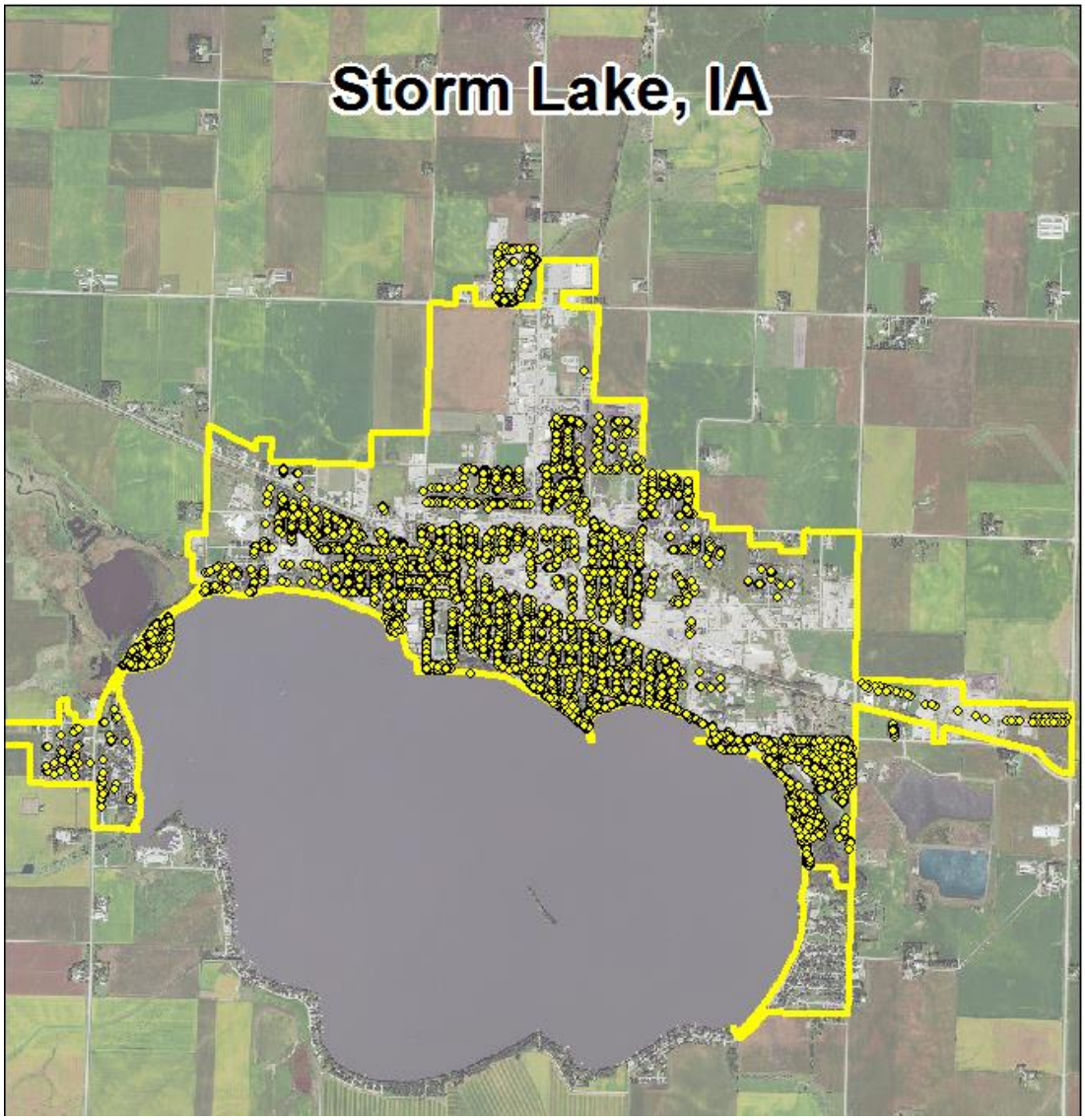
Storm Lake, IA



2016 Urban Forest Management Plan
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Executive Summary

Overview

This plan was developed to assist the City of Storm Lake with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows any 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 17% of Storm 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 2014, 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 5,213 trees inventoried.

- Storm Lake's trees provide $1,094,599 of benefits annually, an average of $208 a tree.
- There are over 74 species of trees and 1 shrub species.
- Silver maple is the most common tree species at 22.5% or 1,175 trees out of 5,213 trees.
- The top three genera are: Maple 43%, Ash 17%, and Linden 5%.
- 45% of trees are in need of some type of management.
- 115 trees are recommended for removal or 2%.

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 115 trees needing removal, 66 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*.
- None of the 861 ash trees show any signs or symptoms related to an EAB infestation.
- All trees should be pruned on a routine schedule- one tenth of the city every year.
- Plant a diverse mix of trees that do not include: ash, maple, cottonwood, poplar, Box elder, Chinese elm, evergreens, willow or Black walnut.
- Check ash street trees with a visual survey as city streets are driven.
- The City should set up a budget line item for tree care and removal and build a history of expenses.

Introduction

This plan was developed to assist Storm 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 Storm 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 Storm 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, 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 Storm 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 Storm 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 5,213 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (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. Storm Lake's trees reduce energy related costs by approximately $277,895 annually (Appendix A, Table 1). These savings are both in Electricity (1,319.8 MWh) and in Natural Gas (181,346.4 Therms).

Annual Stormwater Benefits

Storm Lake's trees intercept about 16,451,488 gallons of rainfall or snowmelt a year (Appendix A, Table 2). This interception provides $445,835 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 can reduce emissions from power plants, and emitting volatile organic matter (ozone). In Storm Lake, it is estimated that trees remove 17,583.9 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 $49,451 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Storm Lake, trees sequester about 3,071,728 lbs. of carbon a year with an associated value of $23,038 (Appendix A, Table 5). In addition, the trees store 66,196,594 lbs. of carbon, with a yearly benefit of $496,474 (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. Storm Lake receives $298,380 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, Storm Lake's trees provide $1,094,599 of total benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 5,213 trees in Storm Lake provide approximately $208 annually (Appendix A, Table 7).

Forest Structure

Genera Distribution

Storm Lake has over 74 different tree species along city streets and parks. The distribution of trees by genera is as follows:

Maple	2291	43%
Ash	861	17%
Cottonwood	290	5%
Linden	267	5%
Locust	263	5%
Spruce	191	5%
Apple (Crab)	178	3%
Oak	162	3%
Other Conifers	124	2%
Pine	67	1%
	4694	88%
All other genera's	519	12%
	5213	100%

Species Distribution

Silver maple	1175	22.5%
Ash	858	16.4%
Norway maple	548	10.5%
Sugar maple	421	8.0%
Cottonwood	259	4.9%
Honeylocust	258	4.9%
Amer. Linden (or Basswood)	211	4.0%
Apple species	178	3.4%
Blue spruce	124	2.3%
Red maple	102	1.9%
Hackberry	83	1.5%
Black walnut	82	1.5%
Other large Conifers	64	1.2%
Littleleaf linden	56	1.0%
Oak	53	1.0%
Other spruce	52	.9%
Pin oak	46	.8%
Small Deciduous broadleaf	44	.8%
Subtotals	4614	87.5%
All 56 other species	599	11.5%
	5213	100.0%

Age Class

Most of Storm Lake's trees (59%) are between 12 and 36 inches in diameter at 4.5 ft (Appendix A, Figure 2). For preferred age distribution is in the smaller trunk diameters having the highest numbers of trees to prepare for natural mortality and to maintain canopy cover. Storm Lake's size curve is on the large side, indicating a maturing stand with fewer trees to replace the declining and dying 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 Storm Lake indicate that 91% of the trees are in good health, with only 2% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 87% of Storm Lake's trees are in good health for wood condition (Appendix A, Figure 4 & Appendix B, Figure 3). The "Wood condition" of 4% of the tree population is in poor health, dead or dying. This 4% are the trees that will 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	1,077	21.00%
Crown Raising	1,212	23.00%
Tree Staking	33	0.63%
Tree Removal	115	2.00%
Crown Reduction	40	<1%

Canopy Cover

The total canopy of the public trees is 159 acres or 6% of the land area. The combined canopy cover of public and private trees is 498 acres or 19% of the land area. Storm Lake has a total land area of 2614.18 acres. The canopy cover graph shown in Appendix A, Figure 5 is for public trees only. Your canopy cover goals can be increased from 19% in the following manners:

	Number to plant
To increase to 20% canopy	1908
To increase to 22% canopy	5725
To increase to 25% canopy	11450

Or Canopy Cover expressed as 30-year goals:
With a 1% increase, plant 64 trees per year for 30 years.
With a 3% increase, plant 191 trees per year for 30 years.
With a 6% increase, plant 382 trees per year for 30 years.

Land Use and Location

The majority of Storm 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 residential	63%
Park/vacant/other	29%
Industrial/Large commercial	2%
Small commercial	4%
Multifamily residential	2%

Location	
Planting strip	67%
Other maintained locations	<1%
Cutout (surrounded by pavement)	<1%
Front yard	32%
Median	<1%

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

Storm Lake has 29 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 25 trees over 24 inches in diameter measured at 4.5 ft. above ground 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 249 young or mature trees marked as needing immediate maintenance.

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figures 3 & 4). Of the 115 removal trees, 1 is an ash tree. There are a total of 861 ash trees, no ash trees shows any signs or symptoms associated with EAB. In addition, no ash tree has wood or leafy crown rated in poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*. When the 29 critical concern trees are removed, you may have fewer of the 115 removal trees to remove.

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 Storm 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 (43%) (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, evergreens, willow or Black walnut, as outlined in your 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 2016

Removal: all 29 of the critical concern trees and the worse 20 trees of the removal trees.

Planting and Replacement: 9 trees to be planted in open locations.

Young Tree Pruning & Maintenance: locate the 23 young trees needing some sort of maintenance by using Appendix B, Figure 4.

Always do a visual ash survey for signs and symptoms of EAB.

Year 2 2017

Removal: 50 of the “removal trees.”
Planting and Replacement: 10 trees in open locations from year one removals.
Young Tree Pruning & Maintenance: do any needed corrective pruning of newly planted seedlings or whips.
Routine trimming: contract to trim 1/5 of the 226 mature trees needing immediate care.
Always do a visual survey for signs and symptoms of EAB.

