*Manning, IA*:

# 2020 Urban Forest Management Plan

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## Overview

**This plan was developed to assist the City of Manning in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like 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 except mountain ash. There is a strong possibility that 23 percent of Manning's city-owned trees will die once EAB becomes established in the community, unless local leaders begin preventative treatment. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.**

## Inventory and Results

In 2020, JEO conducted a tree inventory 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 784 trees inventoried.

- Manning's trees provide $167,318 of benefits annually, an average of $213.42 per tree
- There are over 22 species of trees
- The top three genera are: Maple 32%, Ash 23%, and Oak 9%
- 40 percent of trees need some type of management
- 112 trees should be removed

## Recommendations

Below are some key recommendations, for further details see the Recommendation and Emerald Ash Borer Plan Sections:

- Out of the 112 trees needing removal, 76 trees are over 24 inches in diameter at 4.5 feet and must be addressed immediately. *City ownership of the trees recommended for removal should be verified prior to any removal*
- 58 of the 183 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation.
- All trees should be pruned on a routine schedule: one third of the city every other year.
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Check ash trees yearly with a visual survey.
- With the current budget it could take 26 years to remove ash. We suggest that city officials request a budget increase to $10,000 annually and apply for grants to plant replacement trees

# Introduction

# INTRODUCTION



This plan was developed to assist Manning with managing, budgeting, and future planning of their urban forest. Across the state, forestry budgets continue to decrease as a higher percentage of the budgets are devoted to 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, treatment, and replacement planting. With proper planning and management of the current canopy in Manning, these costs can be spread out over the years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important part of Manning's infrastructure and one of the city's greatest assets. The benefits of trees are immense. Trees improve air quality, intercept stormwater runoff, conserve energy, lower traffic speeds, increase property values, reduce crime, improve mental health, and create a desirable place to live, to name just a few. Good urban forestry management will maintain these important benefits for the people of Manning and future generations.

Urban forestry management sets goals and develops management strategies to achieve them. To develop management strategies, a comprehensive public tree inventory must be conducted. The inventory informs maintenance, removal schedules, tree planting, and budgeting. Aligning management actions with the tree inventory results will help meet Manning's urban forestry goals.

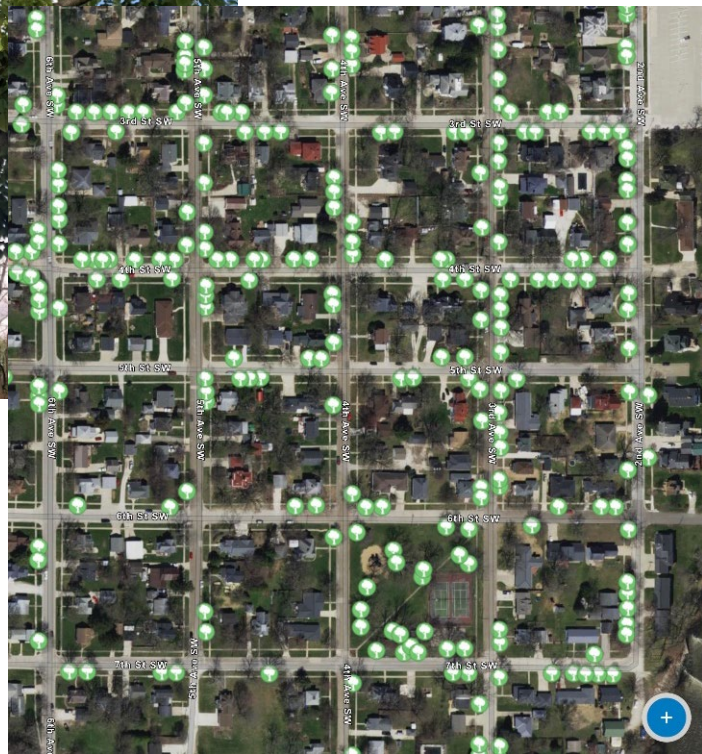| Assist Manning with Managing its Urban Forest | Inform on the Benefits of a Healthy Urban Forest | Establish Preventative Treatment for Emerald Ash Borer | Develop Efficient City Tree Management Techniques | Mitigate Public Safety Issues |

# Inventory Results

# INVENTORY

In 2020, JEO conducted a tree inventory that included 100 percent of the city-owned trees on both streets and parks. The team collected tree data 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 ArcGIS 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 data collectors' programming was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 feet, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, for all ash trees, the team notes signs and symptoms associated with EAB including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

# INVENTORY RESULTS

JEO entered the data collected for the 784 city trees into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as part of the i-Tree suite. Following are results from the i-Tree STREETS analysis.

# ANNUAL BENEFITS

## Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Manning's trees reduce energy-related costs by approximately $40,436 annually (Appendix A, Table 1). These savings are both in electricity (193.8 MWh) and in natural gas (26,249.0 Therms).

## Annual Stormwater Benefits

Manning's trees intercept about 2,536,876 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $68,749 in benefit 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 lessens emissions of volatile organic matter (ozone). In Manning, it is estimated that trees remove 2,498.6 pounds of air pollution (ozone ($O_3$), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide ($NO_2$), and sulfur dioxide ($SO_2$)) per year with a net value of $6,946 (Appendix A, Table 3).

## Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Manning, trees sequester about 520,033 pounds of carbon per year with an associated value of $3,900 (Appendix A, Table 5). In addition, the trees store 10,909,240 pounds of carbon, with a yearly benefit of $81,819 (Appendix A, Table 4).

## Annual Aesthetics Benefits

The social benefits of trees are hard to capture. The i-Tree 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. Manning receives $45,258 in annual social benefits from trees (Appendix A, Table 6).

## Financial Summary of All Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Manning's trees provide $167,318 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 784 trees in Manning provide approximately $213.42 annually (Appendix A, Table 7).

| ENERGY | STORMWATER | AIR QUALITY | CARBON | AESTHETICS | SUMMARY |
|---|---|---|---|---|---|
| • Reduce energy cost by **$40,436** | • Intercept **2,536,876 gallons**<br>• Provides **$68,749** benefit | • Remove **2,498.6 lbs** of pollution<br>• Net value of **$6,946** | • Sequester **520,033 lbs**<br>• Value of **$3,900**<br>• Store **10,909,240 lbs**<br>• Value of **$81,819** | • **$45,258** in social benefits | • **$167,318** annual benefits<br>• Each tree provides **$213.42** annually |

# FOREST STRUCTURE

## Species Distribution

Manning has over 22 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Maple | 249 | 32% | Cedar | 6 | <1% |
| Ash | 183 | 23% | Walnut | 3 | <1% |
| Oak | 70 | 9% | Aspen | 3 | <1% |
| Spruce | 59 | 7.5% | Pear | 3 | <1% |
| Basswood/Linden | 47 | 6% | Sycamore | 2 | <1% |
| Apple | 27 | 3% | Willow | 2 | <1% |
| Locust | 19 | 2% | Buckeye | 1 | <1% |
| Birch | 18 | 2% | Elm | 1 | <1% |
| Hackberry | 13 | 1.5% | Catalpa | 1 | <1% |
| Cherry | 8 | 1% | Conifer Evergreen Other | 35 | 4.5% |
| Pine | 8 | 1% | Other Deciduous | 26 | 3% |

## Age Class

Most of Manning's trees (29.5 percent) are between 18 and 30 inches in diameter at 4.5 feet (Appendix A, Figure 2).

To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Manning's size curve falls in the middle, indicating a mid-aged average stand.

## Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Manning indicate that 60 percent of the trees are in good health, with only 5 percent of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 51 percent of Manning's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Thirteen percent of the tree population's wood condition is in poor health, dead, or dying. This 13 percent 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).

| Action | Number of Trees | Percentage |
|---|---|---|
| Crown Cleaning | 237 | 30% |
| Crown Reduction | 24 | 3% |
| Tree Removal | 112 | 14% |
| Crown Raising | 33 | 4% |
| Tree Staking | 26 | 3% |

## Canopy Cover

The total canopy with both private and public trees is 129.28 acres or around 8 percent. The canopy cover included in the Milo inventory includes approximately 23 acres (Appendix A, Figure 4). The city's canopy goal is to increase canopy by 12 perccent in 30 years. To achieve this goal it is estimated that 38 trees need to be planted annually on public and private lands.

## Land Use and Location

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

| Land Use | Percentage |
|---|---|
| Single Family Residential | 57% |
| Park/Vacant/Other | 41.5% |
| Multifamily Residential | 1.5% |
| Industrail/Large Commercial | <1% |
| Small Commercial | 0% |

# Recommendations

# RECOMMENDATIONS

## Risk Management

Hazardous trees can be a significant threat to both people and property. Trees that are dead, dying, or have large issues such as trunk cracks longer than 18 inches should be removed. Broken branches and branches that interfere with motorists' vision of pedestrians, vehicles, traffic signs and signals should be removed.

### HAZARDOUS TREES

Manning has 112 trees in need of immediate removal. These trees can be seen on the Location of Trees with Recommended Maintenance Map (Appendix B, Figure 4). We recommend starting with the large-diameter, trees first. There are 76 trees over 24 inches in diameter at 4.5 feet that should be addressed immediately. Please refer to the Proposed Schedule and Budget at the end of this section. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing maintenance. There are a total of 320 trees with maintenance needs.

### POOR TREE SPECIES

After removing the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 112 removals, 79 are ash trees. There are a total of 183 ash trees, and 58 of those have signs and symptoms that have been associated with EAB. *City ownership of the trees recommended for removal should be verified prior to any removal*

## Pruning Cycle

Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend that all trees be pruned on a routine schedule every five to seven years. Please refer to the Proposed Schedule and Budget for further information.

## Planting

Most of the planting over the next five years will replace the trees that are removed. We recommend planting 1.2 trees for every tree removed, since survival rates will not be 100 percent. 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 Manning.

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 percent of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10 percent of the total urban forest. Presently, the forest is heavily planted with maple (32 percent) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02
(Appendix C).

## Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. We recommend 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.

# EMERALD ASH BORER PLAN

## Ash Tree Removal

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

## Treatment of Ash Trees

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

## EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles.

A regulated article under the USDA's quarantine includes any of the following items:

- emerald ash borer

- firewood of all hardwood species (for example ash, oak, maple and hickory)

- nursery stock and green lumber of ash

- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

In addition, any other article, product, or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB once a quarantine is in effect for your county.

## Wood Disposal

 A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be normally disposed of 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 151.02 (Appendix C). The new plantings will be a diverse mix and will not include 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 EAB signs and symptoms including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

## Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 151.06 states "If it is determined with reasonable certainty that any such condition exists on private property and that 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."

