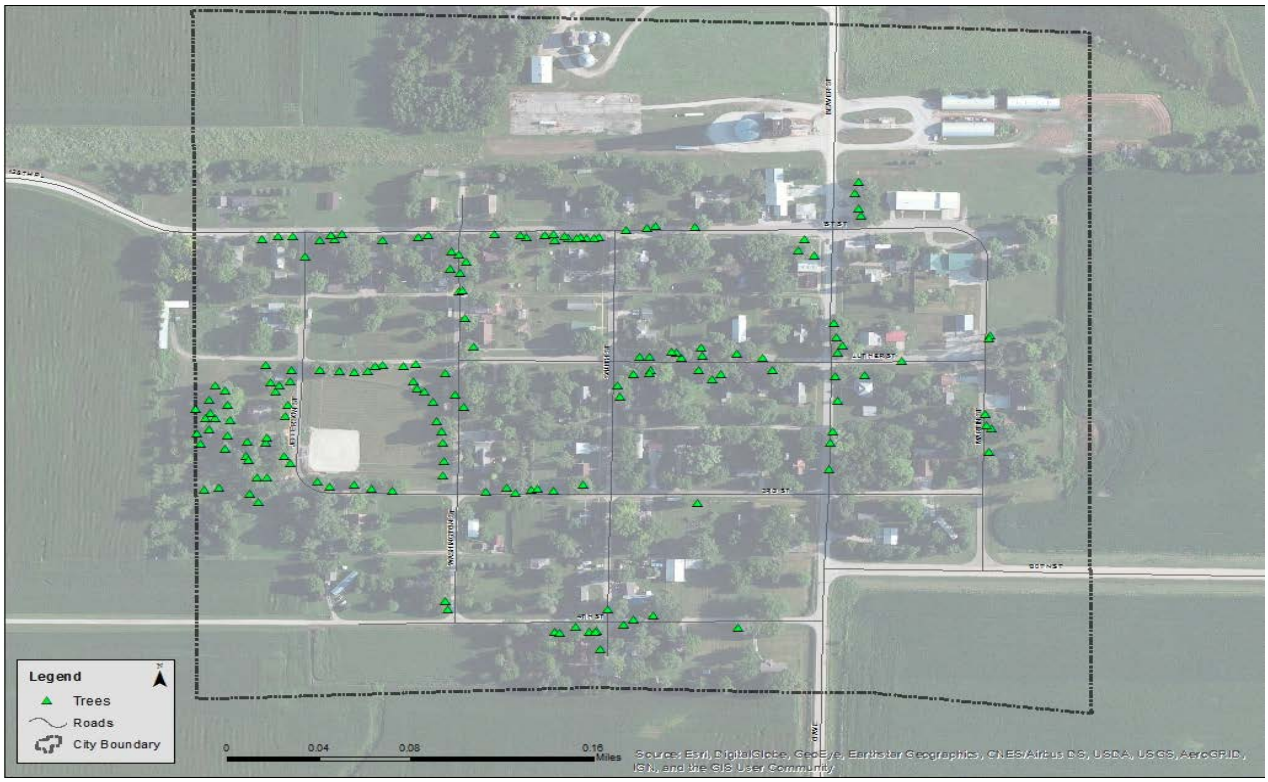
Bouton, IA



2016 Urban Forest Management Plan
Prepared by Kittelson Consulting Arborist, LLC
In Partnership with the Iowa DNR

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Executive Summary

Overview

This plan was developed to assist the City of Bouton with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). There is a strong possibility that 33% of Bouton's city owned trees (ash) will die once EAB becomes established in the community, unless preventative treatment is used. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2016, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 161 trees inventoried.

- Bouton's trees provide $37,352 of benefits annually, an average of $232 a tree
- There are over 27 species of trees
- The top three genera are: Ash 33%, Maple 23%, and Hackberry 11%
- 60% of trees are in need of some type of management
- 43(37 ash) trees are recommended for removal

Recommendations

The core recommendations are detailed in the Recommendations Section. The Emerald Ash Borer Plan includes management recommendations as well. Below are some key recommendations.

- Of the 43 trees needing removal, 30 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*
- 43 of the 53 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: fruiting trees, ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly
- With the current budget it could take 8 years to remove ash – Suggestion: request a budget increase to $9,400 annually and apply for grants to plant replacement trees

Introduction

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

Trees are an important component of Bouton's infrastructure and one of the greatest assets to the community. The benefits of trees are immense. Trees provide the community with improved air quality, stormwater runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and create a desirable place to live, to name just a few benefits. It is essential that these benefits be maintained for the people of Bouton and future generations through good urban forestry management.

Good urban forestry management involves setting goals and developing management strategies to achieve these goals. An essential part of developing management strategies is a comprehensive public tree inventory. The inventory supplies information that will be used for maintenance, removal schedules, tree planting and budgeting. Basing actions on this information will help meet Bouton's urban forestry goals.

Inventory

In 2016, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

The programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

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

Inventory Results

The data collected for the 161 city trees was entered into the USDA Forest service program STREETS, part of the i-Tree suite. The following are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Bouton's trees reduce energy related costs by approximately $9,634 annually (Appendix A, Table 1). These savings are both in Electricity (46.3 MWh) and in Natural Gas (6,246.5 Therms).

Annual Stormwater Benefits

Bouton's trees intercept about 550,444 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $14,917 of benefits to the city.

Annual Air Quality Benefits

Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Bouton, it is estimated that trees remove 612.1 lbs of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $1,734 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Bouton, trees sequester about 107,623 lbs. of carbon a year with an associated value of $807 (Appendix A, Table 4). In addition, the trees store 2,188,868 lbs. of carbon, with a yearly benefit of $16,417 (Appendix A, Table 5).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Bouton receives $9,761 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, Bouton's trees provide $37,352 of benefits annually. Benefits of individual trees vary based on size, species, health and

location, but on average each of the 161 trees in Bouton provide approximately $232 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Bouton has over 27 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of the top 11 trees by genera is as follows:

Ash	53	33%
Maple	37	23%
Hackberry	18	11%
Quaking Aspen	14	8.7%
Honeylocust	6	3.7%
Elm	4	2.5%
Spruce	4	2.5%
Walnut	3	1.9%
Oak	3	1.9%
Northern White Cedar	3	1.9%
Mulberry	3	1.9%

Age Class

Most of Bouton's trees (> 65%) are between 12 and 24 inches and larger in diameter at 4.5 ft (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Bouton's size curve is on the larger side, indicating an older than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Bouton indicate that 70% of the trees are in good health, with only 3.7% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 68% of Bouton's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 32% of the population. This 32% is an estimate of trees that need management follow up.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3).

Crown Cleaning	31	19%
Crown Raising	1	.6%
Tree Staking	1	.6%

Tree Removal	43(37 ash)	27%
Crown Reduction	4	2.5%
Treat	16	10%

Canopy Cover

The total canopy with both private and public trees is 24%, 22 acres. The canopy cover included in the Bouton inventory includes approximately 6 acres (Appendix A, Figure 5).

Land Use and Location

The majority of Bouton'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	
Single family residential	49%
Park/vacant/other	46%
Industrial/Large commercial	0%
Small commercial	5%
Multifamily residential	0%

Location	
Planting strip	54%
Other maintained locations	46%
Cutout (surrounded by pavement)	0%
Front yard	0%

Recommendations

Risk Management

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

Hazardous trees

Bouton has 2 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). It is recommended to start with the large diameter critical concern trees first. In addition, there are 4 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 37 trees with these needs.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 43 removals, 37 are ash trees. There are a total of 53 ash trees, and 43 of those have signs and symptoms that have been associated with EAB. In addition, there are 22 trees that are in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle

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

Planting

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

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 sufficiently planted with maple (23%) (Appendix A, Figure 1). Maples should not be planted. 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.

Continual Monitoring

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

Six Year Maintenance Plan with No Additional Funding

Year 1

Removal: 1 ash tree with poor health
Planting and Replacement: 1 tree to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 2

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

Year 3

Removal: 1 ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 1 tree to be planted in open location or location from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 4

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

Year 5

Removal: 1 ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 1 tree to be planted in open location
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 1 ash in poor health
*Or saving for ash tree treatment
Planting and Replacement: 1 tree to be planted in open location
Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: 6 ash trees removed (approximately 11% of ash). It will take approximately 53 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.
** To remove all ash trees within 6 years, the budget would need to be increased to $7,200 a year. If the removal budget were increased to $10,000 a year all ash could be removed in 4 years.

