Winterset, IA

Urban Forestry Management Plan

SUMMER 2022

JEO CONSULTING GROUP

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Executive Summary

EXECUTIVE SUMMARY

Overview

This plan was developed to assist the City of Winterset 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 5% of Winterset'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 2022, 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 2,043 trees inventoried.

- Winterset trees provide $326,351 of benefits annually, an average of $160 per tree
- There are over 59 species of trees
- The top three genera are: Maple 45%, Oak 9%, and Apple 6%
- 28% of trees need some type of management
- 142 trees should be removed

Recommendations

We detail our core recommendations in the Recommendations Section. In the Emerald Ash Borer Plan, we include management recommendations. Below are some key recommendations.

- Out of the 142 trees needing removal, 26 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*
- 21 of the 102 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 8 years to remove ash. We suggest that city officials request a budget increase to $15,000 annually and apply for grants to plant replacement trees.

Introduction

INTRODUCTION

This plan was developed to assist Winterset 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 Winterset, 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 Winterset'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 Winterset 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 Winterset's urban forestry goals.

Assist Winterset 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

Findings

INVENTORY

In 2022, JEO conducted a tree inventory that included 100% 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 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 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 ft, 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 2,043 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. Winterset's trees reduce energy-related costs by approximately $88,663 annually (Appendix A, Table 1). These savings are both in electricity (421.7 MWh) and in natural gas (57,814.7 Therms).

Annual Stormwater Benefits

Winterset's trees intercept about 4,399,749 gallons of rainfall or snow melt per year (Appendix A, Table 2). This interception provides $119,233 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 Winterset, it is estimated that trees remove 5,453 lbs of air pollution (ozone (O3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO2), and sulfur dioxide (SO2)) per year with a net value of $15,329 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Winterset, trees sequester about 849,824 lbs of carbon per year with an associated value of $11,128 (Appendix A, Table 5). In addition, the trees store 14,329,725 lbs of carbon, with a yearly benefit of $107,473 (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. Winterset receives $91,997 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, Winterset's trees provide $326,351 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 2,043 trees in Winterset provide approximately $160 annually (Appendix A, Table 7).

ENERGY	STORMWATER	AIR QUALITY	CARBON	AESTHETICS	SUMMARY
• Reduce energy cost by **$88,663**	• Intercept 4,399,749 **gallons** • Provides **$119,233** benefit	• Remove 5,453 **lbs** of pollution • Net value of **$15,329**	• Sequester 849,824 **lbs** • Value of **$11,128** • Store 14,329,725 **lbs** • Value of **$107,473**	• **$91,997** in social benefits	• **$326,351** annual benefits • Each tree provides **$160** annually

FOREST STRUCTURE

Species Distribution

Winterset has over 59 different tree species along city streets and parks (Appendix A, Figure 1).

The distribution of trees by genera is as follows:

Maple	918	45%	Coffee Tree	18	1%
Oak	176	9%	Magnolia	10	<1%
Apple	131	6%	Other Evergreen	10	<1%
Hackberry	128	6%	Catalpa	8	<1%
Ash	102	5%	Birch	7	<1%
Pine	82	4%	Ginkgo	7	<1%
Spruce	77	4%	Cherry	6	<1%
Locust	62	3%	Poplar	6	<1%
Hickory	54	3%	Redbud	6	<1%
Basswood/Linden	46	2%	Tree of Heaven	3	<1%
Walnut	43	2%	Buckeye	2	<1%
Sycamore	37	2%	Other Deciduous	2	<1%
Elm	35	2%	Locust	1	<1%
Pear	35	2%	Mulberry	1	<1%
Cedar	29	1%	Sumac	1	<1%

Age Class

Most of Winterset's trees (18%) are between 18 and 24 inches in diameter at 4.5 ft (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. Winterset's size curve is on the middle side, indicating a midrange 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 Winterset indicate that 86% of the trees are in good health, with only 7% of the foliage in poor health, dead, or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 85% of Winterset's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). Nine percent of the tree population's wood condition is in poor health, dead, or dying. This 9% 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	179	9%
Crown Raising	174	9%
Tree Removal	142	7%
Crown Reduction	55	3%
Tree Staking	9	<1%

Canopy Cover

The total canopy with both private and public trees is 600 acres or 20% cover. The canopy cover included in the Winterset inventory includes approximately 47 acres (Appendix A, Figure 4). The city's canopy goal is to increase canopy by 10% in 30 years. To achieve this goal it is estimated that 35 trees need to be planted annually on public and private lands.

Land Use and Location

The majority of Winterset'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	58%
Park/Vacant/Other	39%
Industrial/Large Commercial	3%
Multifamily Residential	<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

Winterset has 89 critical concern trees that need 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, critical concern trees first. There are 20 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Six-Year Maintenance Plan 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 80 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 142 removals, 78 are ash trees. There are a total of 102 ash trees, and 21 of those have signs and symptoms that have been associated with EAB. In addition, there are 5 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 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 Six Year Maintenance Plan 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%. 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 Winterset.

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 (45%) (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: crabapple, Japanese Lilac, serviceberry, oak (red, white), hackberry, linden, elm (disease resistant), cork, London plane, ironwood hornbeam as outlined in section 3.303 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 3.305 (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 3.305 (Appendix C). The new plantings will be a diverse mix and will not include crabapple, Japanese Lilac, serviceberry, oak (red, white), hackberry, linden, elm (disease resistant), cork, London plane, ironwood hornbeam.

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.

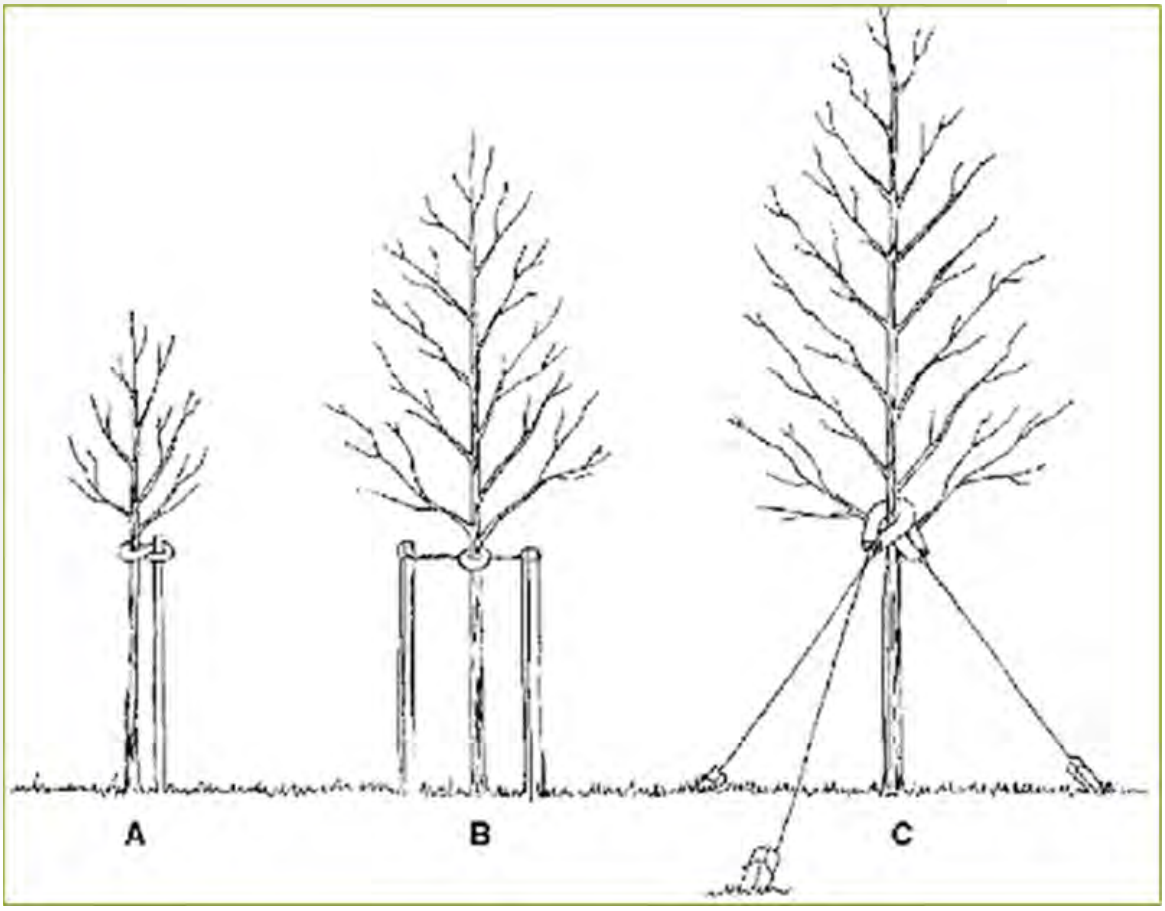
Monitoring

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 3.307 (Appendix C). REMOVAL OF DEAD OR DISEASED STREET TREES. The property owner shall not be required to remove diseased trees or dead wood on the publicly owned property or right of way. However, the property owner may voluntarily do so upon issuance of the permit issued in accordance with this Chapter.

Schedule & Budget



PROPOSED WORK SCHEDULE & BUDGET

Budget Allowance of $10,000/Year – (Based off Reported Yearly Tree Budget)

YEAR 1	Est. Cost
Remove 8 trees recommended for immediate removal	$5,600
Remove 5 ash trees in poor condition	$3,500
Plant 6 trees in open locations	$900
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$10,000**

YEAR 2	Est. Cost
Remove 4 trees recommended for immediate removal	$2,800
Plant 14 trees in open locations	$2,100
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$10,000**

YEAR 3	Est. Cost
Remove 6 trees / ash recommended for removal	$4,200
Remove 6 ash trees	$4,200
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$9,900**

YEAR 4	Est. Cost
Remove 4 trees / ash recommended for removal	$2,800
Plant 14 trees in open locations	$2,100
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$10,000**

YEAR 5	Est. Cost
Remove 10 trees / ash recommended for removal	$7,000
Plant 20 trees in open locations	$3,000
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$10,000**

YEAR 6	Est. Cost
Remove 5 trees / ash recommended for removal	$3,500
Plant 19 trees in open locations	$1,350
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$9,950**

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 $12,000 a year. If the budget were increased to $15,000 a year all ash could be removed in 5 years.*

PROPOSED WORK SCHEDULE WITH INCREASED BUDGET

Budget Allowance of $15,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	Est. Cost
Remove 10 trees recommended for immediate removal	$7,000
Prune 1/6 of city owned trees	$5,100
Plant 19 trees in open locations	$2,850
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$14,950**

YEAR 2	Est. Cost
Remove 11 trees recommended for immediate removal	$7,700
Plant 14 trees in open locations	$2,100
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$14,900**

YEAR 3	Est. Cost
Remove 10 trees recommended for immediate removal	$7,000
Plant 19 trees in open locations	$2,850
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$14,950**

YEAR 4	Est. Cost
Remove 11 trees recommended for immediate removal	$7,000
Plant 14 trees in open locations	$2,100
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$14,900**

YEAR 5	Est. Cost
Remove 10 trees recommended for immediate removal	$7,000
Plant 19 trees in open locations	$2,850
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$14,950**

YEAR 6	Est. Cost
Remove 17 trees recommended for immediate removal	$7,700
Plant 14 trees in open locations	$2,100
Prune 1/6 of city owned trees	$5,100
Visual Survey of EAB Signs/Symptoms	n/a
TOTAL	**$14,900**

Purposed Budget Increase

EAB could potentially kill all ash trees in Winterset within four years of its arrival. To remove all ash trees within six years, the budget would need to be increased to $12,000 a year. If the budget were increased to $15,000 per year all ash could be removed within 5 years. Additionally, we recommend that Winterset 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 20 trees could be treated per year (every other year treatment). Twenty trees would be selected for treatment, and Winterset would still need to find $58,000 for removal. Alternatively, if there are 24 treatable trees, it would cost approximately $3,600 a year for treatment and leave $6,400 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 Winterset. We suggest considering an increased budget to plan for this.