# Schedule & Budget

# PROPOSED WORK SCHEDULE & BUDGET

Budget Allowance of $5,000/Year – (Based off Reported Yearly Tree Budget

| YEAR 1 | Est. Cost |
|---|---|
| Remove 6 trees recommended for immediate removal | $3,500 |
| Plant 10 trees in open locations | $1,500 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$5,000** |

| YEAR 2 | Est. Cost |
|---|---|
| Remove 1 tree recommended for immediate removal | $700 |
| Plant 2 trees in open locations | $300 |
| Prune 1/3 of city owned trees | $3,920 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$4,920** |

| YEAR 3 | Est. Cost |
|---|---|
| Remove 7 trees recommended for immediate removal | $4,900 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$4,900** |

| YEAR 4 | Est. Cost |
|---|---|
| Remove 1 tree recommended for immediate removal | $3,500 |
| Plant 2 trees in open locations | $300 |
| Prune 1/3 of city owned trees | $3,920 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$4,920** |

| YEAR 5 | Est. Cost |
|---|---|
| Remove 6 trees recommended for immediate removal | $3,500 |
| Plant 10 trees in open locations | $1,500 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$5,000** |

| YEAR 6 | Est. Cost |
|---|---|
| Remove 1 tree recommended for immediate removal | $700 |
| Plant 2 trees in open locations | $300 |
| Prune 1/3 of city owned trees | $3,920 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$4,920** |

*Estimated costs based on average costs of $700/tree for removal, $150/tree for planting and maintenance, and $15/tree for pruning.*

*\*\*To remove all ash trees within 6 years alone, the budget would need to be $21,350 a year. If the budget were increased to $18,300 a year all ash could be removed in 7 years.*

# PROPOSED WORK SCHEDULE WITH INCREASED BUDGET

Budget Allowance of $10,000/Year – (Budget Increase Suggested to Best Manage City Trees)

| YEAR 1 | Est. Cost |
|---|---|
| Remove 12 trees recommended for immediate removal | $8,400 |
| Plant 10 trees in open locations | $1,500 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$9,900** |

| YEAR 2 | Est. Cost |
|---|---|
| Remove 8 trees recommended for immediate removal | $5,600 |
| Plant 3 trees in open locations | $450 |
| Prune 1/3 of city owned trees | $3,920 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$9,970** |

| YEAR 3 | Est. Cost |
|---|---|
| Remove 12 trees recommended for immediate removal | $8,400 |
| Plant 10 trees in open locations | $1,500 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$9,900** |

| YEAR 4 | Est. Cost |
|---|---|
| Remove 1 tree recommended for immediate removal | $700 |
| Remove 6 ash in poor health | $4,200 |
| Plant 7 trees in open locations | $1,050 |
| Prune 1/3 of city owned trees | $3,920 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$9,870** |

| YEAR 5 | Est. Cost |
|---|---|
| Remove 12 ash in poor health | $8,400 |
| Plant 10 trees in open locations | $1,500 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$9,900** |

| YEAR 6 | Est. Cost |
|---|---|
| Remove 7 ash in poor health | $4,900 |
| Plant 7 trees in open locations | $1,050 |
| Prune 1/3 of city owned trees | $3,920 |
| Visual Survey of EAB Signs/Symptoms | n/a |
| TOTAL | **$9,870** |

**Proposed Budget Increase**

EAB could potentially kill all ash trees in Manning within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to $21,350 a year. If the

budget were increased to $10,000 per year all ash could be removed within 13 years. Additionally, we recommend that Manning 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 considered by many communities is treating 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 removal 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 16 trees could be treated per year (every other year treatment). Sixteen trees would be selected for treatment, and Manning would still need to find $116,900 for removal. Alternatively, if there are 30 treatable trees, it would cost approximately $9,000 a year for treatment and leave $107,100 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 Manning. We suggest considering an increased budget to plan for this.

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# Appendices

# APPENDIX A: i-TREE DATA

Manning

## Annual Energy Benefits of Public Trees

2/1/2021

| Species | Total Electricity (MWh) | Electricity ($) | Total Natural Gas (Therms) | Natural Gas ($) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|
| Green ash | 60.9 | 4,619 | 8,318.1 | 8,152 | 12,771 | (N/A) | 22.3 | 31.6 | 72.98 |
| Silver maple | 36.0 | 2,734 | 4,744.6 | 4,650 | 7,383 | (N/A) | 12.5 | 18.3 | 75.34 |
| Norway maple | 16.1 | 1,223 | 2,287.4 | 2,242 | 3,465 | (N/A) | 8.2 | 8.6 | 54.14 |
| Sugar maple | 10.1 | 768 | 1,342.3 | 1,315 | 2,084 | (N/A) | 4.2 | 5.2 | 63.14 |
| Maple | 7.1 | 541 | 927.8 | 909 | 1,450 | (N/A) | 4.1 | 3.6 | 45.32 |
| Blue spruce | 2.2 | 164 | 273.9 | 268 | 432 | (N/A) | 4.0 | 1.1 | 13.94 |
| Spruce | 2.5 | 193 | 336.5 | 330 | 523 | (N/A) | 3.6 | 1.3 | 18.68 |
| Apple | 3.4 | 260 | 521.5 | 511 | 771 | (N/A) | 3.4 | 1.9 | 28.54 |
| Broadleaf Deciduous Small | 0.2 | 13 | 31.5 | 31 | 44 | (N/A) | 3.2 | 0.1 | 1.77 |
| Conifer Evergreen Large | 4.4 | 337 | 590.5 | 579 | 916 | (N/A) | 3.2 | 2.3 | 36.63 |
| Littleleaf linden | 5.0 | 376 | 665.1 | 652 | 1,028 | (N/A) | 2.9 | 2.5 | 44.70 |
| American basswood | 8.4 | 638 | 1,194.3 | 1,170 | 1,808 | (N/A) | 2.9 | 4.5 | 78.61 |
| Pin oak | 9.3 | 704 | 1,218.6 | 1,194 | 1,898 | (N/A) | 2.9 | 4.7 | 82.54 |
| Red maple | 4.8 | 365 | 631.6 | 619 | 984 | (N/A) | 2.8 | 2.4 | 44.74 |
| Honeylocust | 5.2 | 393 | 678.6 | 665 | 1,058 | (N/A) | 2.4 | 2.6 | 55.66 |
| Birch | 0.9 | 68 | 126.5 | 124 | 192 | (N/A) | 2.3 | 0.5 | 10.67 |
| Northern red oak | 3.4 | 260 | 479.1 | 470 | 730 | (N/A) | 2.2 | 1.8 | 42.94 |
| Bur oak | 1.8 | 134 | 236.5 | 232 | 366 | (N/A) | 2.2 | 0.9 | 21.54 |
| Northern hackberry | 1.8 | 135 | 248.1 | 243 | 378 | (N/A) | 1.7 | 0.9 | 29.12 |
| Conifer Evergreen Medium | 1.3 | 95 | 164.2 | 161 | 256 | (N/A) | 1.3 | 0.6 | 25.60 |
| Black cherry | 0.0 | 2 | 5.0 | 5 | 7 | (N/A) | 1.0 | 0.0 | 0.87 |
| Swamp white oak | 0.9 | 68 | 128.0 | 125 | 194 | (N/A) | 1.0 | 0.5 | 24.21 |
| Eastern white pine | 1.3 | 98 | 172.2 | 169 | 267 | (N/A) | 0.9 | 0.7 | 38.17 |
| White ash | 1.8 | 133 | 227.6 | 223 | 357 | (N/A) | 0.8 | 0.9 | 59.42 |
| Oak | 0.0 | 1 | 1.9 | 2 | 3 | (N/A) | 0.5 | 0.0 | 0.66 |
| Black walnut | 0.6 | 44 | 81.1 | 80 | 123 | (N/A) | 0.4 | 0.3 | 41.10 |
| Quaking aspen | 0.0 | 1 | 1.4 | 1 | 2 | (N/A) | 0.4 | 0.0 | 0.66 |
| Eastern red cedar | 0.3 | 25 | 49.3 | 48 | 74 | (N/A) | 0.4 | 0.2 | 24.57 |
| Pear | 0.4 | 34 | 62.2 | 61 | 94 | (N/A) | 0.4 | 0.2 | 31.49 |
| Northern white cedar | 0.4 | 31 | 49.0 | 48 | 79 | (N/A) | 0.4 | 0.2 | 26.25 |
| American sycamore | 0.5 | 37 | 63.6 | 62 | 99 | (N/A) | 0.3 | 0.2 | 49.64 |
| Willow | 0.3 | 25 | 48.2 | 47 | 72 | (N/A) | 0.3 | 0.2 | 35.97 |
| Ash | 0.1 | 8 | 17.6 | 17 | 26 | (N/A) | 0.3 | 0.1 | 12.79 |
| Northern catalpa | 0.4 | 33 | 59.0 | 58 | 91 | (N/A) | 0.1 | 0.2 | 91.02 |
| Austrian pine | 0.2 | 13 | 23.3 | 23 | 35 | (N/A) | 0.1 | 0.1 | 35.47 |
| Broadleaf Deciduous Medium | 0.3 | 24 | 47.4 | 46 | 71 | (N/A) | 0.1 | 0.2 | 70.84 |
| Basswood | 0.5 | 37 | 63.1 | 62 | 99 | (N/A) | 0.1 | 0.2 | 98.63 |
| Ohio buckeye | 0.3 | 24 | 47.4 | 46 | 71 | (N/A) | 0.1 | 0.2 | 70.84 |
| White oak | 0.1 | 7 | 13.7 | 13 | 21 | (N/A) | 0.1 | 0.1 | 20.64 |
| American elm | 0.6 | 45 | 71.2 | 70 | 114 | (N/A) | 0.1 | 0.3 | 114.45 |
| Total | 193.8 | 14,712 | 26,249.0 | 25,724 | 40,436 | (N/A) | 100.0 | 100.0 | 51.58 |

# Annual Stormwater Benefits of Public Trees

2/1/2021

| Species | Total rainfall interception (Gal) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|
| Green ash | 818,263 | 22,175 | (N/A) | 22.3 | 32.3 | 126.71 |
| Silver maple | 581,759 | 15,766 | (N/A) | 12.5 | 22.9 | 160.87 |
| Norway maple | 149,462 | 4,050 | (N/A) | 8.2 | 5.9 | 63.29 |
| Sugar maple | 125,672 | 3,406 | (N/A) | 4.2 | 5.0 | 103.20 |
| Maple | 55,925 | 1,516 | (N/A) | 4.1 | 2.2 | 47.36 |
| Blue spruce | 27,585 | 748 | (N/A) | 4.0 | 1.1 | 24.11 |
| Spruce | 50,889 | 1,379 | (N/A) | 3.6 | 2.0 | 49.25 |
| Apple | 15,478 | 419 | (N/A) | 3.4 | 0.6 | 15.54 |
| Broadleaf Deciduous Small | 492 | 13 | (N/A) | 3.2 | 0.0 | 0.53 |
| Conifer Evergreen Large | 106,939 | 2,898 | (N/A) | 3.2 | 4.2 | 115.92 |
| Littleleaf linden | 45,599 | 1,236 | (N/A) | 2.9 | 1.8 | 53.73 |
| American basswood | 119,640 | 3,242 | (N/A) | 2.9 | 4.7 | 140.97 |
| Pin oak | 127,923 | 3,467 | (N/A) | 2.9 | 5.0 | 150.73 |
| Red maple | 38,417 | 1,041 | (N/A) | 2.8 | 1.5 | 47.32 |
| Honeylocust | 62,733 | 1,700 | (N/A) | 2.4 | 2.5 | 89.48 |
| Birch | 6,054 | 164 | (N/A) | 2.3 | 0.2 | 9.12 |
| Northern red oak | 35,342 | 958 | (N/A) | 2.2 | 1.4 | 56.34 |
| Bur oak | 18,139 | 492 | (N/A) | 2.2 | 0.7 | 28.92 |
| Northern hackberry | 15,384 | 417 | (N/A) | 1.7 | 0.6 | 32.07 |
| Conifer Evergreen Medium | 17,726 | 480 | (N/A) | 1.3 | 0.7 | 48.04 |
| Black cherry | 60 | 2 | (N/A) | 1.0 | 0.0 | 0.20 |
| Swamp white oak | 5,186 | 141 | (N/A) | 1.0 | 0.2 | 17.57 |
| Eastern white pine | 32,233 | 874 | (N/A) | 0.9 | 1.3 | 124.79 |
| White ash | 18,875 | 512 | (N/A) | 0.8 | 0.7 | 85.25 |
| Oak | 72 | 2 | (N/A) | 0.5 | 0.0 | 0.48 |
| Black walnut | 6,706 | 182 | (N/A) | 0.4 | 0.3 | 60.58 |
| Quaking aspen | 54 | 1 | (N/A) | 0.4 | 0.0 | 0.48 |
| Eastern red cedar | 4,904 | 133 | (N/A) | 0.4 | 0.2 | 44.30 |
| Pear | 1,598 | 43 | (N/A) | 0.4 | 0.1 | 14.43 |
| Northern white cedar | 6,046 | 164 | (N/A) | 0.4 | 0.2 | 54.62 |
| American sycamore | 7,257 | 197 | (N/A) | 0.3 | 0.3 | 98.33 |
| Willow | 3,777 | 102 | (N/A) | 0.3 | 0.1 | 51.17 |
| Ash | 598 | 16 | (N/A) | 0.3 | 0.0 | 8.11 |
| Northern catalpa | 7,239 | 196 | (N/A) | 0.1 | 0.3 | 196.17 |
| Austrian pine | 2,925 | 79 | (N/A) | 0.1 | 0.1 | 79.26 |
| Broadleaf Deciduous Medium | 3,764 | 102 | (N/A) | 0.1 | 0.1 | 102.01 |
| Basswood | 7,239 | 196 | (N/A) | 0.1 | 0.3 | 196.17 |
| Ohio buckeye | 3,764 | 102 | (N/A) | 0.1 | 0.1 | 102.01 |
| White oak | 608 | 16 | (N/A) | 0.1 | 0.0 | 16.47 |
| American elm | 4,551 | 123 | (N/A) | 0.1 | 0.2 | 123.33 |
| Citywide total | 2,536,876 | 68,749 | (N/A) | 100.0 | 100.0 | 87.69 |

