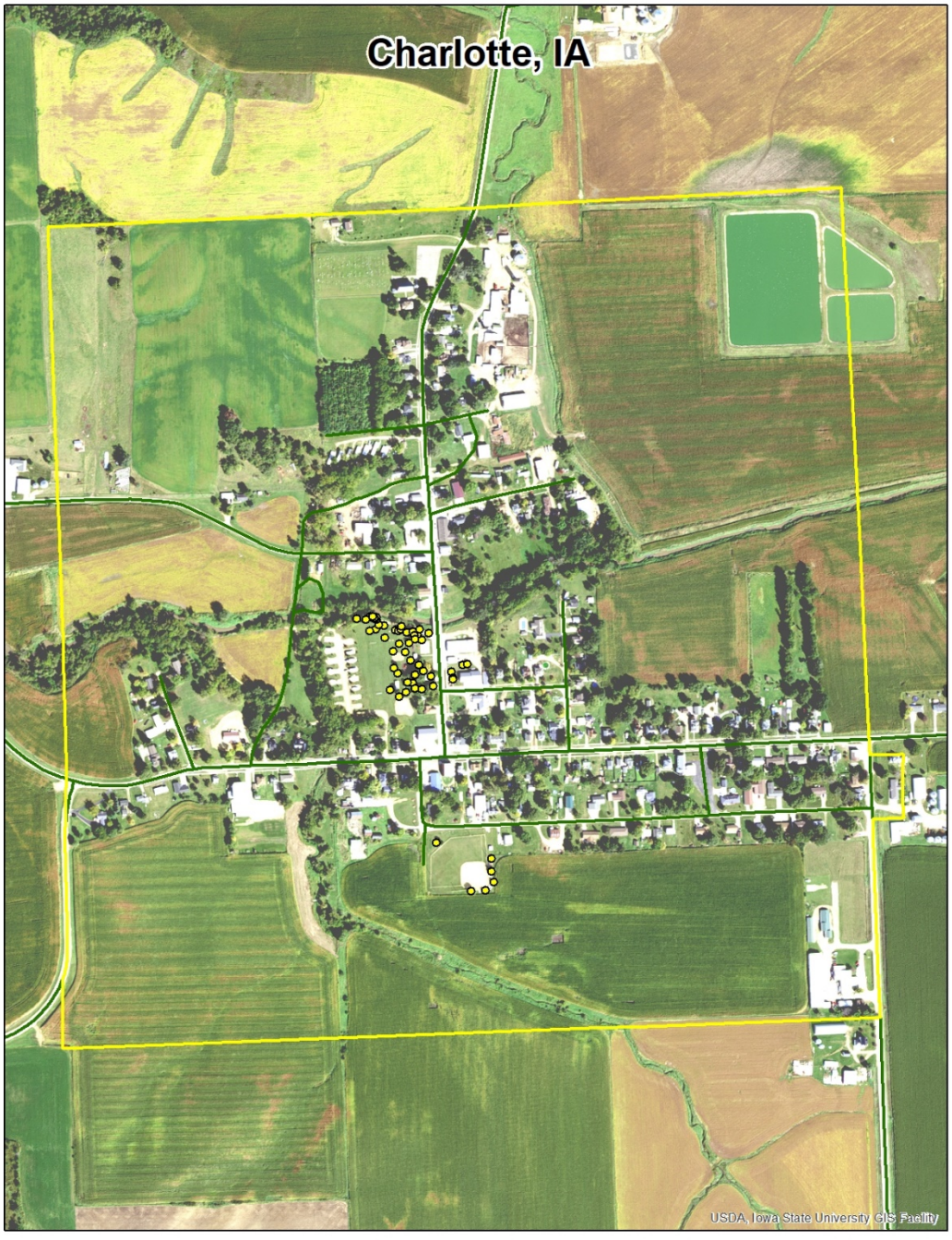
Charlotte, IA



2020 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Charlotte 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 16% of Charlotte'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 2020, 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 57 trees inventoried.

- Charlotte's trees provide $5,150 of benefits annually, an average of $90.35 a tree
- There are over 22 species of trees from at least 16 different genera.
- The top three genera are: Maple 37%, Ash 16%, and Apple 12%
- 30% of trees need some type of management
- 9 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.

- 4 of the 9 ash trees should be carefully examined, as they have two 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 cottonwood
- Check ash trees with a visual survey yearly

Introduction

This plan was developed to assist Charlotte 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 or treatment and replacement planting. With proper planning and management of the current canopy in Charlotte, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Charlotte'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 Charlotte 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 Charlotte's urban forestry goals.

Inventory

In 2020, 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 57 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management as 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. Charlotte's trees reduce energy related costs by approximately $1,437 annually (Appendix A, Table 1). These savings are both in Electricity (6.8 MWh) and in Natural Gas (935.9 Therms).

Annual Stormwater Benefits

Charlotte's trees intercept about 59,354 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $1,608 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 Charlotte, it is estimated that trees remove 83.5 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 $235 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Charlotte, trees sequester about 17,106 lbs of carbon a year with an associated value of $128 (Appendix A, Table 5). In addition, the trees store 185,648 lbs of carbon, with a yearly benefit of $1,392 (Appendix A, Table 4).

Annual Aesthetics Benefits

Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Charlotte receives $1,663in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STREETS analysis, Charlotte's trees provide $5,150 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 57 trees in Charlotte provide approximately $90.35 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Charlotte has over 22 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Genus	Count	Percent
Maple	21	37%
Ash	9	16%
Apple	7	12%
Oak	5	9%
Black Walnut	3	5%
Spruce	3	5%
Alder	1	2%
Broadleaf deciduous S/M/L	1	2%
Catalpa	1	2%
Cedar	1	2%
Lilac	1	2%
Basswood	1	2%
Birch	1	2%
Mulberry	1	2%
Cottonwood	1	2%

Age Class

Most of Charlotte's trees (54%) are between 6 and 18 inches 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. Charlotte's size curve is on the smaller side, indicating a younger 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 Charlotte indicate that 70% of the trees are in good health, with only 13% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 44% of Charlotte'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 21% of the population. This 21% 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	5	9%
Crown Raising	2	4%
Tree Removal	9	16%

Canopy Cover

The total canopy with both private and public trees is 15%, 55.95 acres. The canopy cover included in the Charlotte inventory includes approximately 0.7 acres (Appendix A, Figure 4). The City's Canopy goal is to increase canopy by 3%, in 30 years. To achieve this goal it is estimated that 27 trees need to be planted annually on public and private lands.

