Carter Lake, Iowa

2015 Urban Forest
Management plan
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In Partnership with
the Iowa DNR

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Executive Summary

Overview

This plan was developed to assist the City of Carter Lake with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management plan allows a community to take the best 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 24% of Carter Lake'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 2015, 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 the290 trees inventoried.

- Carter Lake's trees provide $26,537.00 of benefits annually, an average of $91.51 a tree
- There are 36 species of trees
- Carter Lake has 60 ash trees owned by the city
- The top three genera are: Ash 19.3%, Maple 13.4%, and Crabapple 10.7%
- 10 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.

- 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 with a visual survey yearly

Introduction

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

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

Inventory

In 2015, 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 290 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis. Findings

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Carter Lake's trees reduce energy related costs by approximately $2,621 annually (Appendix A, Table 1). These savings are both in Electricity (34.5 MWh) and in Natural Gas (4,823.8 Therms).

Annual Stormwater Benefits

Carter Lake's trees intercept about 369,088 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $10,002.00 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 Carter Lake, it is estimated that trees remove 456 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 $1,296 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Carter Lake, trees sequester about 79,506 lbs of carbon a year with an associated value of $596.00 (Appendix A, Table 4). In addition, the trees store 129,545 lbs of carbon, with a yearly benefit of $972.00 (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. Carter Lake receives $6,918.00 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Carter Lake's trees provide $26,537.00 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 290 trees in Carter Lake provide approximately $91.51 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Carter Lake has over 30 different tree species along city streets and parks (Appendix A, Figure 1).
The distribution of trees is as follows:

Species	# of Standard	% of Public
Green ash	56 (N/A)	19.31
Apple	31 (N/A)	10.69
Honeylocust	21 (N/A)	7.24
Red maple	21 (N/A)	7.24
Silver maple	18 (N/A)	6.21
American	15 (N/A)	5.17

Chinese elm	13 (N/A)	4.48
Siberian elm	12 (N/A)	4.14
Pear	11 (N/A)	3.79
Northern red oak	9 (N/A)	3.10
Maple	8 (N/A)	2.76
American elm	8 (N/A)	2.76
Broadleaf	7 (N/A)	2.41
Mulberry	6 (N/A)	2.07
Eastern white pine	5 (N/A)	1.72
Eastern red cedar	5 (N/A)	1.72
Birch	5 (N/A)	1.72
Littleleaf linden	4 (N/A)	1.38
White ash	4 (N/A)	1.38
Swamp white oak	4 (N/A)	1.38
Catalpa	4 (N/A)	1.38
Norway maple	4 (N/A)	1.38
Ginkgo	3 (N/A)	1.03
Ponderosa pine	2 (N/A)	0.69
Northern	2 (N/A)	0.69
Tulip tree	2 (N/A)	0.69
White mulberry	1 (N/A)	0.34
Black poplar	1 (N/A)	0.34
Amur maple	1 (N/A)	0.34
Black walnut	1 (N/A)	0.34
Sugar maple	1 (N/A)	0.34
Boxelder	1 (N/A)	0.34
Blue spruce	1 (N/A)	0.34
Cherry plum	1 (N/A)	0.34
Bur oak	1 (N/A)	0.34
Amur corktree	1 (N/A)	0.34
Citywide	290 (N/A)	100.00

Age Class

A good portion of Carter Lake's trees (28.71%) 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. Carter Lake's size curve is about in the middle, indicating a stand that has a fair representation of young and mature trees .

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 Carter Lake indicate that over 97% of the trees are in good health. Similarly, over 97% of Carter Lake'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 less than 3% of the population. This 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	280	97%
Tree Removal	10	3%

Canopy Cover

The canopy cover included in the Carter Lake inventory includes approximately 4 acres.

Land Use and Location

The majority of Carter Lake'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 Dwelling	75%
Park	25%

Location	
Planting strip	49%
Front yard	51%

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

Carter Lake has 10 critical concern trees that need immediate removal. This tree 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. 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.

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 Carter Lake.

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 (40.6%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut, as outlined in section 151.02 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.02 (Appendix C).