# Annual Air Quality Benefits of Public Trees

2/1/2021

| Species | Deposition (lb) O$_3$ | NO$_2$ | PM$_{10}$ | SO$_2$ | Total Depos. ($) | Avoided (lb) NO$_2$ | PM$_{10}$ | VOC | SO$_2$ | Total Avoided ($) | BVOC Emissions (lb) | BVOC Emissions ($) | Total (lb) | Total ($) Standard Error | % of Total Trees | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Green ash | 123.9 | 19.8 | 56.1 | 5.5 | 651 | 290.5 | 42.3 | 40.3 | 275.8 | 1,810 | 0.0 | 0 | 854.4 | 2,461 (N/A) | 22.3 | 14.06 |
| Silver maple | 109.8 | 18.6 | 52.9 | 4.9 | 589 | 169.8 | 24.9 | 23.7 | 162.9 | 1,062 | -57.2 | -214 | 510.4 | 1,437 (N/A) | 12.5 | 14.67 |
| Norway maple | 30.7 | 5.3 | 15.1 | 1.4 | 166 | 77.8 | 11.3 | 10.7 | 73.1 | 483 | -7.2 | -27 | 218.2 | 622 (N/A) | 8.2 | 9.71 |
| Sugar maple | 18.4 | 3.1 | 8.9 | 0.8 | 99 | 47.9 | 7.0 | 6.7 | 45.8 | 299 | -14.3 | -54 | 124.3 | 345 (N/A) | 4.2 | 10.44 |
| Maple | 12.8 | 2.2 | 6.0 | 0.6 | 69 | 33.6 | 4.9 | 4.7 | 32.3 | 210 | -4.4 | -16 | 92.7 | 262 (N/A) | 4.1 | 8.20 |
| Blue spruce | 3.5 | 0.7 | 3.0 | 0.4 | 24 | 10.1 | 1.5 | 1.4 | 9.8 | 63 | -10.0 | -37 | 20.5 | 50 (N/A) | 4.0 | 1.60 |
| Spruce | 5.9 | 1.2 | 4.8 | 0.7 | 39 | 12.0 | 1.8 | 1.7 | 11.5 | 75 | -25.9 | -97 | 13.8 | 17 (N/A) | 3.6 | 0.61 |
| Apple | 4.9 | 0.8 | 2.3 | 0.2 | 26 | 16.8 | 2.4 | 2.3 | 15.5 | 103 | 0.0 | 0 | 45.2 | 129 (N/A) | 3.4 | 4.80 |
| Broadleaf Deciduous Small | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.9 | 0.1 | 0.1 | 0.8 | 6 | 0.0 | 0 | 2.0 | 6 (N/A) | 3.2 | 0.23 |
| Conifer Evergreen Large | 13.1 | 2.6 | 10.4 | 1.6 | 85 | 21.0 | 3.1 | 2.9 | 20.1 | 131 | -64.2 | -241 | 10.6 | -24 (N/A) | 3.2 | -0.97 |
| Littleleaf linden | 7.5 | 1.3 | 3.7 | 0.3 | 41 | 23.6 | 3.4 | 3.3 | 22.5 | 147 | -3.7 | -14 | 62.0 | 174 (N/A) | 2.9 | 7.57 |
| American basswood | 18.7 | 3.2 | 8.8 | 0.8 | 100 | 40.6 | 5.9 | 5.6 | 38.1 | 252 | -15.2 | -57 | 106.4 | 294 (N/A) | 2.9 | 12.80 |
| Pin oak | 25.5 | 4.5 | 12.7 | 1.1 | 138 | 43.8 | 6.4 | 6.1 | 42.0 | 274 | -46.4 | -174 | 95.7 | 238 (N/A) | 2.9 | 10.36 |
| Red maple | 8.9 | 1.5 | 4.2 | 0.4 | 47 | 22.7 | 3.3 | 3.2 | 21.8 | 142 | -3.0 | -11 | 63.0 | 178 (N/A) | 2.8 | 8.10 |
| Honeylocust | 12.4 | 2.1 | 5.6 | 0.6 | 66 | 24.4 | 3.6 | 3.4 | 23.4 | 153 | -9.9 | -37 | 65.5 | 181 (N/A) | 2.4 | 9.52 |
| Birch | 1.0 | 0.2 | 0.5 | 0.0 | 5 | 4.3 | 0.6 | 0.6 | 4.1 | 27 | -0.3 | -1 | 11.1 | 31 (N/A) | 2.3 | 1.74 |
| Northern red oak | 7.5 | 1.3 | 3.6 | 0.3 | 40 | 16.4 | 2.4 | 2.3 | 15.5 | 102 | -10.8 | -40 | 38.7 | 102 (N/A) | 2.2 | 6.02 |
| Bur oak | 2.6 | 0.4 | 1.2 | 0.1 | 14 | 8.4 | 1.2 | 1.2 | 8.0 | 52 | 0.0 | 0 | 23.2 | 66 (N/A) | 2.2 | 3.90 |
| Northern hackberry | 2.2 | 0.4 | 1.2 | 0.1 | 12 | 8.6 | 1.2 | 1.2 | 8.1 | 53 | 0.0 | 0 | 23.0 | 66 (N/A) | 1.7 | 5.05 |
| Conifer Evergreen Medium | 2.4 | 0.5 | 2.0 | 0.3 | 16 | 5.9 | 0.9 | 0.8 | 5.7 | 37 | -6.6 | -25 | 11.9 | 28 (N/A) | 1.3 | 2.84 |
| Black cherry | 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) | 1.0 | 0.11 |
| Swamp white oak | 0.7 | 0.1 | 0.4 | 0.0 | 4 | 4.3 | 0.6 | 0.6 | 4.1 | 27 | -0.2 | -1 | 10.7 | 30 (N/A) | 1.0 | 3.75 |
| Eastern white pine | 4.0 | 0.8 | 3.1 | 0.5 | 26 | 6.1 | 0.9 | 0.9 | 5.9 | 38 | -20.1 | -75 | 2.1 | -11 (N/A) | 0.9 | -1.58 |
| White ash | 2.7 | 0.4 | 1.3 | 0.1 | 14 | 8.3 | 1.2 | 1.2 | 8.0 | 52 | 0.0 | 0 | 23.1 | 66 (N/A) | 0.8 | 11.01 |
| Oak | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.1 | 0 (N/A) | 0.5 | 0.08 |
| Black walnut | 0.8 | 0.1 | 0.4 | 0.0 | 4 | 2.8 | 0.4 | 0.4 | 2.6 | 17 | 0.0 | 0 | 7.6 | 22 (N/A) | 0.4 | 7.23 |
| Quaking aspen | 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) | 0.4 | 0.08 |
| Eastern red cedar | 1.0 | 0.2 | 0.8 | 0.1 | 7 | 1.6 | 0.2 | 0.2 | 1.5 | 10 | -2.7 | -10 | 3.1 | 7 (N/A) | 0.4 | 2.19 |
| Pear | 0.5 | 0.1 | 0.2 | 0.0 | 2 | 2.1 | 0.3 | 0.3 | 2.0 | 13 | 0.0 | 0 | 5.5 | 16 (N/A) | 0.4 | 5.22 |
| Northern white cedar | 0.7 | 0.1 | 0.6 | 0.1 | 5 | 1.9 | 0.3 | 0.3 | 1.8 | 12 | -2.5 | -9 | 3.3 | 7 (N/A) | 0.4 | 2.36 |
| American sycamore | 1.6 | 0.3 | 0.7 | 0.1 | 8 | 2.3 | 0.3 | 0.3 | 2.2 | 14 | 0.0 | 0 | 7.8 | 23 (N/A) | 0.3 | 11.32 |
| Willow | 0.9 | 0.1 | 0.4 | 0.0 | 5 | 1.6 | 0.2 | 0.2 | 1.5 | 10 | -0.2 | -1 | 4.8 | 14 (N/A) | 0.3 | 6.86 |
| Ash | 0.1 | 0.0 | 0.0 | 0.0 | 0 | 0.5 | 0.1 | 0.1 | 0.5 | 3 | 0.0 | 0 | 1.3 | 4 (N/A) | 0.3 | 1.80 |
| Northern catalpa | 1.2 | 0.2 | 0.5 | 0.1 | 6 | 2.1 | 0.3 | 0.3 | 2.0 | 13 | 0.0 | 0 | 6.6 | 19 (N/A) | 0.1 | 19.04 |
| Austrian pine | 0.5 | 0.1 | 0.4 | 0.1 | 3 | 0.8 | 0.1 | 0.1 | 0.8 | 5 | -1.1 | -4 | 1.8 | 4 (N/A) | 0.1 | 4.16 |
| Broadleaf Deciduous Medium | 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) | 0.1 | 13.58 |

**Annual Air Quality Benefits of Public Trees**

2/1/2021

| Species | Deposition (lb) | | | | Total Depos. ($) | Avoided (lb) | | | | Total Avoided ($) | BVOC Emissions (lb) | BVOC Emissions ($) | Total (lb) | Total ($) | Standard Error | % of Total Trees | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $O_3$ | $NO_2$ | $PM_{10}$ | $SO_2$ | | $NO_2$ | $PM_{10}$ | VOC | $SO_2$ | | | | | | | | |
| Basswood | 1.6 | 0.3 | 0.7 | 0.1 | 8 | 2.3 | 0.3 | 0.3 | 2.2 | 14 | 0.0 | 0 | 7.7 | 23 | (N/A) | 0.1 | 22.55 |
| 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) | 0.1 | 13.58 |
| White oak | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.5 | 0.1 | 0.1 | 0.4 | 3 | 0.0 | 0 | 1.1 | 3 | (N/A) | 0.1 | 2.99 |
| American elm | 2.2 | 0.4 | 1.0 | 0.1 | 12 | 2.7 | 0.4 | 0.4 | 2.7 | 17 | 0.0 | 0 | 9.9 | 29 | (N/A) | 0.1 | 28.89 |
| Citywide total | 432.1 | 73.1 | 214.5 | 21.7 | 2,341 | 922.4 | 134.5 | 128.3 | 878.1 | 5,752 | -306.1 | -1,148 | 2,498.6 | 6,946 | (N/A) | 100.0 | 8.86 |

