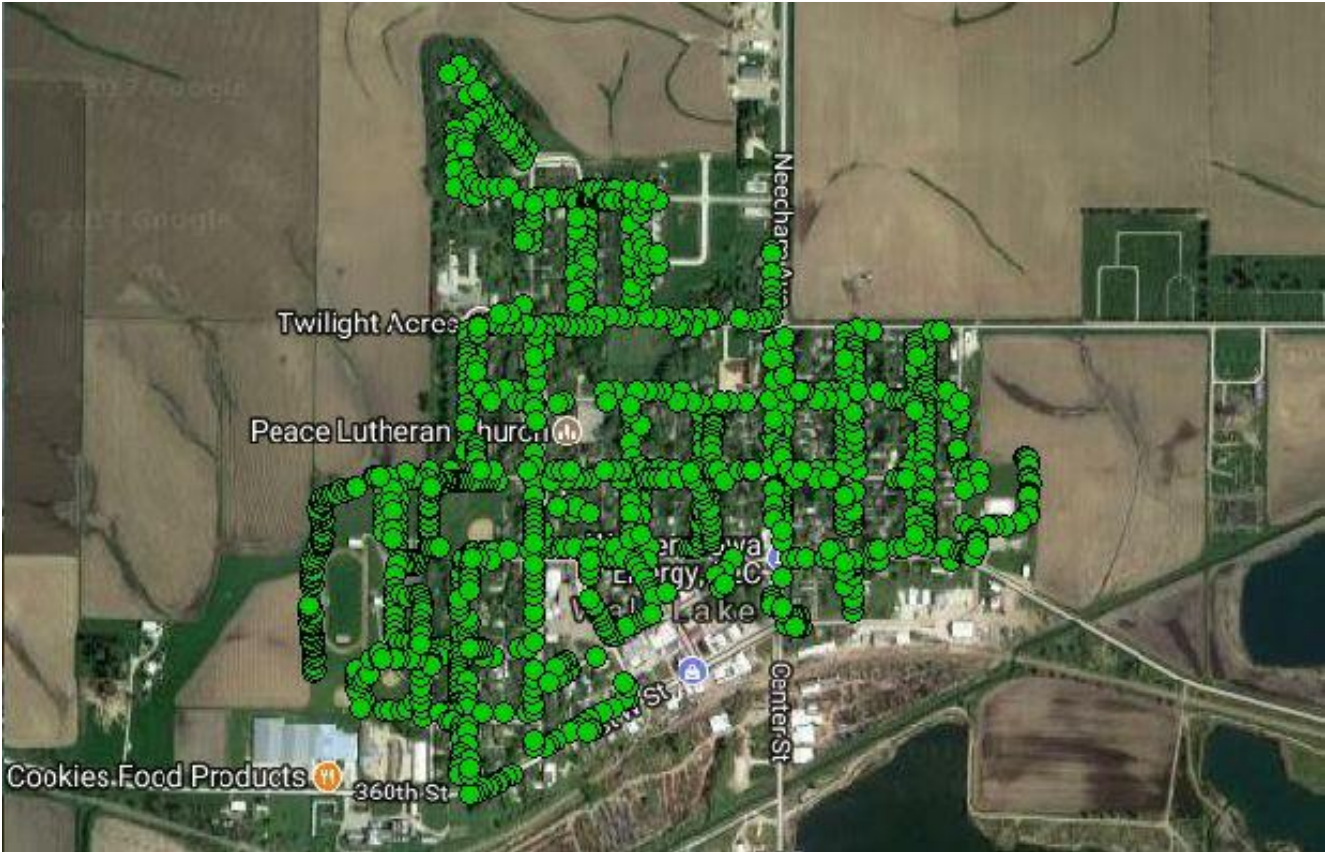


# Community Tree Management Plan for Merville, IA



2017 Urban Forest Management Plan  
Prepared by ArborPro, Inc.  
In Partnership with the Iowa DNR



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# Executive Summary

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## Overview

This plan was developed to assist the City of Merville with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 20.43% of Merville's community, unless preventative treatment is used, will become infested and die once EAB becomes established in 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 2017, 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 734 trees inventoried.

- Merville's trees provide \$29,694 of benefits annually, an average of \$165 a tree
- There are over 33 species of trees
- The top three genera are: Maple 24.38%, Ash 20.43%, and Oak 4.49%
- 96% of trees need some type of management or mitigation.
- 25 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 25 trees needing removal, 13 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\\*](#)
- 22 of the 150 ash trees should be carefully examined, as they present with some of the 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, Bradford Pear, female Ginko, Chinese Elm, Scot's Pine, Austrian Pine, Willow or Black Walnut.
- Check ash trees with a visual survey yearly
- With the current budget it could take 24 years to remove ash – Suggestion: request a budget increase to \$10,000 annually and apply for grants to plant replacement trees

## Introduction

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

Trees are an important component of Menville'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, storm water 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 Menville 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 Menville's urban forestry goals.

## Inventory

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In 2017, a tree inventory was conducted that included 100% of the city owned street trees and park trees. The tree data was collected using a hand held 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

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The data collected for the 734 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. Menville's trees reduce energy related costs by approximately \$29,694 annually (Appendix A, Table 1). These savings are both in Electricity (141 MWh) and in Natural Gas (19,350 Therms).

#### **Annual Stormwater Benefits**

Menville's trees intercept about 1,608,236.5 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides \$43,583.21 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 Menville it is estimated that trees remove 253.61 lbs of air pollution (ozone (O<sub>3</sub>), particulate matter less than 10 microns (PM<sub>10</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and sulfur dioxide (SO<sub>2</sub>)) per year with a net value of \$4,888.78 (Appendix A, Table 3).

#### **Annual Carbon Benefits**

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Menville, trees sequester about 364,824.21lbs of carbon a year with an associated value of \$4,303.07 (Appendix A, Table 4). In addition, the trees store 5,542,488.43 lbs of carbon, with a yearly benefit of \$41568.66 (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. Menville receives \$36,212.31 in annual social benefits from trees (Appendix A, Table 6).

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

According to the USDA Forest Service i-Tree STRATUM analysis, Menville's trees provide \$118681.40 of benefits annually. Benefits of individual trees vary based on size, species, health

and location, but on average each of the 734 trees in Menville provide approximately \$164.83 annually (Appendix A, Table 7).

## **Forest Structure**

### **Species Distribution**

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

Green ash	147	20.02%
Silver maple	73	9.94%
Red maple	58	7.90%
Sugar maple	19	2.58%
Northern red oak	16	2.17%
American basswood	16	2.17%
Pin oak	15	2.04%
Northern hackberry	13	1.77%
Black maple	8	1.08%
White ash	3	0.40%
Kentucky coffeetree	3	0.40%
American elm	3	0.40%
Elm	2	0.27%
Bur oak	2	0.27%
Hickory	1	0.13%
Littleleaf linden	35	4.76%
Honeylocust	27	3.67%
Norway maple	20	2.72%
Ohio buckeye	5	0.68%
River birch	2	0.27%
Apple	104	14.16%
Eastern redbud	13	1.77%
Pear	11	1.49%
Plum	2	0.27%
Amur maple	1	0.13%
Broadleaf Evergreen Medium	2	0.27%
Scotch pine	31	4.22%
Spruce	21	2.86%
Conifer Evergreen Large	14	1.90%
Eastern white pine	4	0.54%
Norway spruce	1	0.13%
Ponderosa pine	1	0.13%
Blue spruce	47	6.40%

## Age Class

Approximately one third (54.49%) of Movable's trees are between 0 and 18 inches in diameter at 4.5 ft. (Appendix A, Figure 2). It is preferred that the highest number of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Movable's size curve is on the upward side, indicating a mature to over-mature forest stand.

## Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Movable indicate that 41.14% of the trees are in fair health, with 55.04% of the trees in good health, and only 3.04% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 40.97% of Movable's trees are in fair health for wood condition, with 55.14% in good wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 3.47% of the population. This 3.47% 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).

**Movable**  
**3/25/2018**

### Priority Tasks for All Trees by Zone (None)

stake/train	82	11.39
clean	226	31.39
raise	176	24.44
reduce	182	25.28

## Canopy Cover

The total canopy with both private and public trees is 2.84%, 569.60 acres. The canopy cover included in the Movable inventory includes approximately 16.20 acres (Appendix A, Figure 4). The City's Canopy goal is 30%, in 30 years. To achieve this goal, it is estimated that 42 public and private trees need to be planted annually.

## Land Use and Location

The majority of Movable'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.

## Moville

### Land Use of All Trees by Zone

3/25/2018

Land Use	Tree Count	Standard Error	% of Zone
Single family residential	447	(N/A)	62.08
Multi-family residential	10	(N/A)	1.39
Small commercial	4	(N/A)	0.56
Industrial/Large commercial	0	(N/A)	0.00
Park/vacant/other	259	(N/A)	35.97

## Moville

### Site Type of All Trees by Zone

3/25/2018

Zone	Site Type	Tree Count	Standard Error	% of Zone	% of All Trees
1	Front yard	208	(N/A)	28.33%	28.33%
	Planting strip	307	(N/A)	41.82%	41.82%
	Cutout	0	(N/A)	0.00%	0.00%
	Median	15	(N/A)	2.04%	2.04%
	Other maintained locations	204	(N/A)	27.79%	27.79%
	Other un-maintained locations	0	(N/A)	0.00%	0.00%
	Backyard	0	(N/A)	0.00%	0.00%
	Total	0	(N/A)	0.00	0.00

## 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.

### Hazardous trees

Moville has 0 critical concern trees that need immediate removal. It is recommended to start with the large diameter critical concern trees first. Please refer to the six-year maintenance plan at the end of this section. After all the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There is a total of 680 trees with these needs.



### Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 25 removals, only 14 are ash trees. There is a total of 150 ash trees, and 39 of those have signs and symptoms that have been associated with EAB. In addition, there are 14 trees that are in poor health. [\\*City ownership of the trees recommended for removal should be verified prior to any removal\\*](#)

### **Pruning Cycle**

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

### **Planting**

Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six-year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Merville.

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 (52.43%) (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. All trees planted must meet the restrictions in city ordinance.

### **Continual Monitoring**

Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

## **Six Year Maintenance Plan with No Additional Funding**

### Year 1

Removal: 8 largest critical concern trees  
Planting and Replacement: 9 trees to be planted in open locations  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

### Year 2

Removal: 2 critical concern trees and 4 additional ash trees with poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 6 trees in open locations from year one removals  
Young Tree Pruning & Maintenance:  
Routine trimming: Contract to trim 1/3 of the city trees  
Visual Survey for signs and symptoms of EAB

### Year 3

Removal: 8 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 9 trees to be planted in open locations and locations from previous removals  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

### Year 4

Removal: 6 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 7 trees in open locations from previous removals  
Routine trimming: Contract to trim 1/3 of the city trees  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

### Year 5

Removal: 8 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 9 trees to be planted in open locations and locations from previous removals  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

### Year 6

Removal: 6 trees - removal of any new critical concern trees and ash in poor health  
\*Or saving for ash tree treatment and/or future ash removal  
Planting and Replacement: 7 trees in open locations from previous removals  
Routine trimming: Contract to trim 1/3 of the city trees  
Young Tree Pruning & Maintenance:  
Visual Survey for signs and symptoms of EAB

\*Reduction of ash over 6 years: 24 ash trees removed (approximately 61.53% of ash). It will take approximately 10 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.