Year 3 2018

Removal: finish removing the 45 “removal trees” any new critical concern trees and ash in poor health as the result of weather.
Planting and Replacement: 10 trees to be planted in open locations and locations from previous removals.
Young Tree Pruning & Maintenance: saving from ash tree treatment only if EAB has been found in Storm Lake, do any needed corrective pruning.
Routine trimming: contract to trim 1/5 of the 226 mature trees needing immediate care.
Always do a visual survey for signs and symptoms of EAB.

Year 4 2019

Removal: removal of any new critical concern trees from storm damage and ash in poor health plus the 20 remaining “removal trees”.
Planting and Replacement: 12 trees in open locations from previous removals.
Routine trimming: contract to trim 1/5 of the 226 mature trees needing immediate care.
Young Tree Pruning & Maintenance: do any needed corrective pruning. Only treat healthy ash trees if EAB has entered the town or within 15 mile radius circle.
Always do a visual survey for signs and symptoms of EAB.

Year 5 2020

Removal: removal of any new critical concern trees and ash in poor health plus reducing the ash population.
Planting and Replacement: 12 trees to be planted in open locations and locations from previous removals.
Routine trimming: contract to trim 1/5 of the 226 mature trees needing immediate care.
Young Tree Pruning & Maintenance:
Always do s visual survey for signs and symptoms of EAB.

Year 6 2021

Removal: remove any new critical concern trees and 40 ash trees prior to replanting.
Planting and Replacement: 35 trees in open locations from previous removals.
Routine trimming: Contract to trim 1/5 of the 226 mature trees needing immediate care.
Young Tree Pruning & Maintenance:
Always do a visual survey for signs and symptoms of EAB.

*Also reducing the ash population by 30 trees per year will take about 29 years. EAB could potentially kill all ash within 4 to 15 years of its arrival.
** To remove all ash trees within 6 years, the tree budget would need to be increased to $129,500 a year and no other work would be accomplished.

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, Figures 2 & 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 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 after a county quarantine is in effect.

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 normal if your county is not in quarantine.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinance (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, cottonwood, poplar, Box elder, Chinese elm, evergreens, 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. State 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.” The City of Storm Lake may adopt or add this section of the State Code to their City Code.

Budget

Current Budget

Cost figures based on an estimated $30,000 to 35,000 per year on tree trimming and removals over the 2015/2016 winter. 70 trees were removed (at or near $450 per tree labor) and other trees were trimmed. Equipment costs are unknown but $400/tree equipment cost was used in the cost estimates below.

FY 2016 Budget*

Removal: $30,000 for 70 trees, any species.
Planting: $1000 utility grant (will not keep up with tree removal rate).
Routine trimming: $5,000 (on trees needing "immediate" care).
Watering & Maintenance: $1500.

FY 2017 Budget*

Removal: 49 trees at $850/tree costs $42,000.
Planting: $1000 utility grant (same).
Routine trimming: $1,700 (on trees needing "immediate" care).
Contract trimming: $10,000 (on trees needing "immediate" care).
Watering & Maintenance: $1500.

FY 2018 Budget*

Removal: 50 trees at $850/tree costs $42,500.
Planting: $1000 utility grant (same).
Routine trimming: $2,000 (on trees needing "immediate" care).
Contract trimming: $10,000 (on trees needing "immediate" care).
Watering & Maintenance: $1500.

FY 2019 Budget*

Removal: remove the last 20 "removal" trees plus new trees needing removal after storm damage or other causes. At $850 per tree, costs $17,000.
Planting: $1000 utility grant (same).
Routine trimming: 45 of the mature trees needing "immediate" pruning. The job must be bided out.
Watering & Maintenance: $500.

FY 2020 Budget*

Removal: remove any dying or hazardous trees and some Green ash trees.
Planting: $1000 utility grant (same).
Routine trimming: prune more 45 of the mature trees needing "immediate" care.
Watering & Maintenance: $500.

FY 2021 Budget*

Removal: remove any hazardous trees and 40 Green ash trees at an estimated cost per tree of $850 or $34,000.
Planting: $1000 utility grant (same).
Routine trimming: prune more of the mature trees needing "immediate" care.
Watering & Maintenance: $500.

*Reduction of ash over 6 years: approximately 144 ash trees removed or 16% per year would add additional costs to the already estimated costs of removing "critical" and "removal" trees. With the current removal rate, it may **take approximately 24 years to remove all ash with the current budget.**

Purposed Budget Increase

EAB could potentially kill all ash trees in Storm Lake within 4 to 6 years of its arrival. To remove all ash trees within 6 years a tree budget of $122,400 a year must be set aside for just ash trees. If the budget were increased by $20,000 a year for ash trees, they would be removed within 36 years. It is recommended that Storm 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.

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 removed 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, if the average ash diameter is 20 inches and at $15 per inch, the cost is $300 per tree per year of treatment. Treatment funds must be set aside each year in the budget. If Storm Lake would budget $10,000 per year for treatment, you would treat 33 ash trees. Storm Lake would still need to find $42,000 to remove hazardous trees in 2017. This is an alternative to the straight removal of ash trees. Whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Storm Lake. It is suggested to consider increasing the budget to plan for this.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Storm Lake

Annual Energy Benefits of Public Trees

4/20/2016

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	413.6	31,393	54,423.9	53,335	84,729	(N/A)	22.5	30.5	72.11
Ash	219.2	16,639	31,782.1	31,146	47,785	(N/A)	16.5	17.2	55.69
Norway maple	139.1	10,554	20,098.3	19,696	30,251	(N/A)	10.5	10.9	55.20
Sugar maple	104.4	7,921	14,007.5	13,727	21,648	(N/A)	8.1	7.8	51.42
Cottonwood	107.2	8,136	14,455.2	14,166	22,303	(N/A)	5.0	8.0	86.11
Honeylocust	51.1	3,877	6,837.7	6,701	10,578	(N/A)	4.9	3.8	41.00
American basswood	48.4	3,672	6,969.4	6,830	10,502	(N/A)	4.0	3.8	49.77
Apple	13.1	998	2,082.9	2,041	3,039	(N/A)	3.4	1.1	17.07
Blue spruce	13.0	989	1,711.9	1,678	2,666	(N/A)	2.4	1.0	21.50
Red maple	16.5	1,254	2,161.7	2,118	3,373	(N/A)	2.0	1.2	33.07
Northern hackberry	32.4	2,457	4,553.1	4,462	6,919	(N/A)	1.6	2.5	83.37
Black walnut	22.7	1,720	3,096.4	3,034	4,754	(N/A)	1.6	1.7	57.98
Conifer Evergreen Large	9.8	741	1,292.1	1,266	2,007	(N/A)	1.2	0.7	31.36
Littleleaf linden	12.6	954	1,830.9	1,794	2,748	(N/A)	1.1	1.0	49.07
Oak	10.4	792	1,393.3	1,365	2,157	(N/A)	1.0	0.8	40.70
Spruce	4.8	365	637.9	625	991	(N/A)	1.0	0.4	19.05
Pin oak	13.3	1,007	1,778.6	1,743	2,750	(N/A)	0.9	1.0	59.78
Broadleaf Deciduous Small	1.9	142	295.6	290	431	(N/A)	0.8	0.2	9.81
Scotch pine	5.8	440	747.0	732	1,172	(N/A)	0.7	0.4	31.67
Amur maple	2.7	207	409.9	402	609	(N/A)	0.7	0.2	17.90
Eastern cottonwood	12.9	980	1,732.6	1,698	2,678	(N/A)	0.6	1.0	86.38
Broadleaf Evergreen Large	10.0	757	1,392.0	1,364	2,121	(N/A)	0.6	0.8	68.43
Juniper	0.1	8	19.3	19	27	(N/A)	0.6	0.0	0.93
Kentucky coffeetree	2.6	198	357.7	351	549	(N/A)	0.5	0.2	20.33
Japanese tree lilac	0.4	32	72.2	71	102	(N/A)	0.5	0.0	4.10
Bur oak	3.1	233	410.1	402	635	(N/A)	0.4	0.2	27.61
Elm	6.9	526	948.4	929	1,455	(N/A)	0.4	0.5	66.15
Broadleaf Evergreen Small	0.3	23	53.8	53	76	(N/A)	0.4	0.0	4.00
Eastern red cedar	1.9	145	282.0	276	421	(N/A)	0.3	0.2	23.41
Eastern white pine	2.0	152	244.2	239	391	(N/A)	0.3	0.1	23.00
Broadleaf Deciduous Mediu	1.6	119	224.3	220	338	(N/A)	0.3	0.1	19.91
Mulberry	2.0	148	305.6	299	447	(N/A)	0.3	0.2	27.97
Swamp white oak	1.0	79	159.6	156	235	(N/A)	0.3	0.1	14.71
American elm	5.1	386	682.2	669	1,054	(N/A)	0.3	0.4	65.90
Birch	1.6	120	235.9	231	352	(N/A)	0.3	0.1	25.11
Pear	0.8	59	119.8	117	176	(N/A)	0.2	0.1	14.67
American sycamore	3.6	277	503.4	493	770	(N/A)	0.2	0.3	64.17
River birch	2.1	158	281.1	275	434	(N/A)	0.2	0.2	39.45
Austrian pine	1.2	90	156.5	153	243	(N/A)	0.2	0.1	27.01
Norway spruce	0.8	62	98.2	96	159	(N/A)	0.2	0.1	17.62
Northern red oak	0.4	31	61.2	60	91	(N/A)	0.2	0.0	11.43
White oak	0.7	53	86.5	85	138	(N/A)	0.2	0.0	17.19
Northern white cedar	0.3	27	49.4	48	75	(N/A)	0.1	0.0	10.70
Northern pin oak	1.4	104	205.6	202	306	(N/A)	0.1	0.1	43.68
Ginkgo	0.8	57	104.2	102	159	(N/A)	0.1	0.1	22.76
Hickory	1.5	116	193.4	190	306	(N/A)	0.1	0.1	43.69
Dogwood	0.2	14	32.0	31	45	(N/A)	0.1	0.0	6.46
White mulberry	0.7	56	111.0	109	165	(N/A)	0.1	0.1	23.58
Conifer Evergreen Small	0.2	13	27.0	26	40	(N/A)	0.1	0.0	6.63
Black spruce	0.2	11	25.2	25	36	(N/A)	0.1	0.0	6.03
Broadleaf Deciduous Large	0.8	61	112.1	110	171	(N/A)	0.1	0.1	28.51
Catalpa	1.1	80	138.4	136	216	(N/A)	0.1	0.1	35.96
Maple	1.4	106	185.0	181	288	(N/A)	0.1	0.1	47.97
Boxelder	1.0	75	140.2	137	213	(N/A)	0.1	0.1	35.45
Chinese elm	0.9	68	108.9	107	175	(N/A)	0.1	0.1	29.10