Land Use and Location

The majority of Charlotte'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	Count	Percent
Park/Vacant/Other	57	100%

Location	Count	Percent
Front Yard	57	100%

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

Charlotte has 3 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. There are 2 trees over 12 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 immediate maintenance. There are a total of 4 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 removals, 1 is an ash tree. There are a total of 9 ash trees, and 4 of those have signs and symptoms that have been associated with EAB. In addition, there are 12 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 Charlotte.

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 (37%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood or other cotton bearing trees 3-2-1 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance (Appendix C).

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 <u>No Additional Funding</u>

Year 1

Removal: 3 critical concern trees
Planting and Replacement: 4 trees to be planted in open locations
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 2

Removal: 2 trees
Planting and Replacement: 3 trees in open locations from year one removals
Young Tree Pruning & Maintenance:
Routine trimming: Contract to trim 1/3 of the city trees
Visual Survey for signs and symptoms of EAB

Year 3

Removal: 3 trees
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 4

Removal: 2 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 3 trees in open locations from previous removals

Routine trimming: Contract to trim 1/3 of the city trees
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

Year 5
Removal: 3 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment and/or future ash removal
Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals
Young Tree Pruning & Maintenance:
Visual Survey for signs and symptoms of EAB

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

*Reduction of ash over 6 years: Approximately 8 ash trees removed (approximately 88% of ash). It will take approximately 9 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 to 15 years of its arrival.

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. All trees will meet the restrictions in city ordinance 3-2-1 (Appendix C). The new plantings will be a diverse mix and will not include cottonwood or other cotton bearing trees.

Postponed Work

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

Monitoring

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

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 3-2-1 states “Diseased or damaged trees or shrubs. Any dead, diseased or damaged trees or shrubs, which may harbor insects or diseased pests or diseases injurious to other trees or shrubs or any healthy tree which is in such a state of deterioration that any part of such tree may fall and damage property or cause injury to persons.”

Budget

Current Budget
Total $15,600 over 6 years ($2,600/year)

FY 2020 Budget
Removal: $2,100
Planting: $400
Watering & Maintenance: $100

FY 2021 Budget
Removal: $1,400
Planting: $300
Routine trimming: $800
Watering & Maintenance: $100

FY 2022 Budget
Removal: $2,100
Planting: $400
Watering & Maintenance: $100

FY 2023 Budget
Removal: $1,400
*Or saving for ash tree treatment and/or future ash removal
Planting: $300
Routine trimming: $800
Watering & Maintenance: $100

FY 2024 Budget
Removal: $2,100
*Or saving for ash tree treatment and/or future ash removal
Planting: $400
Watering & Maintenance: $100

FY 2025 Budget
Removal: $1,400
*Or saving for ash tree treatment and/or future ash removal
Planting: $300
Routine trimming: $800
Watering & Maintenance: $100

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Charlotte

Annual Energy Benefits of Public Trees

8/6/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Boxelder	0.7	54	101.4	99	153	(N/A)	14.0	10.7	19.16
Green ash	1.7	125	211.6	207	333	(N/A)	14.0	23.2	41.60
Apple	0.6	45	99.6	98	143	(N/A)	12.3	9.9	20.36
Maple	0.0	4	7.4	7	11	(N/A)	7.0	0.8	2.73
Silver maple	1.5	113	195.8	192	305	(N/A)	7.0	21.2	76.18
Norway maple	0.3	21	36.5	36	57	(N/A)	5.3	4.0	18.95
Black walnut	0.4	32	54.4	53	86	(N/A)	5.3	6.0	28.50
Swamp white oak	0.1	6	13.2	13	19	(N/A)	5.3	1.3	6.36
Northern red oak	0.1	8	15.4	15	23	(N/A)	3.5	1.6	11.39
Blue spruce	0.1	5	11.4	11	16	(N/A)	3.5	1.1	8.22
Red maple	0.1	11	21.7	21	32	(N/A)	3.5	2.3	16.21
White ash	0.3	20	28.4	28	48	(N/A)	1.8	3.3	48.12
Norway spruce	0.1	4	9.5	9	14	(N/A)	1.8	0.9	13.58
Eastern red cedar	0.0	0	0.7	1	1	(N/A)	1.8	0.1	0.93
Broadleaf Deciduous Small	0.1	6	12.8	13	18	(N/A)	1.8	1.3	18.19
White mulberry	0.1	6	12.8	13	18	(N/A)	1.8	1.3	18.19
River birch	0.0	0	0.8	1	1	(N/A)	1.8	0.1	1.10
Littleleaf linden	0.2	15	23.9	23	39	(N/A)	1.8	2.7	38.70
Catalpa	0.2	18	27.0	26	44	(N/A)	1.8	3.1	44.23
Cottonwood	0.3	20	38.1	37	57	(N/A)	1.8	4.0	57.32
Alder	0.1	6	12.8	13	18	(N/A)	1.8	1.3	18.19
Lilac	0.0	0	0.6	1	1	(N/A)	1.8	0.1	0.87
Total	6.8	520	935.9	917	1,437	(N/A)	100.0	100.0	25.21