\*\* To remove all ash trees within 6 years, the budget would need to be increased to \$19,500 a year. If the budget were increased to \$10,000 a year all ash could be removed in 13 years.

## **Emerald Ash Borer Plan**

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### **Ash Tree Removal**

Tree removal will be prioritized with dead, dying, hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). *\*City ownership of the tree recommended for removal should be verified prior to any removal\**

### **Treatment of Ash Trees**

Chemical treatment can be effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit <http://extension.entm.purdue.edu/treecomputer/>

### **EAB Quarantines**

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. 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 budget permits, all removed trees will be replaced. All trees will meet the restrictions in 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 if tree is not being treated. An example of City Code could state "If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property."

# Budget

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## Current Budget

Total \$20,166 over 6 years (\$3,366/year)

### **FY 2018 Budget**

Removal: \$2000

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$900

Watering & Maintenance: \$500

### **FY 2019 Budget**

Removal: \$1500

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$600

Routine trimming: \$800

Watering & Maintenance: \$500

### **FY 2020 Budget**

Removal: \$2000

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$900

Watering & Maintenance: \$500

### **FY 2021 Budget**

Removal: \$1500

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$600

Routine trimming: \$1,700

Watering & Maintenance: \$500

### **FY 2022 Budget**

Removal: \$2000

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$900

Watering & Maintenance: \$500

### **FY 2023 Budget**

Removal: \$1500

\*Or saving for ash tree treatment and/or future ash removal

Planting: \$600

Routine trimming: \$1,700

Watering & Maintenance: \$500

\*Reduction of ash over 6 years: approximately 24 ash trees removed (approximately 61.53% of ash). **It will take approximately 10 years to remove all ash with the current budget.**

## Purposed Budget Increase

EAB could potentially kill all ash trees in Merville within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to \$19,500 a year. If the budget

were increased to \$10,000 a year all ash could be removed within 13 years. Additionally, it is recommended that Merville apply for grants to fund replacement trees. Utility Company grants are usually between \$500 and \$10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at \$15 per inch, about 4 trees could be treated per year (every other year treatment). This would be 8 trees selected for treatment, and Merville would still need to find \$8,000 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately \$2,250 a year for treatment and leave \$1,800 for removal. These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Merville. 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

Moville

3/25/2018

Annual Energy Benefits of All Trees by Species

Species	Total		Total Natural		Total (\$)	Standard Error	% of Total		Avg. \$/tree
	Electricity (MWh)	Electricity (\$)	Gas (Therms)	Natural Gas (\$)			Tree Numbers	% of Total \$	
Green ash	41.92	3,181.99	5,732.40	5,617.75	8,799.74	(N/A)	20.42	29.63	59.86
Apple	6.66	505.41	1,097.45	1,075.50	1,580.91	(N/A)	14.44	5.32	15.20
Silver maple	26.82	2,035.94	3,525.68	3,455.17	5,491.10	(N/A)	10.14	18.49	75.22
Red maple	9.43	715.56	1,262.59	1,237.34	1,952.90	(N/A)	8.06	6.58	33.67
Blue spruce	3.90	295.86	536.31	525.59	821.45	(N/A)	6.53	2.77	17.48
Littleleaf linden	4.33	328.41	610.16	597.95	926.36	(N/A)	4.86	3.12	26.47
Scotch pine	4.16	315.73	539.67	528.88	844.61	(N/A)	4.31	2.84	27.25
Honeylocust	9.57	726.32	1,245.62	1,220.71	1,947.02	(N/A)	3.75	6.56	72.11
Spruce	1.68	127.72	233.68	229.00	356.72	(N/A)	2.92	1.20	16.99
Norway maple	4.40	334.33	598.90	586.92	921.26	(N/A)	2.78	3.10	46.06
Sugar maple	3.94	299.28	538.33	527.56	826.84	(N/A)	2.64	2.78	43.52
American basswood	3.48	264.50	505.51	495.40	759.90	(N/A)	2.22	2.56	47.49
Northern red oak	1.48	112.47	212.61	208.35	320.82	(N/A)	2.22	1.08	20.05
Pin oak	4.80	364.28	653.64	640.57	1,004.85	(N/A)	2.08	3.38	66.99
Conifer Evergreen Large	1.92	146.11	264.43	259.14	405.24	(N/A)	1.94	1.36	28.95
Eastern redbud	0.04	3.30	8.12	7.96	11.26	(N/A)	1.81	0.04	0.87
Northern hackberry	4.06	308.40	572.58	561.13	869.53	(N/A)	1.81	2.93	66.89
Pear	0.94	71.33	159.94	156.74	228.07	(N/A)	1.53	0.77	20.73
Black maple	1.23	93.54	178.86	175.28	268.82	(N/A)	1.11	0.91	33.60
Ohio buckeye	1.28	97.52	187.76	184.00	281.52	(N/A)	0.69	0.95	56.30
Eastern white pine	0.30	22.61	43.12	42.26	64.87	(N/A)	0.56	0.22	16.22
White ash	0.89	67.22	114.39	112.10	179.32	(N/A)	0.42	0.60	59.77
Kentucky coffeetree	0.80	60.54	100.84	98.82	159.37	(N/A)	0.42	0.54	53.12
American elm	1.70	129.29	209.38	205.19	334.48	(N/A)	0.42	1.13	111.49
Broadleaf Evergreen Mediu	0.12	9.03	18.25	17.89	26.92	(N/A)	0.28	0.09	13.46
Elm	0.06	4.40	7.38	7.23	11.64	(N/A)	0.28	0.04	5.82
Plum	0.10	7.30	16.63	16.30	23.60	(N/A)	0.28	0.08	11.80
River birch	0.34	25.83	46.34	45.42	71.25	(N/A)	0.28	0.24	35.62
Bur oak	0.33	24.96	40.72	39.90	64.87	(N/A)	0.28	0.22	32.43
Ponderosa pine	0.19	14.07	24.60	24.10	38.17	(N/A)	0.14	0.13	38.17
Norway spruce	0.19	14.07	24.60	24.10	38.17	(N/A)	0.14	0.13	38.17
Amur maple	0.07	5.62	12.83	12.58	18.19	(N/A)	0.14	0.06	18.19
Hickory	0.23	17.78	26.99	26.45	44.23	(N/A)	0.14	0.15	44.23
<b>Total</b>	<b>141.38</b>	<b>10,730.70</b>	<b>19,350.32</b>	<b>18,963.31</b>	<b>29,694.02</b>	<b>(N/A)</b>	<b>100.00</b>	<b>100.00</b>	<b>41.24</b>

## Table 2: Annual Storm Water Benefits

Moville

3/25/2018

### Annual Stormwater Benefits of All Trees by Species

Species	Total Rainfall		Standard Error	% of Total		Avg. \$/tree
	Interception (Gal)	Total (\$)		Tree Numbers	% of Total \$	
Green ash	456,476.71	12,370.52	(N/A)	20.42	28.38	84.15
Apple	24,490.47	663.69	(N/A)	14.44	1.52	6.38
Silver maple	425,683.02	11,536.01	(N/A)	10.14	26.47	158.03
Red maple	72,061.30	1,952.86	(N/A)	8.06	4.48	33.67
Blue spruce	50,689.44	1,373.68	(N/A)	6.53	3.15	29.23
Littleleaf linden	35,916.40	973.33	(N/A)	4.86	2.23	27.81
Scotch pine	73,684.15	1,996.84	(N/A)	4.31	4.58	64.41
Honeylocust	116,242.75	3,150.18	(N/A)	3.75	7.23	116.67
Spruce	22,811.41	618.19	(N/A)	2.92	1.42	29.44
Norway maple	32,572.15	882.71	(N/A)	2.78	2.03	44.14
Sugar maple	40,363.98	1,093.86	(N/A)	2.64	2.51	57.57
American basswood	35,196.96	953.84	(N/A)	2.22	2.19	59.61
Northern red oak	12,786.43	346.51	(N/A)	2.22	0.80	21.66
Pin oak	53,767.57	1,457.10	(N/A)	2.08	3.34	97.14
Conifer Evergreen Large	41,886.75	1,135.13	(N/A)	1.94	2.60	81.08
Eastern redbud	96.85	2.62	(N/A)	1.81	0.01	0.20
Northern hackberry	40,397.61	1,094.78	(N/A)	1.81	2.51	84.21
Pear	3,818.92	103.49	(N/A)	1.53	0.24	9.41
Black maple	9,485.73	257.06	(N/A)	1.11	0.59	32.13
Ohio buckeye	11,326.22	306.94	(N/A)	0.69	0.70	61.39
Eastern white pine	3,325.19	90.11	(N/A)	0.56	0.21	22.53
White ash	8,112.86	219.86	(N/A)	0.42	0.50	73.29
Kentucky coffeetree	6,874.05	186.29	(N/A)	0.42	0.43	62.10
American elm	13,653.31	370.00	(N/A)	0.42	0.85	123.33
Broadleaf Evergreen Mediu	832.12	22.55	(N/A)	0.28	0.05	11.28
Elm	343.27	9.30	(N/A)	0.28	0.02	4.65
Plum	333.15	9.03	(N/A)	0.28	0.02	4.51
River birch	1,995.05	54.07	(N/A)	0.28	0.12	27.03
Bur oak	2,073.41	56.19	(N/A)	0.28	0.13	28.09
Ponderosa pine	4,604.65	124.79	(N/A)	0.14	0.29	124.79
Norway spruce	4,604.65	124.79	(N/A)	0.14	0.29	124.79
Amur maple	264.49	7.17	(N/A)	0.14	0.02	7.17
Hickory	1,465.55	39.72	(N/A)	0.14	0.09	39.72
Citywide total	1,608,236.56	43,583.21	(N/A)	100.00	100.00	60.53



