51.5
Citywide total	18.2	27.3	0.0	0.0	3.0	0.0	51.5

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

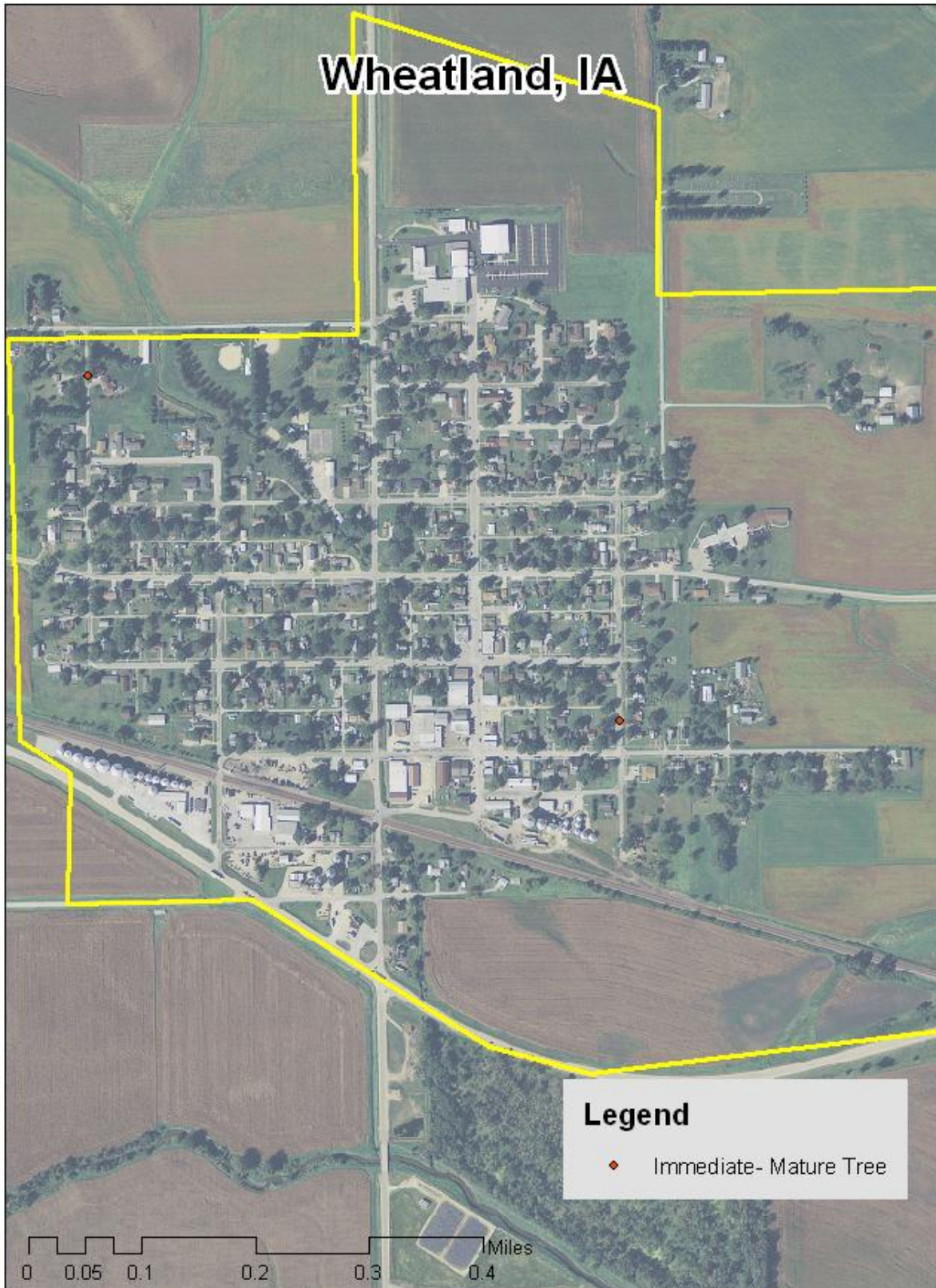


Figure 4: Location of Trees with Recommended Maintenance