Continual Monitoring

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

Year 1

- Removal: 10 critical concern trees
- Planting and Replacement: 12 trees to be planted in open locations
- Visual Survey for signs and symptoms of EAB

Year 2

- Removal: 3 ash trees with poor health
- *Or saving for ash tree treatment
- Planting and Replacement: plant 4 trees in open locations from year one removals
- Routine trimming: Contract to trim city trees
- Visual Survey for signs and symptoms of EAB

Year 3

- Removal: 3 trees - removal of any new critical concern trees and ash in poor health
- *Or saving for ash tree treatment
- Planting and Replacement: 3 trees to be planted in open locations and locations from previous removals
- Visual Survey for signs and symptoms of EAB

Year 4

- Removal: 3 trees - removal of any new critical concern trees and ash in poor health
- *Or saving for ash tree treatment
- Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals
- 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
Planting and Replacement: 3 trees to be planted in open locations and locations from previous removals
Visual Survey for signs and symptoms of EAB

Year 6

Removal: 3 trees - removal of any new critical concern trees and ash in poor health
*Or saving for ash tree treatment
Planting and Replacement: 4 trees to be planted in open locations and locations from previous removals
Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 15 ash trees removed (approximately 25% of ash). EAB could potentially kill all ash within 4 years of its arrival.
** To remove all ash trees within 6 years, the budget would need to be increased to $8,000 a year. If the budget were increased to $3,700.00 a year all ash could be removed in 13 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. All trees will meet the restrictions in city ordinance 151.02 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

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

Monitoring

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

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB. City Code 151.06 states “If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.”

Budget

Current Budget
Total $21,000 over 6 years ($3,500/year)

FY 2017 Budget
Removal: $2,400
Replanting and associated maintenance: $1,100.00

FY 2018 Budget
Removal: $2,400
Replanting and associated maintenance: $1,100.00

FY 2019 Budget
Removal: $2,400
Replanting and associated maintenance: $1,100.00

FY 2020 Budget
Removal: $2,400
Replanting and associated maintenance: $1,100.00

FY 2021 Budget
Removal: $2,400
Replanting and associated maintenance: $1,100.00

FY 2022 Budget
Removal: $2,400
Replanting and associated maintenance: $1,100.00

* Reduction of ash over 6 years: Approximately 10 ash trees removed (approximately 25% of ash). EAB could potentially kill all ash within 4 years of its arrival). **It will take approximately 24 years to remove all ash with the current budget.**

Purposed Budget Increase

EAB could potentially kill all ash trees in Carter Lake within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $8,100 a year. If the budget were increased to $3,700 a year all ash could be removed within 13 years. Additionally, it is recommended that Carter Lake 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.

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Carter Lake

Annual Energy Benefits of Public Trees

6/28/2016

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	9.1	690	1,253.9	1,229	1,919	(N/A)	19.3	26.1	34.27
Apple	1.8	134	277.4	272	406	(N/A)	10.7	5.5	13.09
Honeylocust	1.6	118	212.7	208	327	(N/A)	7.2	4.4	15.57
Red maple	0.6	45	86.0	84	129	(N/A)	7.2	1.8	6.14
Silver maple	4.5	344	601.9	590	934	(N/A)	6.2	12.7	51.87
American basswood	0.2	15	31.8	31	46	(N/A)	5.2	0.6	3.08
Chinese elm	4.4	337	614.6	602	939	(N/A)	4.5	12.8	72.23
Siberian elm	4.7	355	626.4	614	969	(N/A)	4.1	13.2	80.75
Pear	0.3	23	53.0	52	75	(N/A)	3.8	1.0	6.83
Northern red oak	0.3	20	41.0	40	60	(N/A)	3.1	0.8	6.72
American elm	0.6	47	76.9	75	123	(N/A)	2.8	1.7	15.31
Maple	0.0	2	5.9	6	8	(N/A)	2.8	0.1	1.03
Broadleaf Deciduous Small	0.2	15	35.1	34	50	(N/A)	2.4	0.7	7.11
Mulberry	1.2	91	189.7	186	277	(N/A)	2.1	3.8	46.14
Birch	0.7	52	98.3	96	148	(N/A)	1.7	2.0	29.58
Eastern red cedar	0.2	14	28.2	28	42	(N/A)	1.7	0.6	8.30
Eastern white pine	0.1	4	9.9	10	14	(N/A)	1.7	0.2	2.80
Catalpa	1.3	97	174.4	171	268	(N/A)	1.4	3.6	67.02
Littleleaf linden	0.0	2	5.2	5	8	(N/A)	1.4	0.1	1.88
Norway maple	0.1	4	8.6	8	12	(N/A)	1.4	0.2	3.07
Swamp white oak	0.0	1	3.2	3	4	(N/A)	1.4	0.1	1.10
White ash	0.4	28	53.3	52	80	(N/A)	1.4	1.1	20.10
Ginkgo	0.1	5	10.7	10	16	(N/A)	1.0	0.2	5.29
Tulip tree	0.0	0	0.9	1	1	(N/A)	0.7	0.0	0.66
Ponderosa pine	0.2	18	34.1	33	52	(N/A)	0.7	0.7	25.88
Northern hackberry	0.7	56	107.9	106	162	(N/A)	0.7	2.2	81.12
Blue spruce	0.0	0	1.2	1	2	(N/A)	0.3	0.0	1.65
Cherry plum	0.0	2	3.8	4	5	(N/A)	0.3	0.1	5.40
Amur corktree	0.1	8	16.9	17	24	(N/A)	0.3	0.3	24.47
Bur oak	0.0	0	0.5	0	1	(N/A)	0.3	0.0	0.66
Boxelder	0.3	20	36.3	36	55	(N/A)	0.3	0.8	55.14
Black walnut	0.4	33	59.0	58	91	(N/A)	0.3	1.2	91.02
Amur maple	0.2	14	24.7	24	38	(N/A)	0.3	0.5	38.13
Black poplar	0.2	18	27.0	26	44	(N/A)	0.3	0.6	44.23
White mulberry	0.1	6	12.8	13	18	(N/A)	0.3	0.2	18.19
Sugar maple	0.0	0	0.7	1	1	(N/A)	0.3	0.0	1.00
Total	34.5	2,621	4,823.8	4,727	7,349	(N/A)	100.0	100.0	25.34