# Table 3: Annual Air Quality Benefits

Moville

3/25/2018

Annual Air Quality Benefits of All Trees by Species

Species	Deposito		n		Total		Avoide		Avoide		Avoide		Total		BVO		BVO		%		
	Deposito	n	Deposito	n	Deposito	Deposito	Avoide	Avoide	Avoide	Avoide	Avoide	Avoide	Total	Total	Emissions	Emissions	Total	Total	Standard	Tree	Avg.
	n O3 (lb)	(lb)	n PM10 (lb)	(lb)	n SO2 (lb)	n (\$)	NO2 (lb)	PM10 (lb)	VOC (lb)	SO2 (lb)	(\$)	(\$)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	Error	Numbers	\$/tree
Green ash	55.24	8.84	26.61	2.48	294.70	200.12	29.14	27.78	190.01	1,246.79	0.00	0.00	540.23	1,541.48	(N/A)				20.42	10.49	
Apple	5.14	0.85	2.75	0.24	28.30	33.43	4.75	4.50	30.17	204.17	- 0.03	- 0.12	81.79	232.35	(N/A)				14.44	2.23	
Silver maple	78.40	13.29	37.90	3.48	421.04	126.37	18.50	17.66	121.30	790.73	- 39.74	- 149.02	377.16	1,062.74	(N/A)				10.14	14.56	
Red maple	15.94	2.72	7.61	0.71	85.39	44.70	6.53	6.23	42.71	279.18	- 5.51	- 20.65	121.63	343.92	(N/A)				8.06	5.93	
Blue spruce	6.42	1.27	5.52	0.79	42.97	18.58	2.71	2.58	17.65	115.76	- 17.88	- 67.06	37.62	91.67	(N/A)				6.53	1.95	
Littleleaf linden	5.34	0.92	2.78	0.24	29.29	20.86	3.02	2.88	19.64	129.51	- 2.72	- 10.20	52.96	148.60	(N/A)				4.86	4.25	
Scotch pine	8.45	1.68	6.96	1.04	55.75	19.54	2.87	2.74	18.84	122.49	- 33.06	- 123.98	29.06	54.26	(N/A)				4.31	1.75	
Honeylocust	23.11	3.81	10.44	1.05	121.74	45.00	6.60	6.30	43.30	281.86	- 18.41	- 69.03	121.21	334.57	(N/A)				3.75	12.39	
Spruce	2.37	0.47	2.11	0.29	16.07	8.04	1.17	1.12	7.62	50.08	- 8.58	- 32.19	14.61	33.96	(N/A)				2.92	1.62	
Norway maple	5.79	1.00	2.96	0.26	31.62	21.04	3.06	2.92	19.99	131.11	- 1.43	- 5.37	55.59	157.36	(N/A)				2.78	7.87	
Sugar maple	5.05	0.86	2.58	0.22	27.52	18.79	2.74	2.61	17.86	117.11	- 4.01	- 15.02	46.70	129.61	(N/A)				2.64	6.82	
American basswood	4.46	0.76	2.25	0.20	24.24	16.92	2.44	2.33	15.81	104.77	- 3.90	- 14.63	41.28	114.37	(N/A)				2.22	7.15	
Northern red oak	2.45	0.42	1.24	0.11	13.34	7.14	1.03	0.99	6.71	44.32	- 3.52	- 13.18	16.58	44.48	(N/A)				2.22	2.78	
Pin oak	9.40	1.65	4.82	0.42	51.44	22.86	3.33	3.18	21.74	142.50	- 17.44	- 65.39	49.95	128.55	(N/A)				2.08	8.57	
Conifer Evergreen Large	4.99	0.99	4.02	0.61	32.66	9.18	1.34	1.27	8.72	57.19	- 23.36	- 87.60	7.76	2.24	(N/A)				1.94	0.16	
Eastern redbud	0.00	0.00	0.00	0.00	0.02	0.23	0.03	0.03	0.20	1.37	0.00	0.00	0.49	1.39	(N/A)				1.81	0.11	
Northern hackberry	6.45	1.12	3.26	0.29	35.13	19.58	2.84	2.70	18.43	121.55	0.00	0.00	54.67	156.68	(N/A)				1.81	12.05	
Pear	0.89	0.15	0.46	0.04	4.85	4.76	0.67	0.64	4.26	28.98	- 0.01	- 0.02	11.86	33.81	(N/A)				1.53	3.07	
Black maple	1.97	0.33	0.96	0.09	10.60	5.96	0.86	0.82	5.58	36.94	- 0.70	- 2.61	15.88	44.92	(N/A)				1.11	5.62	
Ohio buckeye	2.18	0.38	1.08	0.10	11.83	6.25	0.90	0.86	5.83	38.67	- 0.52	- 1.95	17.06	48.55	(N/A)				0.69	9.71	
Eastern white pine	0.32	0.06	0.31	0.04	2.25	1.44	0.21	0.20	1.35	8.93	- 1.05	- 3.92	2.88	7.25	(N/A)				0.56	1.81	
White ash	0.84	0.13	0.44	0.04	4.60	4.16	0.61	0.58	4.01	26.09	0.00	0.00	10.83	30.69	(N/A)				0.42	10.23	
Kentucky coffeetree	0.71	0.11	0.37	0.03	3.87	3.73	0.55	0.52	3.62	23.45	0.00	0.00	9.65	27.32	(N/A)				0.42	9.11	
American elm	5.91	1.01	2.72	0.26	31.36	7.93	1.17	1.12	7.72	49.89	0.00	0.00	27.83	81.25	(N/A)				0.42	27.08	
Broadleaf Evergreen Medil	0.02	0.00	0.06	0.00	0.27	0.58	0.08	0.08	0.53	3.58	- 0.19	- 0.70	1.18	3.15	(N/A)				0.28	1.57	
Elm	0.00	0.00	0.01	0.00	0.04	0.27	0.04	0.04	0.26	1.70	0.00	0.00	0.62	1.74	(N/A)				0.28	0.87	
Plum	0.05	0.01	0.03	0.00	0.28	0.49	0.07	0.07	0.44	2.97	0.00	0.00	1.15	3.26	(N/A)				0.28	1.63	
River birch	0.27	0.05	0.15	0.01	1.54	1.63	0.24	0.23	1.54	10.13	- 0.08	- 0.29	4.05	11.39	(N/A)				0.28	5.69	
Bur oak	0.13	0.02	0.09	0.01	0.78	1.53	0.23	0.22	1.49	9.64	0.00	0.00	3.71	10.41	(N/A)				0.28	5.21	
Ponderosa pine	0.57	0.11	0.45	0.07	3.69	0.88	0.13	0.12	0.84	5.48	- 2.86	- 10.74	0.30	- 1.58	(N/A)				0.14	- 1.58	
Norway spruce	0.57	0.11	0.45	0.07	3.69	0.88	0.13	0.12	0.84	5.48	- 2.86	- 10.74	0.30	- 1.58	(N/A)				0.14	- 1.58	
Amur maple	0.05	0.01	0.03	0.00	0.26	0.38	0.05	0.05	0.34	2.29	0.00	0.00	0.90	2.55	(N/A)				0.14	2.55	
Hickory	0.11	0.02	0.07	0.00	0.62	1.07	0.16	0.15	1.06	6.80	0.00	0.00	2.65	7.42	(N/A)				0.14	7.42	
Citywide Total	253.61	43.14	131.49	13.18	1,391.73	674.31	98.20	93.63	640.41	4,201.47	- 187.84	- 704.41	1,760.14	4,888.78	(N/A)				100.00	6.79	

## Table 4: Annual Carbon Stored

Moville

3/25/2018

### Stored CO2 Benefits of All Trees by Species

Species	Total stored		Standard Tree Error	% of Total		Avg. \$/tree
	CO2 (lbs)	Total (\$)		Numbers	% of Total \$	
Green ash	1,793,450.87	13,450.88	(N/A)	20.42	32.36	91.50
Apple	93,310.54	699.83	(N/A)	14.44	1.68	6.73
Silver maple	1,804,979.51	13,537.35	(N/A)	10.14	32.57	185.44
Red maple	177,547.07	1,331.60	(N/A)	8.06	3.20	22.96
Blue spruce	42,276.28	317.07	(N/A)	6.53	0.76	6.75
Littleleaf linden	118,884.43	891.63	(N/A)	4.86	2.14	25.48
Scotch pine	78,961.90	592.21	(N/A)	4.31	1.42	19.10
Honeylocust	299,394.53	2,245.46	(N/A)	3.75	5.40	83.17
Spruce	18,342.33	137.57	(N/A)	2.92	0.33	6.55
Norway maple	95,409.95	715.57	(N/A)	2.78	1.72	35.78
Sugar maple	142,971.03	1,072.28	(N/A)	2.64	2.58	56.44
American basswood	161,870.21	1,214.03	(N/A)	2.22	2.92	75.88
Northern red oak	51,144.94	383.59	(N/A)	2.22	0.92	23.97
Pin oak	243,724.54	1,827.93	(N/A)	2.08	4.40	121.86
Conifer Evergreen Large	59,339.53	445.05	(N/A)	1.94	1.07	31.79
Eastern redbud	179.19	1.34	(N/A)	1.81	0.00	0.10
Northern hackberry	98,448.19	738.36	(N/A)	1.81	1.78	56.80
Pear	15,821.78	118.66	(N/A)	1.53	0.29	10.79
Black maple	22,494.58	168.71	(N/A)	1.11	0.41	21.09
Ohio buckeye	35,405.31	265.54	(N/A)	0.69	0.64	53.11
Eastern white pine	1,940.31	14.55	(N/A)	0.56	0.04	3.64
White ash	20,587.20	154.40	(N/A)	0.42	0.37	51.47
Kentucky coffeetree	23,116.43	173.37	(N/A)	0.42	0.42	57.79
American elm	111,882.40	839.12	(N/A)	0.42	2.02	279.71
Broadleaf Evergreen Mediu	557.28	4.18	(N/A)	0.28	0.01	2.09
Elm	370.92	2.78	(N/A)	0.28	0.01	1.39
Plum	1,085.70	8.14	(N/A)	0.28	0.02	4.07
River birch	4,724.83	35.44	(N/A)	0.28	0.09	17.72
Bur oak	4,706.36	35.30	(N/A)	0.28	0.08	17.65
Ponderosa pine	7,490.30	56.18	(N/A)	0.14	0.14	56.18
Norway spruce	7,490.30	56.18	(N/A)	0.14	0.14	56.18
Amur maple	907.91	6.81	(N/A)	0.14	0.02	6.81
Hickory	3,671.83	27.54	(N/A)	0.14	0.07	27.54
Citywide total	5,542,488.43	41,568.66	(N/A)	100.00	100.00	57.73