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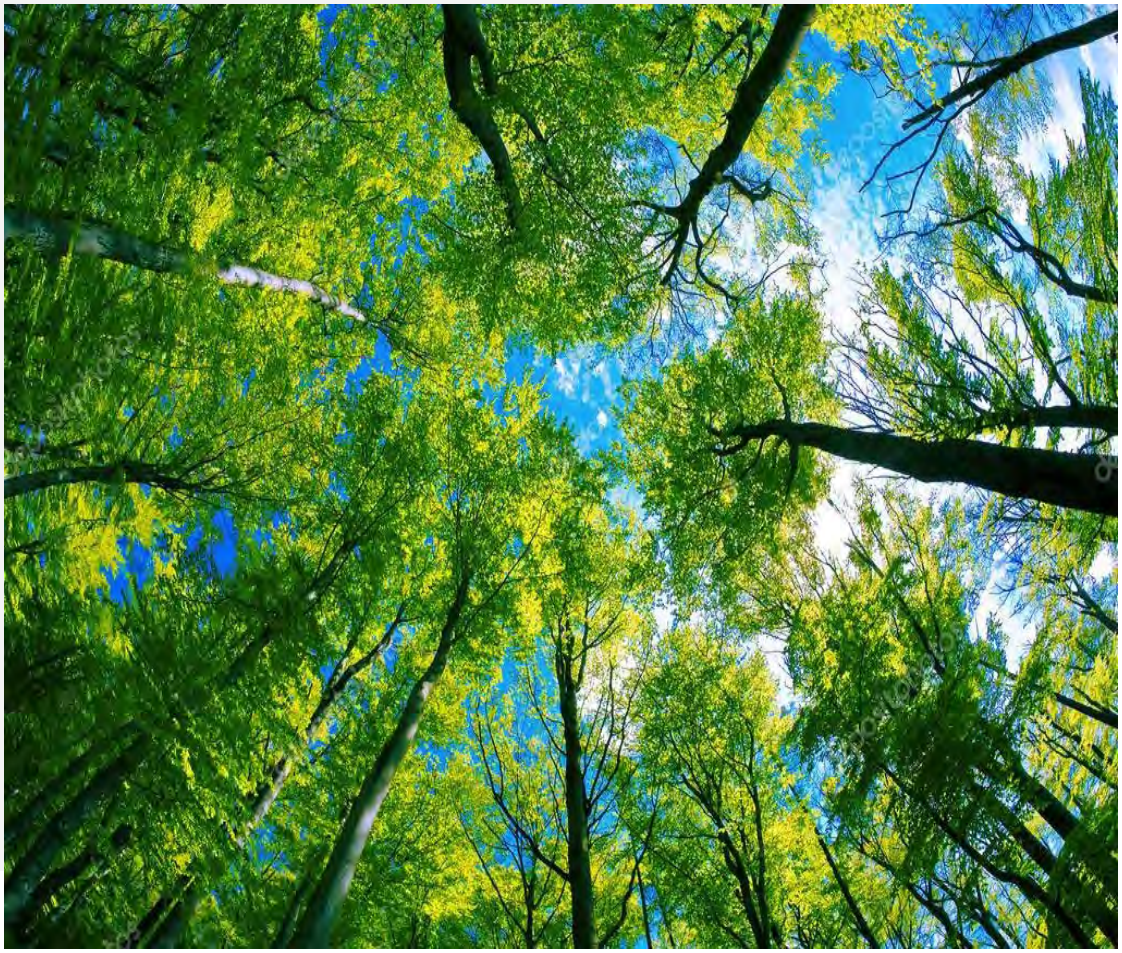
Appendices



APPENDIX A: i-TREE DATA

Table 1: Annual Energy Benefits

Winterset

Annual Energy Benefits of Public Trees

2/8/2023

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Black maple	96.1	7,295	13,108.5	12,846	20,141	(N/A)	18.0	22.7	54.88
Silver maple	62.0	4,703	8,152.5	7,989	12,693	(N/A)	11.4	14.3	54.48
Red maple	27.2	2,065	3,672.7	3,599	5,664	(N/A)	7.9	6.4	34.96
Apple	8.7	659	1,365.2	1,338	1,997	(N/A)	6.3	2.3	15.48
Northern hackberry	37.0	2,807	5,233.9	5,129	7,936	(N/A)	6.3	9.0	62.00
Bur oak	12.5	946	1,710.9	1,677	2,622	(N/A)	4.2	3.0	30.85
Norway maple	15.6	1,184	2,278.8	2,233	3,417	(N/A)	3.9	3.9	42.71
Eastern white pine	8.2	626	1,066.0	1,045	1,670	(N/A)	3.3	1.9	24.93
Sugar maple	15.1	1,148	2,050.4	2,009	3,158	(N/A)	3.2	3.6	48.58
Honeylocust	13.4	1,014	1,762.1	1,727	2,741	(N/A)	3.0	3.1	44.21
Green ash	13.3	1,013	1,734.0	1,699	2,712	(N/A)	3.0	3.1	43.75
Northern red oak	8.7	664	1,202.9	1,179	1,843	(N/A)	2.9	2.1	30.71
Hickory	12.4	945	1,694.9	1,661	2,606	(N/A)	2.6	2.9	48.25
Black walnut	12.7	962	1,756.4	1,721	2,684	(N/A)	2.1	3.0	62.41
Spruce	2.8	215	403.5	395	611	(N/A)	2.0	0.7	14.89
Ash	8.1	616	1,152.9	1,130	1,746	(N/A)	1.9	2.0	45.95
American sycamore	13.9	1,056	1,906.2	1,868	2,924	(N/A)	1.8	3.3	79.02
Callery pear	2.2	167	337.9	331	498	(N/A)	1.7	0.6	14.24
American basswood	8.7	658	1,239.1	1,214	1,873	(N/A)	1.7	2.1	55.08
Northern pin oak	9.0	687	1,333.6	1,307	1,994	(N/A)	1.4	2.2	68.75
Eastern red cedar	2.1	162	321.3	315	477	(N/A)	1.4	0.5	16.44
Blue spruce	2.2	165	299.1	293	458	(N/A)	1.3	0.5	16.97
Siberian elm	5.6	422	723.4	709	1,131	(N/A)	1.1	1.3	51.40
Kentucky coffeetree	5.5	417	772.8	757	1,174	(N/A)	0.9	1.3	65.22
Elm	2.7	203	341.0	334	537	(N/A)	0.6	0.6	41.30
Red pine	0.6	44	80.4	79	123	(N/A)	0.6	0.1	10.26
Southern magnolia	1.4	104	169.3	166	270	(N/A)	0.5	0.3	27.04
Maple	1.6	118	213.6	209	327	(N/A)	0.5	0.4	32.72
Littleleaf linden	0.7	51	102.1	100	151	(N/A)	0.5	0.2	15.11
Catalpa	1.6	124	229.2	225	349	(N/A)	0.4	0.4	43.63
Ginkgo	1.0	75	121.6	119	194	(N/A)	0.3	0.2	27.72
Tulip tree	0.1	8	16.1	16	24	(N/A)	0.3	0.0	3.99
Eastern redbud	0.6	48	96.1	94	142	(N/A)	0.3	0.2	23.68
Black spruce	0.4	31	60.6	59	91	(N/A)	0.2	0.1	18.11
Norway spruce	0.6	48	83.7	82	130	(N/A)	0.2	0.1	32.40
Birch	1.0	73	142.2	139	213	(N/A)	0.1	0.2	70.84
Broadleaf Evergreen Mediur	0.3	19	38.1	37	56	(N/A)	0.1	0.1	18.82
River birch	0.9	67	124.3	122	188	(N/A)	0.1	0.2	62.82
Conifer Evergreen Large	0.5	39	68.9	68	107	(N/A)	0.1	0.1	35.61
Common chokecherry	0.0	1	1.9	2	3	(N/A)	0.1	0.0	0.87
Tree of Heaven	0.7	52	103.8	102	154	(N/A)	0.1	0.2	51.33
White ash	1.1	80	124.3	122	202	(N/A)	0.1	0.2	100.98
Pin oak	0.3	26	46.8	46	72	(N/A)	0.1	0.1	35.83
Basswood	0.5	40	76.2	75	115	(N/A)	0.1	0.1	57.32
Plum	0.2	15	32.2	32	47	(N/A)	0.1	0.1	23.50
Virginia pine	0.3	20	29.3	29	48	(N/A)	0.1	0.1	24.14
Conifer Evergreen Medium	0.3	20	34.7	34	54	(N/A)	0.1	0.1	27.08
Eastern hophornbeam	0.0	2	4.4	4	6	(N/A)	0.1	0.0	3.13
Ohio buckeye	0.2	16	33.7	33	49	(N/A)	0.1	0.1	24.47
Kwanzan cherry	0.0	3	7.6	7	11	(N/A)	0.1	0.0	5.40
Black cherry	0.0	2	3.8	4	5	(N/A)	0.0	0.0	5.40
Paper birch	0.1	7	13.7	13	21	(N/A)	0.0	0.0	20.64
Conifer Evergreen Small	0.0	0	0.7	1	1	(N/A)	0.0	0.0	0.93
Black locust	0.3	24	47.4	46	71	(N/A)	0.0	0.1	70.84
Broadleaf Evergreen Small	0.2	17	28.2	28	44	(N/A)	0.0	0.0	44.11
Amur maple	0.0	0	0.6	1	1	(N/A)	0.0	0.0	0.87

Annual Energy Benefits of Public Trees

2/8/2023

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Mulberry	0.1	6	12.8	13	18	(N/A)	0.0	0.0	18.19
Sumac	0.2	15	31.6	31	46	(N/A)	0.0	0.1	46.14
Scotch pine	0.1	10	14.6	14	24	(N/A)	0.0	0.0	24.14
Total	421.7	32,005	57,814.7	56,658	88,663	(N/A)	100.0	100.0	43.40

Table 2: Annual Stormwater Benefits

Winterset

Annual Stormwater Benefits of Public Trees

2/8/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Black maple	887,256	24,045	(N/A)	18.0	20.2	65.52
Silver maple	831,862	22,543	(N/A)	11.4	18.9	96.75
Red maple	215,605	5,843	(N/A)	7.9	4.9	36.07
Apple	36,603	992	(N/A)	6.3	0.8	7.69
Northern hackberry	338,049	9,161	(N/A)	6.3	7.7	71.57
Bur oak	137,752	3,733	(N/A)	4.2	3.1	43.92
Norway maple	132,118	3,580	(N/A)	3.9	3.0	44.75
Eastern white pine	145,383	3,940	(N/A)	3.3	3.3	58.80
Sugar maple	148,418	4,022	(N/A)	3.2	3.4	61.88
Honeylocust	150,393	4,076	(N/A)	3.0	3.4	65.74
Green ash	130,080	3,525	(N/A)	3.0	3.0	56.86
Northern red oak	79,153	2,145	(N/A)	2.9	1.8	35.75
Hickory	121,217	3,285	(N/A)	2.6	2.8	60.83
Black walnut	146,597	3,973	(N/A)	2.1	3.3	92.39
Spruce	38,293	1,038	(N/A)	2.0	0.9	25.31
Ash	69,131	1,873	(N/A)	1.9	1.6	49.30
American sycamore	196,662	5,330	(N/A)	1.8	4.5	144.04
Callery pear	11,150	302	(N/A)	1.7	0.3	8.63
American basswood	95,256	2,581	(N/A)	1.7	2.2	75.92
Northern pin oak	102,956	2,790	(N/A)	1.4	2.3	96.21
Eastern red cedar	30,574	829	(N/A)	1.4	0.7	28.57
Blue spruce	31,129	844	(N/A)	1.3	0.7	31.24
Siberian elm	53,538	1,451	(N/A)	1.1	1.2	65.95
Kentucky coffeetree	69,297	1,878	(N/A)	0.9	1.6	104.33
Elm	23,575	639	(N/A)	0.6	0.5	49.14
Red pine	10,426	283	(N/A)	0.6	0.2	23.55
Southern magnolia	12,603	342	(N/A)	0.5	0.3	34.15
Maple	13,869	376	(N/A)	0.5	0.3	37.59
Littleleaf linden	5,869	159	(N/A)	0.5	0.1	15.90
Catalpa	20,668	560	(N/A)	0.4	0.5	70.01
Ginkgo	5,882	159	(N/A)	0.3	0.1	22.77
Tulip tree	697	19	(N/A)	0.3	0.0	3.15
Eastern redbud	3,159	86	(N/A)	0.3	0.1	14.27
Black spruce	6,174	167	(N/A)	0.2	0.1	33.46
Norway spruce	13,512	366	(N/A)	0.2	0.3	91.55
Birch	11,293	306	(N/A)	0.1	0.3	102.01
Broadleaf Evergreen Medium	2,030	55	(N/A)	0.1	0.0	18.34
River birch	8,938	242	(N/A)	0.1	0.2	80.74
Conifer Evergreen Large	12,178	330	(N/A)	0.1	0.3	110.01
Common chokecherry	22	1	(N/A)	0.1	0.0	0.20
Tree of Heaven	6,830	185	(N/A)	0.1	0.2	61.69
White ash	15,765	427	(N/A)	0.1	0.4	213.62
Pin oak	3,603	98	(N/A)	0.1	0.1	48.82
Basswood	5,181	140	(N/A)	0.1	0.1	70.21
Plum	1,181	32	(N/A)	0.1	0.0	16.01
Virginia pine	3,077	83	(N/A)	0.1	0.1	41.70
Conifer Evergreen Medium	3,857	105	(N/A)	0.1	0.1	52.26
Eastern hophornbeam	76	2	(N/A)	0.1	0.0	1.03
Ohio buckeye	1,172	32	(N/A)	0.1	0.0	15.88