Carter Lake

Annual Stormwater Benefits of Public Trees

6/28/2016

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	93,137	2,524	(N/A)	19.3	25.2	45.07
Apple	6,270	170	(N/A)	10.7	1.7	5.48
Honeylocust	10,208	277	(N/A)	7.2	2.8	13.17
Red maple	3,980	108	(N/A)	7.2	1.1	5.14
Silver maple	74,355	2,015	(N/A)	6.2	20.1	111.95
American basswood	780	21	(N/A)	5.2	0.2	1.41
Chinese elm	57,506	1,558	(N/A)	4.5	15.6	119.88
Siberian elm	55,811	1,512	(N/A)	4.1	15.1	126.04
Pear	1,037	28	(N/A)	3.8	0.3	2.55
Northern red oak	1,339	36	(N/A)	3.1	0.4	4.03
American elm	5,046	137	(N/A)	2.8	1.4	17.09
Maple	93	3	(N/A)	2.8	0.0	0.32
Broadleaf Deciduous Small	689	19	(N/A)	2.4	0.2	2.67
Mulberry	7,044	191	(N/A)	2.1	1.9	31.82
Birch	4,800	130	(N/A)	1.7	1.3	26.01
Eastern red cedar	2,526	68	(N/A)	1.7	0.7	13.69
Eastern white pine	572	15	(N/A)	1.7	0.2	3.10
Catalpa	14,842	402	(N/A)	1.4	4.0	100.55
Littleleaf linden	114	3	(N/A)	1.4	0.0	0.77
Norway maple	199	5	(N/A)	1.4	0.1	1.35
Swamp white oak	49	1	(N/A)	1.4	0.0	0.33
White ash	2,455	67	(N/A)	1.4	0.7	16.63
Ginkgo	316	9	(N/A)	1.0	0.1	2.85
Tulip tree	36	1	(N/A)	0.7	0.0	0.48
Ponderosa pine	5,200	141	(N/A)	0.7	1.4	70.46
Northern hackberry	7,239	196	(N/A)	0.7	2.0	98.09
Blue spruce	38	1	(N/A)	0.3	0.0	1.03
Cherry plum	69	2	(N/A)	0.3	0.0	1.86
Amur corktree	586	16	(N/A)	0.3	0.2	15.88
Bur oak	18	0	(N/A)	0.3	0.0	0.48
Boxelder	3,090	84	(N/A)	0.3	0.8	83.73
Black walnut	7,239	196	(N/A)	0.3	2.0	196.17
Amur maple	667	18	(N/A)	0.3	0.2	18.06
Black poplar	1,466	40	(N/A)	0.3	0.4	39.72
White mulberry	264	7	(N/A)	0.3	0.1	7.17
Sugar maple	11	0	(N/A)	0.3	0.0	0.29
Citywide total	369,088	10,002	(N/A)	100.0	100.0	34.49