Black locust	0.3	25	52.3	51	76 (N/A)	0.1	0.0	15.18
Paper birch	0.5	40	68.6	67	107 (N/A)	0.1	0.0	21.36
Quaking aspen	0.7	50	94.1	92	142 (N/A)	0.1	0.1	28.35
Conifer Evergreen Medium	0.3	19	40.8	40	59 (N/A)	0.1	0.0	14.80
Southern magnolia	0.2	17	33.8	33	50 (N/A)	0.1	0.0	12.42
Willow	0.8	60	120.7	118	178 (N/A)	0.1	0.1	44.62
Ohio buckeye	0.6	46	85.9	84	130 (N/A)	0.1	0.0	43.31
Alder	0.4	28	50.0	49	77 (N/A)	0.1	0.0	25.71
Callery pear	0.0	1	2.4	2	3 (N/A)	0.1	0.0	1.10
Red pine	0.5	35	58.9	58	93 (N/A)	0.1	0.0	30.93
Broadleaf Evergreen Mediur	0.1	5	11.1	11	16 (N/A)	0.0	0.0	8.11
Black cherry	0.3	21	44.5	44	64 (N/A)	0.0	0.0	32.17
Tulip tree	0.3	25	47.3	46	72 (N/A)	0.0	0.0	35.78
Black ash	0.6	42	76.9	75	118 (N/A)	0.0	0.0	58.81
Plum	0.0	0	0.6	1	1 (N/A)	0.0	0.0	0.87
Green ash	0.2	18	27.0	26	44 (N/A)	0.0	0.0	44.23
Mountain ash	0.1	6	12.8	13	18 (N/A)	0.0	0.0	18.19
Lilac	0.1	6	12.8	13	18 (N/A)	0.0	0.0	18.19
Buckthorn	0.0	2	3.8	4	5 (N/A)	0.0	0.0	5.40
Virginia pine	0.1	10	14.6	14	24 (N/A)	0.0	0.0	24.14
Scarlet oak	0.5	37	63.1	62	99 (N/A)	0.0	0.0	98.63
Total	1,319.8	100,175	181,346.4	177,719	277,895 (N/A)	100.0	100.0	53.31

Table 2: Annual Stormwater Benefits

Storm Lake

Annual Stormwater Benefits of Public Trees

4/20/2016

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	6,306,856	170,916	(N/A)	22.5	38.3	145.46
Ash	2,185,187	59,219	(N/A)	16.5	13.3	69.02
Norway maple	1,362,837	36,933	(N/A)	10.5	8.3	67.40
Sugar maple	1,148,364	31,121	(N/A)	8.1	7.0	73.92
Cottonwood	1,609,054	43,605	(N/A)	5.0	9.8	168.36
Honeylocust	511,908	13,873	(N/A)	4.9	3.1	53.77
American basswood	575,992	15,609	(N/A)	4.0	3.5	73.98
Apple	51,309	1,390	(N/A)	3.4	0.3	7.81
Blue spruce	176,756	4,790	(N/A)	2.4	1.1	38.63
Red maple	119,309	3,233	(N/A)	2.0	0.7	31.70
Northern hackberry	355,236	9,627	(N/A)	1.6	2.2	115.99
Black walnut	264,924	7,179	(N/A)	1.6	1.6	87.55
Conifer Evergreen Large	212,271	5,753	(N/A)	1.2	1.3	89.88
Littleleaf linden	147,415	3,995	(N/A)	1.1	0.9	71.34
Oak	130,966	3,549	(N/A)	1.0	0.8	66.97
Spruce	73,232	1,985	(N/A)	1.0	0.4	38.17
Pin oak	156,287	4,235	(N/A)	0.9	0.9	92.07
Broadleaf Deciduous Small	7,331	199	(N/A)	0.8	0.0	4.52
Scotch pine	118,451	3,210	(N/A)	0.7	0.7	86.76
Amur maple	11,479	311	(N/A)	0.7	0.1	9.15
Eastern cottonwood	187,015	5,068	(N/A)	0.6	1.1	163.49
Broadleaf Evergreen Large	177,056	4,798	(N/A)	0.6	1.1	154.78
Juniper	710	19	(N/A)	0.6	0.0	0.66
Kentucky coffeetree	30,994	840	(N/A)	0.5	0.2	31.11
Japanese tree lilac	1,300	35	(N/A)	0.5	0.0	1.41
Bur oak	32,110	870	(N/A)	0.4	0.2	37.83
Elm	89,808	2,434	(N/A)	0.4	0.5	110.63
Broadleaf Evergreen Small	1,092	30	(N/A)	0.4	0.0	1.56
Eastern red cedar	27,971	758	(N/A)	0.3	0.2	42.11
Eastern white pine	29,755	806	(N/A)	0.3	0.2	47.43
Broadleaf Deciduous Medium	13,697	371	(N/A)	0.3	0.1	21.83
Mulberry	9,710	263	(N/A)	0.3	0.1	16.45
Swamp white oak	9,449	256	(N/A)	0.3	0.1	16.00
American elm	49,784	1,349	(N/A)	0.3	0.3	84.32
Birch	9,900	268	(N/A)	0.3	0.1	19.16
Pear	2,754	75	(N/A)	0.2	0.0	6.22
American sycamore	46,698	1,266	(N/A)	0.2	0.3	105.46
River birch	14,139	383	(N/A)	0.2	0.1	34.83
Austrian pine	17,407	472	(N/A)	0.2	0.1	52.41
Norway spruce	10,973	297	(N/A)	0.2	0.1	33.04
Northern red oak	2,127	58	(N/A)	0.2	0.0	7.20
White oak	4,372	118	(N/A)	0.2	0.0	14.81
Northern white cedar	6,510	176	(N/A)	0.1	0.0	25.20
Northern pin oak	14,533	394	(N/A)	0.1	0.1	56.26
Ginkgo	5,352	145	(N/A)	0.1	0.0	20.72
Hickory	12,414	336	(N/A)	0.1	0.1	48.06
Dogwood	627	17	(N/A)	0.1	0.0	2.43
White mulberry	3,112	84	(N/A)	0.1	0.0	12.05

Conifer Evergreen Small	2,392	65	(N/A)	0.1	0.0	10.80
Black spruce	1,663	45	(N/A)	0.1	0.0	7.51
Broadleaf Deciduous Large	9,966	270	(N/A)	0.1	0.1	45.01
Catalpa	12,701	344	(N/A)	0.1	0.1	57.37
Maple	11,946	324	(N/A)	0.1	0.1	53.96
Boxelder	11,013	298	(N/A)	0.1	0.1	49.74
Chinese elm	5,630	153	(N/A)	0.1	0.0	25.43
Black locust	1,660	45	(N/A)	0.1	0.0	9.00
Paper birch	3,307	90	(N/A)	0.1	0.0	17.92
Quaking aspen	5,979	162	(N/A)	0.1	0.0	32.40
Conifer Evergreen Medium	3,022	82	(N/A)	0.1	0.0	20.47
Southern magnolia	1,565	42	(N/A)	0.1	0.0	10.60
Willow	7,416	201	(N/A)	0.1	0.0	50.24
Ohio buckeye	4,474	121	(N/A)	0.1	0.0	40.42
Alder	1,341	36	(N/A)	0.1	0.0	12.11
Callery pear	37	1	(N/A)	0.1	0.0	0.33
Red pine	9,112	247	(N/A)	0.1	0.1	82.32
Broadleaf Evergreen Medium	311	8	(N/A)	0.0	0.0	4.21
Black cherry	1,439	39	(N/A)	0.0	0.0	19.49
Tulip tree	3,961	107	(N/A)	0.0	0.0	53.67
Black ash	5,173	140	(N/A)	0.0	0.0	70.10
Plum	7	0	(N/A)	0.0	0.0	0.20
Green ash	1,466	40	(N/A)	0.0	0.0	39.72
Mountain ash	264	7	(N/A)	0.0	0.0	7.17
Lilac	264	7	(N/A)	0.0	0.0	7.17
Buckthorn	69	2	(N/A)	0.0	0.0	1.86
Virginia pine	1,539	42	(N/A)	0.0	0.0	41.70
Scarlet oak	7,239	196	(N/A)	0.0	0.0	196.17
Citywide total	16,451,488	445,835	(N/A)	100.0	100.0	85.52