Emerald Ash Borer Plan

Ash Tree Removal

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

Treatment of Ash Trees

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

EAB Quarantines

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

A regulated article under the USDA's quarantine includes any of the following items:
• emerald ash borer
• firewood of all hardwood species (for example ash, oak, maple and hickory)
• nursery stock and green lumber of ash
• any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

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

Canopy Replacement

As budget permits, all removed trees will be replaced. The new plantings will be a diverse mix and will not include fruiting trees ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

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

Monitoring

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

Private Ash Trees

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

Budget

Current Budget
Total $6,000 over 6 years ($1,000/year)

FY 2017 Budget
Removal: $700
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Watering & Maintenance: $200

FY 2018 Budget
Removal: $700
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Routine trimming: $0
Watering & Maintenance: $200

FY 2019 Budget
Removal: $700
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Watering & Maintenance: $200

FY 2020 Budget
Removal: $700
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Routine trimming: $0
Watering & Maintenance: $200

FY 2021 Budget
Removal: $700
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Watering & Maintenance: $200

FY 2022 Budget
Removal: $700
*Or saving for ash tree treatment and/or future ash removal
Planting: $100
Routine trimming: $0
Watering & Maintenance: $200

*Reduction of ash over 6 years: 6 ash trees removed (approximately 11% of ash). **It will take approximately 53 years to remove all ash with the current budget.**

Purposed Budget Increase

EAB could potentially kill all ash trees in Bouton within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $7,200 a year. If the budget were increased to $10,000 a year all ash could be removed within 4 years. Additionally, it is recommended that Bouton apply for grants to fund replacement trees. Utility Company grants

are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing 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 24 inches and at $15 per inch, about 8 of 16 trees could be treated per year (every other year treatment) at $2,400/year. This would be 16 total trees selected for treatment, and Bouton would have nothing for removal. Alternatively, if all 16 treatable trees are done every other year, it would cost approximately $4,800 every other year for treatment and leave nothing for removal those years. These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Bouton It is suggested to consider increasing the budget to plan for this.

Works Cited

Census Bureau. 2010. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2013)

USDA Forest Service, et al. 2006. i-Tree Software Suite v1.0 User's Manual. Pp. 27-40.

McPherson EG, Simpson JR, Peper PJ, Gardner SL, Vargas KE, Ho J, Maco S, Xiao Q. 2005b. City of Charleston, South Carolina, municipal forest resource analysis. Internal Tech Rep. Davis, CA: U.S. Department of Agriculture, Center for Urban Forest Research. p. 57

Nowak, D.J. and J.F. Dwyer. 2007. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, J. (ed.) Urban and Community Forestry in the Northeast. New York: Springer. Pp. 25-46.

Peper, Paula J.; McPherson, E. Gregory; Simpson, James R.; Vargas, Kelaine E.; Xiao, Qingfu 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-219. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. p.115

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

12/13/2016

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	15.9	1,204	2,152.7	2,110	3,314	(N/A)	30.4	34.4	67.63
Silver maple	8.5	648	1,106.6	1,084	1,733	(N/A)	16.8	18.0	64.17
Northern hackberry	6.5	494	914.8	897	1,391	(N/A)	11.2	14.4	77.26
Quaking aspen	3.7	279	495.4	486	764	(N/A)	8.7	7.9	54.59
Honeylocust	1.7	131	236.9	232	363	(N/A)	3.7	3.8	60.56
Norway maple	1.4	106	203.5	199	306	(N/A)	3.1	3.2	61.17
Black maple	0.8	63	105.2	103	166	(N/A)	2.5	1.7	41.61
White ash	0.9	71	113.1	111	182	(N/A)	2.5	1.9	45.48
Northern red oak	0.3	21	34.2	33	54	(N/A)	1.9	0.6	18.07
Black walnut	0.6	47	89.9	88	135	(N/A)	1.9	1.4	45.09
Northern white cedar	0.6	42	73.8	72	115	(N/A)	1.9	1.2	38.17
Mulberry	0.6	43	81.0	79	122	(N/A)	1.9	1.3	40.80
American elm	1.0	74	128.0	125	200	(N/A)	1.2	2.1	99.97
Apple	0.0	3	7.6	7	11	(N/A)	1.2	0.1	5.40
Chinese elm	0.9	66	116.8	114	181	(N/A)	1.2	1.9	90.32
Spruce	0.3	21	34.3	34	55	(N/A)	1.2	0.6	27.30
American sycamore	0.3	20	38.1	37	57	(N/A)	0.6	0.6	57.32
Conifer Evergreen Small	0.0	1	2.5	2	4	(N/A)	0.6	0.0	3.62
Catalpa	0.5	37	63.1	62	99	(N/A)	0.6	1.0	98.63
Boxelder	0.1	8	14.9	15	22	(N/A)	0.6	0.2	22.45
Juniper	0.1	8	16.4	16	25	(N/A)	0.6	0.3	24.57
Blue spruce	0.1	10	15.2	15	25	(N/A)	0.6	0.3	24.51
Norway spruce	0.1	10	14.6	14	24	(N/A)	0.6	0.3	24.14
Paper birch	0.2	18	27.0	26	44	(N/A)	0.6	0.5	44.23
Eastern red cedar	0.1	8	16.4	16	25	(N/A)	0.6	0.3	24.57
Willow	0.3	24	47.4	46	71	(N/A)	0.6	0.7	70.84
River birch	0.1	8	16.9	17	24	(N/A)	0.6	0.3	24.47
Broadleaf Deciduous Mec	0.2	18	29.5	29	47	(N/A)	0.6	0.5	46.78
Broadleaf Deciduous Sma	0.0	2	3.8	4	5	(N/A)	0.6	0.1	5.40
Tulip tree	0.3	25	46.9	46	71	(N/A)	0.6	0.7	70.91
Total	46.3	3,512	6,246.5	6,122	9,634	(N/A)	100.0	100.0	59.84

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

12/13/2016

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	204,574	5,544	(N/A)	30.4	37.2	113.14
Silver maple	127,228	3,448	(N/A)	16.8	23.1	127.70
Northern hackberry	62,651	1,698	(N/A)	11.2	11.4	94.32
Quaking aspen	33,348	904	(N/A)	8.7	6.1	64.55
Honeylocust	16,933	459	(N/A)	3.7	3.1	76.48
Norway maple	13,896	377	(N/A)	3.1	2.5	75.32
Black maple	6,212	168	(N/A)	2.5	1.1	42.09
White ash	7,164	194	(N/A)	2.5	1.3	48.54
Northern red oak	1,528	41	(N/A)	1.9	0.3	13.81
Black walnut	5,789	157	(N/A)	1.9	1.1	52.30
Northern white cedar	13,814	374	(N/A)	1.9	2.5	124.79
Mulberry	2,507	68	(N/A)	1.9	0.5	22.65
American elm	9,102	247	(N/A)	1.2	1.7	123.33
Apple	137	4	(N/A)	1.2	0.0	1.86
Chinese elm	12,729	345	(N/A)	1.2	2.3	172.48
Spruce	4,508	122	(N/A)	1.2	0.8	61.08
American sycamore	2,591	70	(N/A)	0.6	0.5	70.21
Conifer Evergreen Small	183	5	(N/A)	0.6	0.0	4.97
Catalpa	7,239	196	(N/A)	0.6	1.3	196.17
Boxelder	720	20	(N/A)	0.6	0.1	19.51
Juniper	1,635	44	(N/A)	0.6	0.3	44.30
Blue spruce	1,544	42	(N/A)	0.6	0.3	41.85
Norway spruce	1,539	42	(N/A)	0.6	0.3	41.70
Paper birch	1,466	40	(N/A)	0.6	0.3	39.72
Eastern red cedar	1,635	44	(N/A)	0.6	0.3	44.30
Willow	3,764	102	(N/A)	0.6	0.7	102.01
River birch	586	16	(N/A)	0.6	0.1	15.88
Broadleaf Deciduous Medi	1,409	38	(N/A)	0.6	0.3	38.19
Broadleaf Deciduous Small	69	2	(N/A)	0.6	0.0	1.86
Tulip tree	3,943	107	(N/A)	0.6	0.7	106.85
Citywide total	550,444	14,917	(N/A)	100.0	100.0	92.65