Carter Lake

Annual Air Quality Benefits of Public Trees

6/28/2016

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	11.6	1.8	5.6	0.5	62	43.5	6.3	6.0	41.2	271	0.0	0	116.6	332	(N/A)	19.3	5.94
Apple	1.4	0.2	0.7	0.1	8	8.7	1.2	1.2	8.0	54	0.0	0	21.6	61	(N/A)	10.7	1.98
Honeylocust	1.6	0.3	0.8	0.1	9	7.4	1.1	1.0	7.1	46	-1.1	-4	18.2	51	(N/A)	7.2	2.41
Red maple	0.8	0.1	0.4	0.0	4	2.9	0.4	0.4	2.7	18	-0.3	-1	7.4	21	(N/A)	7.2	1.00
Silver maple	14.1	2.4	6.8	0.6	76	21.4	3.1	3.0	20.5	134	-7.3	-27	64.7	182	(N/A)	6.2	10.12
American basswood	0.0	0.0	0.0	0.0	0	1.0	0.1	0.1	0.9	6	0.0	0	2.2	6	(N/A)	5.2	0.40
Chinese elm	7.9	1.3	3.6	0.4	42	21.3	3.1	2.9	20.1	132	0.0	0	60.5	174	(N/A)	4.5	13.37
Siberian elm	10.5	1.8	5.0	0.5	56	22.2	3.2	3.1	21.2	139	0.0	0	67.4	195	(N/A)	4.1	16.22
Pear	0.1	0.0	0.1	0.0	1	1.6	0.2	0.2	1.4	9	0.0	0	3.6	10	(N/A)	3.8	0.94
Northern red oak	0.1	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	-0.2	-1	3.0	8	(N/A)	3.1	0.91
American elm	1.5	0.3	0.7	0.1	8	2.9	0.4	0.4	2.8	18	0.0	0	9.1	26	(N/A)	2.8	3.28
Maple	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.1	1	0.0	0	0.4	1	(N/A)	2.8	0.13
Broadleaf Deciduous Small	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	0.0	0	2.4	7	(N/A)	2.4	0.98
Mulberry	2.6	0.4	1.2	0.1	14	5.9	0.8	0.8	5.4	36	0.0	0	17.3	50	(N/A)	2.1	8.35
Birch	0.8	0.1	0.4	0.0	4	3.3	0.5	0.5	3.1	20	-0.2	-1	8.5	24	(N/A)	1.7	4.79
Eastern red cedar	0.4	0.1	0.3	0.1	3	0.9	0.1	0.1	0.8	6	-1.4	-5	1.5	3	(N/A)	1.7	0.63
Eastern white pine	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.5	1	(N/A)	1.7	0.25
Catalpa	1.9	0.3	0.9	0.1	10	6.1	0.9	0.8	5.8	38	0.0	0	16.8	48	(N/A)	1.4	12.02
Littleleaf linden	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.1	1	0.0	0	0.4	1	(N/A)	1.4	0.25
Norway maple	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.2	2	0.0	0	0.6	2	(N/A)	1.4	0.41
Swamp white oak	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.2	1	(N/A)	1.4	0.14
White ash	0.1	0.0	0.1	0.0	1	1.8	0.3	0.2	1.7	11	0.0	0	4.1	12	(N/A)	1.4	2.91
Ginkgo	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2	(N/A)	1.0	0.75
Tulip tree	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0	(N/A)	0.7	0.08
Ponderosa pine	0.6	0.1	0.5	0.1	4	1.2	0.2	0.2	1.1	7	-3.0	-11	0.9	0	(N/A)	0.7	-0.05
Northern hackberry	1.1	0.2	0.6	0.0	6	3.6	0.5	0.5	3.4	22	0.0	0	9.9	28	(N/A)	0.7	14.21
Blue spruce	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0	(N/A)	0.3	0.18
Cherry plum	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)	0.3	0.71
Amur corktree	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)	0.3	3.47
Bur oak	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)	0.3	0.08
Boxelder	0.4	0.1	0.2	0.0	2	1.2	0.2	0.2	1.2	8	-0.2	-1	3.3	9	(N/A)	0.3	9.31
Black walnut	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.3	19.04
Amur maple	0.2	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	5	0.0	0	2.3	7	(N/A)	0.3	6.56
Black poplar	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)	0.3	7.42
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)	0.3	2.55

Carter Lake

Annual Air Quality Benefits of Public Trees

6/28/2016

Species	Deposition (lb) O_3	Deposition (lb) NO_2	Deposition (lb) PM_{10}	Deposition (lb) SO_2	Total Depos. ($)	Avoided (lb) NO_2	Avoided (lb) PM_{10}	Avoided (lb) VOC	Avoided (lb) SO_2	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	Standard Error	% of Total Trees	Avg. $/tree
Sugar 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)	0.3	0.13
Citywide total	59.4	9.9	29.0	2.7	319	165.6	24.1	22.9	156.5	1,030	-14.0	-53	456.0	1,296	(N/A)	100.0	4.47