Table 2: Annual Stormwater Benefits

Charlotte

Annual Stormwater Benefits of Public Trees

8/6/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Boxelder	4,873	132	(N/A)	14.0	8.2	16.51
Green ash	12,259	332	(N/A)	14.0	20.7	41.53
Apple	2,565	70	(N/A)	12.3	4.3	9.93
Maple	172	5	(N/A)	7.0	0.3	1.17
Silver maple	24,366	660	(N/A)	7.0	41.1	165.08
Norway maple	1,584	43	(N/A)	5.3	2.7	14.31
Black walnut	2,681	73	(N/A)	5.3	4.5	24.22
Swamp white oak	338	9	(N/A)	5.3	0.6	3.05
Northern red oak	548	15	(N/A)	3.5	0.9	7.42
Blue spruce	794	22	(N/A)	3.5	1.3	10.75
Red maple	763	21	(N/A)	3.5	1.3	10.33
White ash	1,663	45	(N/A)	1.8	2.8	45.05
Norway spruce	596	16	(N/A)	1.8	1.0	16.14
Eastern red cedar	24	1	(N/A)	1.8	0.0	0.66
Broadleaf Deciduous Small	264	7	(N/A)	1.8	0.4	7.17
White mulberry	264	7	(N/A)	1.8	0.4	7.17
River birch	12	0	(N/A)	1.8	0.0	0.33
Littleleaf linden	1,260	34	(N/A)	1.8	2.1	34.14
Catalpa	1,466	40	(N/A)	1.8	2.5	39.72
Cottonwood	2,591	70	(N/A)	1.8	4.4	70.21
Alder	264	7	(N/A)	1.8	0.4	7.17
Lilac	7	0	(N/A)	1.8	0.0	0.20
Citywide total	59,354	1,608	(N/A)	100.0	100.0	28.22

Table 3: Annual Air Quality Benefits

Charlotte

Annual Air Quality Benefits of Public Trees

8/6/2020

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								
Boxelder	0.3	0.1	0.2	0.0	2	3.4	0.5	0.5	3.2	21	-0.2	-1	8.0	22	(N/A)	14.0	2.79
Green ash	1.0	0.2	0.6	0.0	6	7.8	1.1	1.1	7.5	49	0.0	0	19.3	54	(N/A)	14.0	6.79
Apple	0.7	0.1	0.3	0.0	4	3.0	0.4	0.4	2.7	18	0.0	0	7.6	22	(N/A)	12.3	3.11
Maple	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	2	(N/A)	7.0	0.38
Silver maple	4.3	0.7	2.1	0.2	23	7.0	1.0	1.0	6.7	44	-2.2	-8	20.9	59	(N/A)	7.0	14.75
Norway maple	0.2	0.0	0.1	0.0	1	1.3	0.2	0.2	1.3	8	-0.1	0	3.3	9	(N/A)	5.3	3.09
Black walnut	0.2	0.0	0.1	0.0	1	2.0	0.3	0.3	1.9	12	0.0	0	4.8	13	(N/A)	5.3	4.47
Swamp white oak	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	2	0.0	0	0.9	3	(N/A)	5.3	0.85
Northern red oak	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	-0.1	0	1.1	3	(N/A)	3.5	1.55
Blue spruce	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.7	2	(N/A)	3.5	0.86
Red maple	0.1	0.0	0.1	0.0	0	0.7	0.1	0.1	0.7	4	0.0	0	1.7	5	(N/A)	3.5	2.38
White ash	0.1	0.0	0.1	0.0	1	1.2	0.2	0.2	1.2	8	0.0	0	3.0	8	(N/A)	1.8	8.32
Norway spruce	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	1	(N/A)	1.8	1.48
Eastern red cedar	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)	1.8	0.09
Broadleaf Deciduous Small	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)	1.8	2.55
White 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)	1.8	2.55
River birch	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)	1.8	0.14
Littleleaf linden	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.9	6	-0.1	0	2.3	6	(N/A)	1.8	6.42
Catalpa	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)	1.8	7.42
Cottonwood	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)	1.8	9.34
Alder	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)	1.8	2.55
Lilac	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)	1.8	0.11
Citywide total	7.8	1.3	4.2	0.4	43	32.6	4.8	4.5	31.0	203	-3.1	-12	83.5	235	(N/A)	100.0	4.12

Table 4: Annual Carbon Stored

Charlotte

Stored CO2 Benefits of Public Trees

8/6/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Boxelder	7,041	53	(N/A)	14.0	3.8	6.60
Green ash	33,672	253	(N/A)	14.0	18.1	31.57
Apple	11,460	86	(N/A)	12.3	6.2	12.28
Maple	269	2	(N/A)	7.0	0.1	0.50
Silver maple	98,100	736	(N/A)	7.0	52.8	183.94
Norway maple	3,859	29	(N/A)	5.3	2.1	9.65
Black walnut	5,741	43	(N/A)	5.3	3.1	14.35
Swamp white oak	454	3	(N/A)	5.3	0.2	1.13
Northern red oak	1,037	8	(N/A)	3.5	0.6	3.89
Blue spruce	286	2	(N/A)	3.5	0.2	1.07
Red maple	1,319	10	(N/A)	3.5	0.7	4.95
White ash	3,672	28	(N/A)	1.8	2.0	27.54
Norway spruce	257	2	(N/A)	1.8	0.1	1.93
Eastern red cedar	3	0	(N/A)	1.8	0.0	0.02
Broadleaf Deciduous	908	7	(N/A)	1.8	0.5	6.81
White mulberry	908	7	(N/A)	1.8	0.5	6.81
River birch	17	0	(N/A)	1.8	0.0	0.13
Littleleaf linden	3,595	27	(N/A)	1.8	1.9	26.96
Catalpa	3,672	28	(N/A)	1.8	2.0	27.54
Cottonwood	8,458	63	(N/A)	1.8	4.6	63.43
Alder	908	7	(N/A)	1.8	0.5	6.81
Lilac	14	0	(N/A)	1.8	0.0	0.10
Citywide total	185,648	1,392	(N/A)	100.0	100.0	24.43