# Table 5: Annual Carbon Sequestered

Moville

3/25/2018

Annual CO2 Benefits of All Trees by Species

Species	Sequestered (lb)	Sequestered (\$)	Decomposition			Maintenance			Total Avoide d (\$)	Net Total (lb)	Total (\$)	Standard Error	% of Total		
			Release (lb)	Release (\$)	Release (lb)	Release (\$)	Release (lb)	Release (\$)					Tree Numbers	% of Total	Avg. \$/tree
Green ash	100,168.02	751.26	- 8,608.56	- 432.12	- 67.81	70,321.23	527.41	161,448.57	1,210.86	(N/A)	20.42	28.14	8.24		
Apple	10,610.36	79.58	- 448.46	- 104.72	- 4.15	11,169.34	83.77	21,226.53	159.20	(N/A)	14.44	3.70	1.53		
Silver maple	124,078.51	930.59	- 8,665.30	- 310.44	- 67.32	44,993.63	337.45	160,096.40	1,200.72	(N/A)	10.14	27.90	16.45		
Red maple	15,700.06	117.75	- 852.44	- 88.92	- 7.06	15,813.72	118.60	30,572.42	229.29	(N/A)	8.06	5.33	3.95		
Blue spruce	2,961.26	22.21	- 202.93	- 69.03	- 2.04	6,538.40	49.04	9,227.70	69.21	(N/A)	6.53	1.61	1.47		
Littleleaf linden	12,216.42	91.62	- 573.71	- 54.80	- 4.71	7,257.70	54.43	18,845.62	141.34	(N/A)	4.86	3.28	4.04		
Scotch pine	4,826.64	36.20	- 379.02	- 73.71	- 3.40	6,977.53	52.33	11,351.44	85.14	(N/A)	4.31	1.98	2.75		
Honeylocust	20,563.54	154.23	- 1,437.09	- 72.93	- 11.33	16,051.37	120.39	35,104.89	263.29	(N/A)	3.75	6.12	9.75		
Spruce	1,685.48	12.64	- 88.04	- 30.81	- 0.89	2,822.53	21.17	4,389.15	32.92	(N/A)	2.92	0.77	1.57		
Norway maple	7,380.23	55.35	- 459.37	- 40.95	- 3.75	7,388.68	55.42	14,268.60	107.01	(N/A)	2.78	2.49	5.35		
Sugar maple	8,388.83	62.92	- 688.47	- 42.71	- 5.48	6,613.99	49.60	14,271.65	107.04	(N/A)	2.64	2.49	5.63		
American basswood	10,049.32	75.37	- 777.06	- 40.37	- 6.13	5,845.32	43.84	15,077.22	113.08	(N/A)	2.22	2.63	7.07		
Northern red oak	1,921.30	14.41	- 245.62	- 20.09	- 1.99	2,485.55	18.64	4,141.15	31.06	(N/A)	2.22	0.72	1.94		
Pin oak	22,711.55	170.34	- 1,169.88	- 51.29	- 9.16	8,050.41	60.38	29,540.80	221.56	(N/A)	2.08	5.15	14.77		
Conifer Evergreen Large	1,984.20	14.88	- 284.83	- 38.22	- 2.42	3,228.91	24.22	4,890.07	36.68	(N/A)	1.94	0.85	2.62		
Eastern redbud	112.88	0.85	- 1.43	- 2.54	- 0.03	72.97	0.55	181.88	1.36	(N/A)	1.81	0.03	0.10		
Northern hackberry	5,164.19	38.73	- 472.79	- 38.61	- 3.84	6,815.55	51.12	11,468.35	86.01	(N/A)	1.81	2.00	6.62		
Pear	1,617.19	12.13	- 75.94	- 14.43	- 0.68	1,576.31	11.82	3,103.13	23.27	(N/A)	1.53	0.54	2.12		
Black maple	1,914.93	14.36	- 107.97	- 12.48	- 0.90	2,067.32	15.50	3,861.79	28.96	(N/A)	1.11	0.67	3.62		
Ohio buckeye	2,265.60	16.99	- 169.95	- 12.87	- 1.37	2,155.10	16.16	4,237.88	31.78	(N/A)	0.69	0.74	6.36		
Eastern white pine	273.42	2.05	- 9.31	- 5.46	- 0.11	499.72	3.75	758.37	5.69	(N/A)	0.56	0.13	1.42		
White ash	2,183.51	16.38	- 98.82	- 7.41	- 0.80	1,485.53	11.14	3,562.82	26.72	(N/A)	0.42	0.62	8.91		
Kentucky coffeetree	1,747.55	13.11	- 110.96	- 7.41	- 0.89	1,338.00	10.03	2,967.18	22.25	(N/A)	0.42	0.52	7.42		
American elm	2,103.58	15.78	- 537.04	- 16.77	- 4.15	2,857.21	21.43	4,406.98	33.05	(N/A)	0.42	0.77	11.02		
Broadleaf Evergreen Medium	72.21	0.54	- 2.67	- 1.76	- 0.03	199.63	1.50	267.41	2.01	(N/A)	0.28	0.05	1.00		
Elm	148.36	1.11	- 1.78	- 1.17	- 0.02	97.28	0.73	242.69	1.82	(N/A)	0.28	0.04	0.91		
Plum	151.81	1.14	- 5.21	- 1.76	- 0.05	161.34	1.21	306.19	2.30	(N/A)	0.28	0.05	1.15		
River birch	609.90	4.57	- 22.68	- 3.12	- 0.19	570.86	4.28	1,154.96	8.66	(N/A)	0.28	0.20	4.33		
Bur oak	654.13	4.91	- 22.59	- 3.12	- 0.19	551.62	4.14	1,180.04	8.85	(N/A)	0.28	0.21	4.43		
Ponderosa pine	0.00	0.00	- 35.95	- 4.29	- 0.30	310.96	2.33	270.71	2.03	(N/A)	0.14	0.05	2.03		
Norway spruce	0.00	0.00	- 35.95	- 5.07	- 0.31	310.96	2.33	269.93	2.02	(N/A)	0.14	0.05	2.02		
Amur maple	113.87	0.85	- 4.36	- 1.17	- 0.04	124.15	0.93	232.50	1.74	(N/A)	0.14	0.04	1.74		
Hickory	445.34	3.34	- 17.62	- 1.95	- 0.15	392.87	2.95	818.63	6.14	(N/A)	0.14	0.14	6.14		
Citywide Total	364,824.21	2,736.18	- 26,613.81	- 1,612.47	- 211.70	237,145.72	1,778.59	573,743.65	4,303.08	(N/A)	100.00	100.00	5.98		

## Table 6: Annual Social and Aesthetic Benefits

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3/25/2018

Average Annual Benefits of All Tree by Species (\$/tree)

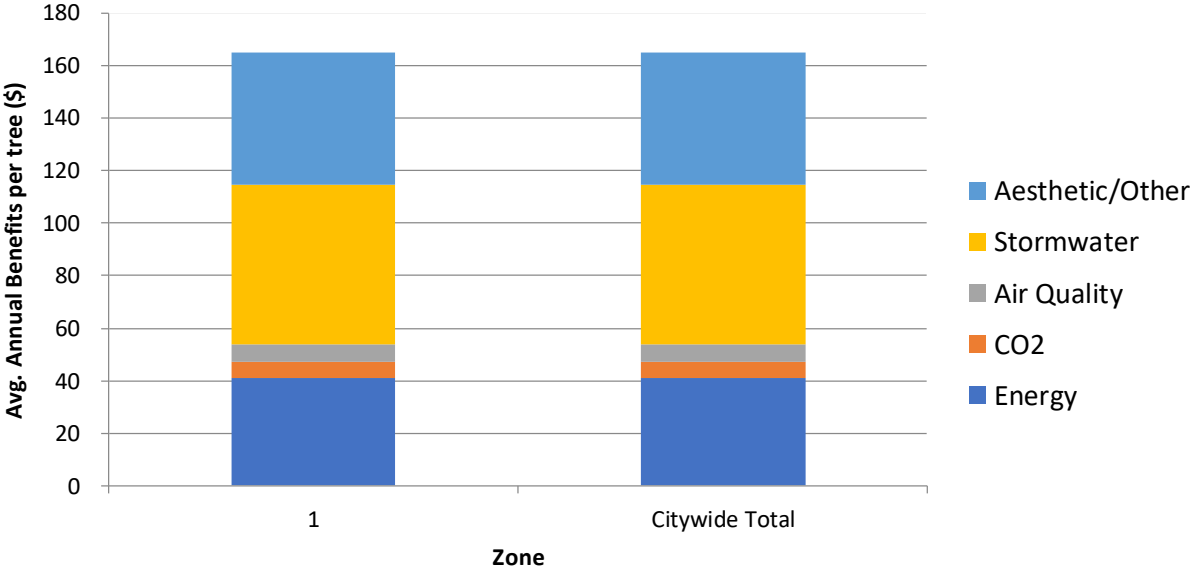
Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total	Standard Error
Green ash	59.86	8.24	10.49	84.15	56.27	219.01	(N/A)
Apple	15.20	1.53	2.23	6.38	5.73	31.08	(N/A)
Silver maple	75.22	16.45	14.56	158.03	124.83	389.08	(N/A)
Red maple	33.67	3.95	5.93	33.67	37.16	114.38	(N/A)
Blue spruce	17.48	1.47	1.95	29.23	18.86	68.99	(N/A)
Littleleaf linden	26.47	4.04	4.25	27.81	39.79	102.35	(N/A)
Scotch pine	27.25	2.75	1.75	64.41	39.06	135.22	(N/A)
Honeylocust	72.11	9.75	12.39	116.67	191.08	402.00	(N/A)
Spruce	16.99	1.57	1.62	29.44	22.33	71.94	(N/A)
Norway maple	46.06	5.35	7.87	44.14	36.47	139.89	(N/A)
Sugar maple	43.52	5.63	6.82	57.57	47.12	160.67	(N/A)
American basswood	47.49	7.07	7.15	59.61	47.50	168.83	(N/A)
Northern red oak	20.05	1.94	2.78	21.66	10.96	57.39	(N/A)
Pin oak	66.99	14.77	8.57	97.14	116.53	304.00	(N/A)
Conifer Evergreen Large	28.95	2.62	0.16	81.08	25.36	138.17	(N/A)
Eastern redbud	0.87	0.10	0.11	0.20	0.03	1.31	(N/A)
Northern hackberry	66.89	6.62	12.05	84.21	52.55	222.32	(N/A)
Pear	20.73	2.12	3.07	9.41	8.44	43.77	(N/A)
Black maple	33.60	3.62	5.62	32.13	36.01	110.98	(N/A)
Ohio buckeye	56.30	6.36	9.71	61.39	42.27	176.03	(N/A)
Eastern white pine	16.22	1.42	1.81	22.53	19.65	61.63	(N/A)
White ash	59.77	8.91	10.23	73.29	88.82	241.01	(N/A)
Kentucky coffeetree	53.12	7.42	9.11	62.10	52.43	184.18	(N/A)
American elm	111.49	11.02	27.08	123.33	85.23	358.16	(N/A)
Broadleaf Evergreen Medium	13.46	1.00	1.57	11.28	15.70	43.01	(N/A)
Elm	5.82	0.91	0.87	4.65	14.73	26.98	(N/A)
Plum	11.80	1.15	1.63	4.51	4.23	23.32	(N/A)
River birch	35.62	4.33	5.69	27.03	32.69	105.37	(N/A)
Bur oak	32.43	4.43	5.21	28.09	37.21	107.37	(N/A)
Ponderosa pine	38.17	2.03	- 1.58	124.79	0.00	163.42	(N/A)
Norway spruce	38.17	2.02	- 1.58	124.79	0.00	163.41	(N/A)
Amur maple	18.19	1.74	2.55	7.17	6.40	36.05	(N/A)
Hickory	44.23	6.14	7.42	39.72	45.86	143.36	(N/A)
Citywide Total	41.24	5.98	6.79	60.53	50.29	164.84	(N/A)

## Table 7: Summary of Benefits in Dollars

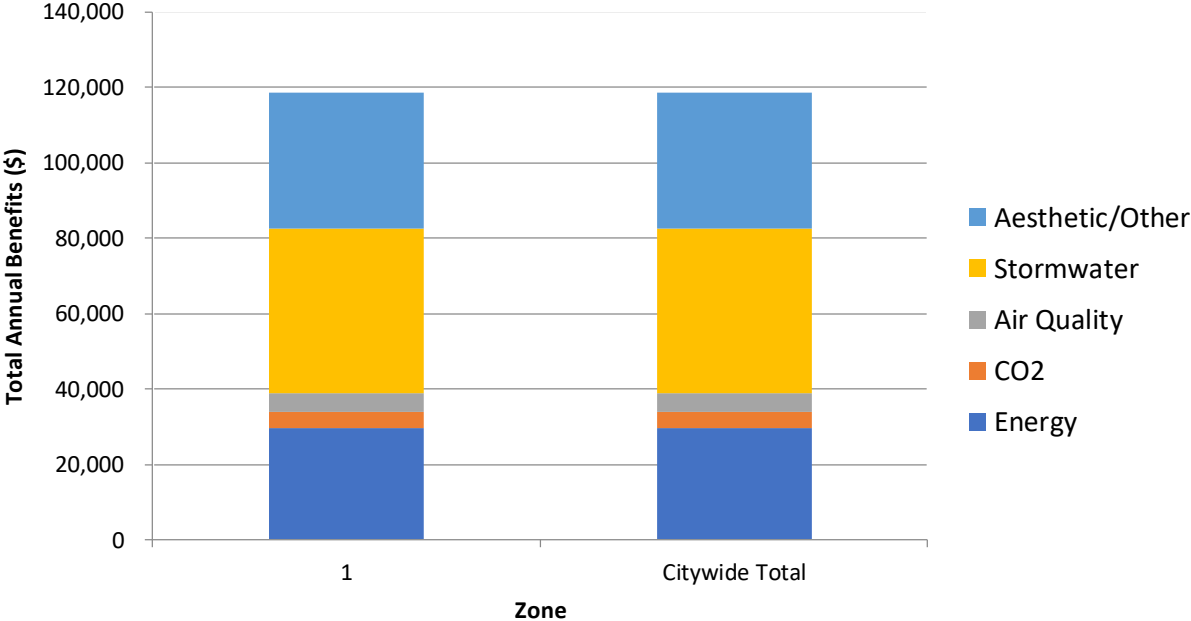
### Average Annual Benefits of All Trees by Species

Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Green ash	8,799.74	1,210.86	1,541.48	12,370.52	8,272.17	32,194.78	(N/A)	27.13
Apple	1,580.91	159.20	232.35	663.69	595.82	3,231.97	(N/A)	2.72
Silver maple	5,491.10	1,200.72	1,062.74	11,536.01	9,112.45	28,403.02	(N/A)	23.93
Red maple	1,952.90	229.29	343.92	1,952.86	2,155.18	6,634.15	(N/A)	5.59
Blue spruce	821.45	69.21	91.67	1,373.68	886.52	3,242.53	(N/A)	2.73
Littleleaf linden	926.36	141.34	148.60	973.33	1,392.78	3,582.42	(N/A)	3.02
Scotch pine	844.61	85.14	54.26	1,996.84	1,210.83	4,191.67	(N/A)	3.53
Honeylocust	1,947.02	263.29	334.57	3,150.18	5,159.03	10,854.09	(N/A)	9.15
Spruce	356.72	32.92	33.96	618.19	468.96	1,510.75	(N/A)	1.27
Norway maple	921.26	107.01	157.36	882.71	729.47	2,797.80	(N/A)	2.36
Sugar maple	826.84	107.04	129.61	1,093.86	895.36	3,052.71	(N/A)	2.57
American basswood	759.90	113.08	114.37	953.84	760.05	2,701.24	(N/A)	2.28
Northern red oak	320.82	31.06	44.48	346.51	175.37	918.25	(N/A)	0.77
Pin oak	1,004.85	221.56	128.55	1,457.10	1,747.99	4,560.05	(N/A)	3.84
Conifer Evergreen Large	405.24	36.68	2.24	1,135.13	355.03	1,934.33	(N/A)	1.63
Eastern redbud	11.26	1.36	1.39	2.62	0.44	17.08	(N/A)	0.01
Northern hackberry	869.53	86.01	156.68	1,094.78	683.18	2,890.18	(N/A)	2.44
Pear	228.07	23.27	33.81	103.49	92.82	481.46	(N/A)	0.41
Black maple	268.82	28.96	44.92	257.06	288.10	887.87	(N/A)	0.75
Ohio buckeye	281.52	31.78	48.55	306.94	211.37	880.16	(N/A)	0.74
Eastern white pine	64.87	5.69	7.25	90.11	78.58	246.51	(N/A)	0.21
White ash	179.32	26.72	30.69	219.86	266.45	723.04	(N/A)	0.61
Kentucky coffeetree	159.37	22.25	27.32	186.29	157.30	552.53	(N/A)	0.47
American elm	334.48	33.05	81.25	370.00	255.70	1,074.49	(N/A)	0.91
Broadleaf Evergreen Medium	26.92	2.01	3.15	22.55	31.39	86.02	(N/A)	0.07
Elm	11.64	1.82	1.74	9.30	29.47	53.97	(N/A)	0.05
Plum	23.60	2.30	3.26	9.03	8.46	46.64	(N/A)	0.04
River birch	71.25	8.66	11.39	54.07	65.38	210.74	(N/A)	0.18
Bur oak	64.87	8.85	10.41	56.19	74.41	214.73	(N/A)	0.18
Ponderosa pine	38.17	2.03	- 1.58	124.79	0.00	163.42	(N/A)	0.14
Norway spruce	38.17	2.02	- 1.58	124.79	0.00	163.41	(N/A)	0.14
Amur maple	18.19	1.74	2.55	7.17	6.40	36.05	(N/A)	0.03
Hickory	44.23	6.14	7.42	39.72	45.86	143.36	(N/A)	0.12
Citywide Total	29,694.02	4,303.08	4,888.78	43,583.21	36,212.31	118,681.40	(N/A)	100.00

### Average Annual Benefits of All Trees by Zone (\$/tree)



### Total Annual Benefits of Public Trees by Zone (\$)



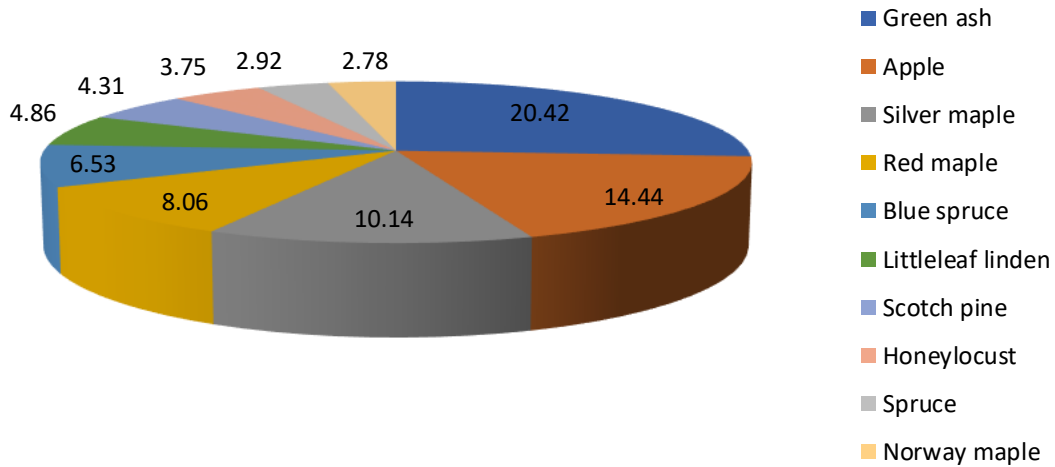
# Figure 1: Species Distribution

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Species Distribution of All Trees

3/25/2018

Species	Percent
Green ash	20.42
Apple	14.44
Silver maple	10.14
Red maple	8.06
Blue spruce	6.53
Littleleaf linden	4.86
Scotch pine	4.31
Honeylocust	3.75
Spruce	2.92
Norway maple	2.78
Other Species	21.81



## Figure 2: Relative Age Distribution

Relative Age Distribution of Top 10 All Tree Species for 1 (%)

DBH class (in)

Species	0 - 3	3 - 6	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	> 42
Green ash	0.00	1.36	4.76	23.13	28.57	23.81	15.65	2.72	0.00
Apple	12.50	21.15	57.69	6.73	1.92	0.00	0.00	0.00	0.00
Silver maple	0.00	2.74	1.37	1.37	6.85	15.07	39.73	19.18	13.70
Red maple	6.90	20.69	25.86	22.41	12.07	5.17	6.90	0.00	0.00
Blue spruce	0.00	34.04	21.28	29.79	10.64	4.26	0.00	0.00	0.00
Littleleaf linden	5.71	14.29	42.86	20.00	5.71	8.57	2.86	0.00	0.00
Scotch pine	0.00	0.00	9.68	29.03	58.06	3.23	0.00	0.00	0.00
Honeylocust	0.00	0.00	0.00	3.70	14.81	40.74	37.04	3.70	0.00
Spruce	0.00	19.05	42.86	23.81	14.29	0.00	0.00	0.00	0.00
Norway maple	0.00	10.00	5.00	55.00	25.00	5.00	0.00	0.00	0.00
Citywide Total	5.56	11.25	21.39	16.11	17.08	11.94	11.81	3.06	1.81

## Relative Age Distribution of All Tree Species for All Zones (%)

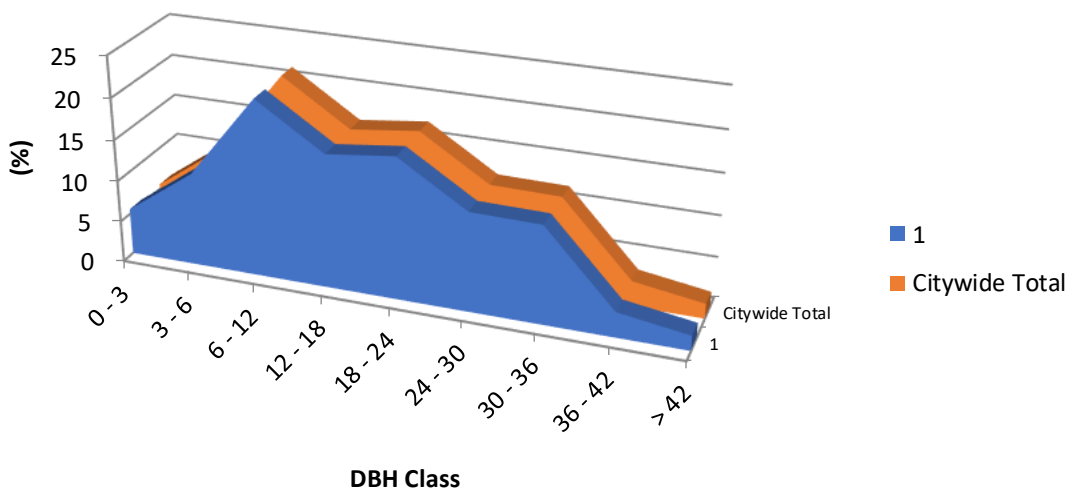


Figure 2: Relative Age Class



### Figure 3: Functional Condition of all Trees

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Functional (Foliage) Condition of All Trees by Zone

3/25/2018

Zone	Condition	Tree Count	Standard Error	% of Zone	% of All Trees
1	Dead or Dying	3 (N/A)		0.42	0.42
	Poor	5 (N/A)		0.69	0.69
	Fair	69 (N/A)		9.58	9.58
	Good	643 (N/A)		89.31	89.31
	Total	720 (N/A)		100.00	100.00

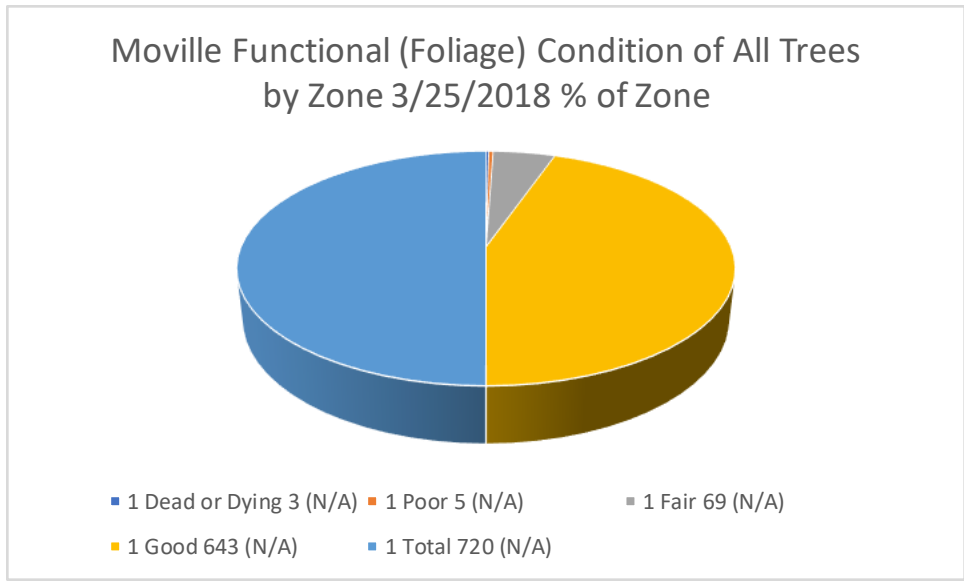


Figure 3: Foliage Condition

## Figure 4: Structural Condition of all Trees

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Structural (Woody) Condition of All Trees by Zone