Carter Lake

Annual CO 2 Benefits of Public Trees

6/28/2016

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	19,619	147	-1,898	-104	-1	15,252	114	32,868	247 (N/A)	19.3	25.4	4.40
Apple	2,702	20	-117	-26	0	2,958	22	5,516	41 (N/A)	10.7	4.3	1.33
Honeylocust	1,638	12	-106	-15	0	2,617	20	4,135	31 (N/A)	7.2	3.2	1.48
Red maple	1,231	9	-47	-9	0	988	7	2,162	16 (N/A)	7.2	1.7	0.77
Silver maple	22,349	168	-1,644	-55	0	7,600	57	28,249	212 (N/A)	6.2	21.8	11.77
American basswood	233	2	-6	-5	0	333	2	554	4 (N/A)	5.2	0.4	0.28
Chinese elm	10,658	80	-1,242	-48	0	7,443	56	16,811	126 (N/A)	4.5	13.0	9.70
Siberian elm	9,264	69	-1,219	-51	0	7,848	59	15,841	119 (N/A)	4.1	12.2	9.90
Pear	499	4	-16	-6	0	512	4	989	7 (N/A)	3.8	0.8	0.67
Northern red oak	379	3	-11	-4	0	450	3	813	6 (N/A)	3.1	0.6	0.68
American elm	893	7	-148	-8	0	1,041	8	1,777	13 (N/A)	2.8	1.4	1.67
Maple	23	0	-1	-2	0	54	0	74	1 (N/A)	2.8	0.1	0.07
Broadleaf Deciduous Smal	330	2	-11	-4	0	340	3	654	5 (N/A)	2.4	0.5	0.70
Mulberry	0	0	-194	-21	0	2,009	15	1,793	13 (N/A)	2.1	1.4	2.24
Birch	1,271	10	-64	-7	0	1,140	9	2,340	18 (N/A)	1.7	1.8	3.51
Eastern red cedar	97	1	-7	-4	0	307	2	394	3 (N/A)	1.7	0.3	0.59
Eastern white pine	47	0	0	-2	0	94	1	138	1 (N/A)	1.7	0.1	0.21
Catalpa	3,119	23	-294	-13	0	2,147	16	4,959	37 (N/A)	1.4	3.8	9.30
Littleleaf linden	114	1	-2	-1	0	54	0	165	1 (N/A)	1.4	0.1	0.31
Norway maple	112	1	-2	-1	0	86	1	195	1 (N/A)	1.4	0.2	0.36
Swamp white oak	22	0	-1	-1	0	29	0	49	0 (N/A)	1.4	0.0	0.09
White ash	728	5	-20	-5	0	622	5	1,326	10 (N/A)	1.4	1.0	2.49
Ginkgo	62	0	-2	-2	0	119	1	177	1 (N/A)	1.0	0.1	0.44
Tulip tree	5	0	0	0	0	9	0	13	0 (N/A)	0.7	0.0	0.05
Ponderosa pine	53	0	-37	-6	0	405	3	415	3 (N/A)	0.7	0.3	1.55
Northern hackberry	998	7	-77	-7	0	1,248	9	2,162	16 (N/A)	0.7	1.7	8.11
Blue spruce	2	0	0	0	0	10	0	12	0 (N/A)	0.3	0.0	0.09
Cherry plum	38	0	-1	-1	0	37	0	74	1 (N/A)	0.3	0.1	0.55
Amur corktree	224	2	-5	-1	0	176	1	393	3 (N/A)	0.3	0.3	2.95
Bur oak	3	0	0	0	0	4	0	7	0 (N/A)	0.3	0.0	0.05
Boxelder	1,038	8	-69	-4	0	433	3	1,399	10 (N/A)	0.3	1.1	10.49
Black walnut	912	7	-188	-5	0	734	6	1,453	11 (N/A)	0.3	1.1	10.90

Annual CO $_2$ Benefits of Public Trees

6/28/2016

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
Amur maple	268	2	-15	-2	0	308	2	560	4	(N/A)	0.3	0.4	4.20
Black poplar	445	3	-18	-2	0	393	3	819	6	(N/A)	0.3	0.6	6.14
White mulberry	114	1	-4	-1	0	124	1	232	2	(N/A)	0.3	0.2	1.74
Sugar maple	19	0	0	0	0	7	0	25	0	(N/A)	0.3	0.0	0.19
Citywide total	79,506	596	-7,468	-425	-3	57,931	434	129,545	972	(N/A)	100.0	100.0	3.35