**Manning**

| Stored CO₂ Benefits of Public Trees |
|---|

2/1/2021

| Species | Total Stored CO2 (lbs) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|
| Green ash | 4,152,952 | 31,147 | (N/A) | 22.3 | 38.1 | 177.98 |
| Silver maple | 2,665,349 | 19,990 | (N/A) | 12.5 | 24.4 | 203.98 |
| Norway maple | 506,532 | 3,799 | (N/A) | 8.2 | 4.6 | 59.36 |
| Sugar maple | 541,874 | 4,064 | (N/A) | 4.2 | 5.0 | 123.15 |
| Maple | 140,671 | 1,055 | (N/A) | 4.1 | 1.3 | 32.97 |
| Blue spruce | 22,554 | 169 | (N/A) | 4.0 | 0.2 | 5.46 |
| Spruce | 63,840 | 479 | (N/A) | 3.6 | 0.6 | 17.10 |
| Apple | 77,177 | 579 | (N/A) | 3.4 | 0.7 | 21.44 |
| Broadleaf Deciduous | 1,165 | 9 | (N/A) | 3.2 | 0.0 | 0.35 |
| Conifer Evergreen La | 166,520 | 1,249 | (N/A) | 3.2 | 1.5 | 49.96 |
| Littleleaf linden | 161,277 | 1,210 | (N/A) | 2.9 | 1.5 | 52.59 |
| American basswood | 717,964 | 5,385 | (N/A) | 2.9 | 6.6 | 234.12 |
| Pin oak | 710,960 | 5,332 | (N/A) | 2.9 | 6.5 | 231.83 |
| Red maple | 97,194 | 729 | (N/A) | 2.8 | 0.9 | 33.13 |
| Honeylocust | 161,387 | 1,210 | (N/A) | 2.4 | 1.5 | 63.71 |
| Birch | 16,530 | 124 | (N/A) | 2.3 | 0.2 | 6.89 |
| Northern red oak | 163,863 | 1,229 | (N/A) | 2.2 | 1.5 | 72.29 |
| Bur oak | 88,833 | 666 | (N/A) | 2.2 | 0.8 | 39.19 |
| Northern hackberry | 33,063 | 248 | (N/A) | 1.7 | 0.3 | 19.07 |
| Conifer Evergreen Me | 16,520 | 124 | (N/A) | 1.3 | 0.2 | 12.39 |
| Black cherry | 110 | 1 | (N/A) | 1.0 | 0.0 | 0.10 |
| Swamp white oak | 11,685 | 88 | (N/A) | 1.0 | 0.1 | 10.95 |
| Eastern white pine | 52,432 | 393 | (N/A) | 0.9 | 0.5 | 56.18 |
| White ash | 52,318 | 392 | (N/A) | 0.8 | 0.5 | 65.40 |
| Oak | 49 | 0 | (N/A) | 0.5 | 0.0 | 0.09 |
| Black walnut | 28,012 | 210 | (N/A) | 0.4 | 0.3 | 70.03 |
| Quaking aspen | 36 | 0 | (N/A) | 0.4 | 0.0 | 0.09 |
| Eastern red cedar | 3,306 | 25 | (N/A) | 0.4 | 0.0 | 8.27 |
| Pear | 6,982 | 52 | (N/A) | 0.4 | 0.1 | 17.46 |
| Northern white cedar | 5,683 | 43 | (N/A) | 0.4 | 0.1 | 14.21 |
| American sycamore | 55,994 | 420 | (N/A) | 0.3 | 0.5 | 209.98 |
| Willow | 14,297 | 107 | (N/A) | 0.3 | 0.1 | 53.61 |
| Ash | 1,118 | 8 | (N/A) | 0.3 | 0.0 | 4.19 |
| Northern catalpa | 39,259 | 294 | (N/A) | 0.1 | 0.4 | 294.44 |
| Austrian pine | 4,893 | 37 | (N/A) | 0.1 | 0.0 | 36.70 |
| Broadleaf Deciduous | 14,280 | 107 | (N/A) | 0.1 | 0.1 | 107.10 |
| Basswood | 55,982 | 420 | (N/A) | 0.1 | 0.5 | 419.86 |
| Ohio buckeye | 14,280 | 107 | (N/A) | 0.1 | 0.1 | 107.10 |
| White oak | 1,035 | 8 | (N/A) | 0.1 | 0.0 | 7.76 |
| American elm | 41,265 | 309 | (N/A) | 0.1 | 0.4 | 309.48 |
| Citywide total | 10,909,240 | 81,819 | (N/A) | 100.0 | 100.0 | 104.36 |

The value of stored carbon dioxide is calculated as the total amount of carbon dioxide sequestered annually over the life of each tree, summed for the population. This value should not be added to the Replacement Value or double-counting of the carbon dioxide storage benefit will occur.

**Annual CO$_2$  Benefits of Public Trees**

2/1/2021

| Species | Sequestered (lb) | Sequestered ($) | Decomposition Release (lb) | Maintenance Release (lb) | Total Released ($) | Avoided (lb) | Avoided ($) | Net Total (lb) | Total Standard ($) Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Green ash | 132,245 | 992 | -19,934 | -673 | -155 | 102,082 | 766 | 213,720 | 1,603 (N/A) | 22.3 | 27.0 | 9.16 |
| Silver maple | 174,648 | 1,310 | -12,794 | -426 | -99 | 60,413 | 453 | 221,840 | 1,664 (N/A) | 12.5 | 28.1 | 16.98 |
| Norway maple | 19,169 | 144 | -2,431 | -171 | -20 | 27,032 | 203 | 43,599 | 327 (N/A) | 8.2 | 5.5 | 5.11 |
| Sugar maple | 24,987 | 187 | -2,602 | -112 | -20 | 16,976 | 127 | 39,249 | 294 (N/A) | 4.2 | 5.0 | 8.92 |
| Maple | 15,534 | 117 | -675 | -63 | -6 | 11,957 | 90 | 26,753 | 201 (N/A) | 4.1 | 3.4 | 6.27 |
| Blue spruce | 1,646 | 12 | -108 | -36 | -1 | 3,621 | 27 | 5,122 | 38 (N/A) | 4.0 | 0.6 | 1.24 |
| Spruce | 2,893 | 22 | -307 | -49 | -3 | 4,272 | 32 | 6,810 | 51 (N/A) | 3.6 | 0.9 | 1.82 |
| Apple | 5,892 | 44 | -370 | -46 | -3 | 5,737 | 43 | 11,212 | 84 (N/A) | 3.4 | 1.4 | 3.11 |
| Broadleaf Deciduous Smal | 363 | 3 | -6 | -7 | 0 | 298 | 2 | 648 | 5 (N/A) | 3.2 | 0.1 | 0.19 |
| Conifer Evergreen Large | 3,753 | 28 | -799 | -95 | -7 | 7,451 | 56 | 10,310 | 77 (N/A) | 3.2 | 1.3 | 3.09 |
| Littleleaf linden | 15,695 | 118 | -774 | -55 | -6 | 8,316 | 62 | 23,181 | 174 (N/A) | 2.9 | 2.9 | 7.56 |
| American basswood | 37,500 | 281 | -3,446 | -104 | -27 | 14,090 | 106 | 48,039 | 360 (N/A) | 2.9 | 6.1 | 15.66 |
| Pin oak | 36,820 | 276 | -3,413 | -106 | -26 | 15,562 | 117 | 48,863 | 366 (N/A) | 2.9 | 6.2 | 15.93 |
| Red maple | 9,185 | 69 | -467 | -43 | -4 | 8,072 | 61 | 16,747 | 126 (N/A) | 2.8 | 2.1 | 5.71 |
| Honeylocust | 15,489 | 116 | -775 | -40 | -6 | 8,675 | 65 | 23,349 | 175 (N/A) | 2.4 | 3.0 | 9.22 |
| Birch | 1,542 | 12 | -80 | -11 | -1 | 1,507 | 11 | 2,958 | 22 (N/A) | 2.3 | 0.4 | 1.23 |
| Northern red oak | 2,513 | 19 | -787 | -45 | -6 | 5,756 | 43 | 7,438 | 56 (N/A) | 2.2 | 0.9 | 3.28 |
| Bur oak | 3,377 | 25 | -427 | -20 | -3 | 2,971 | 22 | 5,901 | 44 (N/A) | 2.2 | 0.7 | 2.60 |
| Northern hackberry | 2,063 | 15 | -159 | -17 | -1 | 2,992 | 22 | 4,879 | 37 (N/A) | 1.7 | 0.6 | 2.81 |
| Conifer Evergreen Mediun | 1,080 | 8 | -79 | -22 | -1 | 2,101 | 16 | 3,080 | 23 (N/A) | 1.3 | 0.4 | 2.31 |
| Black cherry | 69 | 1 | -1 | -2 | 0 | 45 | 0 | 112 | 1 (N/A) | 1.0 | 0.0 | 0.10 |
| Swamp white oak | 1,679 | 13 | -56 | -9 | 0 | 1,508 | 11 | 3,121 | 23 (N/A) | 1.0 | 0.4 | 2.93 |
| Eastern white pine | 768 | 6 | -252 | -29 | -2 | 2,177 | 16 | 2,664 | 20 (N/A) | 0.9 | 0.3 | 2.85 |
| White ash | 4,879 | 37 | -252 | -15 | -2 | 2,950 | 22 | 7,562 | 57 (N/A) | 0.8 | 1.0 | 9.45 |
| Oak | 10 | 0 | 0 | -1 | 0 | 18 | 0 | 27 | 0 (N/A) | 0.5 | 0.0 | 0.05 |
| Black walnut | 1,377 | 10 | -134 | -7 | -1 | 968 | 7 | 2,204 | 17 (N/A) | 0.4 | 0.3 | 5.51 |
| Quaking aspen | 8 | 0 | 0 | -1 | 0 | 13 | 0 | 20 | 0 (N/A) | 0.4 | 0.0 | 0.05 |
| Eastern red cedar | 0 | 0 | -16 | -6 | 0 | 561 | 4 | 539 | 4 (N/A) | 0.4 | 0.1 | 1.35 |
| Pear | 649 | 5 | -34 | -5 | 0 | 741 | 6 | 1,352 | 10 (N/A) | 0.4 | 0.2 | 3.38 |
| Northern white cedar | 418 | 3 | -27 | -7 | 0 | 679 | 5 | 1,064 | 8 (N/A) | 0.4 | 0.1 | 2.66 |
| American sycamore | 481 | 4 | -269 | -6 | -2 | 817 | 6 | 1,024 | 8 (N/A) | 0.3 | 0.1 | 3.84 |
| Willow | 5 | 0 | -69 | -4 | -1 | 546 | 4 | 478 | 4 (N/A) | 0.3 | 0.1 | 1.79 |
| Ash | 229 | 2 | -5 | -1 | 0 | 183 | 1 | 406 | 3 (N/A) | 0.3 | 0.1 | 1.52 |