Table 3: Annual Air Quality Benefits

Storm Lake

Annual Air Quality Benefits of Public Trees

4/20/2016

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								
Silver maple	1,142.5	193.6	555.1	50.7	6,144	1,949.6	285.4	272.5	1,870.8	12,198	-592.6	-2,222	5,727.6	16,119	(N/A)	22.5	13.72
Ash	463.8	80.0	225.8	20.5	2,500	1,064.3	153.8	146.3	994.5	6,589	-107.3	-402	3,041.8	8,686	(N/A)	16.5	10.12
Norway maple	286.6	49.4	139.7	12.7	1,545	674.6	97.5	92.8	630.9	4,177	-66.5	-249	1,917.7	5,473	(N/A)	10.5	9.99
Sugar maple	152.8	26.0	76.3	6.8	828	495.2	72.3	69.0	472.7	3,092	-120.2	-451	1,250.8	3,469	(N/A)	8.1	8.24
Cottonwood	274.4	43.9	121.4	12.3	1,433	510.0	74.4	70.9	485.7	3,181	0.0	0	1,593.0	4,614	(N/A)	5.0	17.82
Honeylocust	96.4	15.9	44.6	4.4	511	242.0	35.4	33.7	231.3	1,512	-74.6	-280	629.1	1,743	(N/A)	4.9	6.75
American basswood	82.1	14.0	39.8	3.6	441	234.5	33.9	32.3	219.5	1,453	-68.9	-258	590.7	1,636	(N/A)	4.0	7.75
Apple	13.0	2.1	6.5	0.6	70	65.3	9.3	8.8	59.6	400	-0.1	0	165.1	470	(N/A)	3.4	2.64
Blue spruce	23.9	4.7	19.9	2.9	158	61.4	9.0	8.6	59.0	384	-64.3	-241	125.1	301	(N/A)	2.4	2.43
Red maple	25.5	4.3	12.3	1.1	137	77.9	11.4	10.9	74.9	488	-9.0	-34	209.4	591	(N/A)	2.0	5.79
Northern hackberry	64.3	11.1	31.6	2.9	348	155.9	22.6	21.5	146.8	968	0.0	0	456.8	1,316	(N/A)	1.6	15.85
Black walnut	34.9	5.6	16.4	1.6	185	108.1	15.7	15.0	102.7	674	0.0	0	300.1	859	(N/A)	1.6	10.47
Conifer Evergreen Large	25.5	5.0	20.4	3.1	166	46.1	6.7	6.4	44.2	288	-117.9	-442	39.6	12	(N/A)	1.2	0.19
Littleleaf linden	27.0	4.7	13.1	1.2	145	61.1	8.8	8.4	57.0	378	-12.7	-48	168.5	476	(N/A)	1.1	8.49
Oak	21.3	3.4	9.7	1.0	112	49.5	7.2	6.9	47.3	309	0.0	0	146.2	421	(N/A)	1.0	7.95
Spruce	8.1	1.6	6.9	1.0	54	22.7	3.3	3.2	21.8	142	-30.4	-114	38.2	82	(N/A)	1.0	1.58
Pin oak	28.5	5.0	14.5	1.3	156	62.9	9.2	8.8	60.1	393	-52.6	-197	137.6	351	(N/A)	0.9	7.64
Broadleaf Deciduous Small	1.8	0.3	0.9	0.1	10	9.3	1.3	1.3	8.5	57	0.0	0	23.4	67	(N/A)	0.8	1.51
Scotch pine	14.1	2.8	11.4	1.7	92	27.2	4.0	3.8	26.3	171	-63.5	-238	27.8	25	(N/A)	0.7	0.67
Amur maple	3.4	0.6	1.6	0.2	18	13.3	1.9	1.8	12.4	82	0.0	0	35.2	101	(N/A)	0.7	2.96
Eastern cottonwood	33.6	5.4	14.8	1.5	175	61.3	9.0	8.5	58.5	383	0.0	0	192.6	558	(N/A)	0.6	18.01
Broadleaf Evergreen Large	27.0	5.4	21.9	3.3	177	47.7	6.9	6.6	44.8	296	-81.3	-305	82.2	168	(N/A)	0.6	5.42
Juniper	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	-0.3	-1	1.0	3	(N/A)	0.6	0.09
Kentucky coffeetree	4.0	0.6	1.9	0.2	21	12.5	1.8	1.7	11.8	78	0.0	0	34.6	99	(N/A)	0.5	3.66
Japanese tree lilac	0.1	0.0	0.1	0.0	1	2.1	0.3	0.3	1.9	13	0.0	0	4.8	14	(N/A)	0.5	0.54
Bur oak	4.3	0.7	2.0	0.2	23	14.6	2.1	2.0	13.9	91	0.0	0	39.8	114	(N/A)	0.4	4.95
Elm	13.4	2.1	6.1	0.6	70	33.1	4.8	4.6	31.4	206	0.0	0	96.1	276	(N/A)	0.4	12.56
Broadleaf Evergreen Small	0.1	0.0	0.2	0.0	1	1.6	0.2	0.2	1.4	9	0.0	0	3.6	10	(N/A)	0.4	0.54
Eastern red cedar	5.8	1.2	4.6	0.7	38	9.3	1.3	1.3	8.6	57	-15.4	-58	17.4	37	(N/A)	0.3	2.08
Eastern white pine	3.4	0.7	2.8	0.4	22	9.3	1.4	1.3	9.1	58	-12.7	-48	15.5	33	(N/A)	0.3	1.94
Broadleaf Deciduous Medium	2.7	0.5	1.4	0.1	15	7.6	1.1	1.0	7.1	47	-0.6	-2	20.8	59	(N/A)	0.3	3.48
Mulberry	3.2	0.5	1.5	0.1	17	9.6	1.4	1.3	8.8	59	0.0	0	26.5	76	(N/A)	0.3	4.76
Swamp white oak	1.9	0.3	0.9	0.1	10	5.1	0.7	0.7	4.7	32	-0.4	-2	14.0	40	(N/A)	0.3	2.50
American elm	7.1	1.2	3.7	0.3	39	24.2	3.5	3.4	23.0	151	0.0	0	66.4	190	(N/A)	0.3	11.85
Birch	1.3	0.2	0.8	0.1	8	7.8	1.1	1.1	7.2	48	-0.4	-1	19.2	54	(N/A)	0.3	3.86
Pear	0.6	0.1	0.3	0.0	4	3.8	0.5	0.5	3.5	23	0.0	0	9.5	27	(N/A)	0.2	2.25
American sycamore	6.4	1.0	2.9	0.3	34	17.4	2.5	2.4	16.5	109	0.0	0	49.6	142	(N/A)	0.2	11.85
River birch	2.4	0.4	1.2	0.1	13	9.9	1.5	1.4	9.5	62	-0.6	-2	25.7	73	(N/A)	0.2	6.61
Austrian pine	2.6	0.5	2.1	0.3	17	5.6	0.8	0.8	5.4	35	-6.5	-24	11.6	28	(N/A)	0.2	3.07
Norway spruce	1.2	0.2	1.0	0.1	8	3.8	0.6	0.5	3.7	24	-4.2	-16	7.0	16	(N/A)	0.2	1.80
Northern red oak	0.2	0.0	0.2	0.0	1	2.0	0.3	0.3	1.9	12	-0.3	-1	4.6	13	(N/A)	0.2	1.57
White oak	0.3	0.0	0.2	0.0	2	3.2	0.5	0.5	3.1	20	0.0	0	7.8	22	(N/A)	0.2	2.74
Northern white cedar	0.7	0.1	0.6	0.1	5	1.7	0.2	0.2	1.6	10	-2.9	-11	2.3	4	(N/A)	0.1	0.59
Northern pin oak	3.1	0.5	1.5	0.1	17	6.7	1.0	0.9	6.2	41	-0.7	-3	19.5	56	(N/A)	0.1	7.96
Ginkgo	1.4	0.2	0.7	0.1	8	3.6	0.5	0.5	3.4	22	-0.4	-2	10.0	28	(N/A)	0.1	4.06
Hickory	1.2	0.2	0.6	0.1	7	7.2	1.1	1.0	6.9	45	0.0	0	18.3	52	(N/A)	0.1	7.37
Dogwood	0.1	0.0	0.1	0.0	1	0.9	0.1	0.1	0.8	6	0.0	0	2.2	6	(N/A)	0.1	0.89
White mulberry	0.9	0.2	0.4	0.0	5	3.6	0.5	0.5	3.4	22	0.0	0	9.6	27	(N/A)	0.1	3.91
Conifer Evergreen Small	0.4	0.1	0.3	0.1	3	0.9	0.1	0.1	0.8	5	-1.3	-5	1.5	3	(N/A)	0.1	0.52
Black spruce	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.7	5	-0.5	-2	1.5	4	(N/A)	0.1	0.63
Broadleaf Deciduous Large	1.3	0.2	0.6	0.1	7	3.9	0.6	0.5	3.7	24	0.0	0	10.8	31	(N/A)	0.1	5.15
Catalpa	2.2	0.3	1.0	0.1	11	5.0	0.7	0.7	4.8	31	0.0	0	14.8	43	(N/A)	0.1	7.12
Maple	2.9	0.5	1.3	0.1	15	6.6	1.0	0.9	6.4	41	-1.0	-4	18.8	53	(N/A)	0.1	8.87
Boxelder	1.4	0.2	0.7	0.1	8	4.8	0.7	0.7	4.5	30	-0.5	-2	12.5	35	(N/A)	0.1	5.90
Chinese elm	0.4	0.1	0.2	0.0	2	4.1	0.6	0.6	4.1	26	0.0	0	10.1	28	(N/A)	0.1	4.72
Black locust	0.1	0.0	0.1	0.0	1	1.6	0.2	0.2	1.5	10	-0.1	0	3.8	11	(N/A)	0.1	2.11
Paper birch	0.2	0.0	0.1	0.0	1	2.5	0.4	0.3	2.4	15	0.0	0	5.9	16	(N/A)	0.1	3.30
Quaking aspen	0.6	0.1	0.3	0.0	3	3.2	0.5	0.4	3.0	20	0.0	0	8.0	23	(N/A)	0.1	4.53
Conifer Evergreen Medium	0.3	0.1	0.3	0.0	2	1.3	0.2	0.2	1.1	8	-0.9	-4	2.5	6	(N/A)	0.1	1.53
Southern magnolia	0.0	0.0	0.1	0.0	0	1.1	0.2	0.1	1.0	7	-0.4	-1	2.2	6	(N/A)	0.1	1.43
Willow	1.5	0.3	0.7	0.1	8	3.9	0.6	0.5	3.6	24	-0.3	-1	10.8	31	(N/A)	0.1	7.67
Ohio buckeye	0.8	0.1	0.4	0.0	4	2.9	0.4	0.4	2.7	18	-0.2	-1	7.6	22	(N/A)	0.1	7.18
Alder	0.4	0.1	0.2	0.0	2	1.8	0.3	0.2	1.7	11	0.0	0	4.6	13	(N/A)	0.1	4.41
Callery pear	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	0.0	0	0.1	0	(N/A)	0.1	0.14
Red pine	1.1	0.2	0.9	0.1	7	2.2	0.3	0.3	2.1	14	-4.8	-18	2.4	3	(N/A)	0.1	0.90
Broadleaf Evergreen Medium	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)	0.0	1.05
Black cherry	0.5	0.1	0.2	0.0	3	1.4	0.2	0.2	1.2	8	0.0	0	3.8	11	(N/A)	0.0	5.45
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	13	(N/A)	0.0	6.28