Carter Lake

Annual Aesthetic/Other Benefits of Public Trees

6/28/2016

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,972	(N/A)	19.3	28.5	35.22
Apple	148	(N/A)	10.7	2.1	4.76
Honeylocust	309	(N/A)	7.2	4.5	14.69
Red maple	161	(N/A)	7.2	2.3	7.64
Silver maple	1,649	(N/A)	6.2	23.8	91.61
American basswood	42	(N/A)	5.2	0.6	2.79
Chinese elm	799	(N/A)	4.5	11.5	61.44
Siberian elm	593	(N/A)	4.1	8.6	49.41
Pear	26	(N/A)	3.8	0.4	2.32
Northern red oak	49	(N/A)	3.1	0.7	5.44
American elm	113	(N/A)	2.8	1.6	14.12
Maple	0	(N/A)	2.8	0.0	0.04
Broadleaf Deciduous Small	17	(N/A)	2.4	0.2	2.43
Mulberry	0	(N/A)	2.1	0.0	0.00
Birch	134	(N/A)	1.7	1.9	26.84
Eastern red cedar	57	(N/A)	1.7	0.8	11.39
Eastern white pine	31	(N/A)	1.7	0.4	6.19
Catalpa	244	(N/A)	1.4	3.5	60.91
Littleleaf linden	19	(N/A)	1.4	0.3	4.68
Norway maple	21	(N/A)	1.4	0.3	5.27
Swamp white oak	11	(N/A)	1.4	0.2	2.74
White ash	134	(N/A)	1.4	1.9	33.42
Ginkgo	8	(N/A)	1.0	0.1	2.51
Tulip tree	11	(N/A)	0.7	0.2	5.26
Ponderosa pine	15	(N/A)	0.7	0.2	7.71
Northern hackberry	127	(N/A)	0.7	1.8	63.56
Blue spruce	5	(N/A)	0.3	0.1	5.03
Cherry plum	2	(N/A)	0.3	0.0	2.06
Amur corktree	26	(N/A)	0.3	0.4	26.22
Bur oak	5	(N/A)	0.3	0.1	5.26
Boxelder	65	(N/A)	0.3	0.9	65.43
Black walnut	58	(N/A)	0.3	0.8	58.34
Amur maple	15	(N/A)	0.3	0.2	15.48
Black poplar	46	(N/A)	0.3	0.7	45.86
White mulberry	6	(N/A)	0.3	0.1	6.40
Sugar maple	0	(N/A)	0.3	0.0	0.49
Citywide total	6,918	(N/A)	100.0	100.0	23.85