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

12/13/2016

Species	Deposition (lb)				Total Depos. ($)	Avoided (lb)				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg $/tree
	O_3	NO_2	PM_{10}	SO_2		NO_2	PM_{10}	VOC	SO_2								
Green ash	29.3	4.7	13.4	1.3	154	75.6	11.0	10.5	71.9	471	0.0	0	217.8	626	(N/A)	30.4	12.77
Silver maple	22.4	3.8	10.9	1.0	121	40.1	5.9	5.6	38.6	251	-11.6	-43	116.7	328	(N/A)	16.8	12.16
Northern hackberry	10.7	1.9	5.4	0.5	58	31.3	4.5	4.3	29.5	195	0.0	0	88.2	253	(N/A)	11.2	14.05
Quaking aspen	3.4	0.5	1.8	0.2	18	17.5	2.5	2.4	16.6	109	0.0	0	44.9	127	(N/A)	8.7	9.10
Honeylocust	3.2	0.5	1.5	0.1	17	8.2	1.2	1.1	7.8	51	-2.3	-9	21.4	60	(N/A)	3.7	9.93
Norway maple	2.9	0.5	1.4	0.1	16	6.8	1.0	0.9	6.4	42	-0.7	-3	19.4	55	(N/A)	3.1	11.08
Black maple	1.4	0.2	0.7	0.1	7	3.9	0.6	0.5	3.8	24	-0.5	-2	10.7	30	(N/A)	2.5	7.54
White ash	0.6	0.1	0.3	0.0	3	4.3	0.6	0.6	4.2	27	0.0	0	10.9	31	(N/A)	2.5	7.68
Northern red oak	0.2	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	-0.3	-1	3.0	8	(N/A)	1.9	2.69
Black walnut	0.6	0.1	0.3	0.0	3	3.0	0.4	0.4	2.8	19	0.0	0	7.6	22	(N/A)	1.9	7.22
Northern white cedar	1.7	0.3	1.3	0.2	11	2.6	0.4	0.4	2.5	16	-8.6	-32	0.9	-5	(N/A)	1.9	-1.58
Mulberry	0.8	0.1	0.4	0.0	4	2.7	0.4	0.4	2.6	17	0.0	0	7.5	21	(N/A)	1.9	7.15
American elm	2.4	0.4	1.2	0.1	13	4.6	0.7	0.6	4.4	29	0.0	0	14.5	42	(N/A)	1.2	20.99
Apple	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)	1.2	0.71
Chinese elm	2.4	0.4	1.0	0.1	12	4.1	0.6	0.6	4.0	26	0.0	0	13.2	38	(N/A)	1.2	19.13
Spruce	0.5	0.1	0.4	0.1	3	1.3	0.2	0.2	1.2	8	-1.9	-7	2.1	4	(N/A)	1.2	2.13
American sycamore	0.3	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.3	9	(N/A)	0.6	9.34
Conifer Evergreen Small	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	-0.1	0	0.1	0	(N/A)	0.6	0.20
Catalpa	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)	0.6	22.55
Boxelder	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3	(N/A)	0.6	3.26
Juniper	0.3	0.1	0.3	0.0	2	0.5	0.1	0.1	0.5	3	-0.9	-3	1.0	2	(N/A)	0.6	2.19
Blue spruce	0.2	0.0	0.2	0.0	1	0.6	0.1	0.1	0.6	4	-0.6	-2	1.2	3	(N/A)	0.6	2.89
Norway spruce	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)	0.6	2.82
Paper birch	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	0.0	0	2.6	7	(N/A)	0.6	7.42
Eastern red cedar	0.3	0.1	0.3	0.0	2	0.5	0.1	0.1	0.5	3	-0.9	-3	1.0	2	(N/A)	0.6	2.19
Willow	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)	0.6	13.58
River birch	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3	(N/A)	0.6	3.47
Broadleaf Deciduous Medi	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.8	8	(N/A)	0.6	7.92
Broadleaf Deciduous Smal	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)	0.6	0.71
Tulip tree	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12	(N/A)	0.6	12.48
Citywide total	87.3	14.6	42.8	4.2	470	220.1	32.1	30.6	209.6	1,373	-29.2	-110	612.1	1,734	(N/A)	100.0	10.77

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

12/13/2016

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	976,481	7,324	(N/A)	30.4	44.6	149.46
Silver maple	515,122	3,863	(N/A)	16.8	23.5	143.09
Northern hackberry	165,926	1,244	(N/A)	11.2	7.6	69.14
Quaking aspen	109,108	818	(N/A)	8.7	5.0	58.45
Honeylocust	40,124	301	(N/A)	3.7	1.8	50.15
Norway maple	48,075	361	(N/A)	3.1	2.2	72.11
Black maple	15,412	116	(N/A)	2.5	0.7	28.90
White ash	16,836	126	(N/A)	2.5	0.8	31.57
Northern red oak	3,968	30	(N/A)	1.9	0.2	9.92
Black walnut	17,950	135	(N/A)	1.9	0.8	44.87
Northern white ceda	22,471	169	(N/A)	1.9	1.0	56.18
Mulberry	12,817	96	(N/A)	1.9	0.6	32.04
American elm	49,081	368	(N/A)	1.2	2.2	184.05
Apple	356	3	(N/A)	1.2	0.0	1.33
Chinese elm	81,925	614	(N/A)	1.2	3.7	307.22
Spruce	4,513	34	(N/A)	1.2	0.2	16.92
American sycamore	8,458	63	(N/A)	0.6	0.4	63.43
Conifer Evergreen S	43	0	(N/A)	0.6	0.0	0.32
Catalpa	55,982	420	(N/A)	0.6	2.6	419.86
Boxelder	1,101	8	(N/A)	0.6	0.1	8.26
Juniper	1,102	8	(N/A)	0.6	0.1	8.27
Blue spruce	1,118	8	(N/A)	0.6	0.1	8.39
Norway spruce	1,170	9	(N/A)	0.6	0.1	8.78
Paper birch	3,672	28	(N/A)	0.6	0.2	27.54
Eastern red cedar	1,102	8	(N/A)	0.6	0.1	8.27
Willow	14,280	107	(N/A)	0.6	0.7	107.10
River birch	1,101	8	(N/A)	0.6	0.1	8.26
Broadleaf Deciduou	3,624	27	(N/A)	0.6	0.2	27.18
Broadleaf Deciduou	178	1	(N/A)	0.6	0.0	1.33
Tulip tree	15,773	118	(N/A)	0.6	0.7	118.30
Citywide total	2,188,868	16,417	(N/A)	100.0	100.0	101.97

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees

12/13/2016

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	35,592	267	-4,687	-172	-36	26,610	200	57,343	430	(N/A)	30.4	32.9	8.78
Silver maple	36,726	275	-2,474	-96	-19	14,324	107	48,480	364	(N/A)	16.8	27.8	13.47
Northern hackberry	8,177	61	-796	-62	-6	10,922	82	18,241	137	(N/A)	11.2	10.5	7.60
Quaking aspen	8,558	64	-524	-36	-4	6,159	46	14,157	106	(N/A)	8.7	8.1	7.58
Honeylocust	3,947	30	-193	-15	-2	2,899	22	6,639	50	(N/A)	3.7	3.8	8.30
Norway maple	1,696	13	-231	-15	-2	2,352	18	3,802	29	(N/A)	3.1	2.2	5.70
Black maple	1,005	8	-74	-7	-1	1,399	10	2,323	17	(N/A)	2.5	1.3	4.36
White ash	2,014	15	-81	-8	-1	1,572	12	3,497	26	(N/A)	2.5	2.0	6.56
Northern red oak	392	3	-19	-3	0	458	3	828	6	(N/A)	1.9	0.5	2.07
Black walnut	1,528	11	-86	-7	-1	1,042	8	2,477	19	(N/A)	1.9	1.4	6.19
Northern white cedar	512	4	-108	-11	-1	933	7	1,326	10	(N/A)	1.9	0.8	3.31
Mulberry	535	4	-62	-7	-1	952	7	1,418	11	(N/A)	1.9	0.8	3.55
American elm	1,221	9	-236	-9	-2	1,646	12	2,622	20	(N/A)	1.2	1.5	9.83
Apple	76	1	-2	-1	0	74	1	147	1	(N/A)	1.2	0.1	0.55
Chinese elm	1,438	11	-393	-10	-3	1,463	11	2,498	19	(N/A)	1.2	1.4	9.37
Spruce	303	2	-22	-5	0	463	3	739	6	(N/A)	1.2	0.4	2.77
American sycamore	660	5	-41	-3	0	441	3	1,058	8	(N/A)	0.6	0.6	7.93
Conifer Evergreen Small	13	0	0	-1	0	26	0	39	0	(N/A)	0.6	0.0	0.29
Catalpa	479	4	-269	-6	-2	813	6	1,017	8	(N/A)	0.6	0.6	7.63
Boxelder	181	1	-5	-1	0	173	1	347	3	(N/A)	0.6	0.2	2.60
Juniper	43	0	-5	-2	0	187	1	222	2	(N/A)	0.6	0.1	1.67
Blue spruce	91	1	-5	-2	0	213	2	296	2	(N/A)	0.6	0.2	2.22
Norway spruce	116	1	-6	-2	0	216	2	324	2	(N/A)	0.6	0.2	2.43
Paper birch	445	3	-18	-2	0	393	3	819	6	(N/A)	0.6	0.5	6.14
Eastern red cedar	0	0	-5	-2	0	187	1	180	1	(N/A)	0.6	0.1	1.35
Willow	370	3	-69	-4	-1	539	4	837	6	(N/A)	0.6	0.5	6.27
River birch	224	2	-5	-1	0	176	1	393	3	(N/A)	0.6	0.2	2.95
Broadleaf Deciduous Me	386	3	-17	-2	0	395	3	762	6	(N/A)	0.6	0.4	5.71
Broadleaf Deciduous Sm	38	0	-1	-1	0	37	0	74	1	(N/A)	0.6	0.0	0.55
Tulip tree	857	6	-76	-4	-1	552	4	1,330	10	(N/A)	0.6	0.8	9.97
Citywide total	107,623	807	-10,508	-495	-83	77,616	582	174,235	1,307	(N/A)	100.0	100.0	8.12