2/1/2021

| Species | Sequestered (lb) | Sequestered ($) | Decomposition Release (lb) | Maintenance Release (lb) | Total Released ($) | Avoided (lb) | Avoided ($) | Net Total (lb) | Total Standard ($) Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern catalpa | 912 | 7 | -188 | -5 | -1 | 734 | 6 | 1,453 | 11 (N/A) | 0.1 | 0.2 | 10.90 |
| Austrian pine | 0 | 0 | -23 | -4 | 0 | 280 | 2 | 253 | 2 (N/A) | 0.1 | 0.0 | 1.90 |
| Broadleaf Deciduous Medi | 370 | 3 | -69 | -4 | -1 | 539 | 4 | 837 | 6 (N/A) | 0.1 | 0.1 | 6.27 |
| Basswood | 479 | 4 | -269 | -6 | -2 | 813 | 6 | 1,017 | 8 (N/A) | 0.1 | 0.1 | 7.63 |
| Ohio buckeye | 370 | 3 | -69 | -4 | -1 | 539 | 4 | 837 | 6 (N/A) | 0.1 | 0.1 | 6.27 |
| White oak | 209 | 2 | -5 | -1 | 0 | 159 | 1 | 361 | 3 (N/A) | 0.1 | 0.0 | 2.71 |
| American elm | 724 | 5 | -198 | -6 | -2 | 987 | 7 | 1,507 | 11 (N/A) | 0.1 | 0.2 | 11.31 |
| Citywide total | 520,033 | 3,900 | -52,371 | -2,261 | -410 | 325,135 | 2,439 | 790,535 | 5,929 (N/A) | 100.0 | 100.0 | 7.56 |

## Annual Aesthetic/Other Benefits of Public Trees

2/1/2021

| Species | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|
| Green ash | 9,778 | (N/A) | 22.3 | 21.6 | 55.88 |
| Silver maple | 12,612 | (N/A) | 12.5 | 27.9 | 128.69 |
| Norway maple | 1,848 | (N/A) | 8.2 | 4.1 | 28.87 |
| Sugar maple | 2,472 | (N/A) | 4.2 | 5.5 | 74.91 |
| Maple | 2,009 | (N/A) | 4.1 | 4.4 | 62.79 |
| Blue spruce | 463 | (N/A) | 4.0 | 1.0 | 14.95 |
| Spruce | 678 | (N/A) | 3.6 | 1.5 | 24.22 |
| Apple | 345 | (N/A) | 3.4 | 0.8 | 12.78 |
| Broadleaf Deciduous Small | 11 | (N/A) | 3.2 | 0.0 | 0.44 |
| Conifer Evergreen Large | 524 | (N/A) | 3.2 | 1.2 | 20.97 |
| Littleleaf linden | 1,604 | (N/A) | 2.9 | 3.5 | 69.74 |
| American basswood | 2,397 | (N/A) | 2.9 | 5.3 | 104.23 |
| Pin oak | 2,673 | (N/A) | 2.9 | 5.9 | 116.22 |
| Red maple | 1,199 | (N/A) | 2.8 | 2.6 | 54.51 |
| Honeylocust | 3,922 | (N/A) | 2.4 | 8.7 | 206.44 |
| Birch | 186 | (N/A) | 2.3 | 0.4 | 10.33 |
| Northern red oak | 201 | (N/A) | 2.2 | 0.4 | 11.83 |
| Bur oak | 351 | (N/A) | 2.2 | 0.8 | 20.66 |
| Northern hackberry | 316 | (N/A) | 1.7 | 0.7 | 24.28 |
| Conifer Evergreen Medium | 227 | (N/A) | 1.3 | 0.5 | 22.71 |
| Black cherry | 0 | (N/A) | 1.0 | 0.0 | 0.03 |
| Swamp white oak | 189 | (N/A) | 1.0 | 0.4 | 23.58 |
| Eastern white pine | 79 | (N/A) | 0.9 | 0.2 | 11.25 |
| White ash | 532 | (N/A) | 0.8 | 1.2 | 88.66 |
| Oak | 21 | (N/A) | 0.5 | 0.0 | 5.26 |
| Black walnut | 124 | (N/A) | 0.4 | 0.3 | 41.24 |
| Quaking aspen | 16 | (N/A) | 0.4 | 0.0 | 5.26 |
| Eastern red cedar | 0 | (N/A) | 0.4 | 0.0 | 0.00 |
| Pear | 37 | (N/A) | 0.4 | 0.1 | 12.46 |
| Northern white cedar | 112 | (N/A) | 0.4 | 0.2 | 37.24 |
| American sycamore | 34 | (N/A) | 0.3 | 0.1 | 16.92 |
| Willow | 3 | (N/A) | 0.3 | 0.0 | 1.37 |
| Ash | 29 | (N/A) | 0.3 | 0.1 | 14.48 |
| Northern catalpa | 58 | (N/A) | 0.1 | 0.1 | 58.34 |
| Austrian pine | 0 | (N/A) | 0.1 | 0.0 | 0.00 |
| Broadleaf Deciduous Medium | 31 | (N/A) | 0.1 | 0.1 | 31.46 |
| Basswood | 29 | (N/A) | 0.1 | 0.1 | 28.57 |
| Ohio buckeye | 31 | (N/A) | 0.1 | 0.1 | 31.46 |
| White oak | 29 | (N/A) | 0.1 | 0.1 | 28.56 |
| American elm | 87 | (N/A) | 0.1 | 0.2 | 86.69 |
| Citywide total | 45,258 | (N/A) | 100.0 | 100.0 | 57.73 |

## Total Annual Benefits, Net Benefits, and Costs for Public Trees

2/1/2021

| Benefits | Total ($) Standard Error | $/tree Standard Error | $/capita Standard Error |
|---|---|---|---|
| Energy | 40,436 (N/A) | 51.58 (N/A) | 0.00 (N/A) |
| CO2 | 5,929 (N/A) | 7.56 (N/A) | 0.00 (N/A) |
| Air Quality | 6,946 (N/A) | 8.86 (N/A) | 0.00 (N/A) |
| Stormwater | 68,749 (N/A) | 87.69 (N/A) | 0.00 (N/A) |
| Aesthetic/Other | 45,258 (N/A) | 57.73 (N/A) | 0.00 (N/A) |
| Total Benefits | 167,318 (N/A) | 213.42 (N/A) | 0.00 (N/A) |
| Costs | | | |
| Planting | 0 | 0.00 | 0.00 |
| Contract Pruning | 0 | 0.00 | 0.00 |
| Pest Management | 0 | 0.00 | 0.00 |
| Irrigation | 0 | 0.00 | 0.00 |
| Removal | 0 | 0.00 | 0.00 |
| Administration | 0 | 0.00 | 0.00 |
| Inspection/Service | 0 | 0.00 | 0.00 |
| Infrastructure Repairs | 0 | 0.00 | 0.00 |
| Litter Clean-up | 0 | 0.00 | 0.00 |
| Liability/Claims | 0 | 0.00 | 0.00 |
| Other Costs | 0 | 0.00 | 0.00 |
| Total Costs | 0 | 0.00 | 0.00 |
| Net Benefits | 167,318 (N/A) | 213.42 (N/A) | 0.00 (N/A) |
| Benefit-cost ratio | 0.00 (N/A) | | |

**Manning**

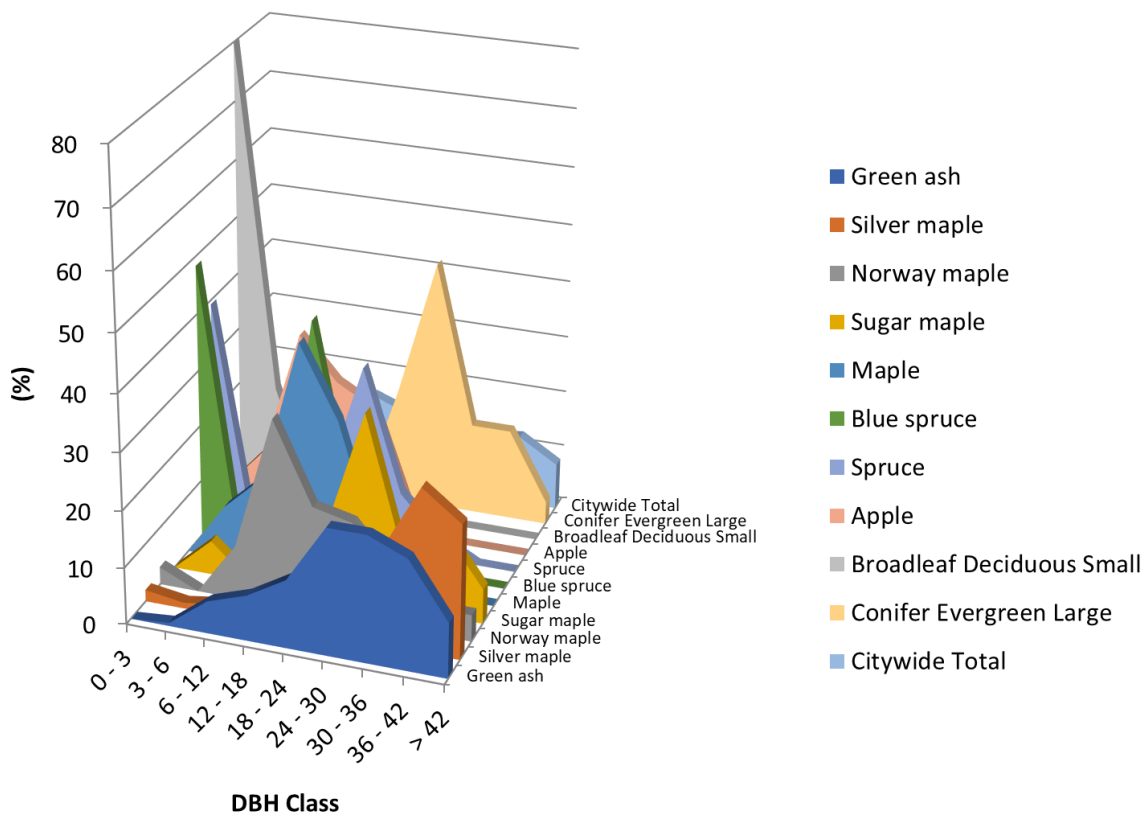**Species Distribution of Public Trees**

2/1/2021
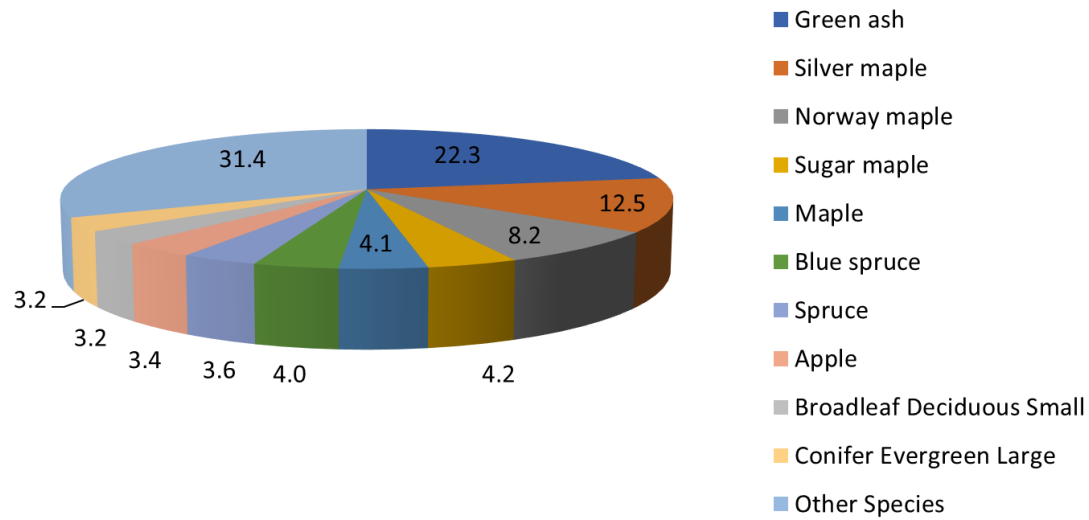


| Species | Percent |
|---|---|
| Green ash | 22.3 |
| Silver maple | 12.5 |
| Norway maple | 8.2 |
| Sugar maple | 4.2 |
| Maple | 4.1 |
| Blue spruce | 4.0 |
| Spruce | 3.6 |
| Apple | 3.4 |
| Broadleaf Deciduous Small | 3.2 |
| Conifer Evergreen Large | 3.2 |
| Other Species | 31.4 |
| Total | 100.0 |