Annual Stormwater Benefits of Public Trees

2/8/2023

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Kwanzan cherry	137	4	(N/A)	0.1	0.0	1.86
Black cherry	69	2	(N/A)	0.0	0.0	1.86
Paper birch	608	16	(N/A)	0.0	0.0	16.47
Conifer Evergreen Small	24	1	(N/A)	0.0	0.0	0.66
Black locust	3,764	102	(N/A)	0.0	0.1	102.01
Broadleaf Evergreen Small	2,052	56	(N/A)	0.0	0.0	55.60
Amur maple	7	0	(N/A)	0.0	0.0	0.20
Mulberry	264	7	(N/A)	0.0	0.0	7.17
Sumac	1,174	32	(N/A)	0.0	0.0	31.82
Scotch pine	1,539	42	(N/A)	0.0	0.0	41.70
Citywide total	4,399,749	119,233	(N/A)	100.0	100.0	58.36

Table 3: Annual Air Quality Benefits

Winterset

Annual Air Quality Benefits of Public Trees

2/8/2023

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								
Black maple	222.7	38.0	102.8	9.9	1,183	457.9	66.7	63.6	435.3	2,854	-73.4	-275	1,323.4	3,762	(N/A)	18.0	10.25
Silver maple	136.5	23.1	67.9	6.0	738	292.1	42.8	40.8	280.4	1,828	-73.1	-274	816.6	2,292	(N/A)	11.4	9.84
Red maple	48.9	8.3	23.2	2.2	261	129.2	18.9	18.0	123.2	807	-16.7	-63	355.2	1,005	(N/A)	7.9	6.21
Apple	10.3	1.7	5.0	0.5	55	43.0	6.1	5.8	39.4	264	-0.1	0	111.7	319	(N/A)	6.3	2.47
Northern hackberry	52.7	9.1	27.1	2.4	288	178.4	25.9	24.6	167.7	1,107	0.0	0	487.9	1,395	(N/A)	6.3	10.90
Bur oak	17.7	2.8	8.5	0.8	94	59.5	8.7	8.3	56.5	371	0.0	0	162.8	465	(N/A)	4.2	5.47
Norway maple	25.0	4.3	12.6	1.1	136	75.9	10.9	10.4	70.8	469	-6.0	-23	204.9	582	(N/A)	3.9	7.28
Eastern white pine	16.8	3.3	13.8	2.1	111	38.7	5.7	5.4	37.3	243	-71.0	-266	52.2	87	(N/A)	3.3	1.30
Sugar maple	18.6	3.2	9.6	0.8	102	72.0	10.5	10.0	68.5	449	-14.9	-56	178.3	495	(N/A)	3.2	7.61
Honeylocust	29.3	4.8	13.4	1.3	155	63.1	9.2	8.8	60.5	394	-23.1	-87	167.4	463	(N/A)	3.0	7.46
Green ash	16.4	2.6	8.0	0.7	88	62.9	9.2	8.8	60.5	394	0.0	0	169.2	482	(N/A)	3.0	7.77
Northern red oak	16.0	2.8	7.9	0.7	87	41.8	6.1	5.8	39.6	260	-22.8	-85	97.9	261	(N/A)	2.9	4.36
Hickory	13.2	2.1	6.6	0.6	71	59.3	8.6	8.2	56.4	370	0.0	0	155.2	441	(N/A)	2.6	8.17
Black walnut	18.4	2.9	8.7	0.8	98	60.7	8.8	8.4	57.5	378	0.0	0	166.4	476	(N/A)	2.1	11.06
Spruce	3.9	0.8	3.5	0.5	27	13.6	2.0	1.9	12.8	85	-14.3	-54	24.8	58	(N/A)	2.0	1.41
Ash	13.4	2.3	6.7	0.6	73	39.2	5.7	5.4	36.8	243	-3.2	-12	106.9	304	(N/A)	1.9	8.00
American sycamore	31.5	5.0	14.1	1.4	165	66.4	9.7	9.2	63.0	414	0.0	0	200.4	579	(N/A)	1.8	15.64
Callery pear	1.0	0.2	0.7	0.0	6	10.9	1.6	1.5	10.0	67	-0.4	-1	25.5	72	(N/A)	1.7	2.05
American basswood	13.0	2.2	6.4	0.6	70	42.0	6.1	5.8	39.4	260	-11.1	-41	104.2	289	(N/A)	1.7	8.49
Northern pin oak	23.3	4.0	11.2	1.0	125	44.1	6.4	6.0	41.0	273	-5.3	-20	131.8	378	(N/A)	1.4	13.03
Eastern red cedar	5.7	1.1	4.6	0.7	37	10.4	1.5	1.4	9.6	64	-16.7	-63	18.3	39	(N/A)	1.4	1.33
Blue spruce	4.5	0.9	3.7	0.5	29	10.4	1.5	1.4	9.9	65	-11.4	-43	21.3	51	(N/A)	1.3	1.90
Siberian elm	8.4	1.4	4.2	0.4	46	26.2	3.8	3.7	25.2	164	0.0	0	73.3	210	(N/A)	1.1	9.52
Kentucky coffeetree	9.2	1.5	4.3	0.4	49	26.4	3.8	3.6	24.9	164	0.0	0	74.1	213	(N/A)	0.9	11.81
Elm	2.5	0.4	1.3	0.1	13	12.5	1.8	1.8	12.1	79	0.0	0	32.5	92	(N/A)	0.6	7.09
Red pine	1.1	0.2	1.0	0.1	8	2.8	0.4	0.4	2.6	17	-5.2	-19	3.5	6	(N/A)	0.6	0.47
Southern magnolia	0.9	0.2	1.1	0.1	7	6.4	0.9	0.9	6.2	40	-3.6	-13	13.1	34	(N/A)	0.5	3.38
Maple	3.4	0.6	1.6	0.2	18	7.4	1.1	1.0	7.0	46	-1.1	-4	21.1	60	(N/A)	0.5	6.01
Littleleaf linden	0.9	0.1	0.4	0.0	5	3.3	0.5	0.5	3.1	20	-0.4	-2	8.3	23	(N/A)	0.5	2.34
Catalpa	2.8	0.4	1.3	0.1	15	7.9	1.1	1.1	7.4	49	0.0	0	22.1	64	(N/A)	0.4	7.94
Ginkgo	1.5	0.3	0.7	0.1	8	4.6	0.7	0.6	4.5	29	-0.5	-2	12.4	35	(N/A)	0.3	5.01
Tulip tree	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3	(N/A)	0.3	0.57
Eastern redbud	1.1	0.2	0.5	0.0	6	3.1	0.4	0.4	2.9	19	0.0	0	8.6	25	(N/A)	0.3	4.13
Black spruce	0.8	0.2	0.7	0.1	6	2.0	0.3	0.3	1.9	12	-2.3	-8	4.0	9	(N/A)	0.2	1.89
Norway spruce	1.6	0.3	1.3	0.2	10	3.0	0.4	0.4	2.8	19	-7.0	-26	3.1	3	(N/A)	0.2	0.69

Winterset

Annual Air Quality Benefits of Public Trees

2/8/2023

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								
Birch	2.6	0.4	1.2	0.1	14	4.7	0.7	0.6	4.4	29	-0.6	-2	14.2	41	(N/A)	0.1	13.58
Broadleaf Evergreen Medium	0.1	0.0	0.1	0.0	1	1.2	0.2	0.2	1.1	8	-0.5	-2	2.4	6	(N/A)	0.1	2.10
River birch	1.9	0.3	0.9	0.1	10	4.2	0.6	0.6	4.0	26	-0.4	-2	12.3	35	(N/A)	0.1	11.69
Conifer Evergreen Large	1.5	0.3	1.2	0.2	10	2.4	0.4	0.3	2.3	15	-7.1	-27	1.5	-2	(N/A)	0.1	-0.57
Common chokecherry	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)	0.1	0.11
Tree of Heaven	1.4	0.2	0.7	0.1	8	3.4	0.5	0.5	3.1	21	-0.3	-1	9.5	27	(N/A)	0.1	9.07
White ash	3.9	0.6	1.7	0.2	20	4.9	0.7	0.7	4.8	31	0.0	0	17.4	51	(N/A)	0.1	25.38
Pin oak	0.6	0.1	0.3	0.0	3	1.6	0.2	0.2	1.5	10	-1.1	-4	3.5	9	(N/A)	0.1	4.59
Basswood	0.5	0.1	0.3	0.0	3	2.5	0.4	0.4	2.4	16	0.0	0	6.6	19	(N/A)	0.1	9.34
Plum	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.1	4.23
Virginia pine	0.3	0.1	0.3	0.0	2	1.2	0.2	0.2	1.2	7	-1.1	-4	2.3	6	(N/A)	0.1	2.82
Conifer Evergreen Medium	0.5	0.1	0.4	0.1	4	1.2	0.2	0.2	1.2	8	-1.4	-5	2.5	6	(N/A)	0.1	2.99
Eastern hophornbeam	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)	0.1	0.41
Ohio buckeye	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	1.0	6	0.0	0	2.5	7	(N/A)	0.1	3.47
Kwanzan cherry	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	1	(N/A)	0.1	0.71
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)	0.0	0.71
Paper birch	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)	0.0	2.99
Conifer Evergreen Small	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.0	0.09
Black locust	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)	0.0	13.58
Broadleaf Evergreen Small	0.7	0.1	0.5	0.1	4	1.0	0.1	0.1	1.0	6	0.0	0	3.7	11	(N/A)	0.0	10.84
Amur maple	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	(N/A)	0.0	0.11
Mulberry	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3	(N/A)	0.0	2.55
Sumac	0.4	0.1	0.2	0.0	2	1.0	0.1	0.1	0.9	6	0.0	0	2.9	8	(N/A)	0.0	8.35
Scotch pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3	(N/A)	0.0	2.82
Citywide total	789.2	134.3	393.1	38.1	4,280	2,012.5	293.0	279.4	1,910.3	12,537	-396.7	-1,488	5,453.3	15,329	(N/A)	100.0	7.50