Table 5: Annual Carbon Sequestered

Charlotte

Annual CO Benefits of Public Trees

8/6/2020

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
Boxelder	1,198	9	-35	-8	0	1,190	9	2,345	18	(N/A)	14.0	8.5	2.20
Green ash	3,518	26	-162	-16	-1	2,772	21	6,113	46	(N/A)	14.0	22.1	5.73
Apple	1,086	8	-55	-9	0	993	7	2,014	15	(N/A)	12.3	7.3	2.16
Maple	47	0	-1	-1	0	81	1	125	1	(N/A)	7.0	0.5	0.23
Silver maple	6,793	51	-471	-17	-4	2,494	19	8,798	66	(N/A)	7.0	31.9	16.50
Norway maple	487	4	-19	-3	0	467	4	932	7	(N/A)	5.3	3.4	2.33
Black walnut	863	6	-28	-4	0	710	5	1,541	12	(N/A)	5.3	5.6	3.85
Swamp white oak	197	1	-4	-1	0	136	1	328	2	(N/A)	5.3	1.2	0.82
Northern red oak	152	1	-5	-1	0	171	1	317	2	(N/A)	3.5	1.1	1.19
Blue spruce	40	0	-1	-1	0	117	1	154	1	(N/A)	3.5	0.6	0.58
Red maple	204	2	-6	-2	0	246	2	442	3	(N/A)	3.5	1.6	1.66
White ash	494	4	-18	-2	0	449	3	923	7	(N/A)	1.8	3.3	6.92
Norway spruce	53	0	-1	-1	0	94	1	145	1	(N/A)	1.8	0.5	1.08
Eastern red cedar	1	0	0	0	0	6	0	6	0	(N/A)	1.8	0.0	0.05
Broadleaf Deciduous Smal	114	1	-4	-1	0	124	1	232	2	(N/A)	1.8	0.8	1.74
White mulberry	114	1	-4	-1	0	124	1	232	2	(N/A)	1.8	0.8	1.74
River birch	5	0	0	0	0	7	0	12	0	(N/A)	1.8	0.0	0.09
Littleleaf linden	514	4	-17	-2	0	337	3	832	6	(N/A)	1.8	3.0	6.24
Catalpa	445	3	-18	-2	0	393	3	819	6	(N/A)	1.8	3.0	6.14
Cottonwood	660	5	-41	-3	0	441	3	1,058	8	(N/A)	1.8	3.8	7.93
Alder	114	1	-4	-1	0	124	1	232	2	(N/A)	1.8	0.8	1.74
Lilac	9	0	0	0	0	6	0	14	0	(N/A)	1.8	0.1	0.10
Citywide total	17,106	128	-895	-78	-7	11,482	86	27,615	207	(N/A)	100.0	100.0	3.63

Table 6: Annual Social and Aesthetic Benefits

Charlotte

Annual Aesthetic/Other Benefits of Public Trees

8/6/2020

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Boxelder	201	(N/A)	14.0	12.1	25.10
Green ash	356	(N/A)	14.0	21.4	44.49
Apple	63	(N/A)	12.3	3.8	8.98
Maple	7	(N/A)	7.0	0.4	1.85
Silver maple	504	(N/A)	7.0	30.3	126.09
Norway maple	55	(N/A)	5.3	3.3	18.26
Black walnut	103	(N/A)	5.3	6.2	34.32
Swamp white oak	29	(N/A)	5.3	1.7	9.50
Northern red oak	18	(N/A)	3.5	1.1	8.89
Blue spruce	26	(N/A)	3.5	1.6	13.06
Red maple	37	(N/A)	3.5	2.2	18.56
White ash	64	(N/A)	1.8	3.8	63.74
Norway spruce	15	(N/A)	1.8	0.9	15.42
Eastern red cedar	4	(N/A)	1.8	0.3	4.27
Broadleaf Deciduous Small	6	(N/A)	1.8	0.4	6.40
White mulberry	6	(N/A)	1.8	0.4	6.40
River birch	3	(N/A)	1.8	0.2	2.74
Littleleaf linden	55	(N/A)	1.8	3.3	55.09
Catalpa	46	(N/A)	1.8	2.8	45.86
Cottonwood	58	(N/A)	1.8	3.5	57.69
Alder	6	(N/A)	1.8	0.4	6.40
Lilac	0	(N/A)	1.8	0.0	0.03
Citywide total	1,663	(N/A)	100.0	100.0	29.17

Table 7: Summary of Benefits in Dollars

Charlotte

Total Annual Benefits of Public Trees by Species ($)

8/6/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Boxelder	153	18	22	132	201	526	(N/A)	10.2
Green ash	333	46	54	332	356	1,121	(N/A)	21.8
Apple	143	15	22	70	63	312	(N/A)	6.1
Maple	11	1	2	5	7	25	(N/A)	0.5
Silver maple	305	66	59	660	504	1,594	(N/A)	31.0
Norway maple	57	7	9	43	55	171	(N/A)	3.3
Black walnut	86	12	13	73	103	286	(N/A)	5.6
Swamp white oak	19	2	3	9	29	62	(N/A)	1.2
Northern red oak	23	2	3	15	18	61	(N/A)	1.2
Blue spruce	16	1	2	22	26	67	(N/A)	1.3
Red maple	32	3	5	21	37	98	(N/A)	1.9
White ash	48	7	8	45	64	172	(N/A)	3.3
Norway spruce	14	1	1	16	15	48	(N/A)	0.9
Eastern red cedar	1	0	0	1	4	6	(N/A)	0.1
Broadleaf Deciduous Sn	18	2	3	7	6	36	(N/A)	0.7
White mulberry	18	2	3	7	6	36	(N/A)	0.7
River birch	1	0	0	0	3	4	(N/A)	0.1
Littleleaf linden	39	6	6	34	55	141	(N/A)	2.7
Catalpa	44	6	7	40	46	143	(N/A)	2.8
Cottonwood	57	8	9	70	58	202	(N/A)	3.9
Alder	18	2	3	7	6	36	(N/A)	0.7
Lilac	1	0	0	0	0	1	(N/A)	0.0
Citywide Total	1,437	207	235	1,608	1,663	5,150	(N/A)	100.0