Black ash	1.1	0.2	0.5	0.0	6	2.7	0.4	0.4	2.5	17	-0.3	-1	7.5	21 (N/A)	0.0	10.75
Plum	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	0.0	0.11
Green ash	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)	0.0	7.42
Mountain ash	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.0	2.55
Lilac	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3 (N/A)	0.0	2.55
Buckthorn	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.0	0.71
Virginia pine	0.2	0.0	0.1	0.0	1	0.6	0.1	0.1	0.6	4	-0.5	-2	1.2	3 (N/A)	0.0	2.82
Scarlet oak	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)	0.0	22.55
Citywide total	2,936.7	499.6	1,451.8	139.5	15,888	6,303.8	917.4	874.6	5,978.6	39,256	-1,518.0	-5,693	17,583.9	49,451 (N/A)	100.0	9.49

Table 4: Annual Carbon Stored

Storm Lake

Stored CO2 Benefits of Public Trees

4/20/2016

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	26,776,007	200,820	(N/A)	22.5	40.4	170.91
Ash	7,662,694	57,470	(N/A)	16.5	11.6	66.98
Norway maple	4,723,922	35,429	(N/A)	10.5	7.1	64.65
Sugar maple	4,408,134	33,061	(N/A)	8.1	6.7	78.53
Cottonwood	9,364,122	70,231	(N/A)	5.0	14.1	271.16
Honeylocust	1,245,951	9,345	(N/A)	4.9	1.9	36.22
American basswood	3,092,665	23,195	(N/A)	4.0	4.7	109.93
Apple	218,175	1,636	(N/A)	3.4	0.3	9.19
Blue spruce	163,279	1,225	(N/A)	2.4	0.2	9.88
Red maple	286,503	2,149	(N/A)	2.0	0.4	21.07
Northern hackberry	1,021,385	7,660	(N/A)	1.6	1.5	92.29
Black walnut	1,149,554	8,622	(N/A)	1.6	1.7	105.14
Conifer Evergreen La	300,018	2,250	(N/A)	1.2	0.5	35.16
Littleleaf linden	571,597	4,287	(N/A)	1.1	0.9	76.55
Oak	731,918	5,489	(N/A)	1.0	1.1	103.57
Spruce	69,284	520	(N/A)	1.0	0.1	9.99
Pin oak	759,850	5,699	(N/A)	0.9	1.1	123.89
Broadleaf Deciduous	31,377	235	(N/A)	0.8	0.0	5.35
Scotch pine	160,022	1,200	(N/A)	0.7	0.2	32.44
Amur maple	54,585	409	(N/A)	0.7	0.1	12.04
Eastern cottonwood	1,153,987	8,655	(N/A)	0.6	1.7	279.19
Broadleaf Evergreen I	313,151	2,349	(N/A)	0.6	0.5	75.76
Juniper	73	1	(N/A)	0.6	0.0	0.02
Kentucky coffeetree	134,043	1,005	(N/A)	0.5	0.2	37.23
Japanese tree lilac	3,535	27	(N/A)	0.5	0.0	1.06
Bur oak	143,807	1,079	(N/A)	0.4	0.2	46.89
Elm	447,174	3,354	(N/A)	0.4	0.7	152.45
Broadleaf Evergreen S	2,304	17	(N/A)	0.4	0.0	0.91
Eastern red cedar	18,778	141	(N/A)	0.3	0.0	7.82
Eastern white pine	29,518	221	(N/A)	0.3	0.0	13.02
Broadleaf Deciduous I	45,241	339	(N/A)	0.3	0.1	19.96
Mulberry	50,873	382	(N/A)	0.3	0.1	23.85
Swamp white oak	31,770	238	(N/A)	0.3	0.0	14.89
American elm	163,331	1,225	(N/A)	0.3	0.2	76.56
Birch	23,571	177	(N/A)	0.3	0.0	12.63
Pear	10,847	81	(N/A)	0.2	0.0	6.78
American sycamore	210,548	1,579	(N/A)	0.2	0.3	131.59
River birch	39,546	297	(N/A)	0.2	0.1	26.96
Austrian pine	19,867	149	(N/A)	0.2	0.0	16.56
Norway spruce	9,237	69	(N/A)	0.2	0.0	7.70
Northern red oak	3,659	27	(N/A)	0.2	0.0	3.43
White oak	9,635	72	(N/A)	0.2	0.0	9.03
Northern white cedar	6,769	51	(N/A)	0.1	0.0	7.25
Northern pin oak	52,122	391	(N/A)	0.1	0.1	55.84
Ginkgo	20,364	153	(N/A)	0.1	0.0	21.82
Hickory	38,930	292	(N/A)	0.1	0.1	41.71
Dogwood	2,049	15	(N/A)	0.1	0.0	2.20
White mulberry	14,824	111	(N/A)	0.1	0.0	15.88
Conifer Evergreen Sm	1,389	10	(N/A)	0.1	0.0	1.74
Black spruce	577	4	(N/A)	0.1	0.0	0.72
Broadleaf Deciduous I	42,284	317	(N/A)	0.1	0.1	52.86
Catalpa	75,463	566	(N/A)	0.1	0.1	94.33
Maple	31,303	235	(N/A)	0.1	0.0	39.13
Boxelder	52,357	393	(N/A)	0.1	0.1	65.45

Chinese elm	13,097	98	(N/A)	0.1	0.0	16.37
Black locust	2,857	21	(N/A)	0.1	0.0	4.29
Paper birch	6,788	51	(N/A)	0.1	0.0	10.18
Quaking aspen	18,148	136	(N/A)	0.1	0.0	27.22
Conifer Evergreen Me	1,137	9	(N/A)	0.1	0.0	2.13
Southern magnolia	1,044	8	(N/A)	0.1	0.0	1.96
Willow	24,427	183	(N/A)	0.1	0.0	45.80
Ohio buckeye	12,670	95	(N/A)	0.1	0.0	31.68
Alder	6,088	46	(N/A)	0.1	0.0	15.22
Callery pear	51	0	(N/A)	0.1	0.0	0.13
Red pine	12,003	90	(N/A)	0.1	0.0	30.01
Broadleaf Evergreen I	147	1	(N/A)	0.0	0.0	0.55
Black cherry	7,651	57	(N/A)	0.0	0.0	28.69
Tulip tree	15,785	118	(N/A)	0.0	0.0	59.19
Black ash	17,904	134	(N/A)	0.0	0.0	67.14
Plum	14	0	(N/A)	0.0	0.0	0.10
Green ash	3,672	28	(N/A)	0.0	0.0	27.54
Mountain ash	908	7	(N/A)	0.0	0.0	6.81
Lilac	908	7	(N/A)	0.0	0.0	6.81
Buckthorn	178	1	(N/A)	0.0	0.0	1.33
Virginia pine	1,170	9	(N/A)	0.0	0.0	8.78
Scarlet oak	55,982	420	(N/A)	0.0	0.1	419.86
Citywide total	66,196,594	496,474	(N/A)	100.0	100.0	95.24

Table 5: Annual Carbon Sequestered

Storm Lake

Annual CO Benefits of Public Trees

4/20/2016

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
Silver maple	1,860,442	13,953	-128,534	-4,721	-35	0	0	1,727,187	12,954 (N/A)	22.5	56.2	11.02
Ash	221,433	1,661	-36,809	-2,467	-18	0	0	182,157	1,366 (N/A)	16.5	5.9	1.59
Norway maple	173,456	1,301	-22,688	-1,494	-11	0	0	149,275	1,120 (N/A)	10.5	4.9	2.04
Sugar maple	232,526	1,744	-21,179	-1,128	-8	0	0	210,218	1,577 (N/A)	8.1	6.8	3.74
Cottonwood	202,715	1,520	-44,948	-1,232	-9	0	0	156,535	1,174 (N/A)	5.0	5.1	4.53
Honeylocust	109,836	824	-6,015	-414	-3	0	0	103,407	776 (N/A)	4.9	3.4	3.01
American basswood	173,285	1,300	-14,846	-587	-4	0	0	157,852	1,184 (N/A)	4.0	5.1	5.61
Apple	20,384	153	-1,049	-196	-1	0	0	19,140	144 (N/A)	3.4	0.6	0.81
Blue spruce	10,407	78	-784	-226	-2	0	0	9,398	70 (N/A)	2.4	0.3	0.57
Red maple	31,785	238	-1,376	-152	-1	0	0	30,258	227 (N/A)	2.0	1.0	2.22
Northern hackberry	44,271	332	-4,903	-322	-2	0	0	39,046	293 (N/A)	1.6	1.3	3.53
Black walnut	52,855	396	-5,518	-242	-2	0	0	47,096	353 (N/A)	1.6	1.5	4.31
Conifer Evergreen Large	6,443	48	-1,440	-205	-2	0	0	4,798	36 (N/A)	1.2	0.2	0.56
Littleleaf linden	27,205	204	-2,747	-167	-1	0	0	24,291	182 (N/A)	1.1	0.8	3.25
Oak	19,350	145	-3,514	-119	-1	0	0	15,717	118 (N/A)	1.0	0.5	2.22
Spruce	5,108	38	-333	-86	-1	0	0	4,690	35 (N/A)	1.0	0.2	0.68
Pin oak	64,381	483	-3,648	-144	-1	0	0	60,588	454 (N/A)	0.9	2.0	9.88
Broadleaf Deciduous Smal	3,297	25	-151	-33	0	0	0	3,113	23 (N/A)	0.8	0.1	0.53
Scotch pine	6,920	52	-768	-106	-1	0	0	6,046	45 (N/A)	0.7	0.2	1.23
Amur maple	4,368	33	-262	-40	0	0	0	4,066	30 (N/A)	0.7	0.1	0.90
Eastern cottonwood	22,366	168	-5,539	-149	-1	0	0	16,678	125 (N/A)	0.6	0.5	4.04
Broadleaf Evergreen Large	21,261	159	-1,503	-91	-1	0	0	19,667	148 (N/A)	0.6	0.6	4.76
Juniper	17	0	-1	-6	0	0	0	11	0 (N/A)	0.6	0.0	0.00
Kentucky coffeetree	6,014	45	-644	-32	0	0	0	5,338	40 (N/A)	0.5	0.2	1.48
Japanese tree lilac	732	5	-17	-11	0	0	0	703	5 (N/A)	0.5	0.0	0.21
Bur oak	6,551	49	-691	-35	0	0	0	5,826	44 (N/A)	0.4	0.2	1.90
Elm	15,107	113	-2,146	-76	-1	0	0	12,884	97 (N/A)	0.4	0.4	4.39
Broadleaf Evergreen Small	321	2	-12	-7	0	0	0	302	2 (N/A)	0.4	0.0	0.12
Eastern red cedar	313	2	-90	-34	0	0	0	189	1 (N/A)	0.3	0.0	0.08
Eastern white pine	2,048	15	-142	-33	0	0	0	1,873	14 (N/A)	0.3	0.1	0.83
Broadleaf Deciduous Medi	1,616	12	-218	-19	0	0	0	1,378	10 (N/A)	0.3	0.0	0.61
Broadleaf Evergreen Medi	32	0	-1	-1	0	0	0	30	0 (N/A)	0.0	0.0	0.11
Black cherry	592	4	-37	-4	0	0	0	552	4 (N/A)	0.0	0.0	2.07
Tulip tree	859	6	-76	-4	0	0	0	780	6 (N/A)	0.0	0.0	2.92
Black ash	756	6	-86	-5	0	0	0	665	5 (N/A)	0.0	0.0	2.49
Plum	9	0	0	0	0	0	0	8	0 (N/A)	0.0	0.0	0.06
Green ash	445	3	-18	-2	0	0	0	426	3 (N/A)	0.0	0.0	3.19
Mountain ash	114	1	-4	-1	0	0	0	108	1 (N/A)	0.0	0.0	0.81
Lilac	114	1	-4	-1	0	0	0	108	1 (N/A)	0.0	0.0	0.81
Buckthorn	38	0	-1	-1	0	0	0	37	0 (N/A)	0.0	0.0	0.27
Virginia pine	116	1	-6	-2	0	0	0	108	1 (N/A)	0.0	0.0	0.81
Scarlet oak	479	4	-269	-6	0	0	0	204	2 (N/A)	0.0	0.0	1.53
Citywide total	3,404,604	25,535	-317,870	-15,006	-113	0	0	3,071,728	23,038 (N/A)	100.0	100.0	4.42