3/25/2018

Zone	Condition	Tree Count	Standard Error	% of Zone	% of All Trees
1	Dead or Dying	3 (N/A)		0.42	0.42
	Poor	25 (N/A)		3.47	3.47
	Fair	295 (N/A)		40.97	40.97
	Good	397 (N/A)		55.14	55.14
	Total	720 (N/A)		100.00	100.00

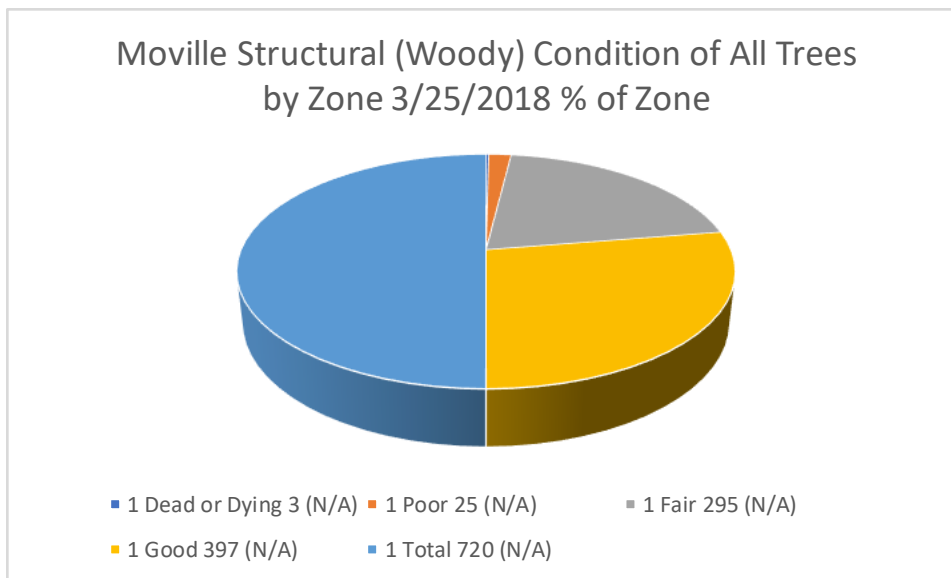


Figure 4: Wood Condition

### Figure 5: Canopy of all Trees

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Canopy Cover of All Trees (Acres)

3/25/2018

Zone	Acres	% of Total Canopy
1	16.20	100.00
Citywide Total	16.20	100.00

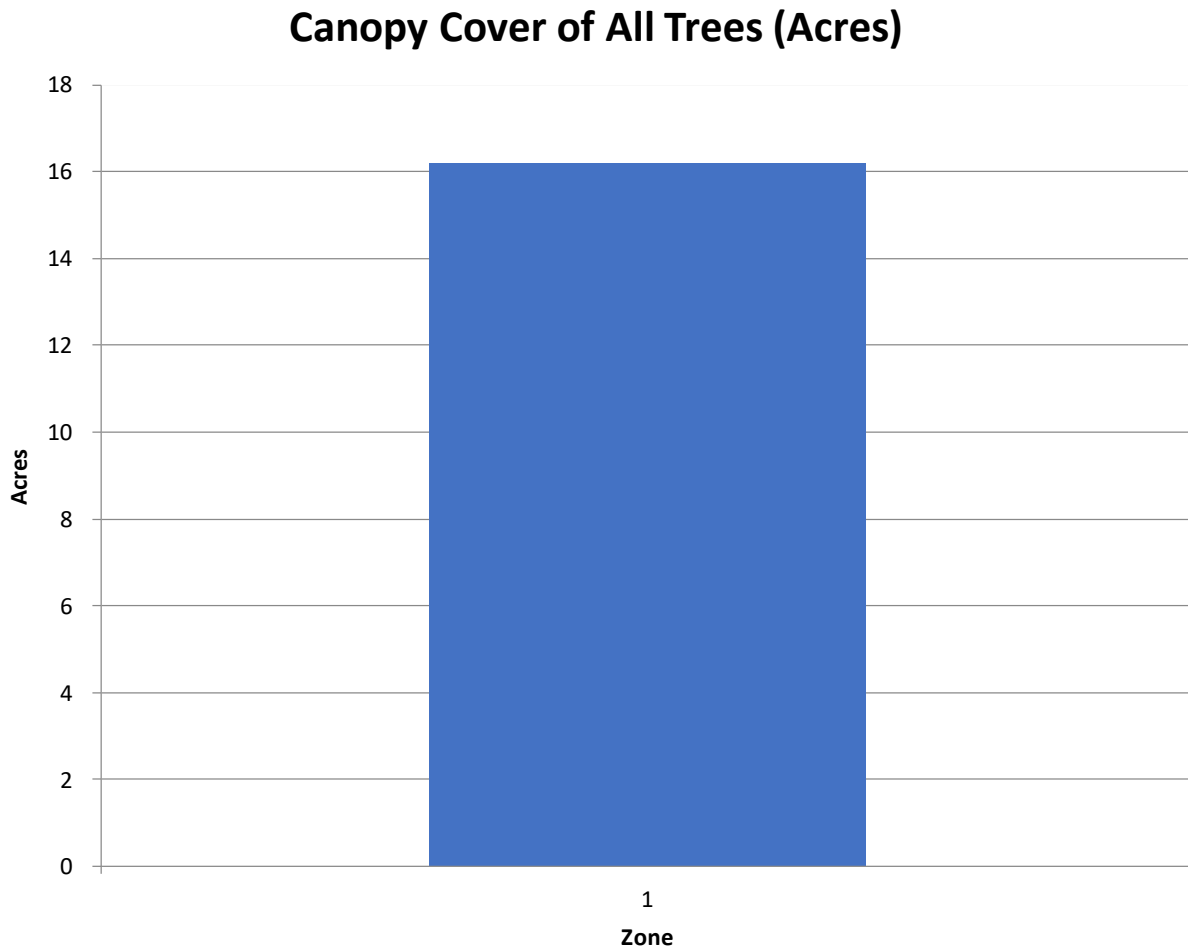


Figure 5: Canopy Cover in Acres

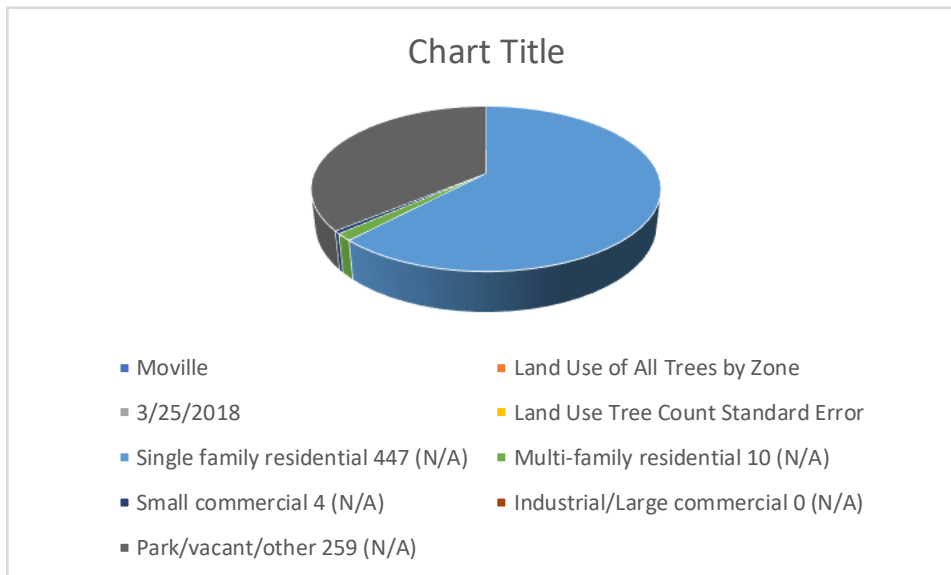
## Figure 6: Land Use of city/park trees

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Land Use of All Trees by Zone

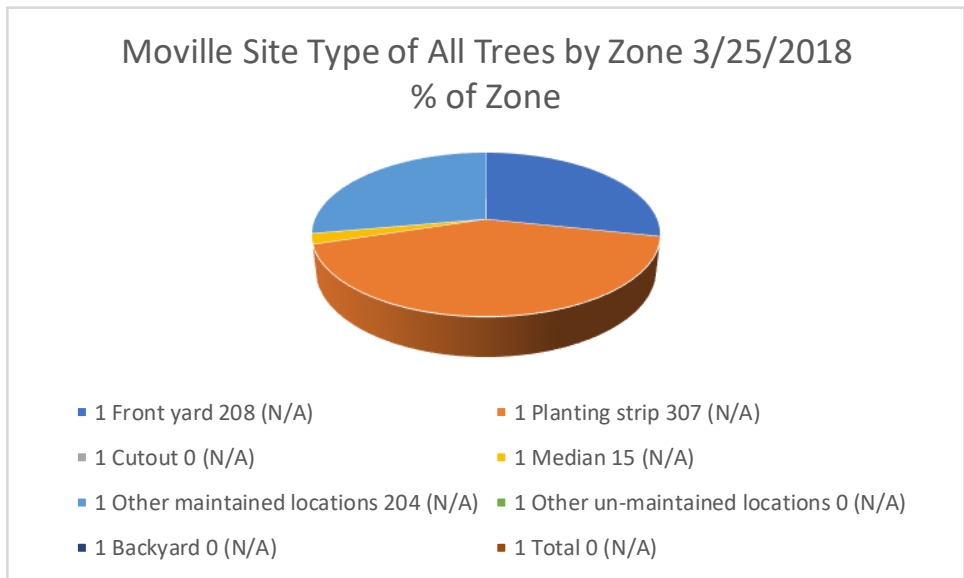
3/25/2018

Land Use	Tree Count	Standard Error	% of Zone
Single family residential	447	(N/A)	62.08
Multi-family residential	10	(N/A)	1.39
Small commercial	4	(N/A)	0.56
Industrial/Large commercial	0	(N/A)	0.00
Park/vacant/other	259	(N/A)	35.97



**Moville**  
**Site Type of All Trees by Zone**  
**3/25/2018**

Zone	Site Type	Tree Count	Standard Error	% of Zone	% of All Trees
1	Front yard	208	(N/A)	28.33%	28.33%
	Planting strip	307	(N/A)	41.82%	41.82%
	Cutout	0	(N/A)	0.00%	0.00%
	Median	15	(N/A)	2.04%	2.04%
	Other maintained locations	204	(N/A)	27.79%	27.79%
	Other un-maintained locations	0	(N/A)	0.00%	0.00%
	Backyard	0	(N/A)	0.00%	0.00%
	Total	0	(N/A)	0.00%	0.00%