Table 4: Annual Carbon Stored

Winterset

Stored CO2 Benefits of Public Trees

2/8/2023

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Black maple	2,384,351	17,883	(N/A)	18.0	16.6	48.73
Silver maple	3,087,910	23,159	(N/A)	11.4	21.5	99.40
Red maple	540,604	4,055	(N/A)	7.9	3.8	25.03
Apple	168,706	1,265	(N/A)	6.3	1.2	9.81
Northern hackberry	799,125	5,993	(N/A)	6.3	5.6	46.82
Bur oak	593,723	4,453	(N/A)	4.2	4.1	52.39
Norway maple	414,575	3,109	(N/A)	3.9	2.9	38.87
Eastern white pine	173,079	1,298	(N/A)	3.3	1.2	19.37
Sugar maple	535,990	4,020	(N/A)	3.2	3.7	61.85
Honeylocust	379,267	2,845	(N/A)	3.0	2.6	45.88
Green ash	557,206	4,179	(N/A)	3.0	3.9	67.40
Northern red oak	333,431	2,501	(N/A)	2.9	2.3	41.68
Hickory	429,682	3,223	(N/A)	2.6	3.0	59.68
Black walnut	598,999	4,492	(N/A)	2.1	4.2	104.48
Spruce	30,133	226	(N/A)	2.0	0.2	5.51
Ash	221,927	1,664	(N/A)	1.9	1.5	43.80
American sycamore	1,065,244	7,989	(N/A)	1.8	7.4	215.93
Callery pear	20,633	155	(N/A)	1.7	0.1	4.42
American basswood	482,200	3,617	(N/A)	1.7	3.4	106.37
Northern pin oak	384,464	2,883	(N/A)	1.4	2.7	99.43
Eastern red cedar	18,925	142	(N/A)	1.4	0.1	4.89
Blue spruce	33,275	250	(N/A)	1.3	0.2	9.24
Siberian elm	209,227	1,569	(N/A)	1.1	1.5	71.33
Kentucky coffeetree	299,403	2,246	(N/A)	0.9	2.1	124.75
Elm	81,786	613	(N/A)	0.6	0.6	47.18
Red pine	12,351	93	(N/A)	0.6	0.1	7.72
Southern magnolia	14,841	111	(N/A)	0.5	0.1	11.13
Maple	36,775	276	(N/A)	0.5	0.3	27.58
Littleleaf linden	18,909	142	(N/A)	0.5	0.1	14.18
Catalpa	91,699	688	(N/A)	0.4	0.6	85.97
Ginkgo	20,970	157	(N/A)	0.3	0.1	22.47
Tulip tree	1,095	8	(N/A)	0.3	0.0	1.37
Eastern redbud	16,892	127	(N/A)	0.3	0.1	21.11
Black spruce	5,893	44	(N/A)	0.2	0.0	8.84
Norway spruce	17,519	131	(N/A)	0.2	0.1	32.85
Birch	42,840	321	(N/A)	0.1	0.3	107.10
Broadleaf Evergreen I	1,452	11	(N/A)	0.1	0.0	3.63
River birch	32,184	241	(N/A)	0.1	0.2	80.46
Conifer Evergreen La	18,323	137	(N/A)	0.1	0.1	45.81
Common chokecherry	41	0	(N/A)	0.1	0.0	0.10
Tree of Heaven	23,326	175	(N/A)	0.1	0.2	58.32
White ash	51,886	389	(N/A)	0.1	0.4	194.57
Pin oak	15,251	114	(N/A)	0.1	0.1	57.19
Basswood	16,915	127	(N/A)	0.1	0.1	63.43
Plum	6,756	51	(N/A)	0.1	0.0	25.34
Virginia pine	2,340	18	(N/A)	0.1	0.0	8.78
Conifer Evergreen M	3,779	28	(N/A)	0.1	0.0	14.17
Eastern hophornbeam	192	1	(N/A)	0.1	0.0	0.72
Ohio buckeye	2,201	17	(N/A)	0.1	0.0	8.26
Kwanzan cherry	356	3	(N/A)	0.1	0.0	1.33
Black cherry	178	1	(N/A)	0.0	0.0	1.33
Paper birch	1,035	8	(N/A)	0.0	0.0	7.76
Conifer Evergreen Sn	3	0	(N/A)	0.0	0.0	0.02
Black locust	14,280	107	(N/A)	0.0	0.1	107.10
Broadleaf Evergreen S	6,743	51	(N/A)	0.0	0.0	50.57

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.

Stored CO2 Benefits of Public Trees

2/8/2023

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Amur maple	14	0	(N/A)	0.0	0.0	0.10
Mulberry	908	7	(N/A)	0.0	0.0	6.81
Sumac	6,743	51	(N/A)	0.0	0.0	50.57
Scotch pine	1,170	9	(N/A)	0.0	0.0	8.78
Citywide total	14,329,725	107,473	(N/A)	100.0	100.0	52.61

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.

Table 5: Annual Carbon Sequestered

Winterset

Annual CO $_2$ Benefits of Public Trees

2/8/2023

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
Black maple	133,764	1,003	-11,445	-892	-93	161,215	1,209	282,643	2,120 (N/A)	18.0	19.0	5.78
Silver maple	241,785	1,813	-14,835	-672	-116	103,944	780	330,221	2,477 (N/A)	11.4	22.3	10.63
Red maple	47,350	355	-2,595	-258	-21	45,634	342	90,130	676 (N/A)	7.9	6.1	4.17
Apple	13,715	103	-811	-135	-7	14,569	109	27,337	205 (N/A)	6.3	1.8	1.59
Northern hackberry	44,234	332	-3,837	-346	-31	62,031	465	102,083	766 (N/A)	6.3	6.9	5.98
Bur oak	28,116	211	-2,851	-143	-22	20,902	157	46,024	345 (N/A)	4.2	3.1	4.06
Norway maple	25,660	192	-1,994	-161	-16	26,155	196	49,660	372 (N/A)	3.9	3.3	4.66
Eastern white pine	8,850	66	-831	-147	-7	13,824	104	21,696	163 (N/A)	3.3	1.5	2.43
Sugar maple	31,202	234	-2,574	-160	-21	25,381	190	53,849	404 (N/A)	3.2	3.6	6.21
Honeylocust	40,356	303	-1,824	-106	-14	22,416	168	60,842	456 (N/A)	3.0	4.1	7.36
Green ash	27,258	204	-2,675	-138	-21	22,385	168	46,831	351 (N/A)	3.0	3.2	5.67
Northern red oak	11,550	87	-1,601	-111	-13	14,674	110	24,513	184 (N/A)	2.9	1.7	3.06
Hickory	29,330	220	-2,063	-128	-16	20,877	157	48,017	360 (N/A)	2.6	3.2	6.67
Black walnut	30,839	231	-2,875	-134	-23	21,267	160	49,097	368 (N/A)	2.1	3.3	8.56
Spruce	2,859	21	-145	-53	-1	4,754	36	7,415	56 (N/A)	2.0	0.5	1.36
Ash	12,091	91	-1,068	-83	-9	13,618	102	24,558	184 (N/A)	1.9	1.7	4.85
American sycamore	28,624	215	-5,113	-157	-40	23,333	175	46,686	350 (N/A)	1.8	3.1	9.46
Callery pear	4,825	36	-117	-27	-1	3,699	28	8,380	63 (N/A)	1.7	0.6	1.80
American basswood	28,074	211	-2,315	-101	-18	14,551	109	40,209	302 (N/A)	1.7	2.7	8.87
Northern pin oak	4,016	30	-1,845	-113	-15	15,180	114	17,238	129 (N/A)	1.4	1.2	4.46
Eastern red cedar	545	4	-91	-41	-1	3,576	27	3,989	30 (N/A)	1.4	0.3	1.03
Blue spruce	1,890	14	-160	-41	-2	3,652	27	5,342	40 (N/A)	1.3	0.4	1.48
Siberian elm	9,838	74	-1,005	-58	-8	9,322	70	18,098	136 (N/A)	1.1	1.2	6.17
Kentucky coffeetree	13,654	102	-1,437	-60	-11	9,209	69	21,366	160 (N/A)	0.9	1.4	8.90
Elm	5,840	44	-393	-26	-3	4,482	34	9,903	74 (N/A)	0.6	0.7	5.71
Red pine	669	5	-59	-12	-1	980	7	1,578	12 (N/A)	0.6	0.1	0.99
Southern magnolia	1,010	8	-71	-13	-1	2,309	17	3,235	24 (N/A)	0.5	0.2	2.43
Maple	2,542	19	-177	-15	-1	2,605	20	4,955	37 (N/A)	0.5	0.3	3.72
Littleleaf linden	2,217	17	-92	-10	-1	1,129	8	3,244	24 (N/A)	0.5	0.2	2.43
Catalpa	3,883	29	-440	-19	-3	2,749	21	6,172	46 (N/A)	0.4	0.4	5.79
Ginkgo	1,045	8	-101	-13	-1	1,655	12	2,587	19 (N/A)	0.3	0.2	2.77
Tulip tree	222	2	-5	-2	0	181	1	395	3 (N/A)	0.3	0.0	0.49

Annual CO ₂ Benefits of Public Trees

2/8/2023

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
Eastern redbud	1,309	10	-81	-9	-1	1,058	8	2,277	17 (N/A)	0.3	0.2	2.85
Black spruce	373	3	-28	-8	0	688	5	1,025	8 (N/A)	0.2	0.1	1.54
Norway spruce	818	6	-84	-12	-1	1,050	8	1,773	13 (N/A)	0.2	0.1	3.32
Birch	0	0	-206	-13	-2	1,616	12	1,397	10 (N/A)	0.1	0.1	3.49
Broadleaf Evergreen Medi	169	1	-7	-4	0	422	3	581	4 (N/A)	0.1	0.0	1.45
River birch	756	6	-154	-10	-1	1,472	11	2,064	15 (N/A)	0.1	0.1	5.16
Conifer Evergreen Large	699	5	-88	-10	-1	868	7	1,470	11 (N/A)	0.1	0.1	3.68
Common chokecherry	26	0	0	-1	0	17	0	42	0 (N/A)	0.1	0.0	0.10
Tree of Heaven	694	5	-112	-8	-1	1,154	9	1,728	13 (N/A)	0.1	0.1	4.32
White ash	1,922	14	-249	-9	-2	1,772	13	3,436	26 (N/A)	0.1	0.2	12.88
Pin oak	1,502	11	-73	-4	-1	569	4	1,994	15 (N/A)	0.1	0.1	7.48
Basswood	1,319	10	-81	-5	-1	883	7	2,115	16 (N/A)	0.1	0.1	7.93
Plum	487	4	-32	-3	0	340	3	792	6 (N/A)	0.1	0.1	2.97
Virginia pine	231	2	-11	-4	0	433	3	649	5 (N/A)	0.1	0.0	2.43
Conifer Evergreen Mediun	238	2	-18	-5	0	445	3	660	5 (N/A)	0.1	0.0	2.48
Eastern hophornbeam	47	0	-1	-1	0	43	0	88	1 (N/A)	0.1	0.0	0.33
Ohio buckeye	448	3	-11	-2	0	352	3	787	6 (N/A)	0.1	0.1	2.95
Kwanzan cherry	76	1	-2	-1	0	74	1	147	1 (N/A)	0.1	0.0	0.55
Black cherry	38	0	-1	-1	0	37	0	74	1 (N/A)	0.0	0.0	0.55
Paper birch	209	2	-5	-1	0	159	1	361	3 (N/A)	0.0	0.0	2.71
Conifer Evergreen Small	1	0	0	0	0	6	0	6	0 (N/A)	0.0	0.0	0.05
Black locust	370	3	-69	-4	-1	539	4	837	6 (N/A)	0.0	0.1	6.27
Broadleaf Evergreen Small	0	0	-32	-2	0	365	3	331	2 (N/A)	0.0	0.0	2.48
Amur maple	9	0	0	0	0	6	0	14	0 (N/A)	0.0	0.0	0.10
Mulberry	114	1	-4	-1	0	124	1	232	2 (N/A)	0.0	0.0	1.74
Sumac	0	0	-32	-4	0	335	3	299	2 (N/A)	0.0	0.0	2.24
Scotch pine	116	1	-6	-2	0	216	2	324	2 (N/A)	0.0	0.0	2.43
Citywide total	849,824	6,374	-68,833	-4,497	-550	707,303	5,305	1,483,798	11,128 (N/A)	100.0	100.0	5.45