**Manning**

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

2/1/2021



| Species | 0-3 | 3-6 | 6-12 | 12-18 | 18-24 | 24-30 | 30-36 | 36-42 | > 42 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | DBH class | (in) | | | | |
| Green ash | 0.00 | 0.57 | 5.71 | 8.00 | 12.00 | 22.29 | 22.29 | 19.43 | 9.71 |
| Silver maple | 2.04 | 1.02 | 2.04 | 5.10 | 7.14 | 14.29 | 16.33 | 28.57 | 23.47 |
| Norway maple | 3.13 | 0.00 | 9.38 | 32.81 | 18.75 | 17.19 | 9.38 | 4.69 | 4.69 |
| Sugar maple | 0.00 | 6.06 | 0.00 | 18.18 | 12.12 | 33.33 | 9.09 | 15.15 | 6.06 |
| Maple | 0.00 | 9.38 | 15.63 | 40.63 | 28.13 | 6.25 | 0.00 | 0.00 | 0.00 |
| Blue spruce | 48.39 | 0.00 | 0.00 | 41.94 | 9.68 | 0.00 | 0.00 | 0.00 | 0.00 |
| Spruce | 39.29 | 0.00 | 3.57 | 10.71 | 32.14 | 10.71 | 3.57 | 0.00 | 0.00 |
| Apple | 3.70 | 11.11 | 33.33 | 25.93 | 22.22 | 3.70 | 0.00 | 0.00 | 0.00 |
| Broadleaf Deciduous Sm | 80.00 | 20.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Conifer Evergreen Large | 0.00 | 0.00 | 0.00 | 0.00 | 20.00 | 44.00 | 16.00 | 16.00 | 4.00 |
| Citywide Total | 13.90 | 2.30 | 6.89 | 15.69 | 13.14 | 16.33 | 11.35 | 12.24 | 8.16 |

1

**Figure 3: Foliage Condition**

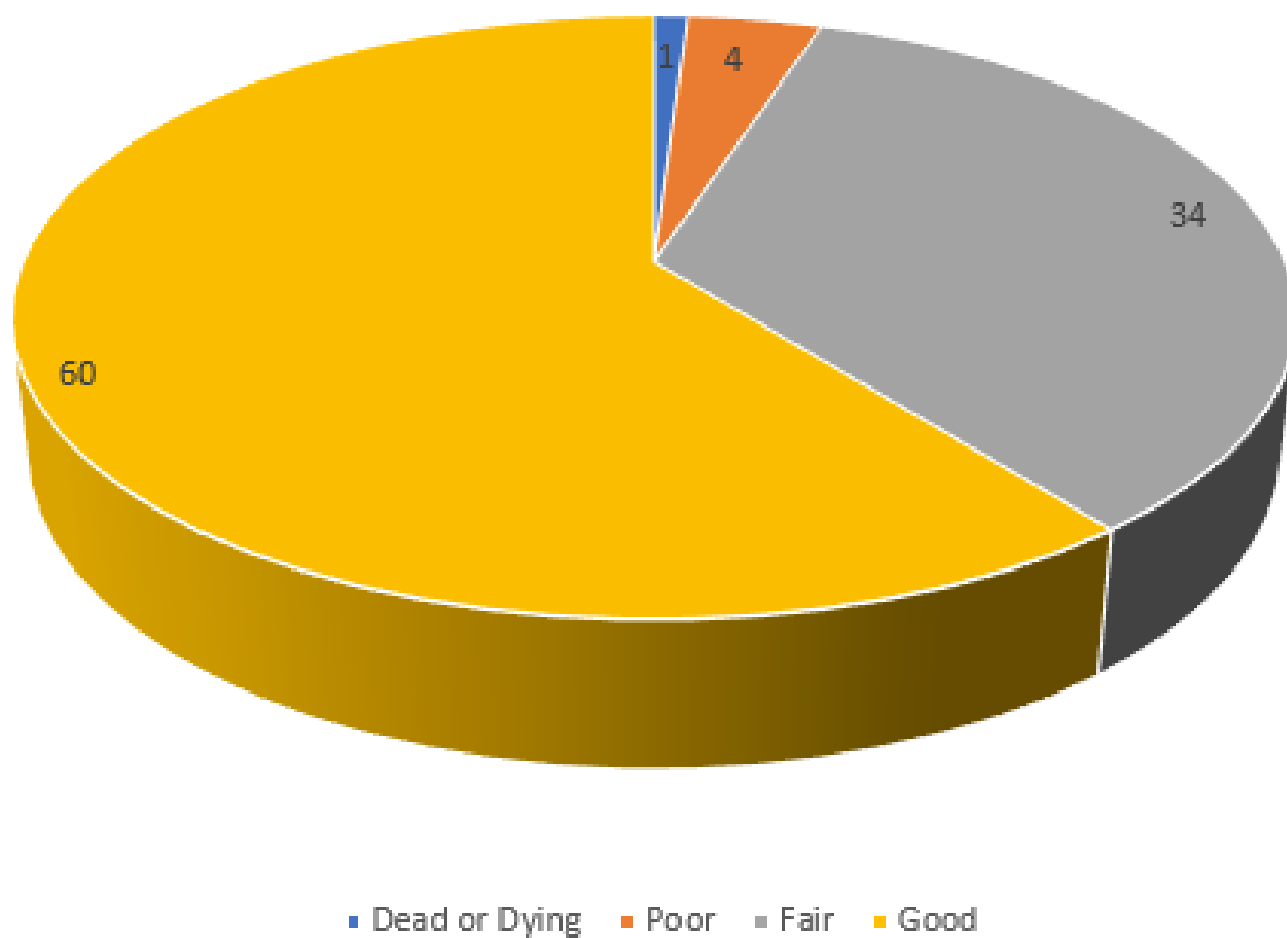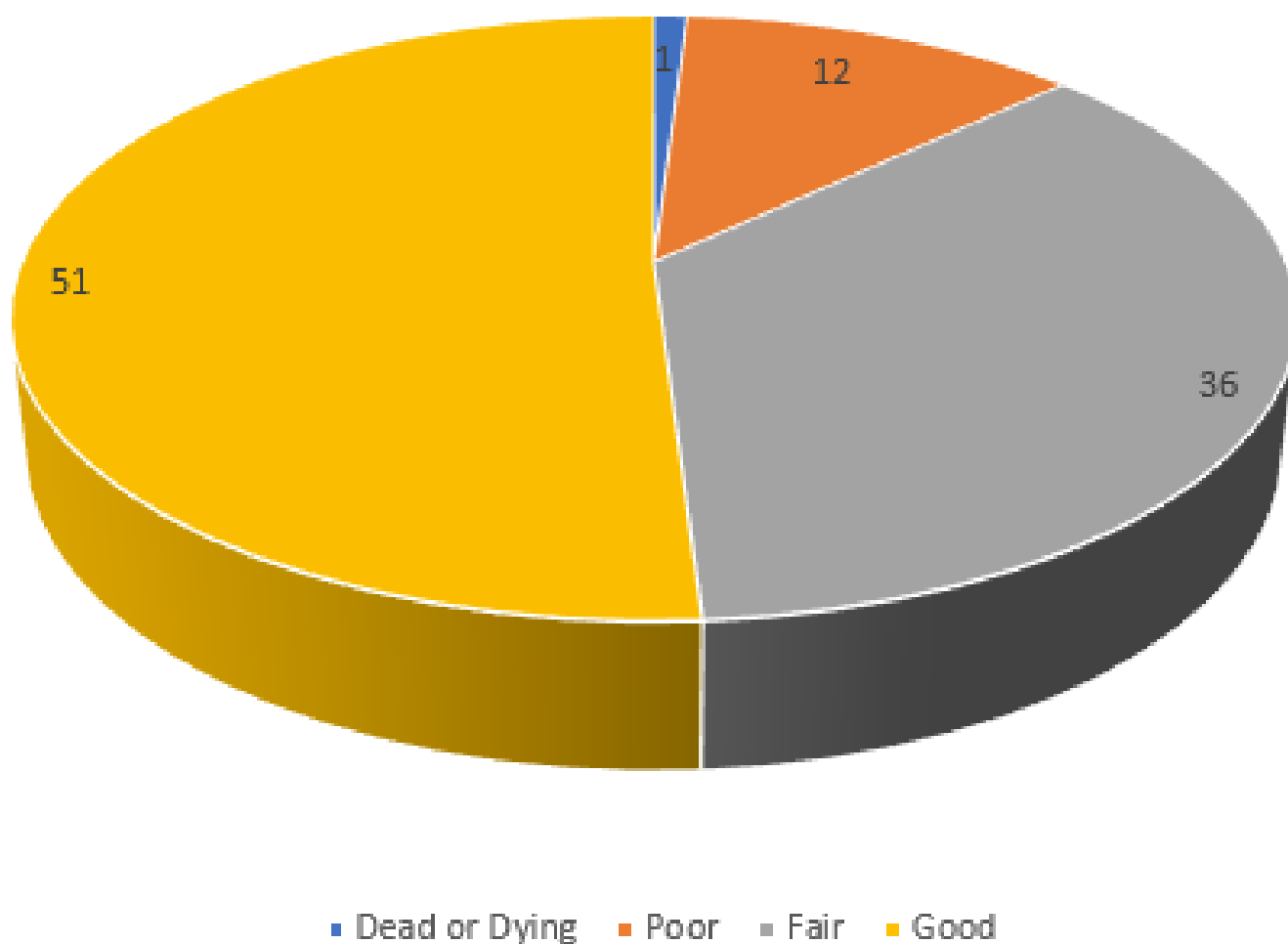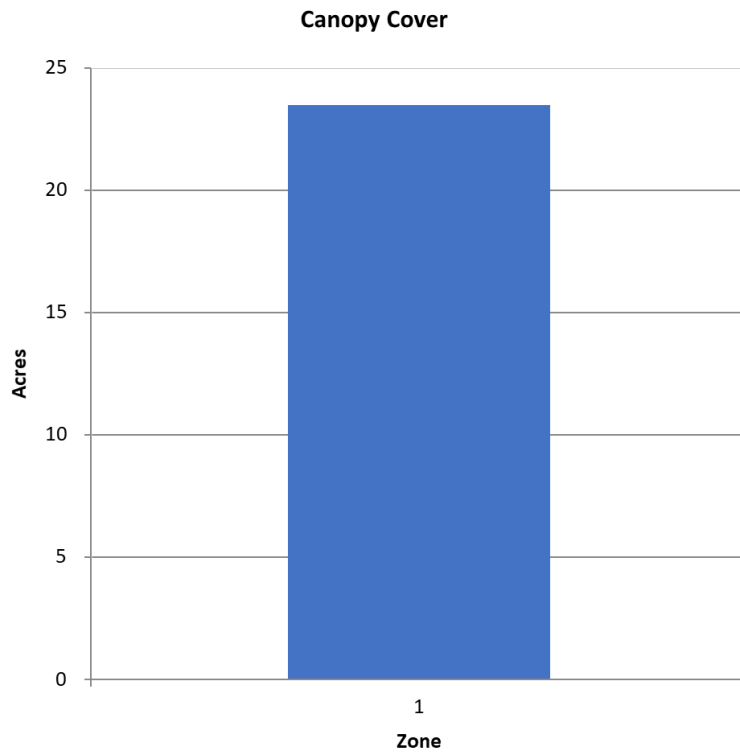## Functional (Foliage) Condition of Public Trees by Zone