Carter Lake

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

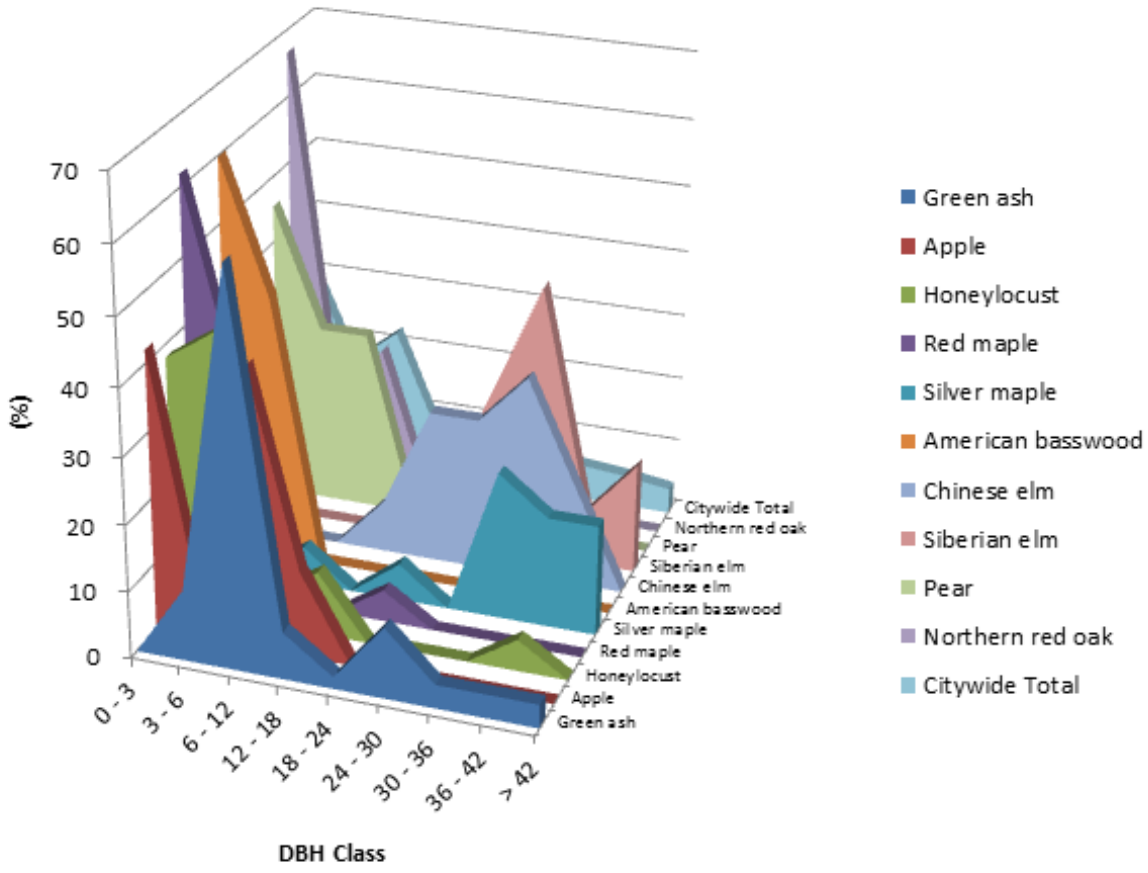
6/28/2016

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Green ash	34.27	4.40	5.94	45.07	35.22	124.90	(N/A)
Apple	13.09	1.33	1.98	5.48	4.76	26.65	(N/A)
Honeylocust	15.57	1.48	2.41	13.17	14.69	47.32	(N/A)
Red maple	6.14	0.77	1.00	5.14	7.64	20.70	(N/A)
Silver maple	51.87	11.77	10.12	111.95	91.61	277.32	(N/A)
American basswood	3.08	0.28	0.40	1.41	2.79	7.96	(N/A)
Chinese elm	72.23	9.70	13.37	119.88	61.44	276.62	(N/A)
Siberian elm	80.75	9.90	16.22	126.04	49.41	282.31	(N/A)
Pear	6.83	0.67	0.94	2.55	2.32	13.32	(N/A)
Northern red oak	6.72	0.68	0.91	4.03	5.44	17.77	(N/A)
American elm	15.31	1.67	3.28	17.09	14.12	51.47	(N/A)
Maple	1.03	0.07	0.13	0.32	0.04	1.58	(N/A)
Broadleaf Deciduous S	7.11	0.70	0.98	2.67	2.43	13.89	(N/A)
Mulberry	46.14	2.24	8.35	31.82	0.00	88.55	(N/A)
Birch	29.58	3.51	4.79	26.01	26.84	90.74	(N/A)
Eastern red cedar	8.30	0.59	0.63	13.69	11.39	34.61	(N/A)
Eastern white pine	2.80	0.21	0.25	3.10	6.19	12.55	(N/A)
Catalpa	67.02	9.30	12.02	100.55	60.91	249.80	(N/A)
Littleleaf linden	1.88	0.31	0.25	0.77	4.68	7.90	(N/A)
Norway maple	3.07	0.36	0.41	1.35	5.27	10.47	(N/A)
Swamp white oak	1.10	0.09	0.14	0.33	2.74	4.40	(N/A)
White ash	20.10	2.49	2.91	16.63	33.42	75.55	(N/A)
Ginkgo	5.29	0.44	0.75	2.85	2.51	11.84	(N/A)
Tulip tree	0.66	0.05	0.08	0.48	5.26	6.53	(N/A)
Ponderosa pine	25.88	1.55	-0.05	70.46	7.71	105.56	(N/A)
Northern hackberry	81.12	8.11	14.21	98.09	63.56	265.09	(N/A)
Blue spruce	1.65	0.09	0.18	1.03	5.03	7.97	(N/A)
Cherry plum	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Amur corktree	24.47	2.95	3.47	15.88	26.22	72.99	(N/A)
Bur oak	0.66	0.05	0.08	0.48	5.26	6.53	(N/A)
Boxelder	55.14	10.49	9.31	83.73	65.43	224.09	(N/A)
Black walnut	91.02	10.90	19.04	196.17	58.34	375.47	(N/A)
Amur maple	38.13	4.20	6.56	18.06	15.48	82.43	(N/A)
Black poplar	44.23	6.14	7.42	39.72	45.86	143.36	(N/A)
White mulberry	18.19	1.74	2.55	7.17	6.40	36.05	(N/A)
Sugar maple	1.00	0.19	0.13	0.29	0.49	2.09	(N/A)
Citywide Total	25.34	3.35	4.47	34.49	23.85	91.51	(N/A)