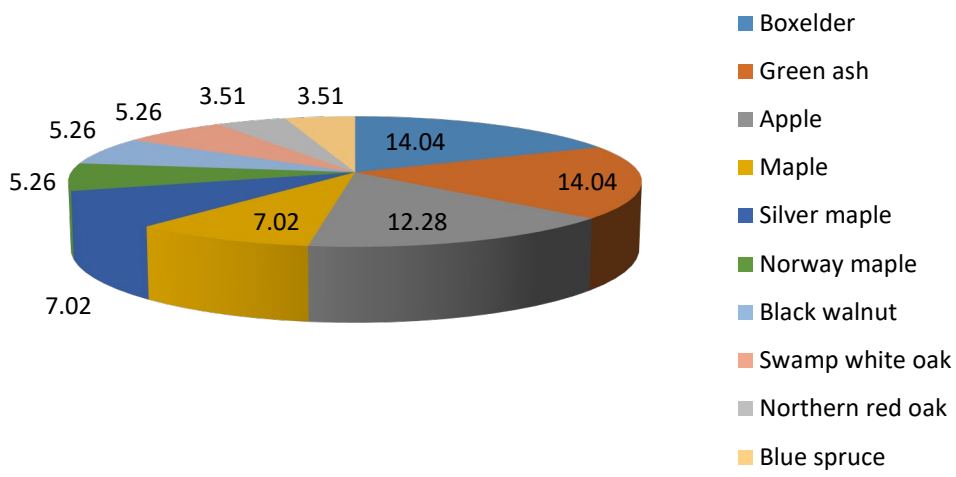

Figure 1: Species Distribution

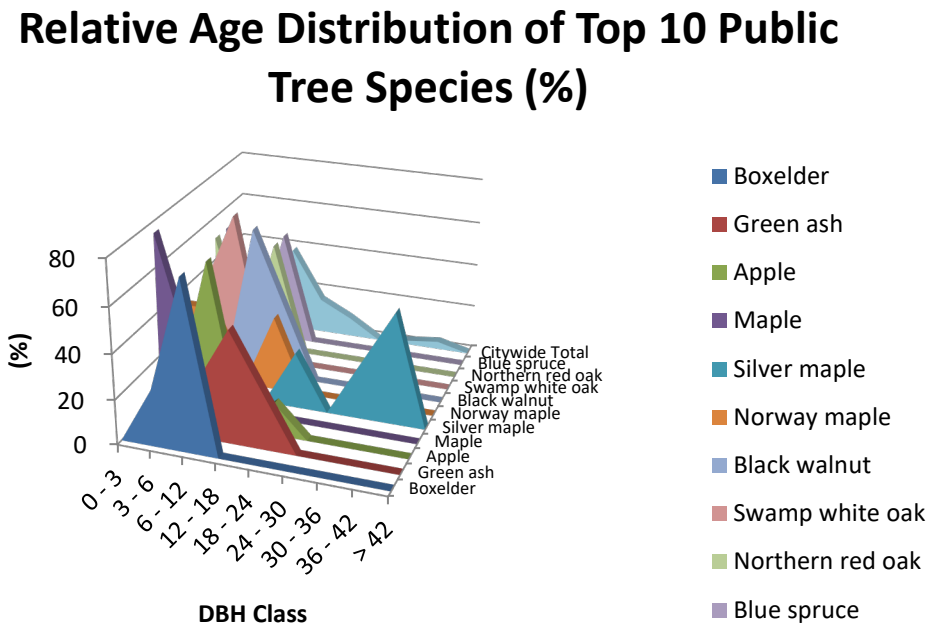

Figure 2: Relative Age Class

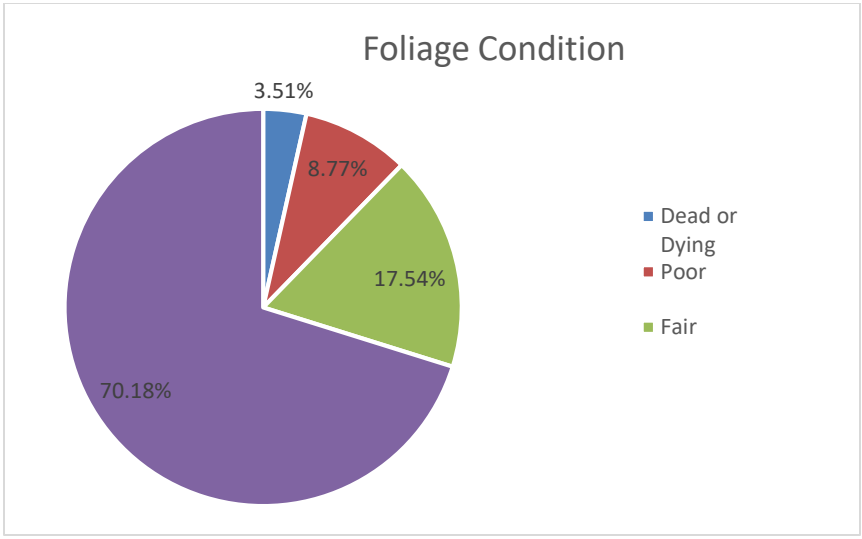

Figure 3: Foliage Condition

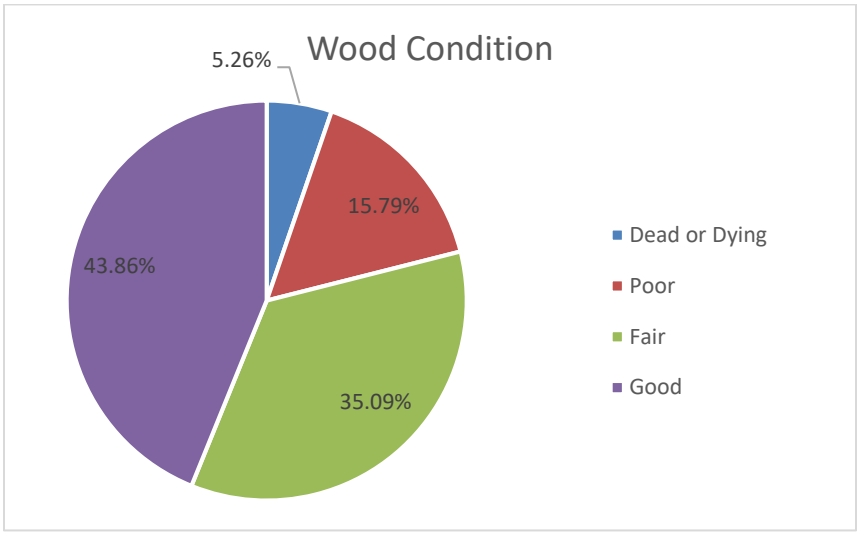

Figure 4: Wood Condition

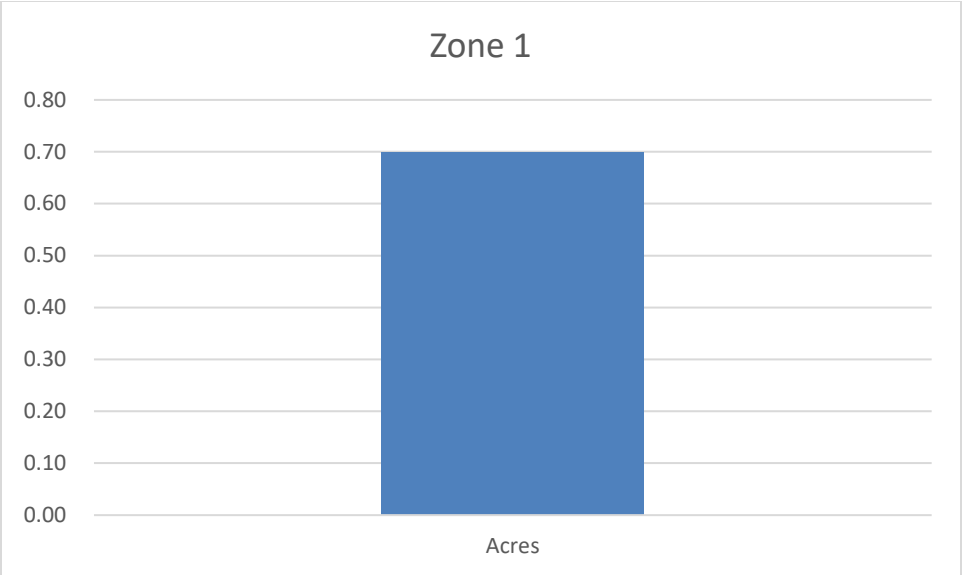

Figure 5: Canopy Cover in Acres

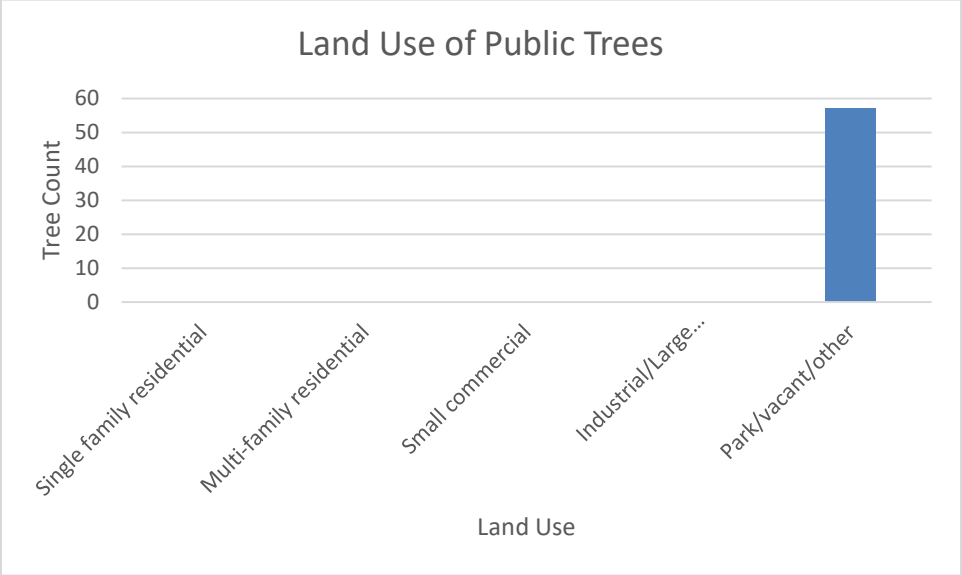