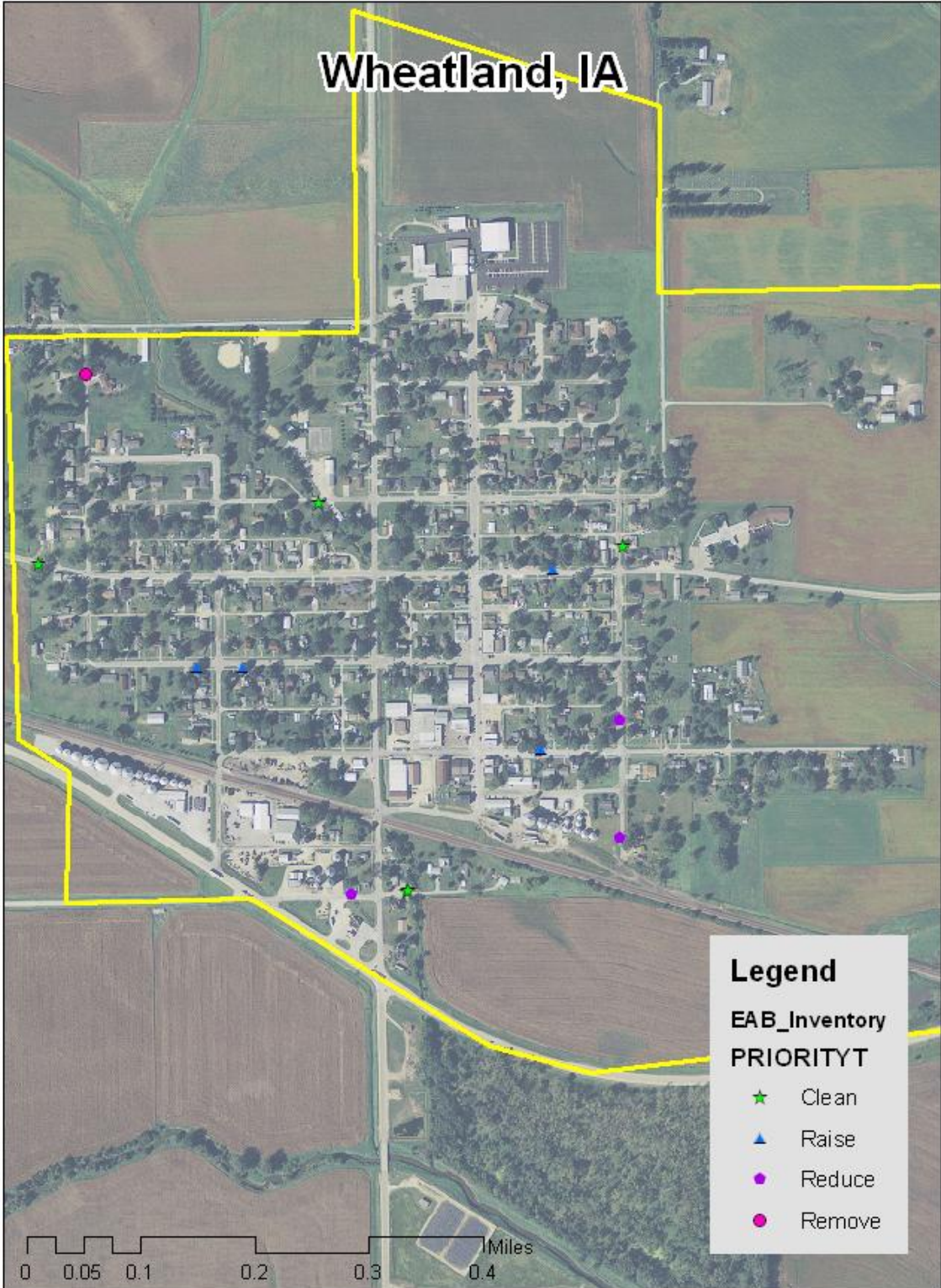


Figure 5: Maintenance Tasks \*City ownership of the trees recommended for removal should be verified prior to any removal\*

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