**Figure 7: Location of city/park trees**

# Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees

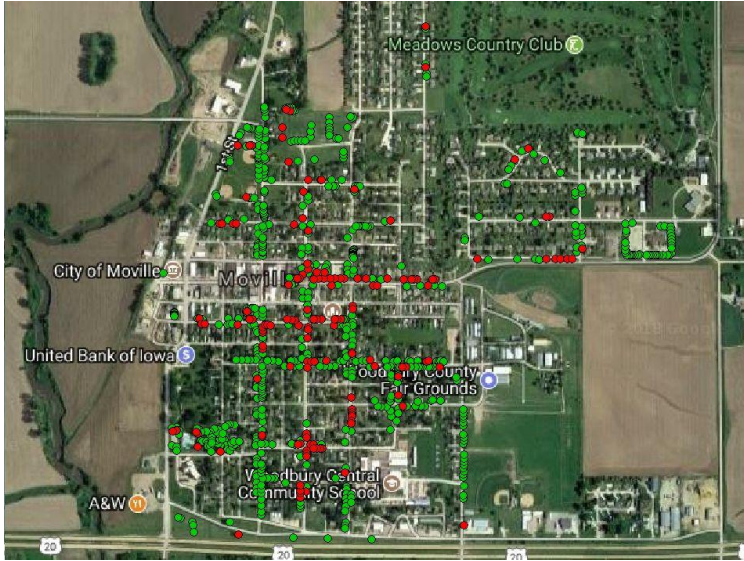


Figure 2: Location of EAB symptoms

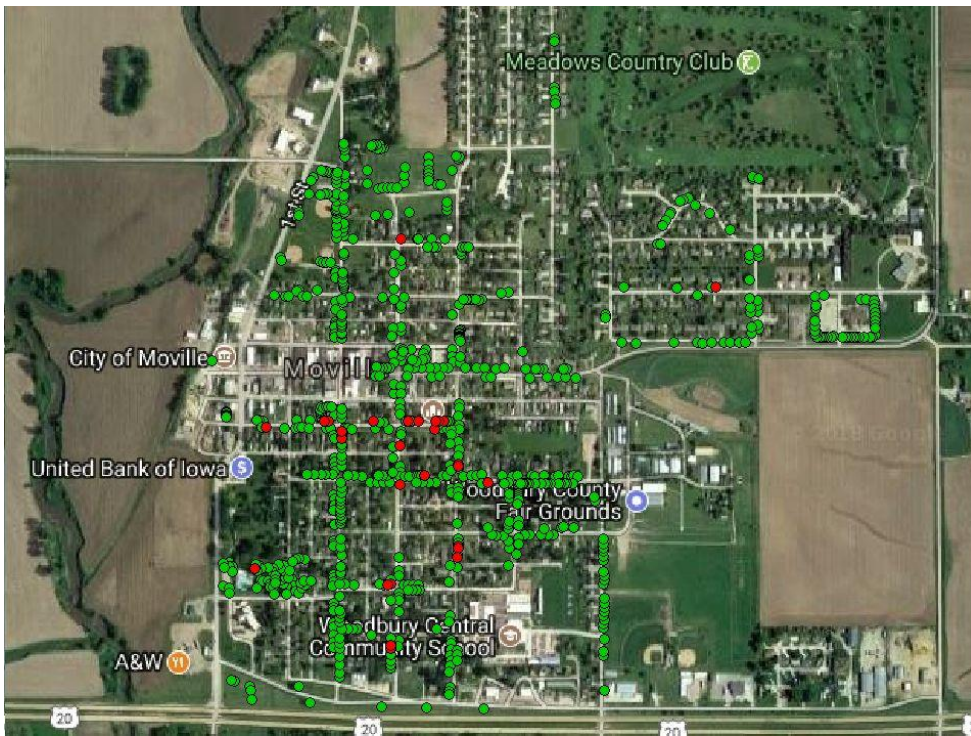


Figure 3: Location of Poor Condition Trees

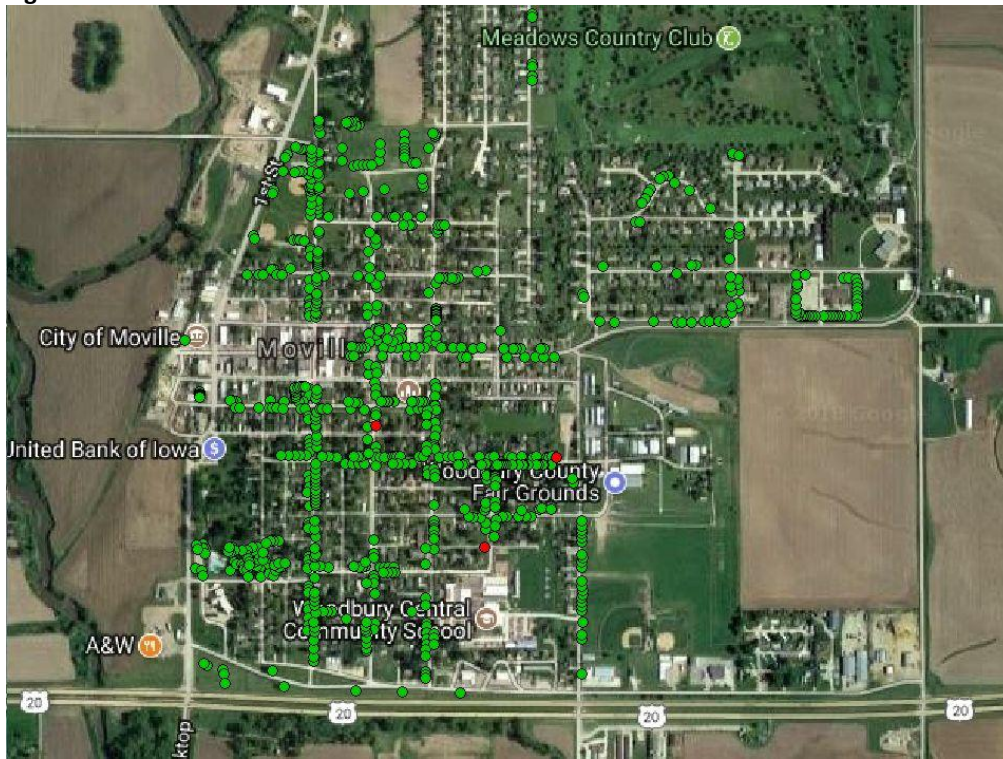


Figure 4: Location of Trees with Recommended Maintenance

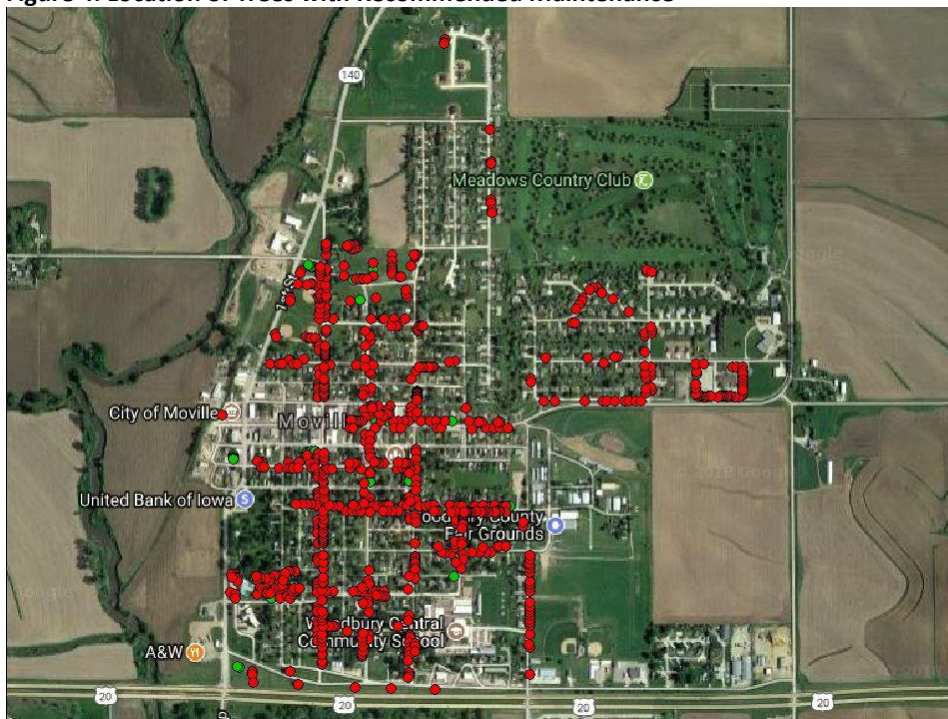


Figure 5: Maintenance Tasks **\*City ownership of the trees recommended for removal should be verified prior to any removal\***

## Appendix C: Movable Tree Ordinances

### **URBAN FORESTRY ORDINANCE** (example)

#### **Sections:**

- 01 Title**
- 02 Purpose**
- 03 Definitions**
- 04 Maintenance of Street Trees**
- 05 Planting and Removal of Street Trees**
- 06 Protection of Trees and Landscape Material**
- 07 Nuisance Trees; Abatement**
- 08 Materials Deleterious to Plant Growth Prohibited**
- 09 Paving Prohibited on Parkway**
- 10 Exemptions**
- 11 Urban Forestry Account**
- 12 Penalties for Violation of Ordinance**

#### **01. Title.**

The ordinance codified in this chapter shall be known as The City of Movable Urban Forestry Ordinance.

#### **02. Purpose.**

The City of Movable Urban Forestry Ordinance is enacted to further the following public purposes:

- (a) To realize the optimum benefits of trees on the City's streets and public places, including favorable modification of microclimates, mitigation of air, water and noise pollution, reduction of soil erosion and runoff, enhancement of the visual environment, and promotion of community pride;
- (b) To provide habitat for wildlife and green space;



- (c) To integrate street planting and maintenance with other urban elements and amenities, including but not limited to utilities, vehicular and pedestrian traffic;
- (d) To promote efficient, cost-effective management of the City's urban forest by coordinating public and private efforts within a comprehensive and professional management system;
- (e) To promote the attractiveness of the City to residents and visitors and enhance property values and the quality of life within the City;
- (f) To reduce the public hazard, nuisance, and expense occasioned by improper tree selection, planting, and maintenance;
- (g) To create and maintain a unified urban-forest resource, enhancing the City's overall character and sense of place; and
- (h) To provide a mechanism by which a "street tree" may be removed, as well as the imposition of penalties for any unauthorized removal or violations of the Urban Forestry Ordinance.

### **03. Definitions.**

Unless the context otherwise clearly indicates, the words and phrases used in this chapter shall be defined as follows:

- (a) "Cumulative diameter" shall refer to the sum diameter of the trunks of multi-stemmed trees, or to the sum diameter of the trunks of several trees, when measured at four and one-half feet (4-1/2') feet above natural grade.
- (b) "Department" shall mean the Department of Public Works or the Department's designee.
- (c) "Director" shall mean the Director of the Department of Public Works or the Director's designee.
- (d) "Drip line" shall mean the outermost limit of the canopy of a tree as determined by the perimeter of its branches which, extended perpendicularly to the ground, encloses the tree.
- (e) "Injure" or "injury" shall mean any act which harms or damages a tree, including but not limited to impact, cutting, carving, transplanting, or knocking over, and includes but is not limited to the following: injurious attachment of any rope, wire, nail, advertising poster, or other contrivance to any street tree; intentionally or negligently allowing any gaseous liquid or solid substance that is harmful to a tree to come into contact with a tree; setting fire or intentionally or negligently permitting any fire to burn when such fire

or the heat therefrom will injure any part of any tree; pruning which in and of itself will kill or cause a tree to decline; or severing of all or part of a tree.

(f) "Landscape material" shall mean any tree, shrub, groundcover or other plant.