Table 6: Annual Social and Aesthetic Benefits

Winterset

Annual Aesthetic/Other Benefits of Public Trees

2/8/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Black maple	16,705	(N/A)	18.0	18.2	45.52
Silver maple	19,858	(N/A)	11.4	21.6	85.23
Red maple	6,371	(N/A)	7.9	6.9	39.33
Apple	779	(N/A)	6.3	0.8	6.04
Northern hackberry	6,225	(N/A)	6.3	6.8	48.63
Bur oak	2,655	(N/A)	4.2	2.9	31.23
Norway maple	2,556	(N/A)	3.9	2.8	31.95
Eastern white pine	1,954	(N/A)	3.3	2.1	29.17
Sugar maple	3,395	(N/A)	3.2	3.7	52.23
Honeylocust	10,001	(N/A)	3.0	10.9	161.30
Green ash	2,564	(N/A)	3.0	2.8	41.36
Northern red oak	928	(N/A)	2.9	1.0	15.46
Hickory	2,631	(N/A)	2.6	2.9	48.71
Black walnut	2,475	(N/A)	2.1	2.7	57.56
Spruce	824	(N/A)	2.0	0.9	20.10
Ash	1,195	(N/A)	1.9	1.3	31.45
American sycamore	2,045	(N/A)	1.8	2.2	55.26
Callery pear	597	(N/A)	1.7	0.6	17.05
American basswood	2,009	(N/A)	1.7	2.2	59.09
Northern pin oak	357	(N/A)	1.4	0.4	12.31
Eastern red cedar	288	(N/A)	1.4	0.3	9.91
Blue spruce	419	(N/A)	1.3	0.5	15.51
Siberian elm	789	(N/A)	1.1	0.9	35.86
Kentucky coffeetree	1,052	(N/A)	0.9	1.1	58.42
Elm	550	(N/A)	0.6	0.6	42.31
Red pine	169	(N/A)	0.6	0.2	14.11
Southern magnolia	209	(N/A)	0.5	0.2	20.93
Maple	321	(N/A)	0.5	0.3	32.13
Littleleaf linden	257	(N/A)	0.5	0.3	25.74
Catalpa	325	(N/A)	0.4	0.4	40.67
Ginkgo	83	(N/A)	0.3	0.1	11.83
Tulip tree	55	(N/A)	0.3	0.1	9.14
Eastern redbud	77	(N/A)	0.3	0.1	12.87
Black spruce	87	(N/A)	0.2	0.1	17.43
Norway spruce	167	(N/A)	0.2	0.2	41.87
Birch	0	(N/A)	0.1	0.0	0.00
Broadleaf Evergreen Medium	66	(N/A)	0.1	0.1	21.93
River birch	71	(N/A)	0.1	0.1	23.54
Conifer Evergreen Large	100	(N/A)	0.1	0.1	33.20
Common chokecherry	0	(N/A)	0.1	0.0	0.03
Tree of Heaven	69	(N/A)	0.1	0.1	23.09
White ash	185	(N/A)	0.1	0.2	92.30
Pin oak	117	(N/A)	0.1	0.1	58.57
Basswood	115	(N/A)	0.1	0.1	57.69
Plum	29	(N/A)	0.1	0.0	14.42
Virginia pine	65	(N/A)	0.1	0.1	32.32
Conifer Evergreen Medium	45	(N/A)	0.1	0.0	22.60
Eastern hophornbeam	2	(N/A)	0.1	0.0	1.05

Annual Aesthetic/Other Benefits of Public Trees

2/8/2023

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Ohio buckeye	52	(N/A)	0.1	0.1	26.22
Kwanzan cherry	4	(N/A)	0.1	0.0	2.06
Black cherry	2	(N/A)	0.0	0.0	2.06
Paper birch	29	(N/A)	0.0	0.0	28.56
Conifer Evergreen Small	4	(N/A)	0.0	0.0	4.27
Black locust	31	(N/A)	0.0	0.0	31.46
Broadleaf Evergreen Small	0	(N/A)	0.0	0.0	0.00
Amur maple	0	(N/A)	0.0	0.0	0.03
Mulberry	6	(N/A)	0.0	0.0	6.40
Sumac	0	(N/A)	0.0	0.0	0.00
Scotch pine	32	(N/A)	0.0	0.0	32.32
Citywide total	91,997	(N/A)	100.0	100.0	45.03

Table 7: Summary of Benefits in Dollars

Winterset

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

2/8/2023

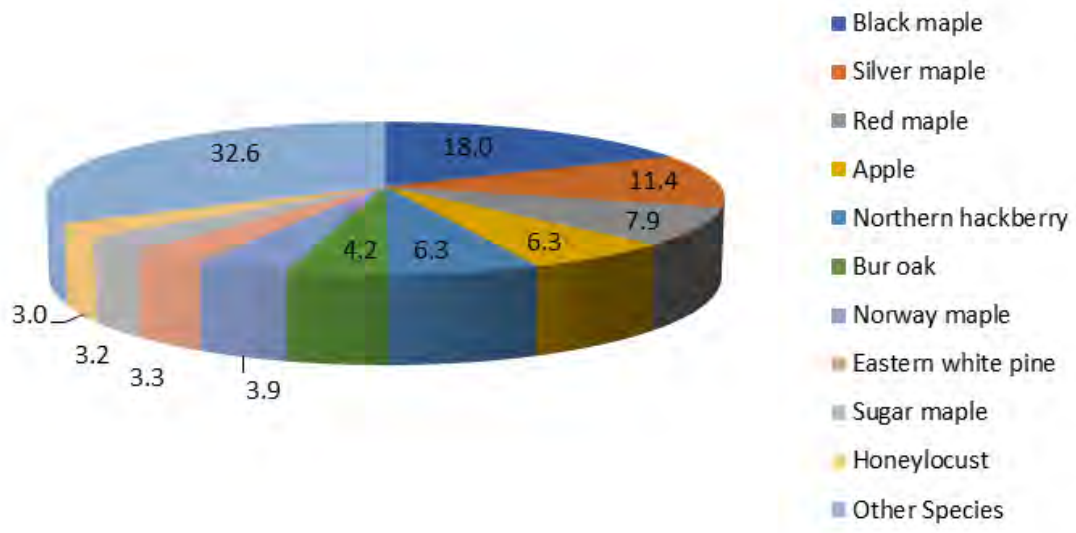
Benefits	Total ($)	Standard Error	$/tree	Standard Error	$/capita	Standard Error
Energy	88,663	(N/A)	43.40	(N/A)	16.56	(N/A)
CO2	11,128	(N/A)	5.45	(N/A)	2.08	(N/A)
Air Quality	15,329	(N/A)	7.50	(N/A)	2.86	(N/A)
Stormwater	119,233	(N/A)	58.36	(N/A)	22.27	(N/A)
Aesthetic/Other	91,997	(N/A)	45.03	(N/A)	17.19	(N/A)
Total Benefits	326,351	(N/A)	159.74	(N/A)	60.97	(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	326,351	(N/A)	159.74	(N/A)	60.97	(N/A)
Benefit-cost ratio	0.00	(N/A)				

Figure 1: Species Distribution

Winterset

Species Distribution of Public Trees

2/8/2023



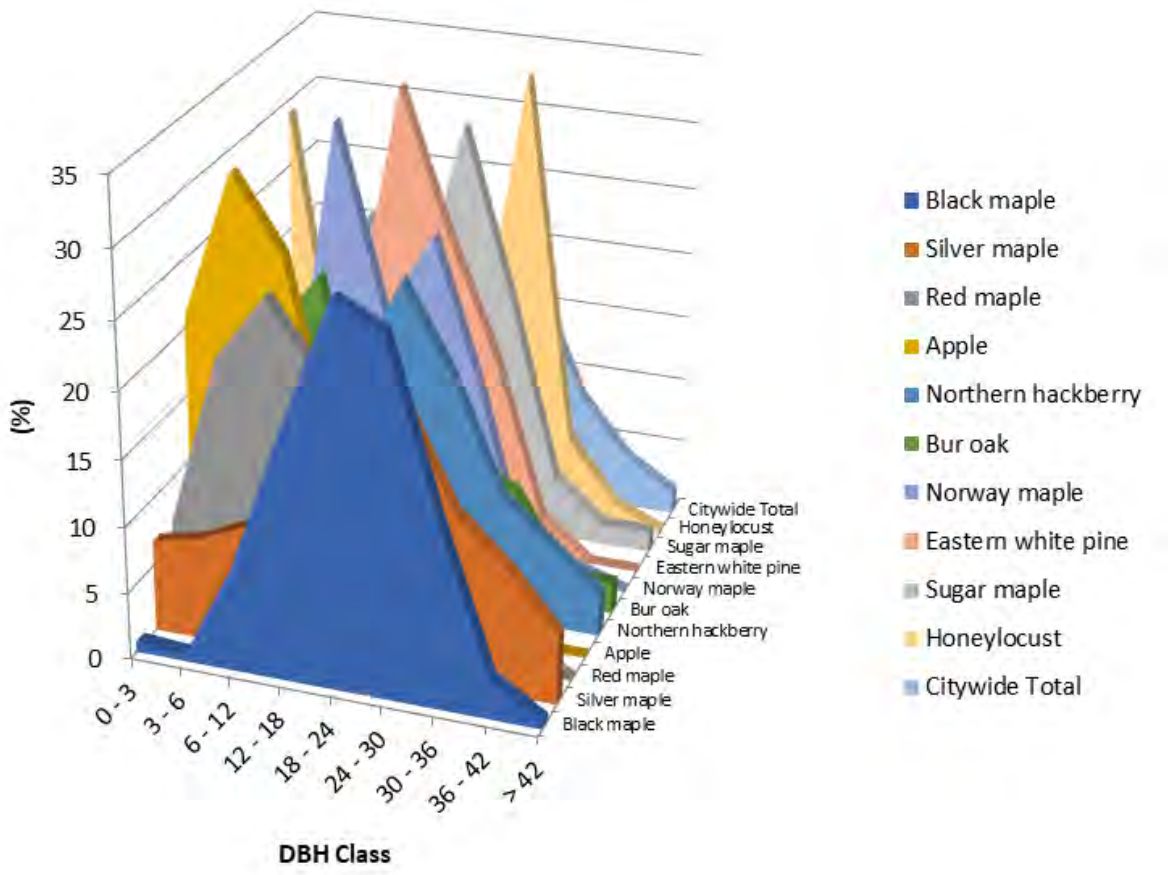
Species	Percent
Black maple	18.0
Silver maple	11.4
Red maple	7.9
Apple	6.3
Northern hackberry	6.3
Bur oak	4.2
Norway maple	3.9
Eastern white pine	3.3
Sugar maple	3.2
Honeylocust	3.0
Other Species	32.6
Total	100.0

Figure 2: Relative Age Class

Winterset

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

2/8/2023



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Black maple	0.82	0.54	7.90	18.53	28.34	26.43	13.90	3.00	0.54
Silver maple	6.87	7.73	9.44	12.45	15.88	20.17	12.88	9.44	5.15
Red maple	6.79	19.75	24.69	19.75	16.05	8.64	2.47	1.85	0.00
Apple	20.93	31.78	26.36	10.85	6.98	3.10	0.00	0.00	0.00
Northern hackberry	6.25	3.91	11.72	17.19	24.22	17.97	9.38	6.25	3.13
Bur oak	23.53	17.65	22.35	7.06	7.06	9.41	8.24	2.35	2.35
Norway maple	1.25	7.50	32.50	18.75	25.00	13.75	0.00	1.25	0.00
Eastern white pine	0.00	8.96	14.93	34.33	23.88	14.93	2.99	0.00	0.00
Sugar maple	1.54	1.54	23.08	16.92	30.77	18.46	4.62	1.54	1.54
Honeylocust	29.03	6.45	6.45	4.84	11.29	33.87	6.45	1.61	0.00
Citywide Total	8.37	9.64	16.35	16.54	18.45	16.74	8.27	3.96	1.66