Table 6: Annual Social and Aesthetic Benefits

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	2,713	(N/A)	30.4	27.8	55.38
Silver maple	2,829	(N/A)	16.8	29.0	104.79
Northern hackberry	1,076	(N/A)	11.2	11.0	59.78
Quaking aspen	764	(N/A)	8.7	7.8	54.59
Honeylocust	810	(N/A)	3.7	8.3	134.98
Norway maple	157	(N/A)	3.1	1.6	31.35
Black maple	139	(N/A)	2.5	1.4	34.77
White ash	262	(N/A)	2.5	2.7	65.56
Northern red oak	39	(N/A)	1.9	0.4	12.83
Black walnut	144	(N/A)	1.9	1.5	47.98
Northern white cedar	53	(N/A)	1.9	0.5	17.50
Mulberry	31	(N/A)	1.9	0.3	10.32
American elm	157	(N/A)	1.2	1.6	78.40
Apple	4	(N/A)	1.2	0.0	2.06
Chinese elm	95	(N/A)	1.2	1.0	47.59
Spruce	79	(N/A)	1.2	0.8	39.70
American sycamore	58	(N/A)	0.6	0.6	57.69
Conifer Evergreen Small	13	(N/A)	0.6	0.1	13.37
Catalpa	29	(N/A)	0.6	0.3	28.57
Boxelder	27	(N/A)	0.6	0.3	27.10
Juniper	14	(N/A)	0.6	0.1	13.68
Blue spruce	25	(N/A)	0.6	0.3	25.23
Norway spruce	32	(N/A)	0.6	0.3	32.32
Paper birch	46	(N/A)	0.6	0.5	45.86
Eastern red cedar	0	(N/A)	0.6	0.0	0.00
Willow	31	(N/A)	0.6	0.3	31.46
River birch	26	(N/A)	0.6	0.3	26.22
Broadleaf Deciduous Medi	39	(N/A)	0.6	0.4	39.16
Broadleaf Deciduous Small	2	(N/A)	0.6	0.0	2.06
Tulip tree	66	(N/A)	0.6	0.7	65.59
Citywide total	9,761	(N/A)	100.0	100.0	60.63

Table 7: Summary of Benefits in Dollars

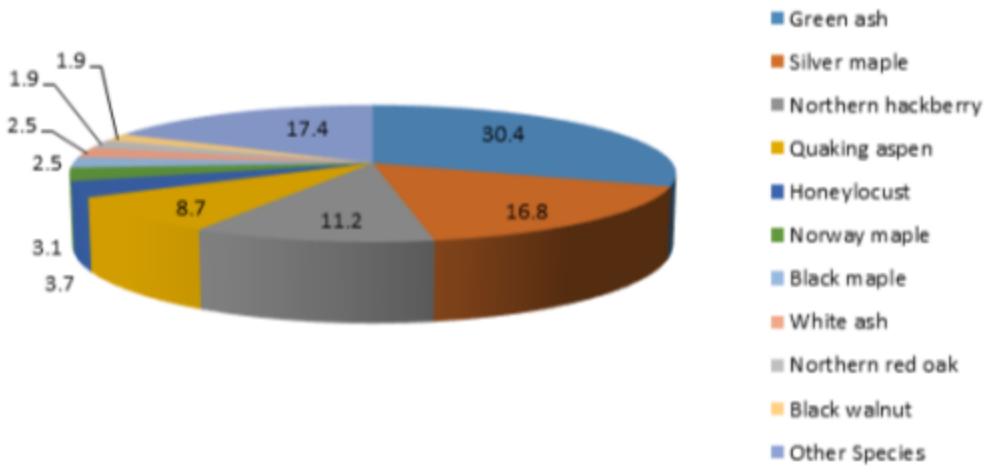
Annual Benefits of Public Trees by Species ($/tree)

12/13/2016

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Green ash	67.63	8.78	12.77	113.14	55.38	257.69	(N/A)
Silver maple	64.17	13.47	12.16	127.70	104.79	322.29	(N/A)
Northern hackberry	77.26	7.60	14.05	94.32	59.78	253.02	(N/A)
Quaking aspen	54.59	7.58	9.10	64.55	54.59	190.42	(N/A)
Honeylocust	60.56	8.30	9.93	76.48	134.98	290.26	(N/A)
Norway maple	61.17	5.70	11.08	75.32	31.35	184.61	(N/A)
Black maple	41.61	4.36	7.54	42.09	34.77	130.36	(N/A)
White ash	45.48	6.56	7.68	48.54	65.56	173.82	(N/A)
Northern red oak	18.07	2.07	2.69	13.81	12.83	49.47	(N/A)
Black walnut	45.09	6.19	7.22	52.30	47.98	158.78	(N/A)
Northern white ceda	38.17	3.31	-1.58	124.79	17.50	182.20	(N/A)
Mulberry	40.80	3.55	7.15	22.65	10.32	84.47	(N/A)
American elm	99.97	9.83	20.99	123.33	78.40	332.52	(N/A)
Apple	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Chinese elm	90.32	9.37	19.13	172.48	47.59	338.89	(N/A)
Spruce	27.30	2.77	2.13	61.08	39.70	132.99	(N/A)
American sycamore	57.32	7.93	9.34	70.21	57.69	202.49	(N/A)
Conifer Evergreen S	3.62	0.29	0.20	4.97	13.37	22.45	(N/A)
Catalpa	98.63	7.63	22.55	196.17	28.57	353.55	(N/A)
Boxelder	22.45	2.60	3.26	19.51	27.10	74.93	(N/A)
Juniper	24.57	1.67	2.19	44.30	13.68	86.40	(N/A)
Blue spruce	24.51	2.22	2.89	41.85	25.23	96.70	(N/A)
Norway spruce	24.14	2.43	2.82	41.70	32.32	103.40	(N/A)
Paper birch	44.23	6.14	7.42	39.72	45.86	143.36	(N/A)
Eastern red cedar	24.57	1.35	2.19	44.30	0.00	72.40	(N/A)
Willow	70.84	6.27	13.58	102.01	31.46	224.17	(N/A)
River birch	24.47	2.95	3.47	15.88	26.22	72.99	(N/A)
Broadleaf Deciduous	46.78	5.71	7.92	38.19	39.16	137.75	(N/A)
Broadleaf Deciduous	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Tulip tree	70.91	9.97	12.48	106.85	65.59	265.81	(N/A)
Citywide Total	59.84	8.12	10.77	92.65	60.63	232.00	(N/A)