(g) "Maintenance" shall mean those actions necessary to promote the life, growth, health, or beauty of a tree. Maintenance includes both routine and major activities. "Routine maintenance" shall include adequate watering to ensure the tree's growth and sustainability; weed control; removal of tree-well trash; staking; fertilizing; routine adjustment and timely removal of stakes, ties, tree guards, and tree grates; bracing; and sidewalk repairs related to the tree's growth or root system. "Major maintenance" shall include structural pruning as necessary to maintain public safety and to sustain the health, safety, and natural growth habit of the tree; pest- and disease-management procedures as needed and, in a manner, consistent with public health and ecological diversity; replacement of dead or damaged trees.

(h) "Nuisance tree" shall mean any tree that poses a hazard to person or property. A tree may be deemed a nuisance if it or any part of it: (1) appears dead, dangerous, or likely to fall; (2) obstructs or damages a street or sidewalk; (3) harbors a serious disease or infestation threatening the health of other trees; (4) interferes with vehicular or pedestrian traffic; (5) obstructs official street cleaning activities; or (6) poses any other significant hazard or potential hazard, as determined by the Department.

(i) "Parking strip" or "parkway" shall mean the area between the property line and roadway, except sidewalk and curb, if any.

(j) "Replacement value fee" shall mean a fee equal to the value of the tree as determined by an appraisal prepared by a certified arborist by using the most current edition of the "Guide for Plant Appraisal" published by the Council of Tree and Landscape Appraisers. All trees four inches (4") and greater in diameter at four and one-half feet (4-1/2') above natural grade level shall be evaluated using the trunk formula method of appraisal. All other trees shall be evaluated using the replacement cost method of appraisal.

(k) "Street tree" shall mean any tree growing within the public right-of-way, including unimproved public streets and sidewalks, and any tree growing on land under the jurisdiction of the City of Menville.

#### **04 Maintenance of Street Trees.**

(a) Responsibilities of Property Owners. It shall be the duty of all public agencies and property owners whose lots or portions of lots abut, front or are adjacent to any street tree to maintain such street tree. This duty shall include both routine and major maintenance of the street tree. This duty shall be extended to any property owner where the conditions of development approval require maintenance.

(b) Responsibilities of the Department. The Department shall maintain all street trees and landscapes on properties wholly owned by the City and those landscapes that are not the responsibility of any other entity under subsection (a) of this section. In addition, the Department may, at the Department's discretion, determine to undertake the regular routine and/or major maintenance of certain street trees or corridors of street trees to promote consistency in the maintenance of trees or when in the public interest.

(c) Liability. Nothing in this chapter shall be deemed to impose any liability upon the City of Merville or upon any of its officers or employees or agents, or to relieve the owner and occupant of any private property from the duty to keep trees upon such property or under his or her control in a safe condition.

(d) Department Street Tree Inventory and Documentation. The Department shall use its best efforts to maintain an inventory of all trees under its jurisdiction; such information shall be made available to the public upon request.

#### **05 Planting and Removal of Street Trees.**

(a) Encroachment Permit Required – Planting. It shall be unlawful for any person to plant a street tree without a valid encroachment permit for such work issued by the Department.

(b) Encroachment Permit Required – Removal. It shall be unlawful for any person to remove any street tree without a valid tree removal permit for such work issued in accordance with this chapter and a valid encroachment permit for such work issued by the Department.

(c) Planting. An abutting property owner who desires a permit to plant a street tree shall apply to the Department as part of the encroachment permit process. The details of the planting, such as the species of street tree, soil testing, soil amending, staking, location and other details shall be approved by the Department. If approved, a permit to plant the specified species of tree(s) shall be issued to the applicant. The Department may elect to plant the street tree or permit the applicant to do so and condition any permits on the abutting property owner's agreement to water or otherwise maintain the street tree or upon such other conditions as may be appropriate. In order to encourage the planting of street trees, the Department may, in its discretion, waive the permit fee for the planting of a street tree.

(d) Tree Removal Permit. An abutting property owner who desires to remove a street tree shall apply to the Department for a tree removal permit. Such application must be accompanied by payment of the encroachment permit fee in accordance with the Master Fee Schedule adopted by the City.

(e) Removal Application. An applicant requesting a tree removal permit to remove a street tree shall be required to submit a plan showing (1) the location, species, trunk diameter at four and one-half feet (4-

1/2') above natural grade, canopy size, and drip line (as defined in Section 03) of all street trees to be removed, (2) a red "X" over each street tree to be removed, (3) an appraisal of the replacement value fee (as defined in Section 03) of all street trees identified in the plan to be removed, (4) a tree report prepared by a certified arborist providing accurate information and opinion regarding the location, species, trunk diameter measured at four and one half feet (4-1/2') above natural grade, canopy size, and condition of all street trees identified in the plan to be removed, and (5) such other information or details as the Department may require. Further, applicants for a street tree removal permit shall also comply with the submittal requirements for an encroachment permit as set forth in Section 04.

(f) Decision to Grant Permit. The Department shall present the application to remove a street tree to the Planning Commission at a noticed public hearing. The Planning Commission may grant or deny the tree removal permit for removal of a street tree as determined in its sole discretion. If the Planning Commission grants a permit for tree removal, the Planning Commission shall require the planting of replacement trees of equal or cumulative diameter to the trees approved for removal and payment of the replacement value fee of the street tree(s) to be removed. When replacement of a tree of equal diameter is not feasible, for reasons related to site-specific conditions, replacement at the largest practicable diameter, as determined by the Planning Commission, shall be required. When the replacement tree cannot match the diameter of the tree to be removed, due to site-specific conditions, the Planning Commission shall require replacement planting of several trees of equal cumulative diameter to the tree being removed. In cases where the need for street tree removal is without fault of the property owner and the property owner is not otherwise responsible for maintenance of the street tree, or for other good cause shown, the Planning Commission may waive the requirement to plant a replacement tree of equal or cumulative value or payment of a replacement value fee.

(g) Notice Required. Upon receipt of an application for a tree removal permit for street tree removal, the Department shall post notice of the public hearing on such application on the affected street tree(s), in a manner not injurious to the tree(s); at the locations designated in Section 01.

(h) Appeals.

(1) Any person aggrieved by the decision of the Planning Commission may appeal to the City Council within fifteen (15) days after final action by the Planning Commission. The decision of the City Council shall be final.

(2) All appeals under this section shall be governed by the City Council and Planning Commission procedures.

(i) Compliance with Landscaping Provisions of Zoning Ordinance. In all cases, tree planting and landscaping undertaken pursuant to this chapter shall comply with all except when, in the discretion of the Public Works Department or the Planning Department, site conditions are such that modification is warranted.

**06 Protection of Trees and Landscape Material.**

(a) Injury to or Destruction of Trees Prohibited. It shall be unlawful for any person to intentionally, maliciously or through negligence injure or destroy a street tree.

(b) Injury to or Destruction of Landscape Materials Prohibited. It shall be unlawful for any person to intentionally, maliciously or through negligence injure or destroy any landscape material in any street median, center strip, or other landscaped portion of a public right-of-way under the City's jurisdiction, except as authorized by the Department.

(c) Construction Work – Protection of Trees Required. It shall be unlawful for any person to engage in any construction work on private or public property without first taking steps to protect all street trees from damage, including damage caused by soil compaction or contamination.

**07 Nuisance Trees; Abatement.**

(a) Notice to Property Owner(s). Upon a finding by the Department that any tree on private property or a street tree for which a property owner is responsible is a "nuisance tree" as defined herein, the Department shall send notice to the property owner(s) which describes the condition creating the nuisance, the actions required to be taken to abate the nuisance, and the date by which compliance must be completed. Required action may include replacement or removal of the tree. In cases of extreme danger, as determined by the Department, the Department may require immediate compliance.

(b) Department of Public Works to Abate Nuisance If Owner Fails to Do So. If the responsible property owner does not undertake in a timely manner the abatement action, as required by said notice, the Department may perform necessary work to abate the nuisance. The cost of such abatement, including labor, equipment, materials, inspection services, and administrative costs, shall be an obligation owing by the responsible property owner(s) to the City.

(c) Method of Enforcement and Collection of Lien. The City Manager or his or her designee shall calculate all costs of abatement. The property owner shall be billed by the City Manager or his or her designee for the total costs and payment shall be due and payable within fifteen (15) days of the billing date. If the property owner fails timely to remit payment, the costs for abating such nuisance shall constitute a special

assessment against the property to which it relates, and upon recordation in the office of the County Recorder of a notice of lien, as so made and confirmed, shall constitute a lien on said property for the amount of such assessment.

**08 Materials Deleterious to Plant Growth Prohibited.**

Except where approved by the Department, it shall be unlawful for any person to place or allow to be placed in or upon any parking strip, parking area or public plat any salt, oil, herbicide, or any other material deleterious to the growth of plants, or in such close proximity to such public squares, parking areas, or public plats, that such deleterious material will permeate the soil thereof.

**09 Paving Prohibited on Parkway.**

It is unlawful for any person to pave any parking strip or parkway in any manner or with any material whatsoever without first securing the written permission of the Department. Such permission shall be given in accordance with rules and regulations adopted by the Department.

**10 Exemptions.**

The City of Merville is not subject to the requirements of this chapter.

**11 Urban Forestry Account.**

All replacement value fees and penalties collected under this chapter shall be deposited in an Urban Forestry Account for use by the Department in tree planting and landscape maintenance.

**12 Penalties for Violation of Ordinance.**

It shall be unlawful for any person to violate any provisions or to fail to comply with any requirement of this chapter.

(a) Criminal Penalties. Any person violating any provisions of this chapter shall be punishable as set forth in appropriate City legislation.

(b) Civil Penalties. Any person, including but not limited to the property owner, the person performing the work, and/or any other responsible person who violates any provision of this chapter or any condition established as part of any permit issued hereunder, may be required to replace any removed or damaged street tree or landscaping and shall become liable to the City for a civil penalty three (3) times the replacement value fee of the street tree or landscaping plus the City's incurred appraisal costs, if any. The replacement value fee shall be determined by a City-selected certified arborist qualified to perform plant and tree appraisals, if the replacement value fee has not already been determined.

(c) Cumulative. The remedies set forth in this section are not exclusive, but cumulative, and may be used in addition to those set forth elsewhere in this Municipal Code or by law.

(d) The imposition of any fine or civil penalty for violation of this chapter shall be determined by the City Manager or his designee and may be appealed to the City Council in accordance with the appeal procedures set forth in appropriate City legislation.

(e) A decision of the City Manager not to impose a fine or civil penalty for an alleged violation of this chapter shall be presented to the City Council at its next regularly scheduled meeting, and if in the opinion of the City Council good cause appears for imposition of a fine or civil penalty, the City Council shall set a time for the hearing and shall cause no less than ten (10) calendar days' notice thereof to be given to the alleged violator(s) and such other persons who may have an interest in the matter.

## Works Cited

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Tree City USA Bulletins [www.arborday.org/programs/treecitybulletinsbrowse](http://www.arborday.org/programs/treecitybulletinsbrowse)

Abbey, B. 1998. U.S. Landscape Ordinances: An Annotated Reference Handbook. New York: John Wiley and Sons, Inc.

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[www.urbanforestrysouth.usda.gov/ordinances/index.htm](http://www.urbanforestrysouth.usda.gov/ordinances/index.htm)

The City of Emeryville, <http://www.ci.emeryville.ca.us>, City Telephone: (510)596-4300  
City Clerk's Office has the official version of the Emeryville Municipal Code, The Emeryville Municipal Code is current through 01/01/18

<https://www.codebook.com/>