1   4   34   60

■ Dead or Dying   ■ Poor   ■ Fair   ■ Good

**Figure 4: Wood Condition**

# Structural (Woody) Condition of Public Trees by Zone



■ Dead or Dying  ■ Poor  ■ Fair  ■ Good

**Manning**

**Canopy Cover of Public Trees (Acres)**

2/1/2021

**Canopy Cover**
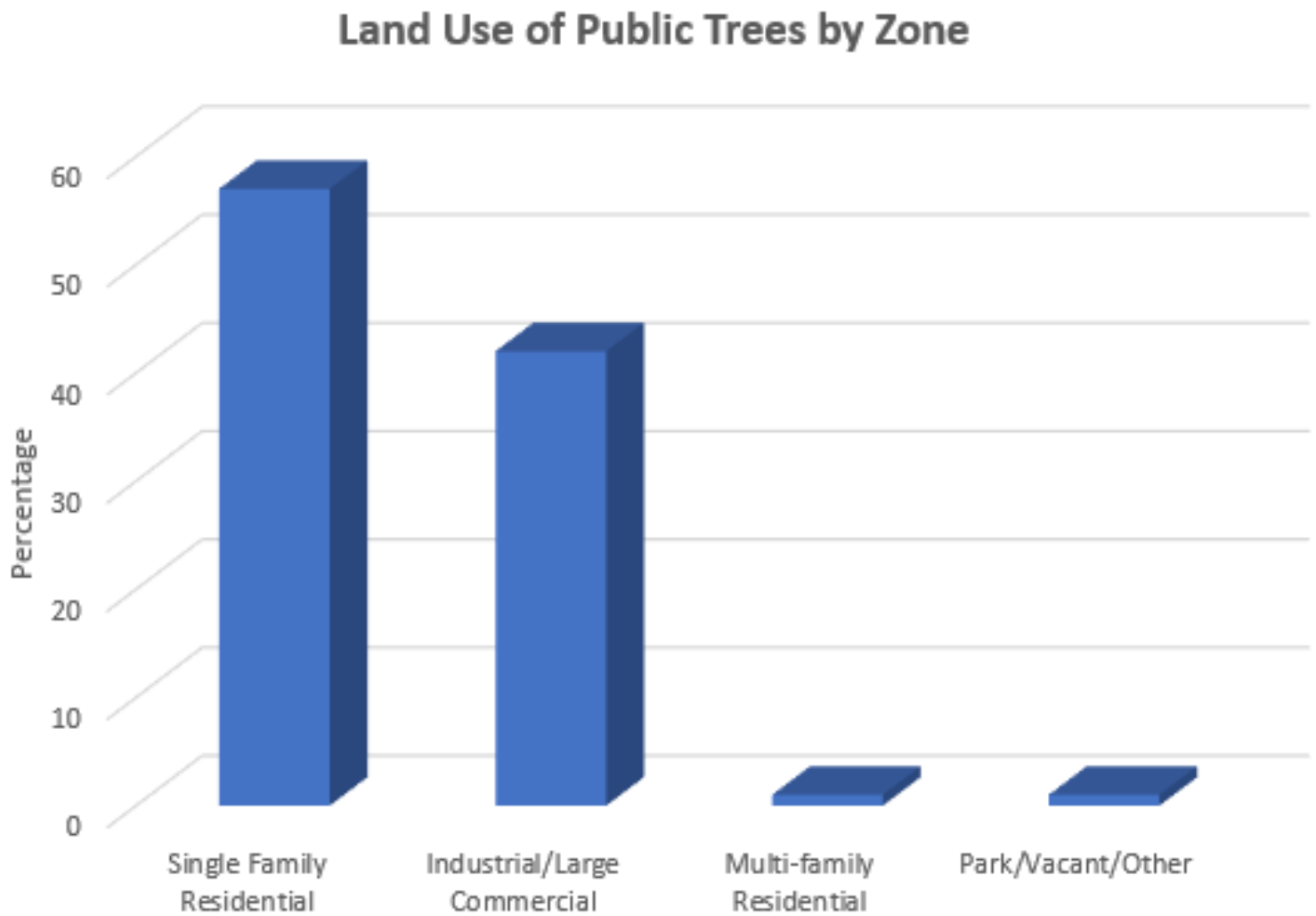


| Zone | Acres | % of Total Canopy Cover |
|------|-------|------------------------|
| 1 | 23 | 100.0 |
| Citywide total | 23 | 100.0 |

| | 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 Total | 0 | 0 | 23 | 0.00 | 0.00 |

**Figure 6: Land Use of City/Park Trees**

## Land Use of Public Trees by Zone

# APPENDIX B: ArcGIS MAPPING

Figure 1: Location of Ash Trees

Legend
- White Ash
- Green Ash
- Ash
- City Boundary

0    0.2    0.4         0.8
                        Miles
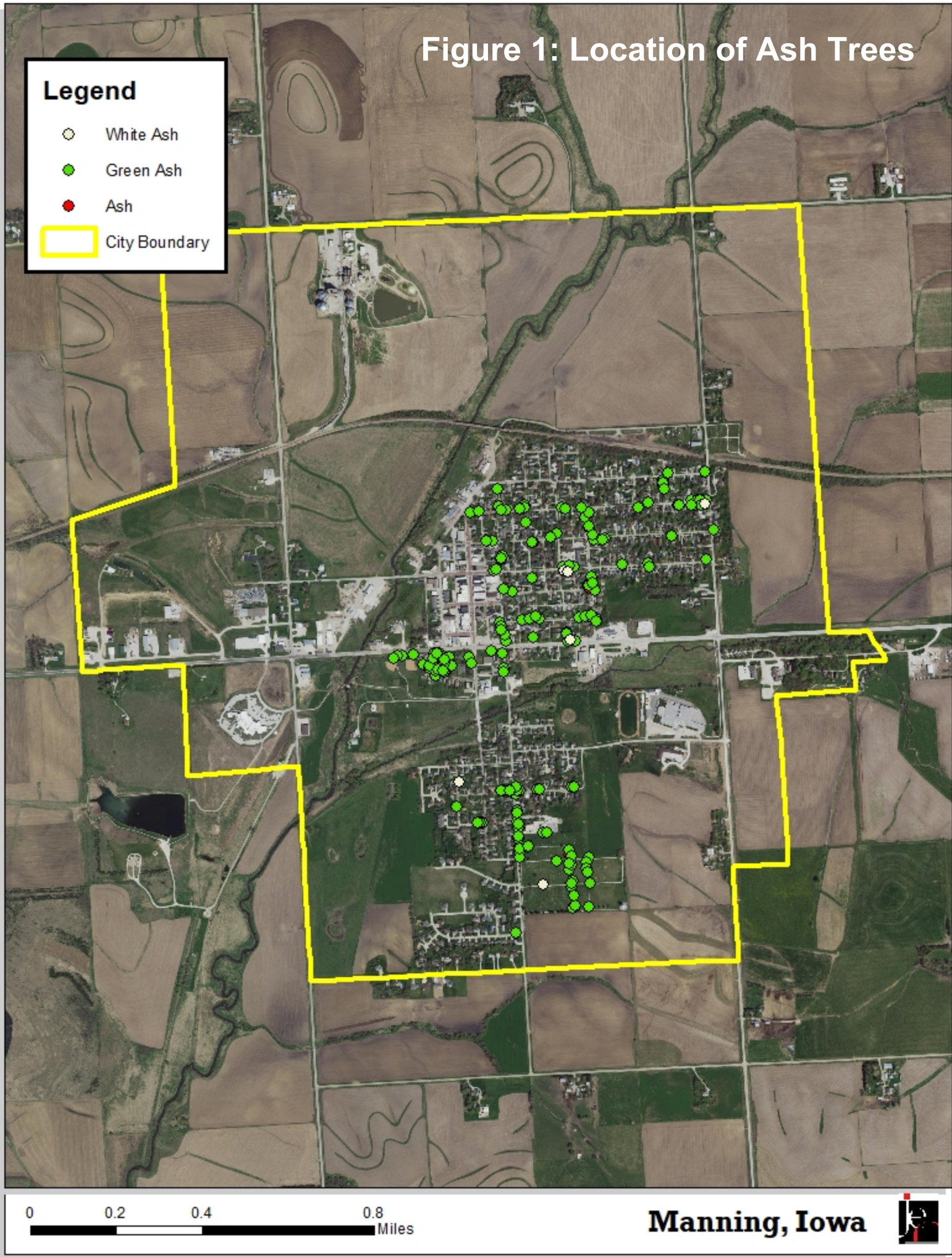
Manning, Iowa

Figure 2: Location of EAB Symptoms

Legend
- ◇ D-Shaped Exit Holes
- ● Epicormic Shoots
- ▭ City Boundary

0    0.2    0.4              0.8
                            Miles
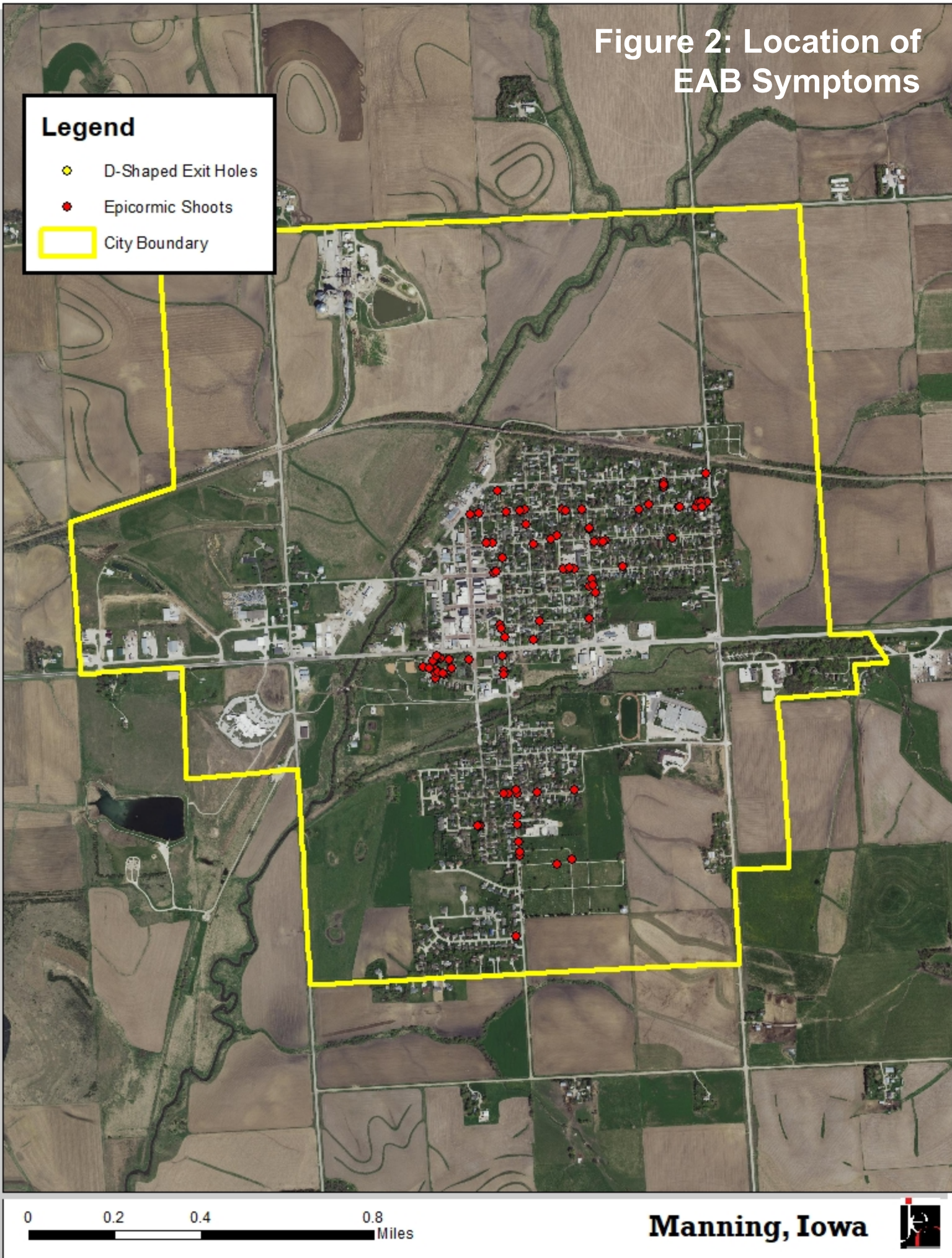
Manning, Iowa