Table 6: Annual Social and Aesthetic Benefits

Storm Lake

Annual Aesthetic/Other Benefits of Public Trees

4/20/2016

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	138,850	(N/A)	22.5	46.5	118.17
Ash	21,216	(N/A)	16.5	7.1	24.73
Norway maple	16,305	(N/A)	10.5	5.5	29.75
Sugar maple	24,196	(N/A)	8.1	8.1	57.47
Cottonwood	13,644	(N/A)	5.0	4.6	52.68
Honeylocust	25,869	(N/A)	4.9	8.7	100.27
American basswood	12,019	(N/A)	4.0	4.0	56.96
Apple	1,154	(N/A)	3.4	0.4	6.48
Blue spruce	2,523	(N/A)	2.4	0.8	20.34
Red maple	4,330	(N/A)	2.0	1.5	42.45
Northern hackberry	5,392	(N/A)	1.6	1.8	64.96
Black walnut	4,284	(N/A)	1.6	1.4	52.25
Conifer Evergreen Large	1,468	(N/A)	1.2	0.5	22.93
Littleleaf linden	2,759	(N/A)	1.1	0.9	49.26
Oak	1,647	(N/A)	1.0	0.6	31.08
Spruce	1,369	(N/A)	1.0	0.5	26.32
Pin oak	4,857	(N/A)	0.9	1.6	105.58
Broadleaf Deciduous Small	184	(N/A)	0.8	0.1	4.18
Scotch pine	1,277	(N/A)	0.7	0.4	34.50
Amur maple	251	(N/A)	0.7	0.1	7.39
Eastern cottonwood	1,524	(N/A)	0.6	0.5	49.16
Broadleaf Evergreen Large	3,628	(N/A)	0.6	1.2	117.04
Juniper	124	(N/A)	0.6	0.0	4.27
Kentucky coffeetree	606	(N/A)	0.5	0.2	22.44
Japanese tree lilac	36	(N/A)	0.5	0.0	1.42
Bur oak	643	(N/A)	0.4	0.2	27.94
Elm	1,154	(N/A)	0.4	0.4	52.44
Broadleaf Evergreen Small	17	(N/A)	0.4	0.0	0.88
Eastern red cedar	109	(N/A)	0.3	0.0	6.07
Eastern white pine	519	(N/A)	0.3	0.2	30.51
Broadleaf Deciduous Medium	188	(N/A)	0.3	0.1	11.05
Mulberry	151	(N/A)	0.3	0.1	9.45
Swamp white oak	157	(N/A)	0.3	0.1	9.83
American elm	854	(N/A)	0.3	0.3	53.37
Birch	346	(N/A)	0.3	0.1	24.74
Pear	65	(N/A)	0.2	0.0	5.43
American sycamore	666	(N/A)	0.2	0.2	55.50
River birch	358	(N/A)	0.2	0.1	32.54
Austrian pine	175	(N/A)	0.2	0.1	19.42
Norway spruce	227	(N/A)	0.2	0.1	25.22
Northern red oak	73	(N/A)	0.2	0.0	9.18
White oak	179	(N/A)	0.2	0.1	22.42
Northern white cedar	125	(N/A)	0.1	0.0	17.87
Northern pin oak	116	(N/A)	0.1	0.0	16.62
Ginkgo	51	(N/A)	0.1	0.0	7.24
Hickory	312	(N/A)	0.1	0.1	44.57
Dogwood	15	(N/A)	0.1	0.0	2.14

White mulberry	46 (N/A)	0.1	0.0	6.55
Conifer Evergreen Small	38 (N/A)	0.1	0.0	6.40
Black spruce	62 (N/A)	0.1	0.0	10.38
Broadleaf Deciduous Large	182 (N/A)	0.1	0.1	30.28
Catalpa	156 (N/A)	0.1	0.1	25.97
Maple	248 (N/A)	0.1	0.1	41.36
Boxelder	269 (N/A)	0.1	0.1	44.86
Chinese elm	200 (N/A)	0.1	0.1	33.32
Black locust	91 (N/A)	0.1	0.0	18.22
Paper birch	137 (N/A)	0.1	0.0	27.36
Quaking aspen	164 (N/A)	0.1	0.1	32.79
Conifer Evergreen Medium	84 (N/A)	0.1	0.0	21.08
Southern magnolia	53 (N/A)	0.1	0.0	13.33
Willow	95 (N/A)	0.1	0.0	23.87
Ohio buckeye	108 (N/A)	0.1	0.0	36.14
Alder	31 (N/A)	0.1	0.0	10.33
Callery pear	8 (N/A)	0.1	0.0	2.74
Red pine	79 (N/A)	0.1	0.0	26.47
Broadleaf Evergreen Medium	19 (N/A)	0.0	0.0	9.46
Black cherry	35 (N/A)	0.0	0.0	17.60
Tulip tree	71 (N/A)	0.0	0.0	35.43
Black ash	71 (N/A)	0.0	0.0	35.31
Plum	0 (N/A)	0.0	0.0	0.03
Green ash	46 (N/A)	0.0	0.0	45.86
Mountain ash	6 (N/A)	0.0	0.0	6.40
Lilac	6 (N/A)	0.0	0.0	6.40
Buckthorn	2 (N/A)	0.0	0.0	2.06
Virginia pine	32 (N/A)	0.0	0.0	32.32
Scarlet oak	29 (N/A)	0.0	0.0	28.57
Citywide total	298,380 (N/A)	100.0	100.0	57.24

Table 7: Summary of Benefits in Dollars

Storm Lake

Total Annual Benefits of Public Trees by Species ($)