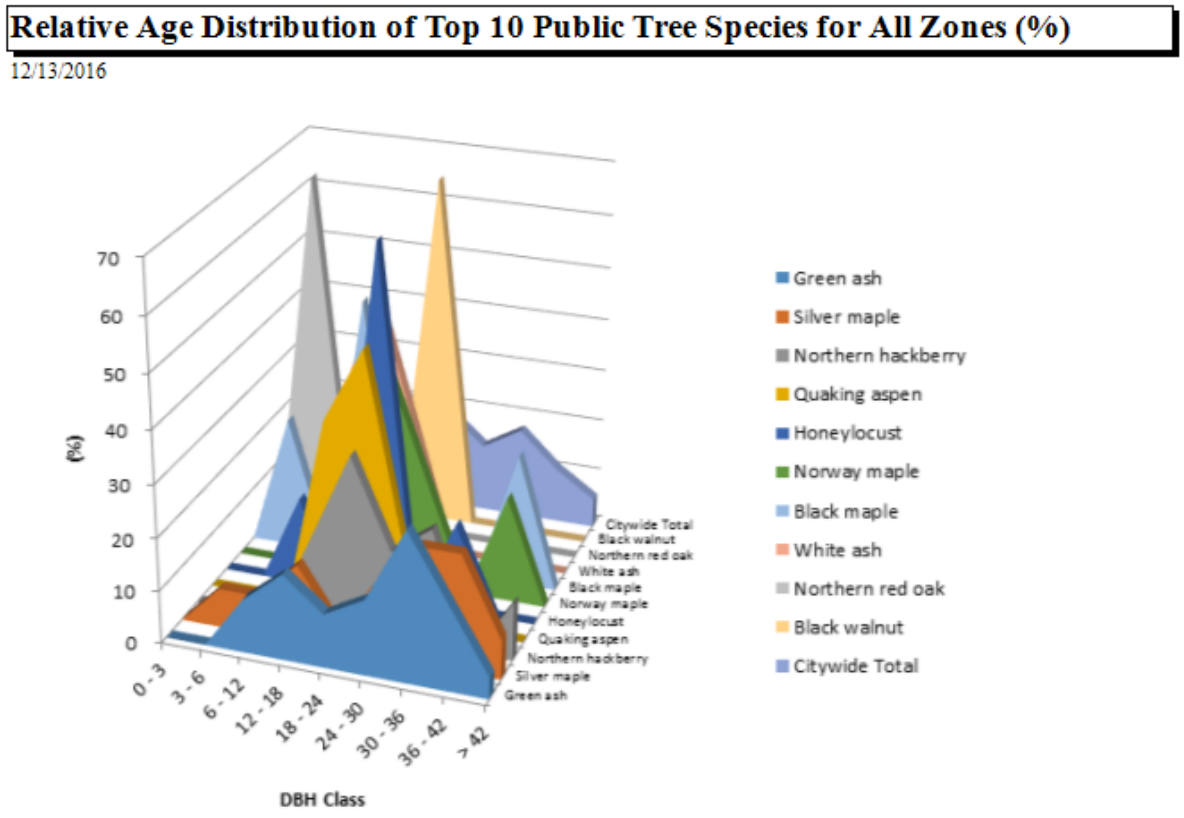
Species Distribution of Public Trees

12/13/2016



Species	Percent
Green ash	30.4
Silver maple	16.8
Northern hackberry	11.2
Quaking aspen	8.7
Honeylocust	3.7
Norway maple	3.1
Black maple	2.5
White ash	2.5
Northern red oak	1.9
Black walnut	1.9
Other Species	17.4
Total	100.0

Figure 1: Species Distribution



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Green ash	0.00	0.00	10.20	16.33	10.20	14.29	28.57	16.33	4.08
Silver maple	0.00	7.41	7.41	14.81	3.70	14.81	22.22	22.22	7.41
Northern hackberry	0.00	0.00	0.00	16.67	33.33	16.67	22.22	0.00	11.11
Quaking aspen	0.00	0.00	0.00	35.71	50.00	14.29	0.00	0.00	0.00
Honeylocust	0.00	0.00	16.67	0.00	66.67	0.00	16.67	0.00	0.00
Norway maple	0.00	0.00	0.00	20.00	40.00	20.00	0.00	20.00	0.00
Black maple	0.00	25.00	0.00	50.00	0.00	0.00	0.00	25.00	0.00
White ash	0.00	0.00	25.00	50.00	25.00	0.00	0.00	0.00	0.00
Northern red oak	0.00	66.67	0.00	33.33	0.00	0.00	0.00	0.00	0.00
Black walnut	0.00	0.00	33.33	0.00	66.67	0.00	0.00	0.00	0.00
Citywide Total	0.00	5.59	7.45	21.12	19.25	13.04	17.39	10.56	5.59

Figure 2: Relative Age Class

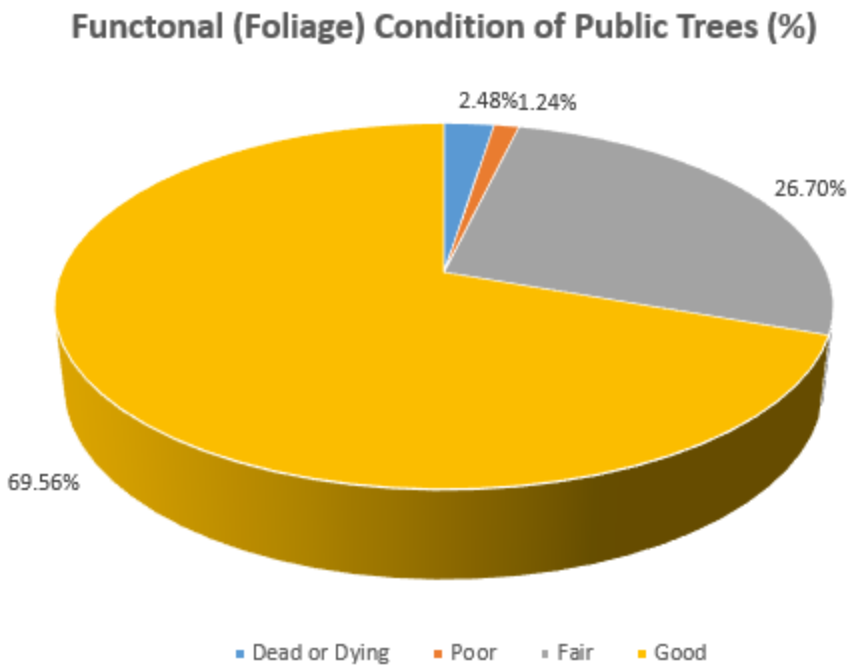


Figure 3: Foliage Condition

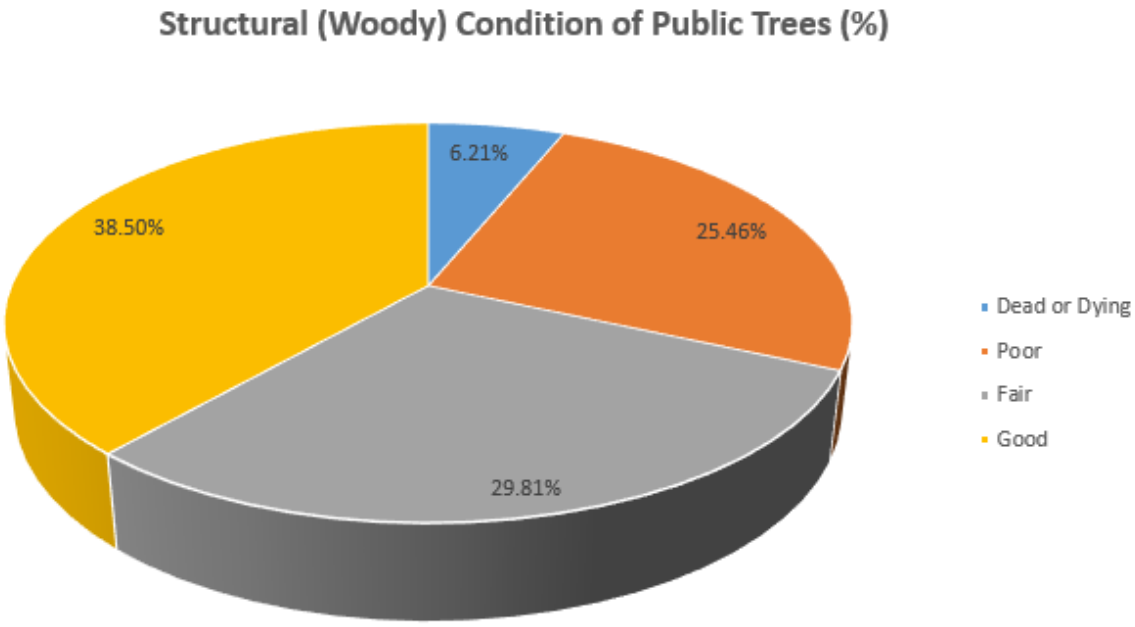
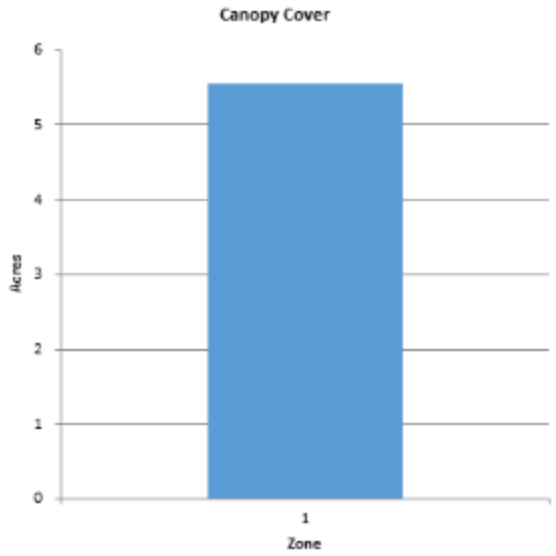