Figure 3: Foliage Condition

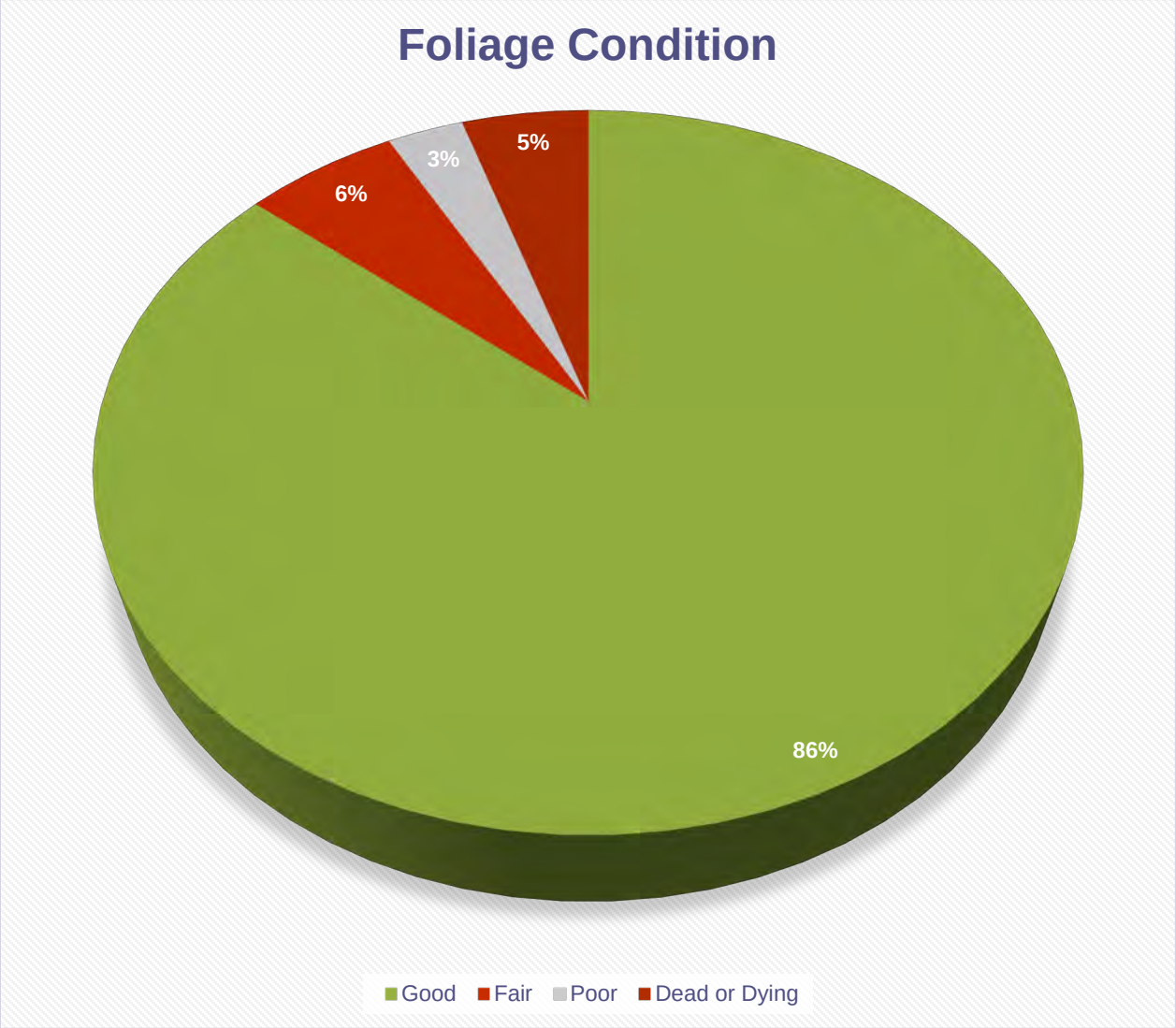


Figure 4: Wood Condition

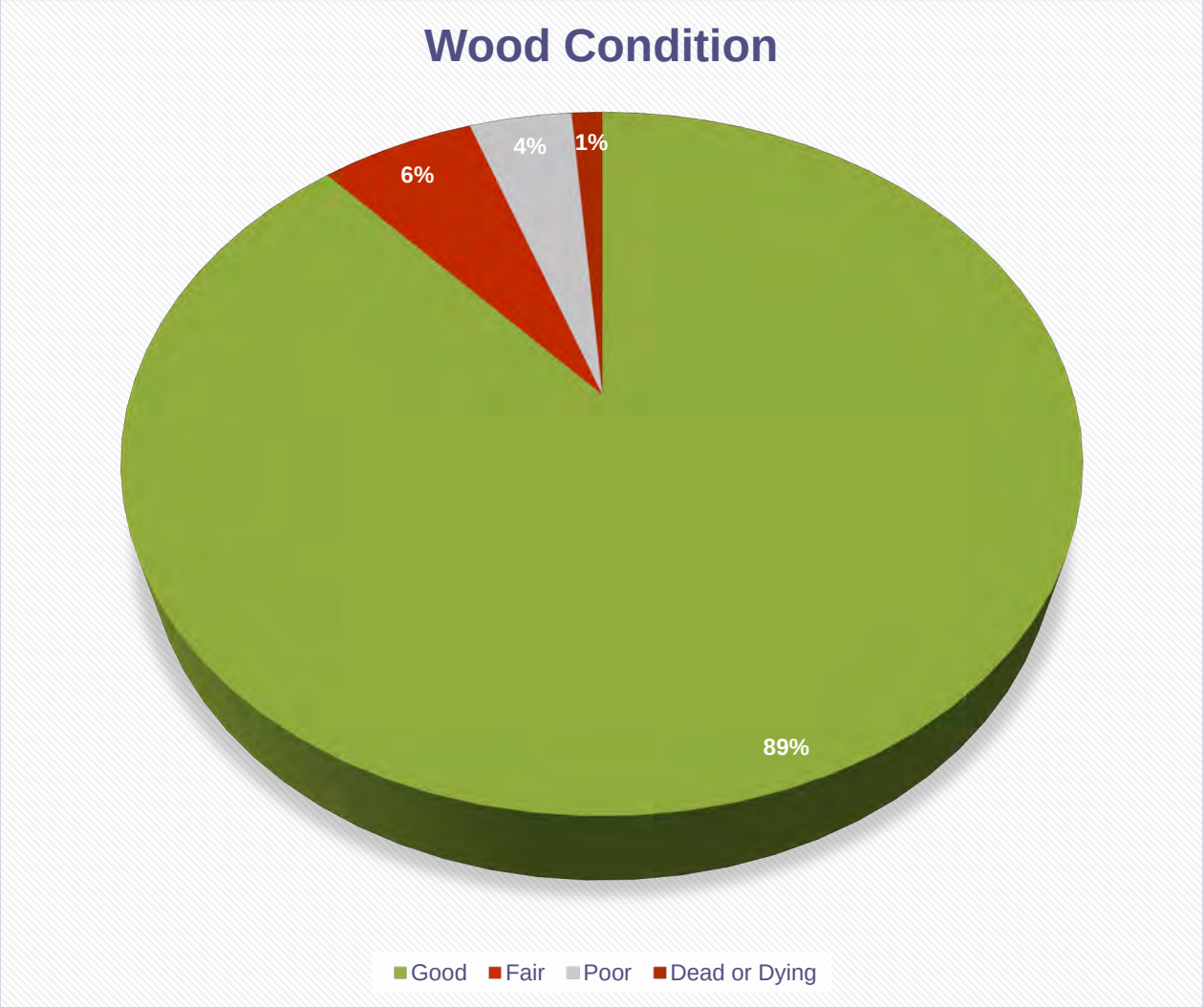
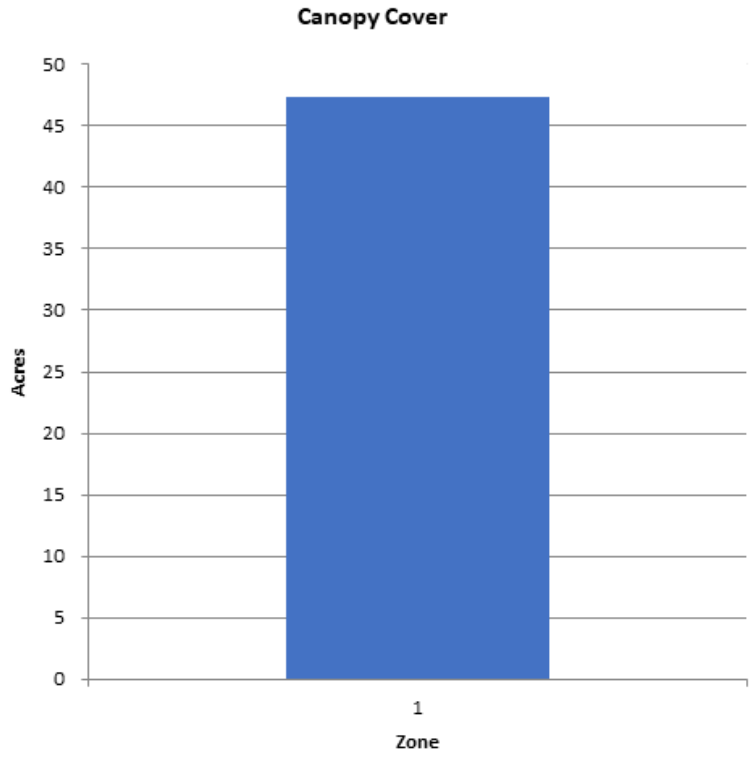


Figure 5: Canopy Cover in Acres

Winterset

Canopy Cover of Public Trees (Acres)

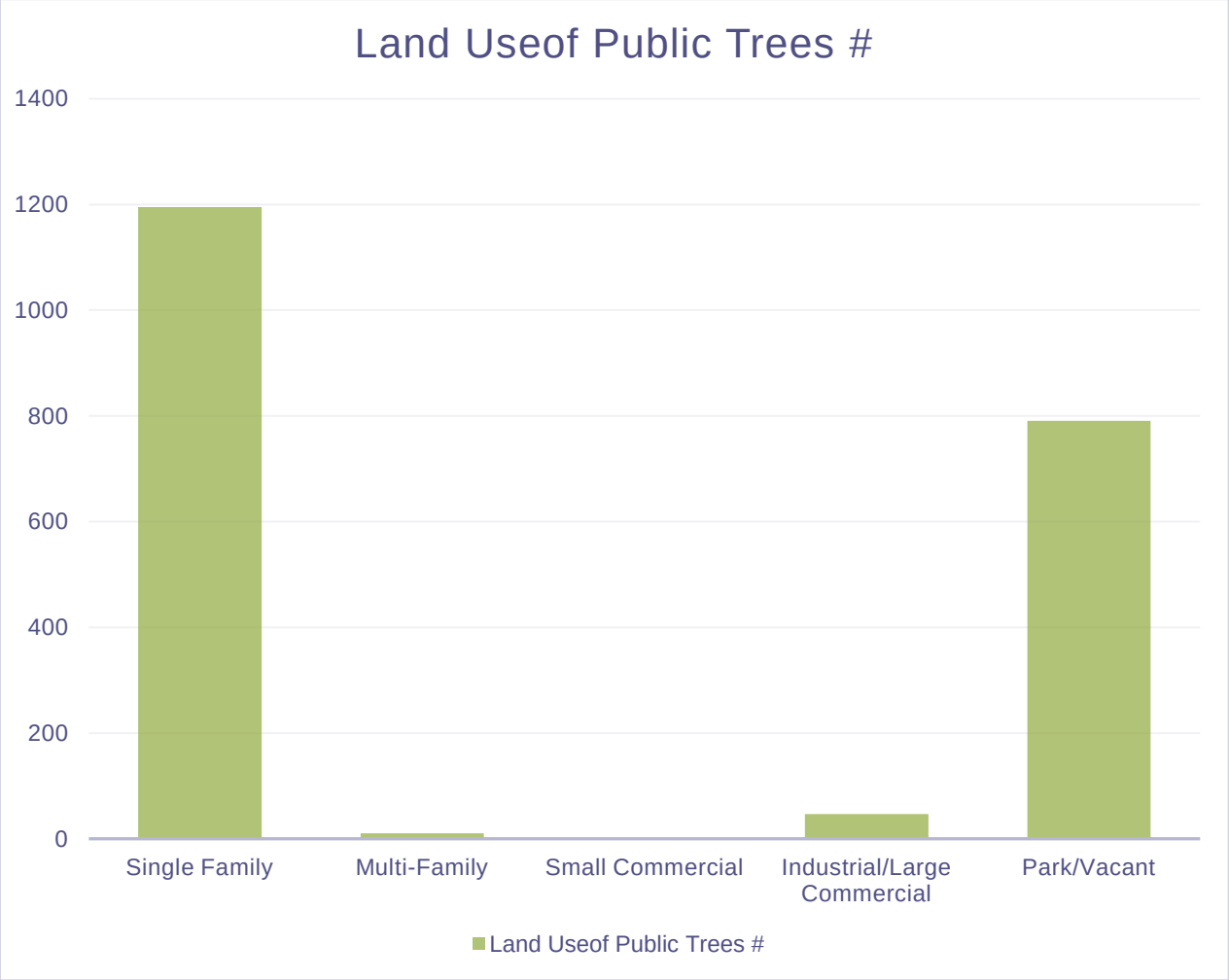
2/8/2023



Zone	Acres	% of Total Canopy Cover
1	47	100.0
Citywide total	47	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	47	0.00	0.00