Figure 6: Land Use of city/park trees

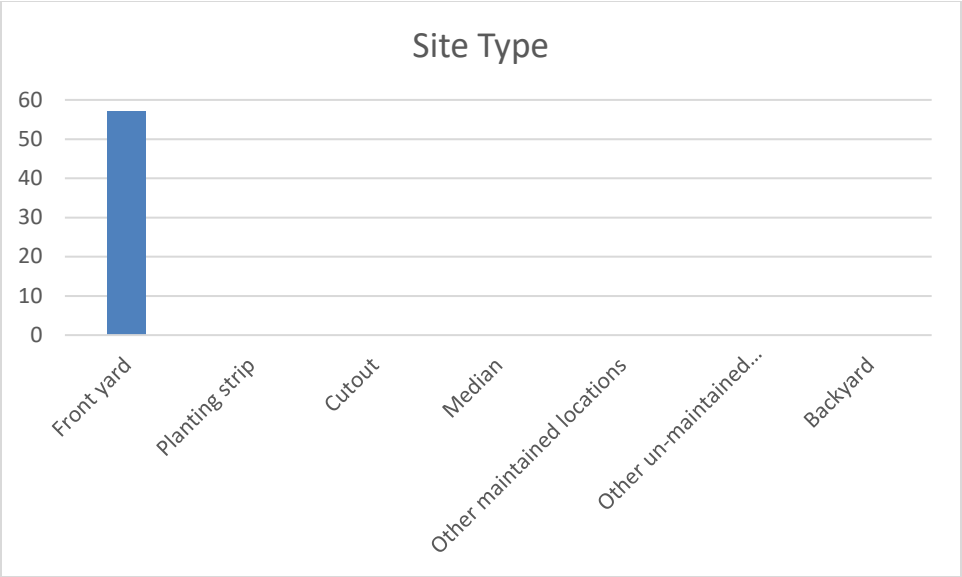

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

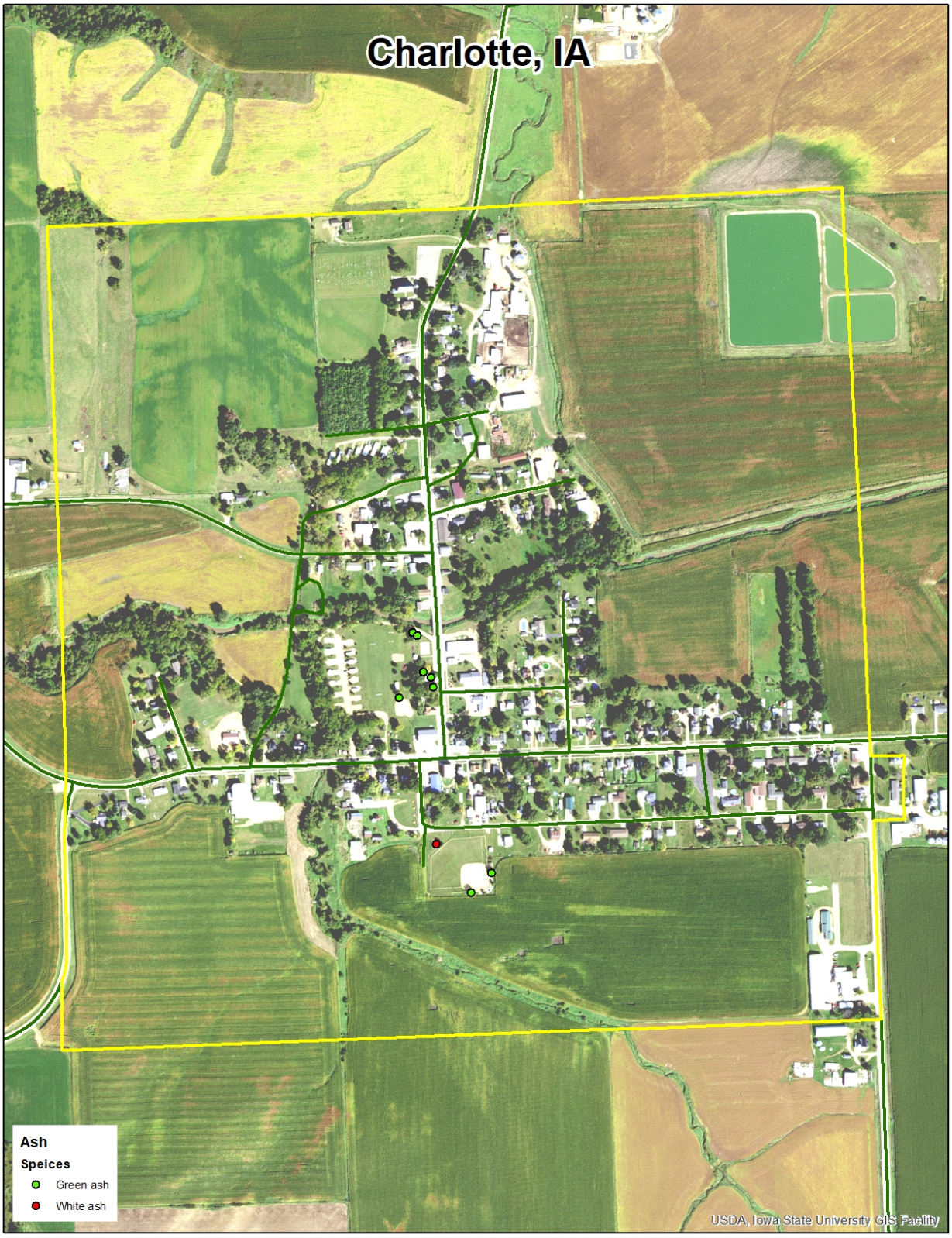

Figure 1: Location of Ash Trees

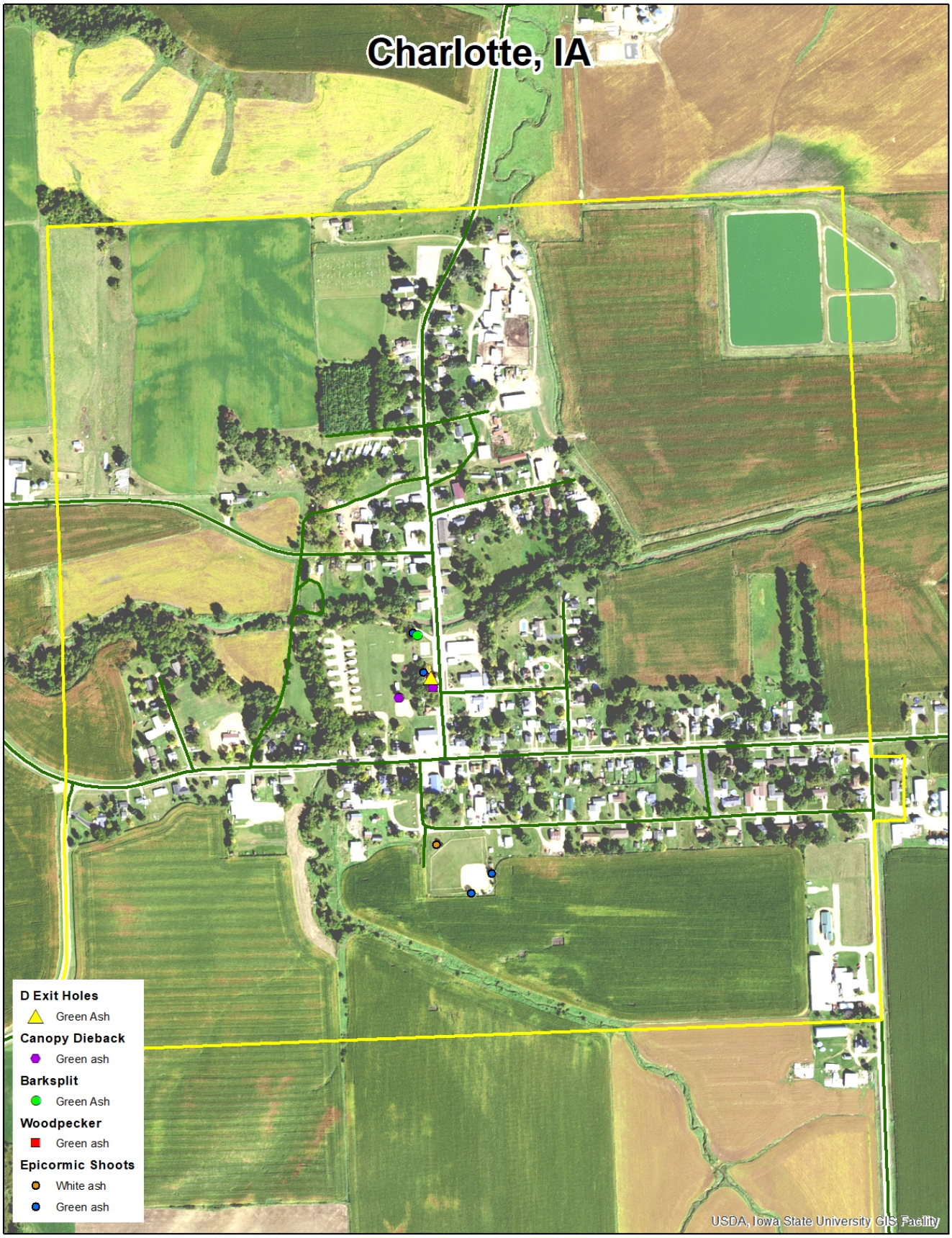

Figure 2: Location of EAB symptoms

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

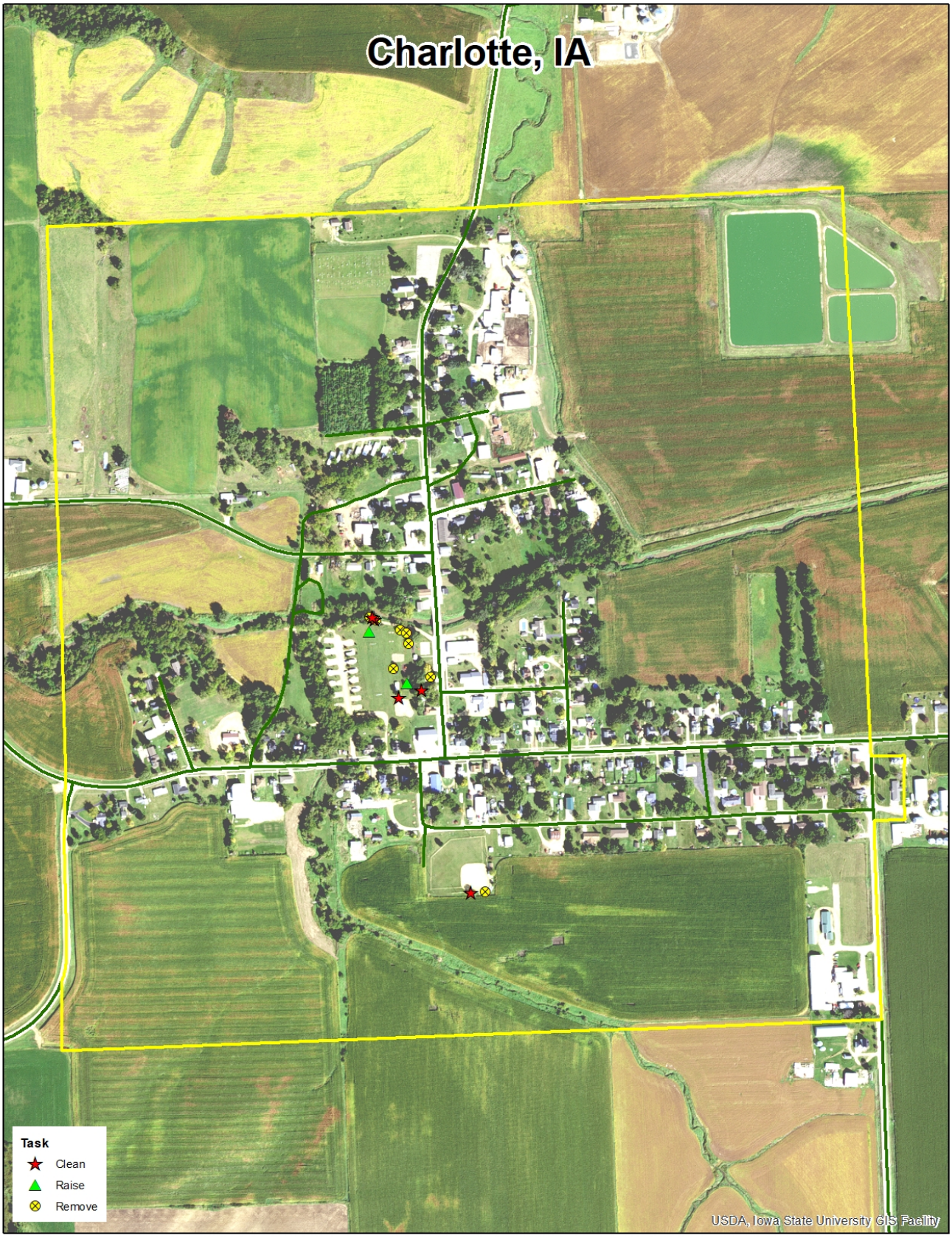

Figure 5: Maintenance Tasks ***City ownership of the trees recommended for removal should be verified prior to any removal***

Appendix C: Charlotte Tree Ordinances

3-2-1 r. Diseased or damaged trees or shrubs. Any dead, diseased or damaged trees or shrubs, which may harbor insects or diseased pests or diseases injurious to other trees or shrubs or any healthy tree which is in such a state of deterioration that any part of such tree may fall and damage property or cause injury to persons.

3-2-1 aa. Any hazardous thing or condition on property which may contribute to injury of any person present on the property; hazards include, but are not limited to, open holes, open wells, open foundation, dangerous trees or limbs, abandoned and unsecured refrigerators or trapping devices.

3-2-1 h. Cotton-bearing cottonwood trees and all other cotton-bearing poplar trees in the City.