Figure 4: Wood Condition

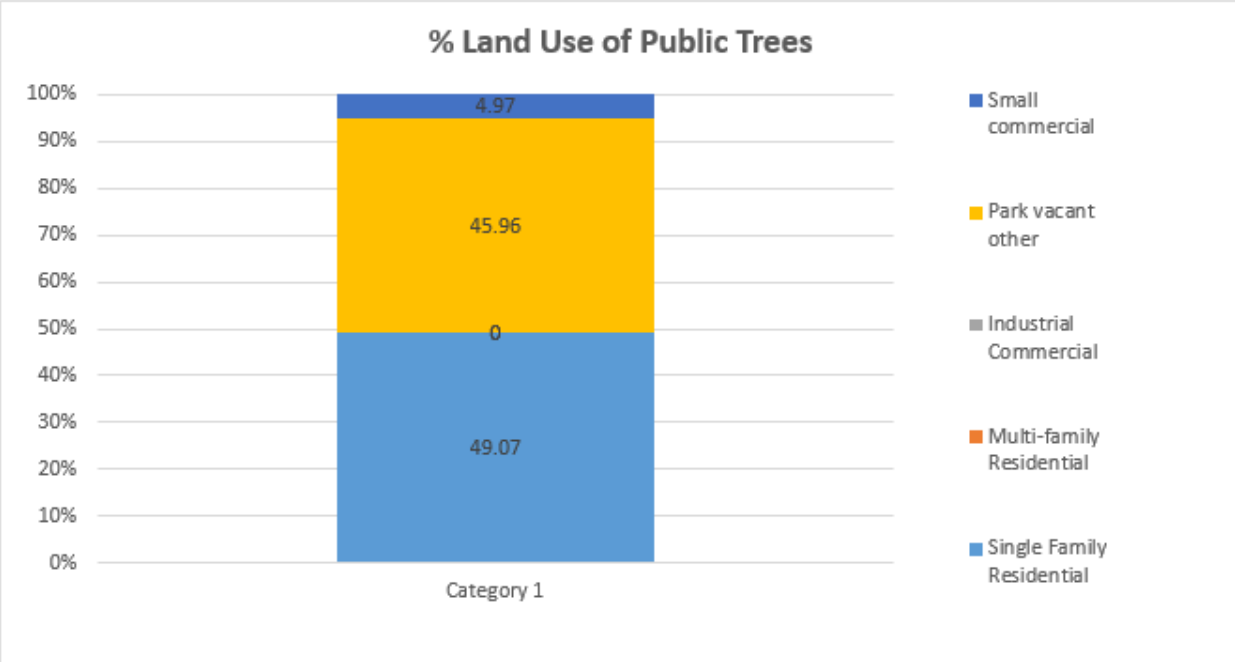
Canopy Cover of Public Trees (Acres)

12/13/2016



Zone	Acres	% of Total Canopy Cover
1	6	100.0
Citywide total	6	100.0

Figure 5: Canopy Cover in Acres

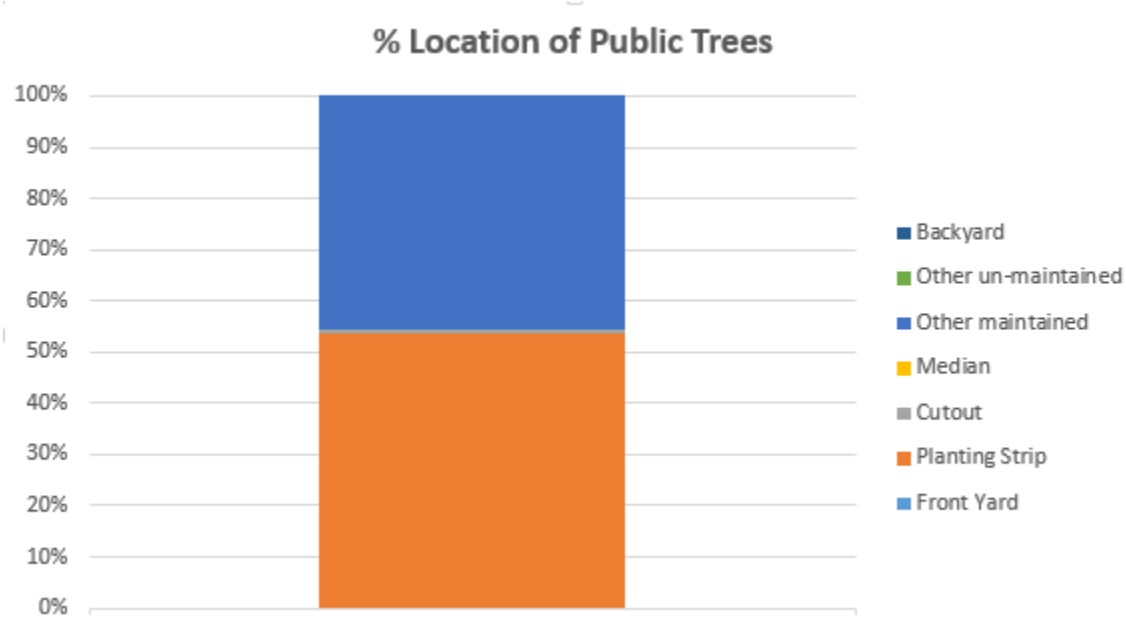


Land Use of Public Trees by Zone

12/13/2016

Zone	Land Use	Tree Count	Standard Error	% of Zone	% of Public Trees
1	Single family residential	79	(N/A)	49.07	49.07
	Multi-family residential	0	(N/A)	0.00	0.00
	Industrial/Large commercial	0	(N/A)	0.00	0.00
	Park/vacant/other	74	(N/A)	45.96	45.96
	Small Commercial	8	(N/A)	4.97	4.97
	Total	161	(N/A)	100.00	100.00
Citywide	Single family residential	79	(N/A)	49.07	49.07
	Multi-family residential	0	(N/A)	0.00	0.00
	Industrial/Large commercial	0	(N/A)	0.00	0.00
	Park/vacant/other	74	(N/A)	45.96	45.96
	Small Commercial	8	(N/A)	4.97	4.97
	Total	161	(N/A)	100.00	100.00

Figure 6: Land Use of city/park trees



Citywide	Front yard	0	(N/A)	0.00
	Planting strip	87	(N/A)	54.00
	Cutout	0	(N/A)	0.00
	Median	0	(N/A)	0.00
	Other maintained locations	74	(N/A)	46.00
	Other un-maintained locations	0	(N/A)	0.00
	Backyard	0	(N/A)	0.00
	Total	161	(N/A)	100.00