Figure 6: Land Use of City/Park Trees



APPENDIX B: ArcGIS MAPPING

Figure 1: Location of Ash Trees

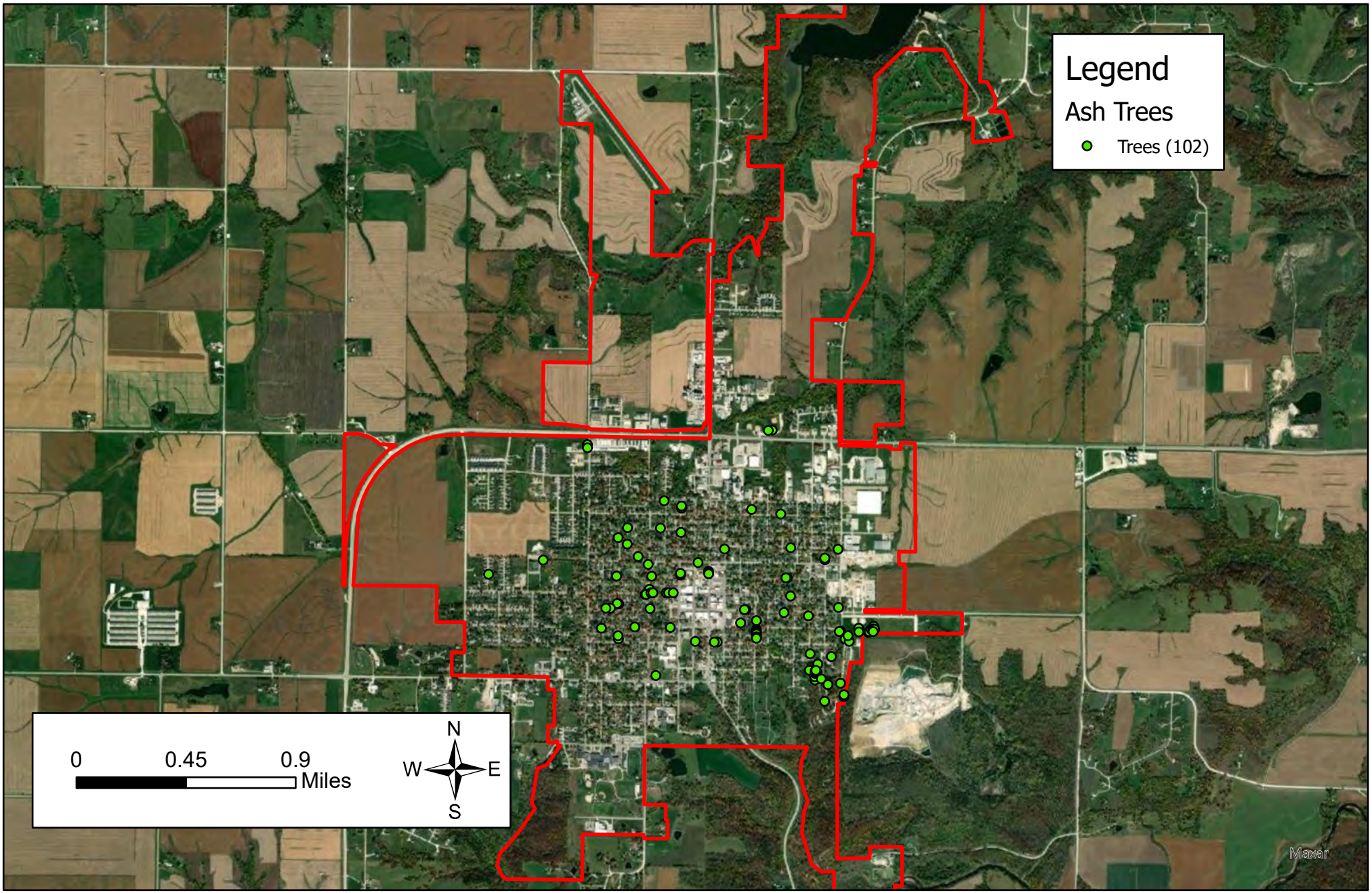
Figure 2: Location of EAB Symptoms

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

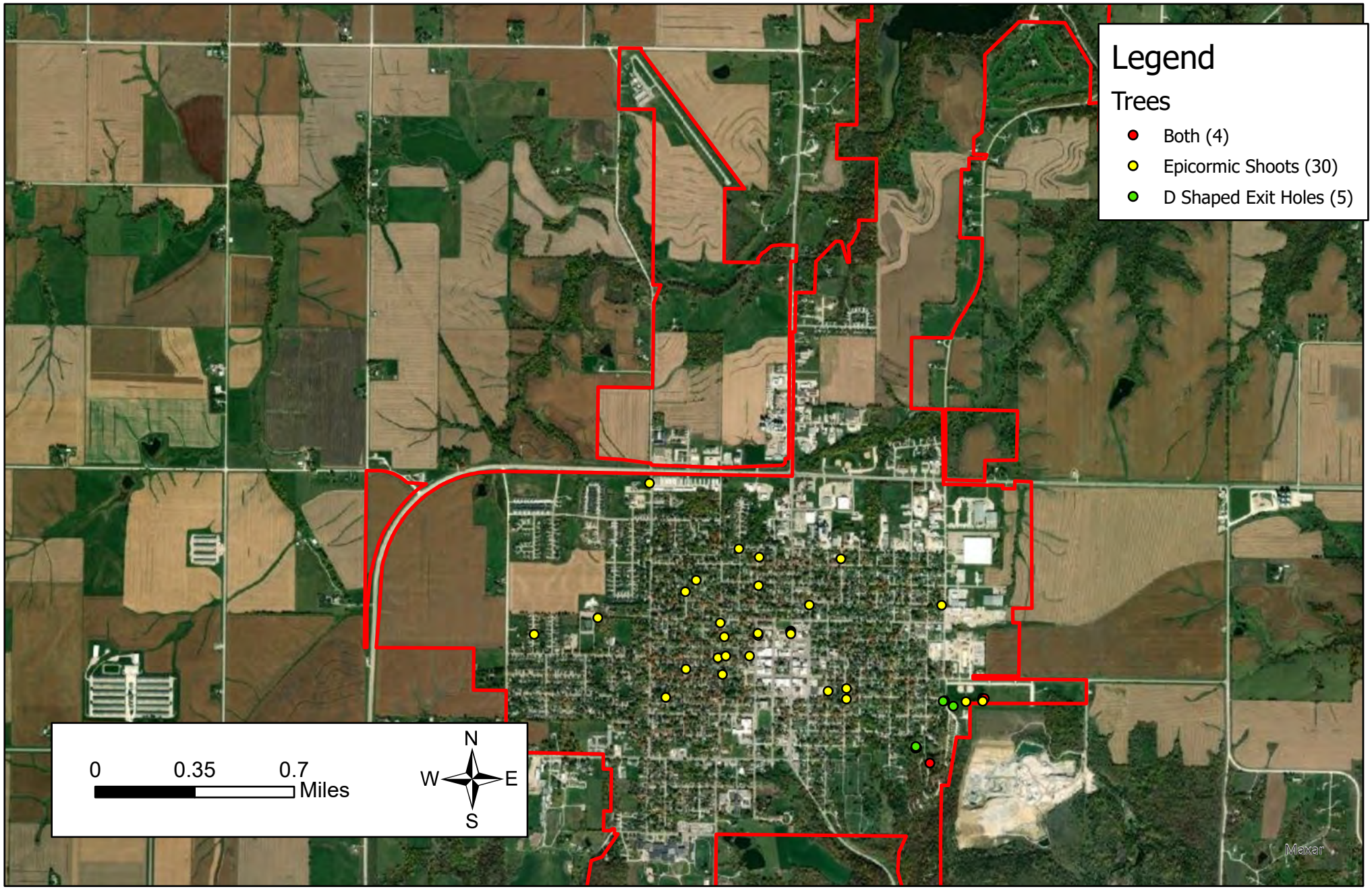


Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 1 - Ash Tree Location
Winterset, Iowa

JEO CONSULTING GROUP INC

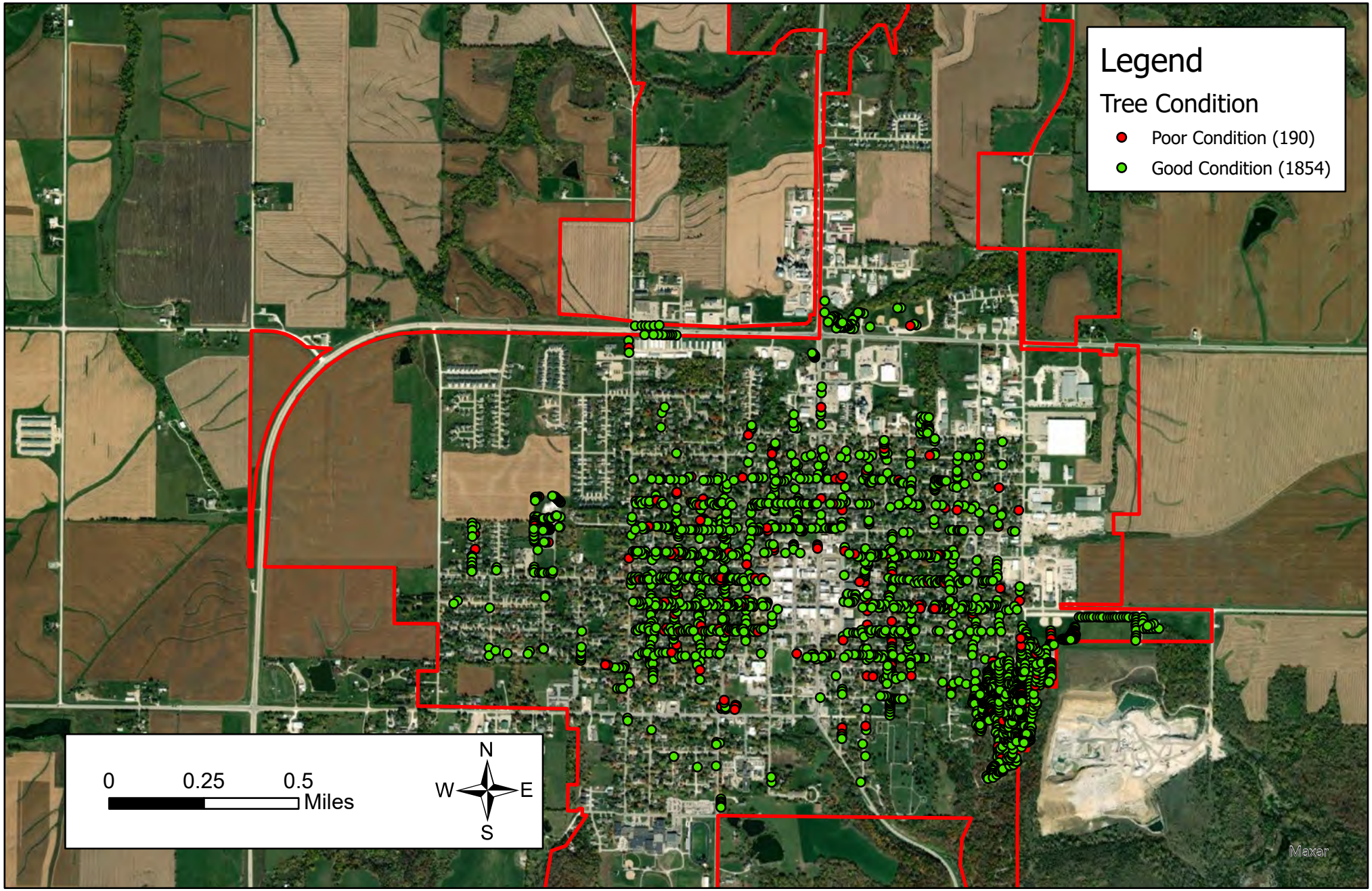


Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 2 - EAB Symptoms
Winterset, Iowa

JEO CONSULTING GROUP INC



Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 3 - Poor Condition Trees
Winterset, Iowa