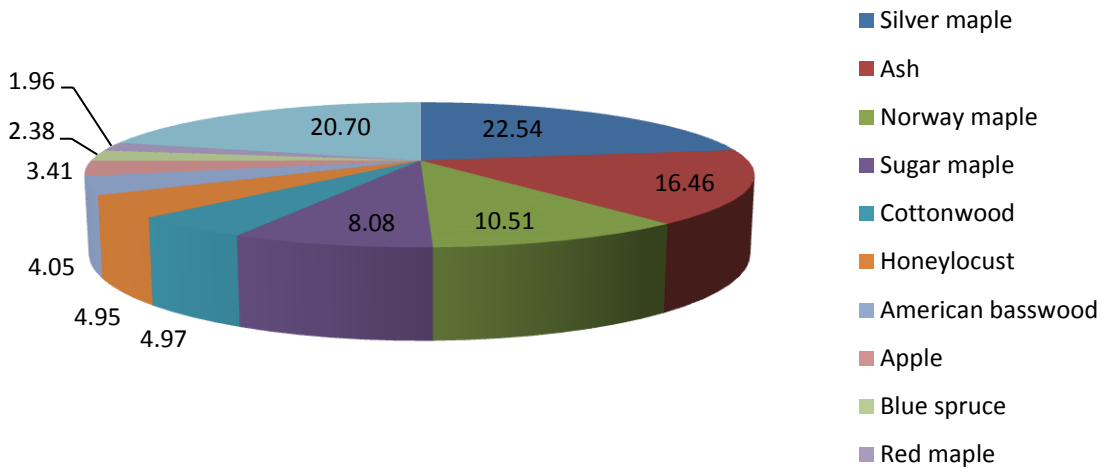
4/20/2016

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	84,729	12,954	16,119	170,916	138,850	423,568	(N/A)	38.7
Ash	47,785	1,366	8,686	59,219	21,216	138,272	(N/A)	12.6
Norway maple	30,251	1,120	5,473	36,933	16,305	90,081	(N/A)	8.2
Sugar maple	21,648	1,577	3,469	31,121	24,196	82,010	(N/A)	7.5
Cottonwood	22,303	1,174	4,614	43,605	13,644	85,341	(N/A)	7.8
Honeylocust	10,578	776	1,743	13,873	25,869	52,838	(N/A)	4.8
American basswood	10,502	1,184	1,636	15,609	12,019	40,950	(N/A)	3.7
Apple	3,039	144	470	1,390	1,154	6,197	(N/A)	0.6
Blue spruce	2,666	70	301	4,790	2,523	10,351	(N/A)	0.9
Red maple	3,373	227	591	3,233	4,330	11,754	(N/A)	1.1
Northern hackberry	6,919	293	1,316	9,627	5,392	23,547	(N/A)	2.2
Black walnut	4,754	353	859	7,179	4,284	17,430	(N/A)	1.6
Conifer Evergreen Large	2,007	36	12	5,753	1,468	9,276	(N/A)	0.8
Littleleaf linden	2,748	182	476	3,995	2,759	10,160	(N/A)	0.9
Oak	2,157	118	421	3,549	1,647	7,892	(N/A)	0.7
Spruce	991	35	82	1,985	1,369	4,461	(N/A)	0.4
Pin oak	2,750	454	351	4,235	4,857	12,648	(N/A)	1.2
Broadleaf Deciduous Sm	431	23	67	199	184	904	(N/A)	0.1
Scotch pine	1,172	45	25	3,210	1,277	5,729	(N/A)	0.5
Amur maple	609	30	101	311	251	1,302	(N/A)	0.1
Eastern cottonwood	2,678	125	558	5,068	1,524	9,953	(N/A)	0.9
Broadleaf Evergreen Lar	2,121	148	168	4,798	3,628	10,863	(N/A)	1.0
Juniper	27	0	3	19	124	173	(N/A)	0.0
Kentucky coffeetree	549	40	99	840	606	2,134	(N/A)	0.2
Japanese tree lilac	102	5	14	35	36	192	(N/A)	0.0
Bur oak	635	44	114	870	643	2,305	(N/A)	0.2
Elm	1,455	97	276	2,434	1,154	5,416	(N/A)	0.5
Broadleaf Evergreen Sm	76	2	10	30	17	135	(N/A)	0.0
Eastern red cedar	421	1	37	758	109	1,327	(N/A)	0.1
Eastern white pine	391	14	33	806	519	1,763	(N/A)	0.2
Broadleaf Deciduous Md	338	10	59	371	188	967	(N/A)	0.1
Mulberry	447	17	76	263	151	955	(N/A)	0.1
Swamp white oak	235	8	40	256	157	697	(N/A)	0.1
American elm	1,054	38	190	1,349	854	3,486	(N/A)	0.3
Birch	352	22	54	268	346	1,043	(N/A)	0.1
Pear	176	8	27	75	65	351	(N/A)	0.0
American sycamore	770	57	142	1,266	666	2,900	(N/A)	0.3
River birch	434	24	73	383	358	1,272	(N/A)	0.1
Austrian pine	243	6	28	472	175	923	(N/A)	0.1
Norway spruce	159	5	16	297	227	705	(N/A)	0.1
Northern red oak	91	4	13	58	73	239	(N/A)	0.0
White oak	138	10	22	118	179	467	(N/A)	0.0
Northern white cedar	75	3	4	176	125	383	(N/A)	0.0
Northern pin oak	306	7	56	394	116	878	(N/A)	0.1
Ginkgo	159	4	28	145	51	387	(N/A)	0.0
Hickory	306	23	52	336	312	1,029	(N/A)	0.1
Dogwood	45	2	6	17	15	86	(N/A)	0.0

White mulberry	165	5	27	84	46	328 (N/A)	0.0
Conifer Evergreen Smal	40	0	3	65	38	146 (N/A)	0.0
Black spruce	36	1	4	45	62	148 (N/A)	0.0
Broadleaf Deciduous La	171	14	31	270	182	667 (N/A)	0.1
Catalpa	216	11	43	344	156	769 (N/A)	0.1
Maple	288	13	53	324	248	926 (N/A)	0.1
Boxelder	213	25	35	298	269	841 (N/A)	0.1
Chinese elm	175	13	28	153	200	568 (N/A)	0.1
Black locust	76	5	11	45	91	228 (N/A)	0.0
Paper birch	107	8	16	90	137	357 (N/A)	0.0
Quaking aspen	142	11	23	162	164	502 (N/A)	0.0
Conifer Evergreen Medi	59	1	6	82	84	233 (N/A)	0.0
Southern magnolia	50	1	6	42	53	152 (N/A)	0.0
Willow	178	6	31	201	95	512 (N/A)	0.0
Ohio buckeye	130	8	22	121	108	389 (N/A)	0.0
Alder	77	4	13	36	31	162 (N/A)	0.0
Callery pear	3	0	0	1	8	13 (N/A)	0.0
Red pine	93	2	3	247	79	424 (N/A)	0.0
Broadleaf Evergreen Me	16	0	2	8	19	46 (N/A)	0.0
Black cherry	64	4	11	39	35	154 (N/A)	0.0
Tulip tree	72	6	13	107	71	268 (N/A)	0.0
Black ash	118	5	21	140	71	355 (N/A)	0.0
Plum	1	0	0	0	0	1 (N/A)	0.0
Green ash	44	3	7	40	46	140 (N/A)	0.0
Mountain ash	18	1	3	7	6	35 (N/A)	0.0
Lilac	18	1	3	7	6	35 (N/A)	0.0
Buckthorn	5	0	1	2	2	10 (N/A)	0.0
Virginia pine	24	1	3	42	32	102 (N/A)	0.0
Scarlet oak	99	2	23	196	29	347 (N/A)	0.0
Citywide Total	277,895	23,038	49,451	445,835	298,380	1,094,599 (N/A)	100.0

Appendix A, Figures

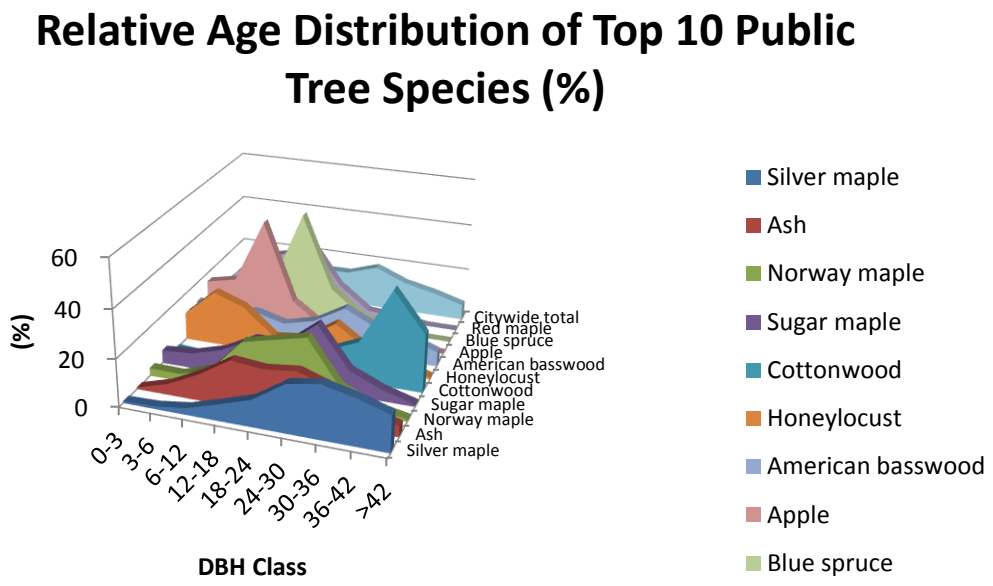
Figure 1. Species Distribution of Public Trees in Percent



Species Distribution of Public Trees (%)
4/20/2016

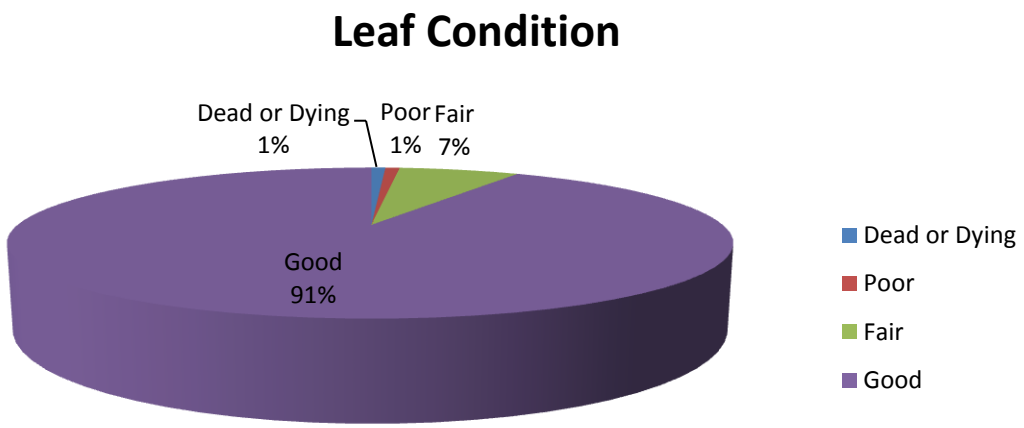
Species	Percent
Silver maple	22.54
Ash	16.46
Norway maple	10.51
Sugar maple	8.08
Cottonwood	4.97
Honeylocust	4.95
American basswood	4.05
Apple	3.41
Blue spruce	2.38
Red maple	1.96
Other species	20.70
Total	100.00

Figure 2. Relative Age Distribution of Top 10 Public Tree Species (%)



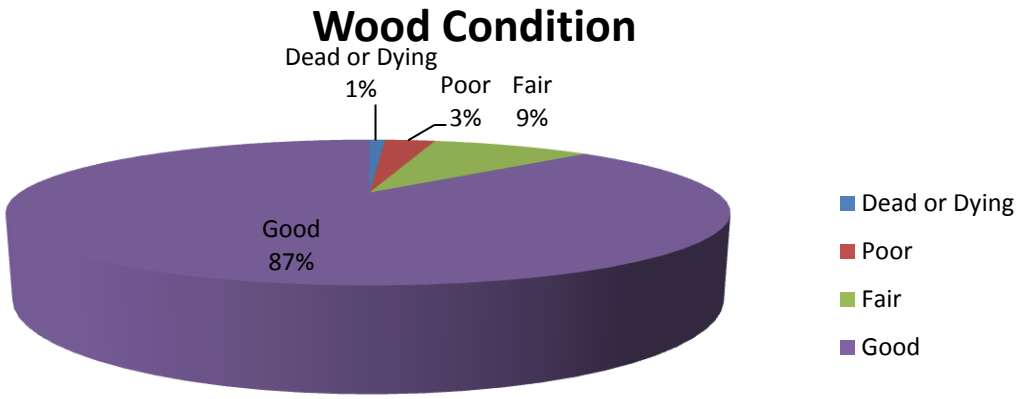
Storm Lake									
Relative Age Distribution of Top 10 Public Tree Species (%)									
4/20/2016									
	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Silver maple	0.77	1.11	2.89	6.98	11.32	20.09	22.38	19.32	15.15
Ash	0.70	4.55	10.96	19.11	17.83	19.35	15.03	8.04	4.43
Norway maple	3.28	3.10	7.30	21.17	24.27	27.37	9.12	3.47	0.91
Sugar maple	5.46	6.41	10.21	17.10	17.10	27.55	10.45	4.75	0.95
Cottonwood	0.77	0.00	0.00	1.54	4.63	11.20	16.99	40.54	24.32
Honeylocust	11.63	22.87	18.22	7.36	8.91	17.44	8.53	4.26	0.78
American basswood	11.85	9.00	11.37	8.06	11.37	18.96	12.80	10.43	6.16
Apple	16.29	19.10	46.07	12.92	3.93	1.69	0.00	0.00	0.00
Blue spruce	8.06	6.45	16.13	46.77	16.13	5.65	0.81	0.00	0.00
Red maple	7.84	20.59	23.53	30.39	12.75	2.94	1.96	0.00	0.00
Citywide total	6.58	7.02	10.28	14.04	14.06	18.22	13.01	10.22	6.56