Carter Lake

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

6/28/2016

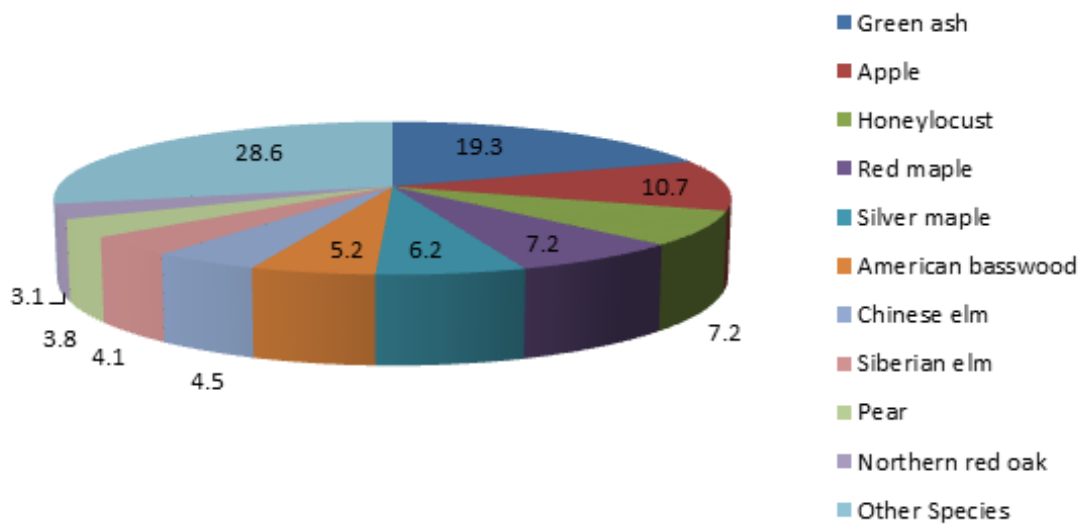


	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Green ash	0.00	10.71	58.93	7.14	1.79	10.71	3.57	3.57	3.57
Apple	41.94	3.23	41.94	12.90	0.00	0.00	0.00	0.00	0.00
Honeylocust	38.10	42.86	4.76	9.52	0.00	0.00	0.00	4.76	0.00
Red maple	61.90	33.33	0.00	0.00	4.76	0.00	0.00	0.00	0.00
Silver maple	33.33	0.00	5.56	0.00	5.56	0.00	22.22	16.67	16.67
American basswood	60.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chinese elm	0.00	0.00	0.00	7.69	23.08	23.08	30.77	15.38	0.00
Siberian elm	0.00	0.00	0.00	0.00	8.33	25.00	41.67	8.33	16.67
Pear	45.45	27.27	27.27	0.00	0.00	0.00	0.00	0.00	0.00
Northern red oak	66.67	11.11	22.22	0.00	0.00	0.00	0.00	0.00	0.00
Citywide Total	32.76	16.55	22.41	5.52	2.76	5.86	5.52	4.83	3.79

Carter Lake

Species Distribution of Public Trees

6/28/2016



Species	Percent
Green ash	19.3
Apple	10.7
Honeylocust	7.2
Red maple	7.2
Silver maple	6.2
American basswood	5.2
Chinese elm	4.5
Siberian elm	4.1
Pear	3.8
Northern red oak	3.1
Other Species	28.6
Total	100.0

Carter Lake, Iowa

Data and map created by:
COPPER TREE CONSULTING LLC.
515-559-4152
CopperTreeConsulting@gmail.com
www.coppertreeconsulting.com

Miles
0 0.15 0.3 0.6

Date: 1/25/2016

WhiteAsh
Green Ash

N

Carter Lake, Iowa

Data and map created by:
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CopperTreeConsulting@gmail.com
www.coppertreeconsulting.com

Date: 1/25/2016

- Bark Split (0)
- Epicormics (0)
- Canopy Dieback (6)
- Woodpecker Damage (2)
- D Exit Holes (0)

N

Carter Lake, Iowa

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0 0.15 0.3 0.6 Miles

Date: 1/26/2016

Wood Condition		Leaf Condition	
Dead (3)		Dead (0)	
Poor (14)		Poor (1)	

N

Carter Lake, Iowa

Data and map created by:
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Date: 1/26/2016

PRIORITY

- Stake/Train (0)
- Crown Cleaning (0)
- Crown Raising (0)
- Crown Reduction (0)
- Remove (10)
- Treat Pests/Disease (0)

N

Appendix C: Carter Lake Tree Ordinances

CHAPTER 151
TREES AND GRASS

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

151.02 PLANTING RESTRICTIONS. No tree shall be planted in any boulevard or street except in accordance with the following:
1. Alignment. All tress planted in any street shall be planted in the boulevard midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line.
2. Spacing. Trees shall not be planted on any boulevard which is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible trees should be planted inside the property lines and not between the sidewalk and the curb.
3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

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

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

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

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

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.
2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that the danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.
(Code of Iowa, Sec. 364.12[3b & h])

151.07 CUTTING OR MOWING OF GRASS.
1. Duty to Cut and Mow Lawns and Lots. The owner of any property shall cut and mow all lawns and lots so that such growth shall be less than four (4) inches at all times.
2. Cutting and Mowing by City. If a property owner refuses or fails to cut and mow lawns and lots within forty-eight (48) hours after being delivered a notice from the City to perform such action, the Council may require said work to be done and the cost and expenses thereof shall be assessed to the property owner after due notice is given. The amount of such assessment shall be certified to the County Auditor as provided by law and the same shall be collected with and in the same manner as general property taxes.