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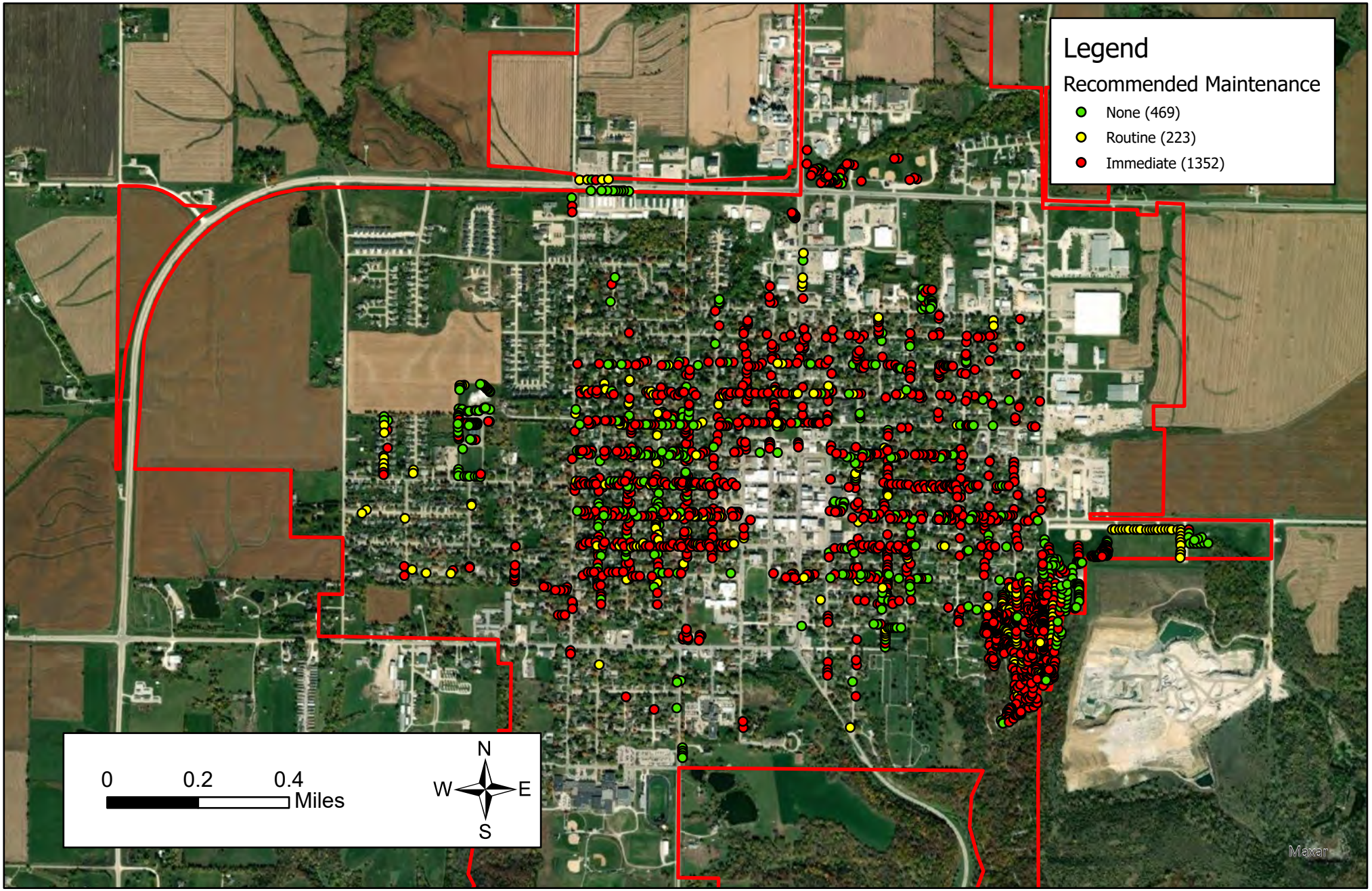

Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 4 - Recommended Maintenance
Winterset, Iowa

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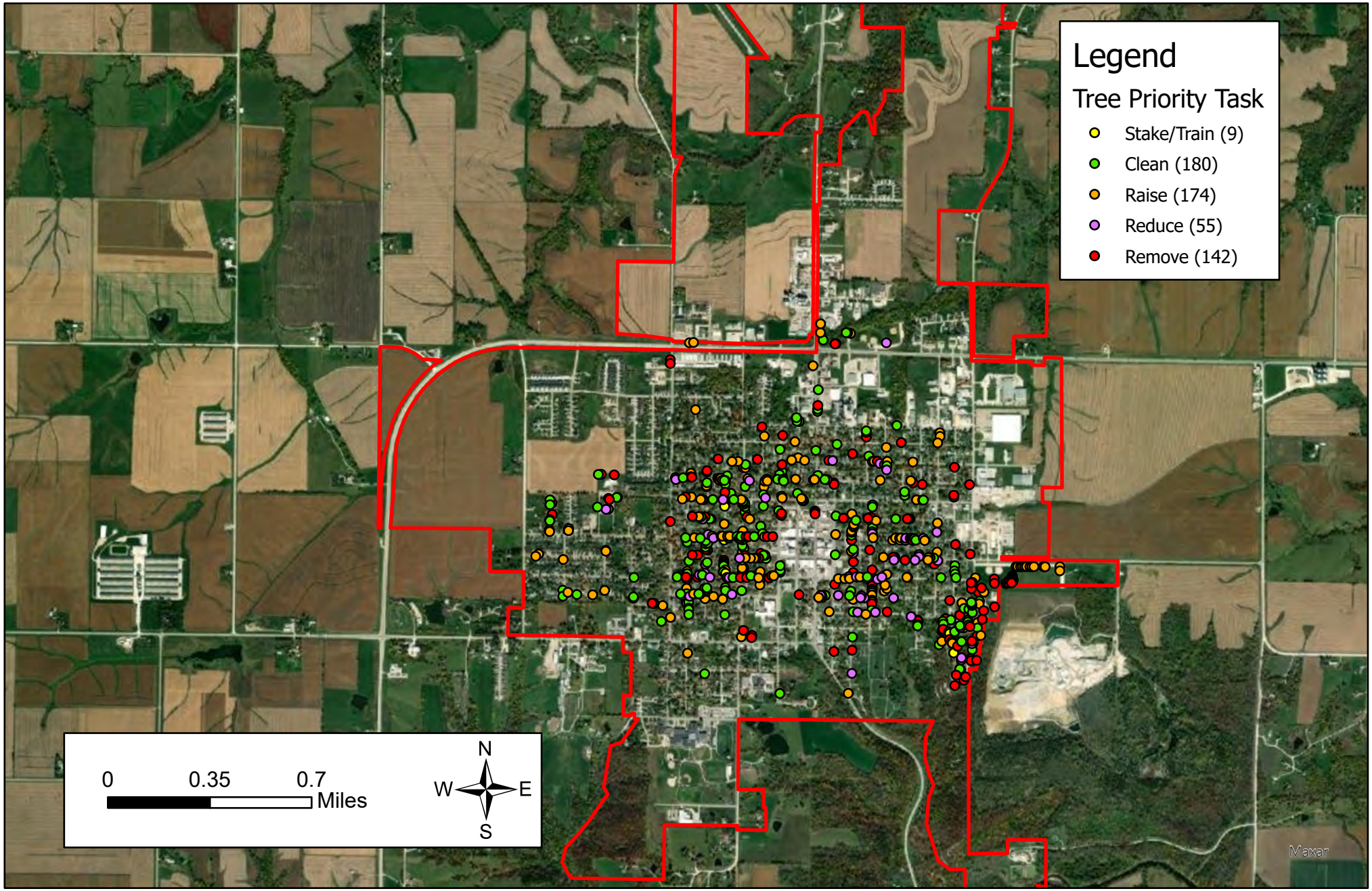

Created By: D. Genereux
Date: 1/26/2023
Software: ArcGIS Pro 3.0.3
File: 2022 IDNR Tree Inventory.aprx

2022 IDNR Tree Inventory

Figure 5 - Maintenance Priorities
Winterset, Iowa

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APPENDIX C: WINTERSET TREE ORDINANCES

3.301. DEFINITIONS**.** In this Chapter the following terms shall have the meanings described below unless the context otherwise indicates:

(1) "Property owner" means the holder of legal title of record, or the contract purchaser, if there is one.

(2) "Street trees" mean trees located between the street property line, otherwise known as the right-of-way line, and the street curb or street surface of all streets, avenues or public right-of-ways within the City.

(3) "Street parking" means the portion of the street right-of-way between the property line (usually the outside edge of the public sidewalk) and the edge of the curb and/or driving surface of the public street.

(4) "Cul-de-sac island" means the open land area located in the center of a hard-surfaced street turn-around.

(5) "Flowers" means the annual and perennial plants that consist of a shortened axis bearing modified leaves.

(6) "Shrubs" means a low growing, woody plant or bush.

3.302. PERMIT TO PLANT OR REMOVE TREES. No person shall plant, move or remove any tree in any street parking, cul-de-sac island, parking, or public-owned place in the City nor cause such action to be done by others without first obtaining a written permit from the City Administrator or designee. A permit shall not be required for planting flowers in the street parking or cul-de-sac islands provided the flowers not have a maximum height greater than 30 inches within 35 feet of a street intersection.

3.303. APPLICATION FOR PERMIT. An application for a permit to plant, move or remove any tree in any street parking, cul-de-sac island or other public-owned place shall be on forms supplied by the City and shall be accompanied by a plan or drawing which shall accurately show:

(1) the location of the applicant's adjoining property.

(2) the tree species and location of each tree proposed to be planted and of each tree already existing in the street parking or other public owned area within twenty-five (25) feet of the proposed tree planting.

(3) the location of any public utility fixture such as utility poles, wires and accessories, or traffic control devices, or mail boxes or other appurtenances located upon the street parking.

3.304. ISSUANCE OF PERMIT. The City Administrator, or designee, shall issue a permit to plant, move or remove a street tree after review and consideration of the application. Any such permit shall expire within 120 days after issuance of the permit.

All permits to plant trees shall be issued upon the express condition that the permit may be revoked at any time, and any trees planted pursuant to said permit may be removed by the City.

3.305. STREET TREE PLANTING STANDARDS**.** The following standards shall govern the planting of street trees:

(1) No tree may be planted which would cause a public danger or nuisance.

(2) No tree may be planted within three feet of a sidewalk or other impervious surface such as the curb and gutter or the street surface.

(3) No tree or shrub that will grow above 30 inches in height shall be planted on a corner lot where two street intersect for a distance of 35 feet in any direction from the point of intersection at the curb line.

(4) No tree shall be planted within 15 lateral feet of an overhead utility line, within 3 feet of any buried utility line, within 10 feet of a fire hydrant, within 5 feet of a driveway and 25 feet of a traffic control sign.

(5) No tree shall be planted if the tree species is not included on the list of permitted tree species developed by the Winterset Tree Commission.

(6) No tree shall be planted without first calling Iowa One Call and complying with the procedures for locating underground utilities.

(7) In cases of damage to utility lines, any street tree planted in the right-of-way may be trimmed or removed in order to repair the utility line.

3.306. MAINTENANCE OF STREET TREES**.** It shall be the duty of the abutting property owners or resident to keep all trees pruned and trimmed so that the lowest branches are not less than eight (8) feet above the public sidewalk. The abutting property owner shall be responsible to prune and trim branches that overhang or come in contact with their residential home or commercial building. The property owner shall also remove all damaged and broken tree limbs that overhang private property, and to remove tree limbs that are or may become dangerous or a potential nuisance to abutting real and personal property.

The City shall maintain that portion of a street tree that overhangs the public street or alley, and shall remove branches and limbs that interfere with the visions of drivers approaching any intersection, street, alley or traffic control sign.

3.307. REMOVAL OF DEAD OR DISEASED STREET TREES. The property owner shall not be required to remove diseased trees or dead wood on the publicly owned property or right of way. However, the property owner may voluntarily do so upon issuance of the permit issued in accordance with this Chapter.

3.308. NOTICE TO REMOVE**.** The abutting property owner may be ordered to remove at their expense any tree or shrub which was planted in violation of the provisions of this Chapter. Such property owner shall be served with a written notice served in the manner of an original notice, by personal service or by certified mail to the last known post office address. If such property owner fails to comply with the notice within thirty (30) days of the date of service of the notice, the City may cause the tree or shrub to be removed and the cost of removal may be assessed against the abutting property for collection in the same manner as a property tax.

3.309. WRITTEN COMPLAINT**.** Any person having cause to believe that any tree or shrub is infected with Dutch Elm disease or other infectious tree disease may file a written complaint with the City Administrator, which complaint shall set forth the location and description of such tree or shrub. Upon filing of the complaint, the City Administrator shall cause a specimen of such tree or shrub to be tested by such technological facilities or testing procedures as the City Administrator may select. Such test may also be carried out without the filing of a complaint upon the initiative or request of any city employee or of the City Council. In the event testing discloses the tree or shrub is infected with Dutch Elm disease or other infectious tree disease, the City Administrator shall proceed to initiate removal of said tree or shrub using the provisions of this Chapter.

3.310. PROTECTION OF STREET TREES. No person shall willfully break, deface, kill, damage or destroy any street tree in any street parking, park or other public-owned place in the City unless authorized by permit issued in accordance with this Chapter.

3.311. PENALTY**.** Any person violating any provision of this Chapter shall upon conviction be guilty of a simple misdemeanor punishable as provided by law. Any tree planted in violation of the provisions of this Chapter may be removed by the City or may be ordered to be removed by the abutting property owner.

3.312. REMOVAL OF DEAD OR DISEASED TREES FROM PRIVATE PROPERTY. Action commenced by the City for the removal of dead or diseased trees and dead wood from private property is regulated by Chapter 5 of Title III of this Code.

3.313. APPEALS. Any action of the City Administrator pursuant to this Chapter may be appealed to the Tree Commission pursuant to the provisions of Section 1.1703 of this Code.