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

Figure 1: Location of Ash Trees

Figure 2: Location of EAB symptoms

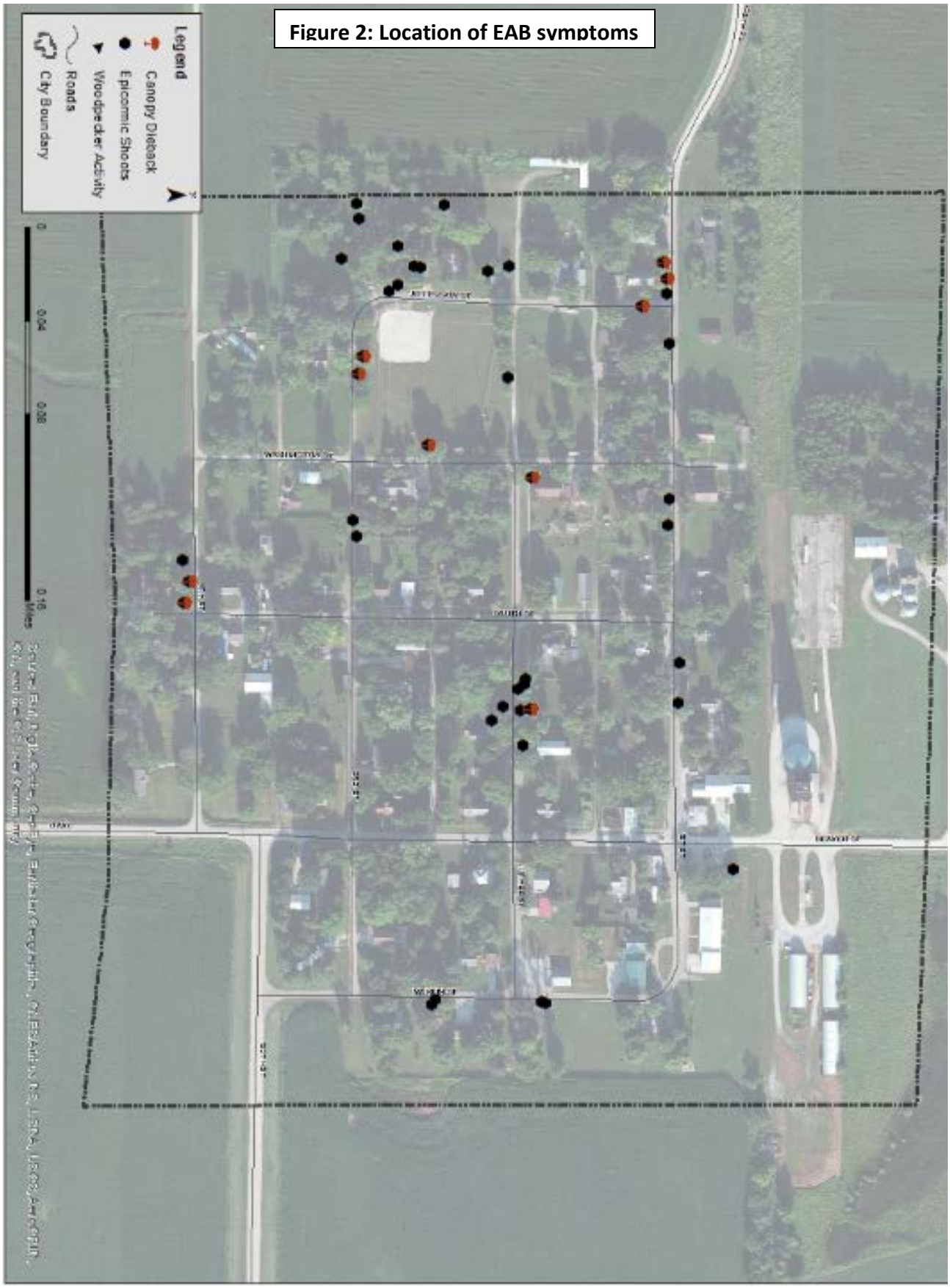


Figure 3: Location of Ash with Canopy Dieback

Figure 4: Location of Ash with Epicormic Shoots

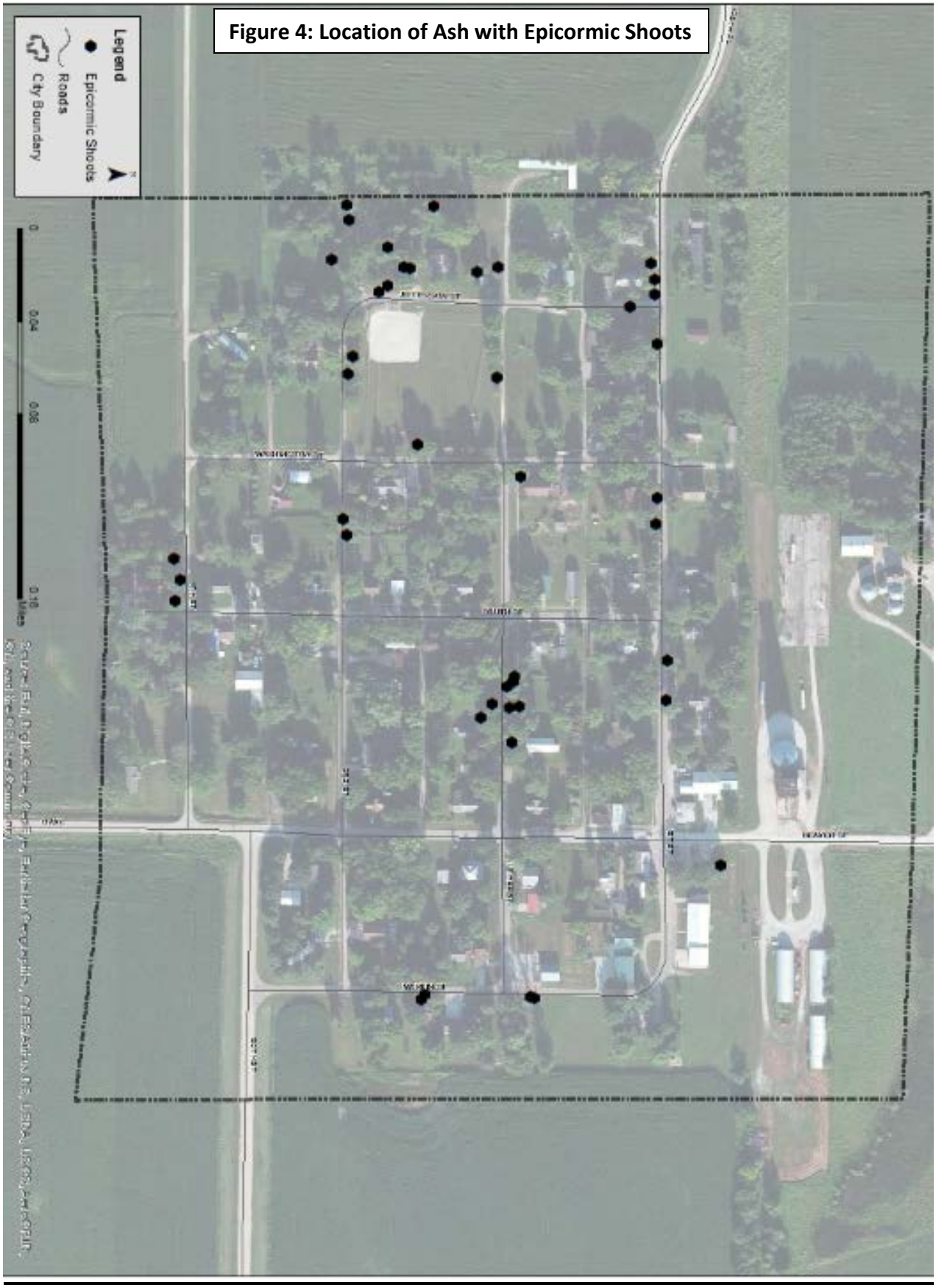