Figure 3: Location of Poor Condition Trees

Legend
- Dead or Dying
- Poor Condition
- City Boundary

0   0.2   0.4   0.8
Miles

Manning, Iowa

Figure 4: Location of Trees with Recommended Maintenance
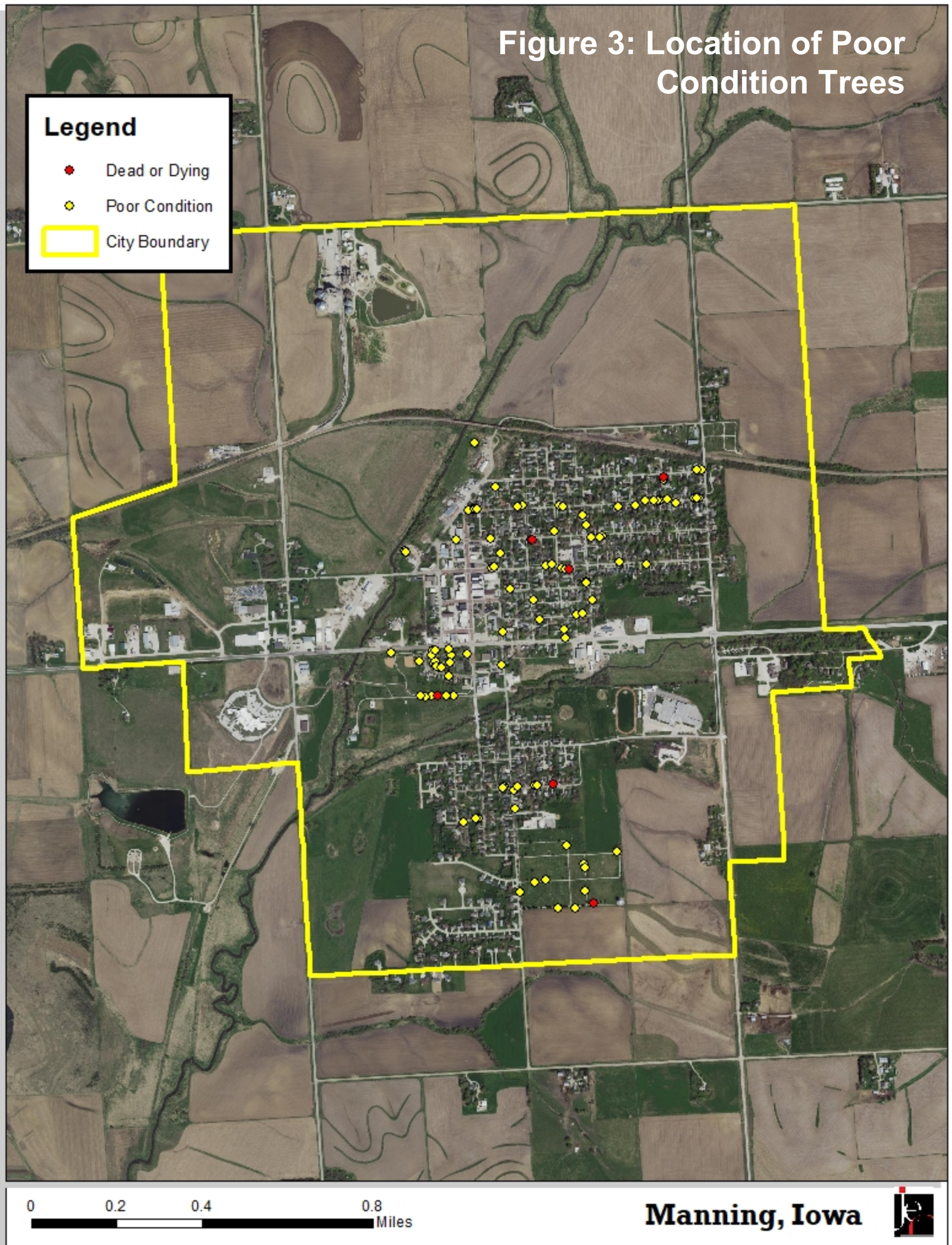
**Legend**
- Clean Crown
- Stake/Train
- Raise Crown
- Reduce Canopy
- Remove
- City Boundary
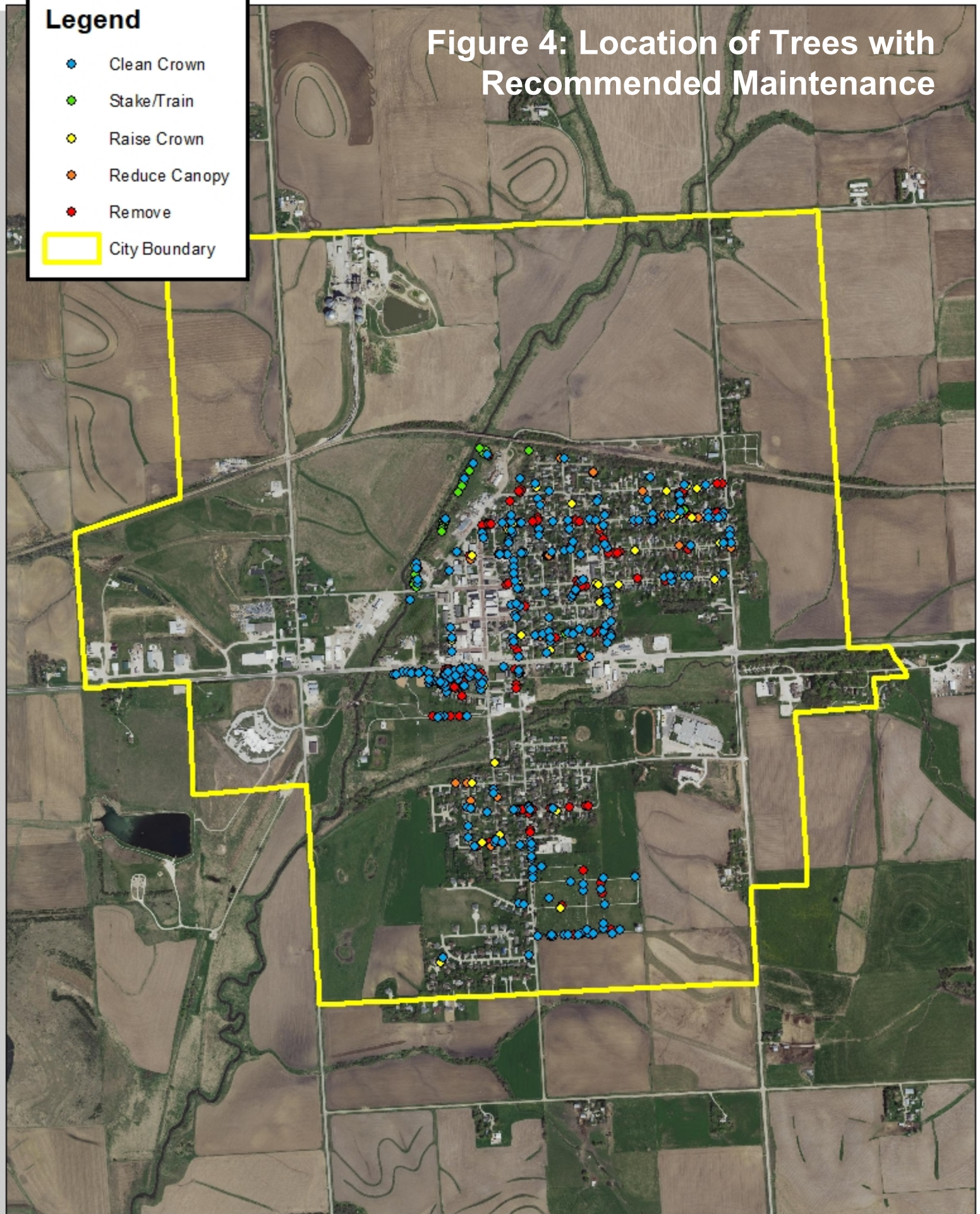
0    0.2    0.4    0.8 Miles

Manning, Iowa

# APPENDIX C: MANNING TREE ORDINANCES

**151.01 DEFINITION.**

For use in this chapter, "boulevard" means that part of the street, avenue or highway in the City not covered by sidewalk and lying between the lot line and the curb line; or, on unpaved streets, that part of the street, avenue or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

**151.02 PLANTING RESTRICTIONS.**

1. No tree shall be planted in any boulevard or street except in accordance with the following:  Alignment. All tress planted in any street shall be planted in the boulevard midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.

2. Spacing. Trees shall not be planted on any boulevard which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.

3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

**151.03 DUTY TO TRIM TREES.**

The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least eighteen (18) feet above the surface of a street, twenty (20) feet above the surface of a primary highway, and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax. *(Code of Iowa, Sec. 364.12[2c, d, & e])*

**151.04 TRIMMING TREES TO BE SUPERVISED.**

Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

**151.05 DISEASE CONTROL.**

Any dead, diseased or damaged tree or shrub which may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

**151.06 INSPECTION AND REMOVAL.**

The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests, and such trees and shrubs shall be subject to removal as follows:

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.

2. Private Property. If it is determined with reasonable certainty that any such condition exists 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. *(Code of Iowa, Sec. 364.12[3b & h])*

**151.07 CUTTING OR MOWING OF GRASS.**

1. Duty to Cut and Mow Lawns and Lots. The owner of any property shall cut and mow all lawns and lots so that such growth shall be less than four (4) inches at all times.

2. Cutting and Mowing by City. If a property owner refuses or fails to cut and mow lawns and lots within forty-eight (48) hours after being delivered a notice from the City to perform such action, the Council may require said work to be done and the cost and expenses thereof shall be assessed to the property owner after due notice is given. The amount of such assessment shall be certified to the County Auditor as provided by law and the same shall be collected with and in the same manner as general property taxes. The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

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Federal law prohibits employment discrimination on the basis of race, color, age, religion, national origin, sex or disability. State law prohibits employment discrimination on the basis of race, color, creed, age, sex, sexual orientation, gender identity, national origin, religion, pregnancy, or disability. State law also prohibits public accommodation (such as access to services or physical facilities) discrimination on the basis of race, color, creed, religion, sex, sexual orientation, gender identity, religion, national origin, or disability. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please contact the Iowa Civil Rights Commission, 1-800-457-4416, or write to the Iowa Department of Natural Resources, Wallace State Office Bldg., 502 E 9th St, Des Moines IA 50319.

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