Figure 5: Location of Treatable Ash in Good Condition

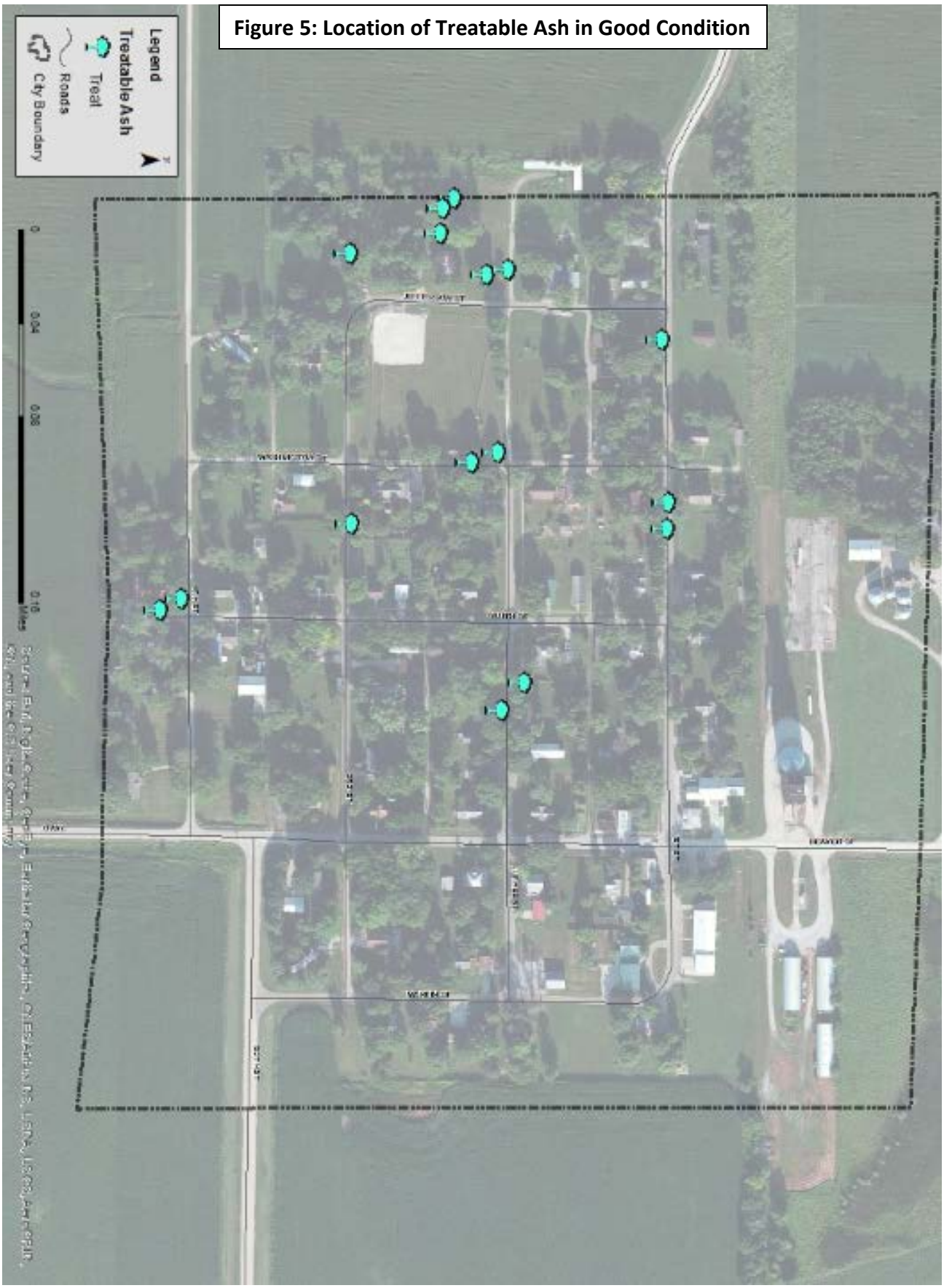


Figure 6: Location of Trees with Recommended Maintenance

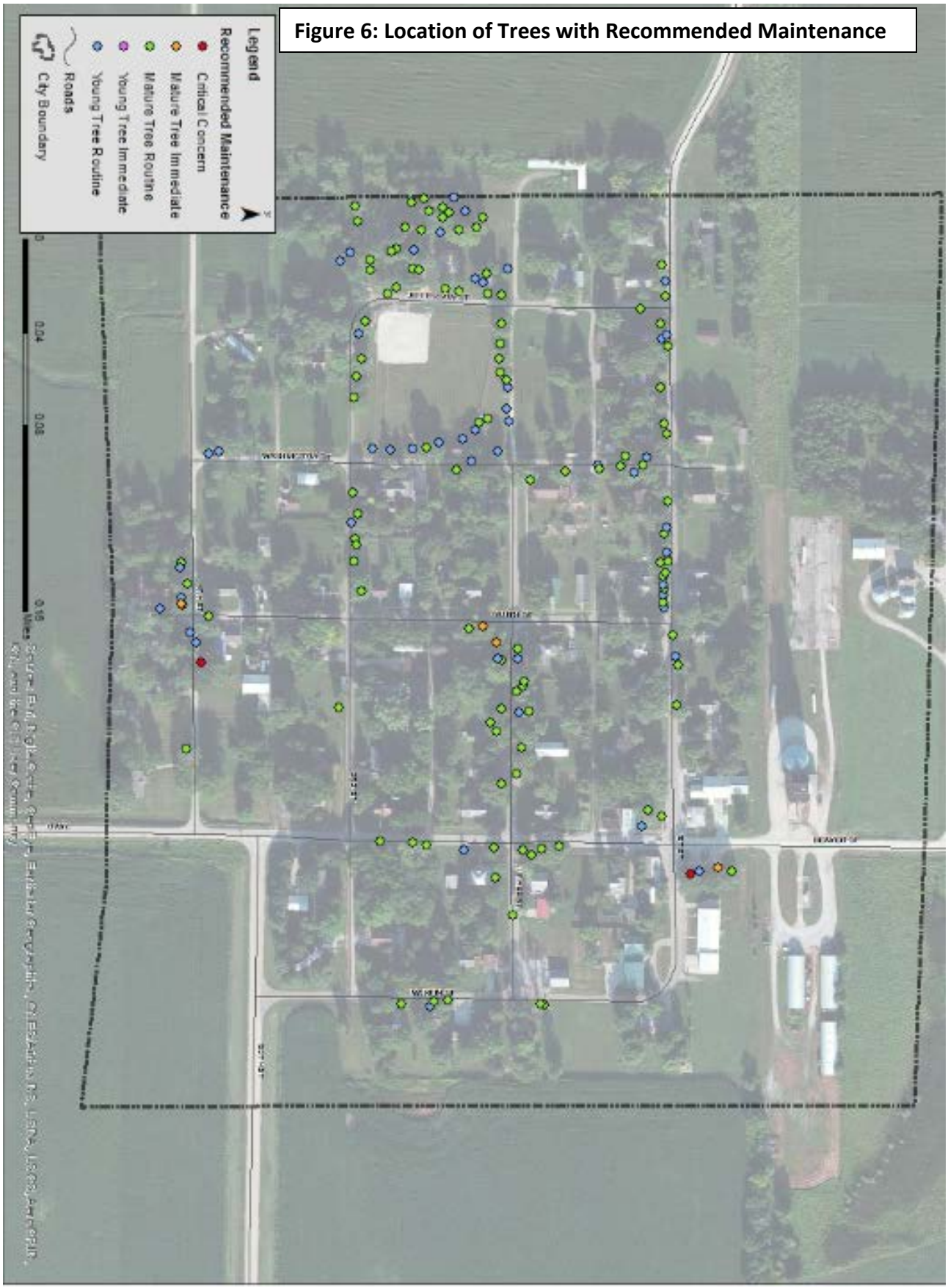
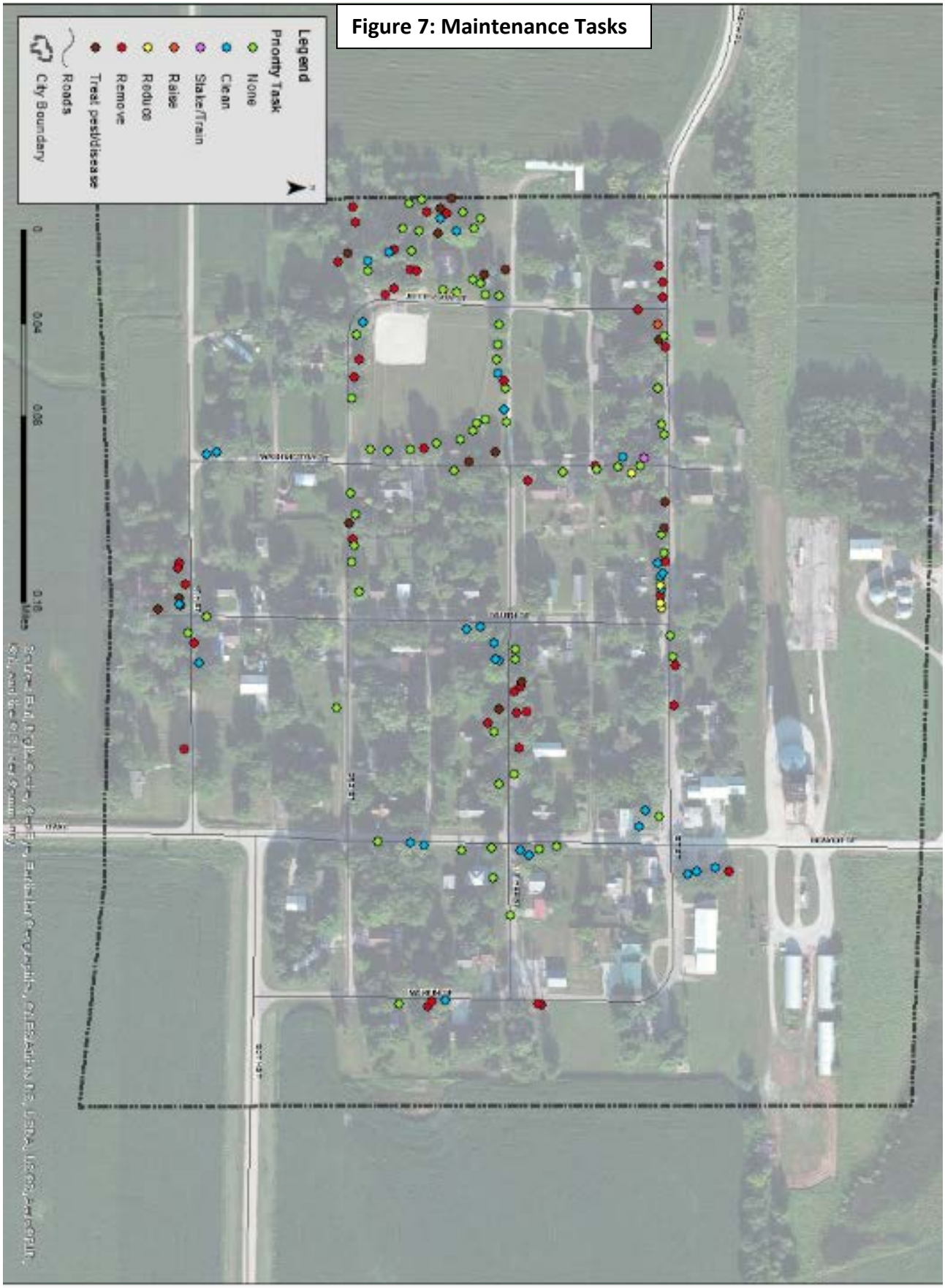


Figure 7: Maintenance Tasks



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