Figure 3. Foliage Condition



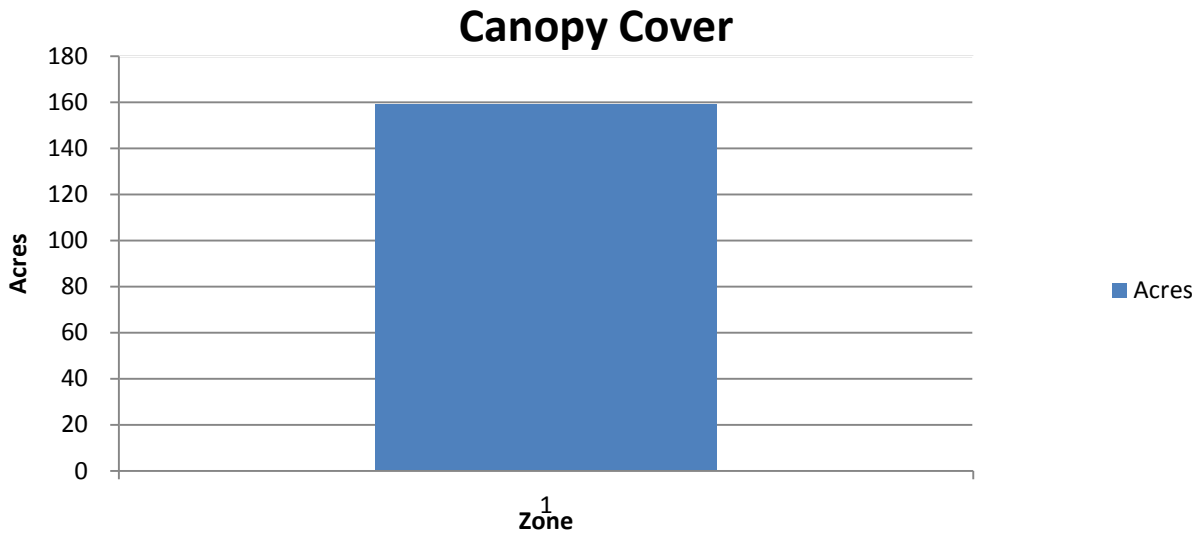
Storm Lake				
Condition (Foliage) of Public Trees by Species (%)				
4/20/2016				
Species Name	Dead or Dying	Poor	Fair	Good
Silver maple	0.43	0.43	4.94	94.21
Ash	1.75	1.28	7.46	89.51
Norway maple	0.00	0.00	2.55	97.45
Sugar maple	0.48	1.19	5.70	92.64
Cottonwood	0.77	0.39	14.29	84.56
Honeylocust	0.00	0.39	5.81	93.80
American basswood	1.90	0.00	2.84	95.26
Apple	0.56	0.00	12.92	86.52
Blue spruce	0.00	0.81	4.03	95.16
Red maple	0.00	1.96	16.67	81.37
Northern hackberry	0.00	6.02	4.82	89.16
Black walnut	0.00	1.22	13.41	85.37
Conifer Evergreen Large	0.00	0.00	3.13	96.88
Littleleaf linden	0.00	0.00	3.57	96.43
Oak	0.00	0.00	1.89	98.11
Citywide total	0.79	0.79	6.75	91.67

Figure 4. Wood Condition



Storm Lake				
Condition (Woody) of Public Trees by Species (%)				**4/20/2016**
Species Name	Dead or Dying	Poor	Fair	Good
Silver maple	0.60	2.04	6.72	90.64
Ash	1.63	2.56	7.58	88.23
Norway maple	0.00	4.01	11.68	84.31
Sugar maple	1.43	5.94	10.93	81.71
Cottonwood	1.16	3.47	17.76	77.61
Honeylocust	0.39	2.71	15.12	81.78
American basswood	1.90	1.90	8.06	88.15
Apple	0.00	3.37	11.24	85.39
Blue spruce	0.00	0.81	3.23	95.97
Red maple	0.98	4.90	20.59	73.53
Northern hackberry	2.41	3.61	4.82	89.16
Black walnut	0.00	3.66	1.22	95.12
Conifer Evergreen Large	0.00	0.00	1.56	98.44
Littleleaf linden	0.00	1.79	8.93	89.29
Oak	0.00	3.77	3.77	92.45
Citywide total	0.92	2.90	9.27	86.92

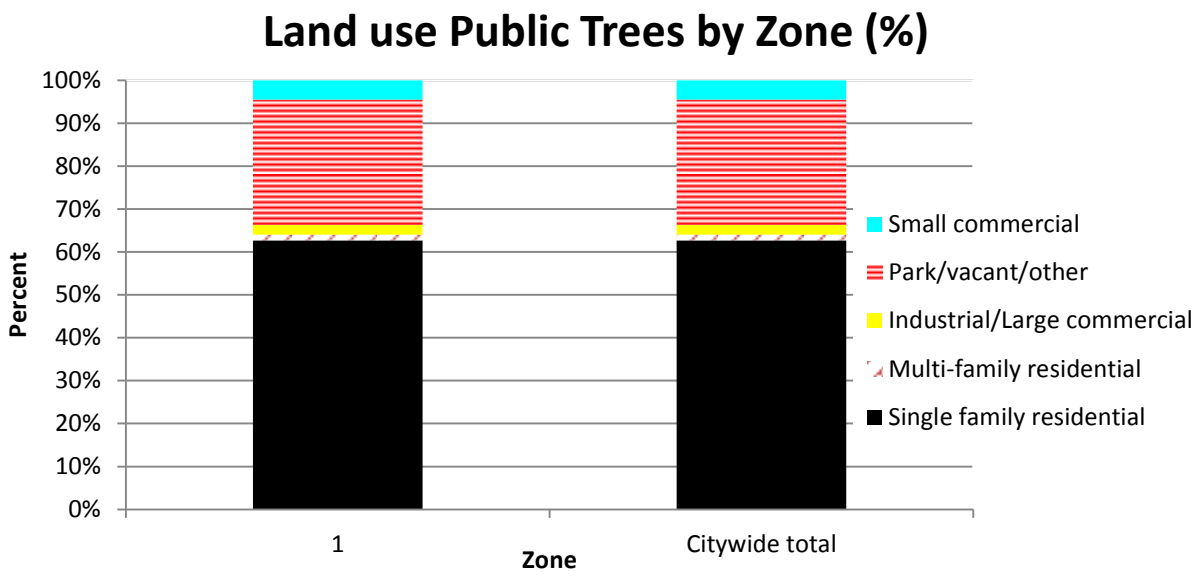
Figure 5. Canopy Cover in Acres



Storm Lake		
Canopy Cover of Public Trees (Acres)		
4/20/2016		

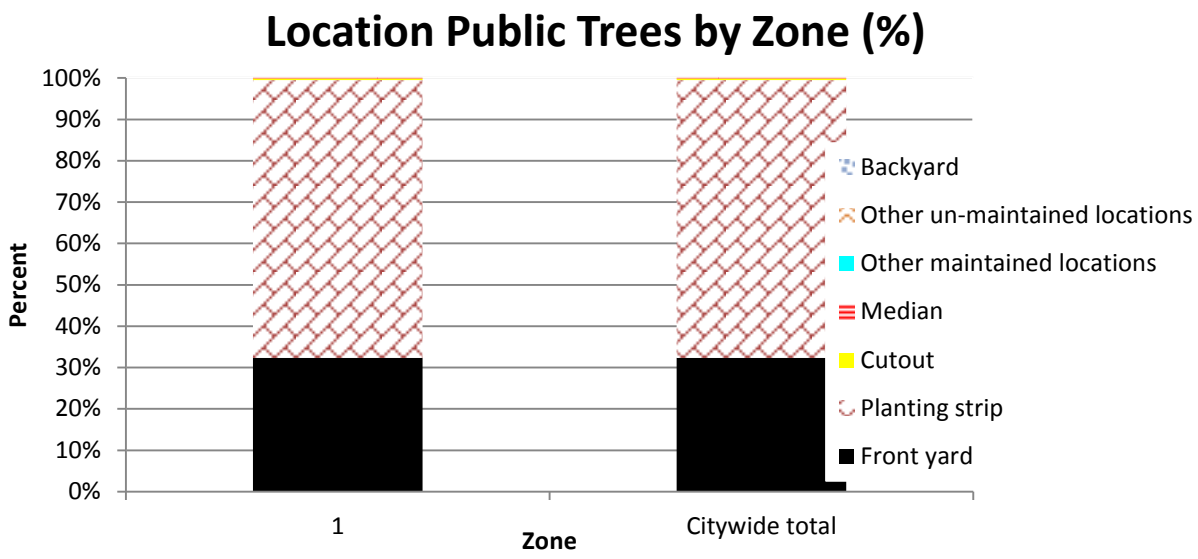
	Total Land Area	Total Canopy Cover	Canopy Cover as % of Total Land Area
Citywide total	2,614.18	159.12	0.19

Figure 6. Land Use of city/park trees



Storm Lake					
Land use Public Trees by Zone (%)					
4/20/2016					
Zone	Single family residential	Multi-family residential	Industrial/Large commercial	Park/vacant/other	Small commercial
Citywide total	62.69	1.34	2.26	29.22	4.49

Figure 7. Location of city/park Trees



Storm Lake							
Location Public Trees by Zone (%)							
4/20/2016							
Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
Citywide total	32.30	67.20	0.35	0.15	0.00	0.00	0.00

Appendix B: ArcGIS Mapping

Figure 1. Location of Ash Trees.

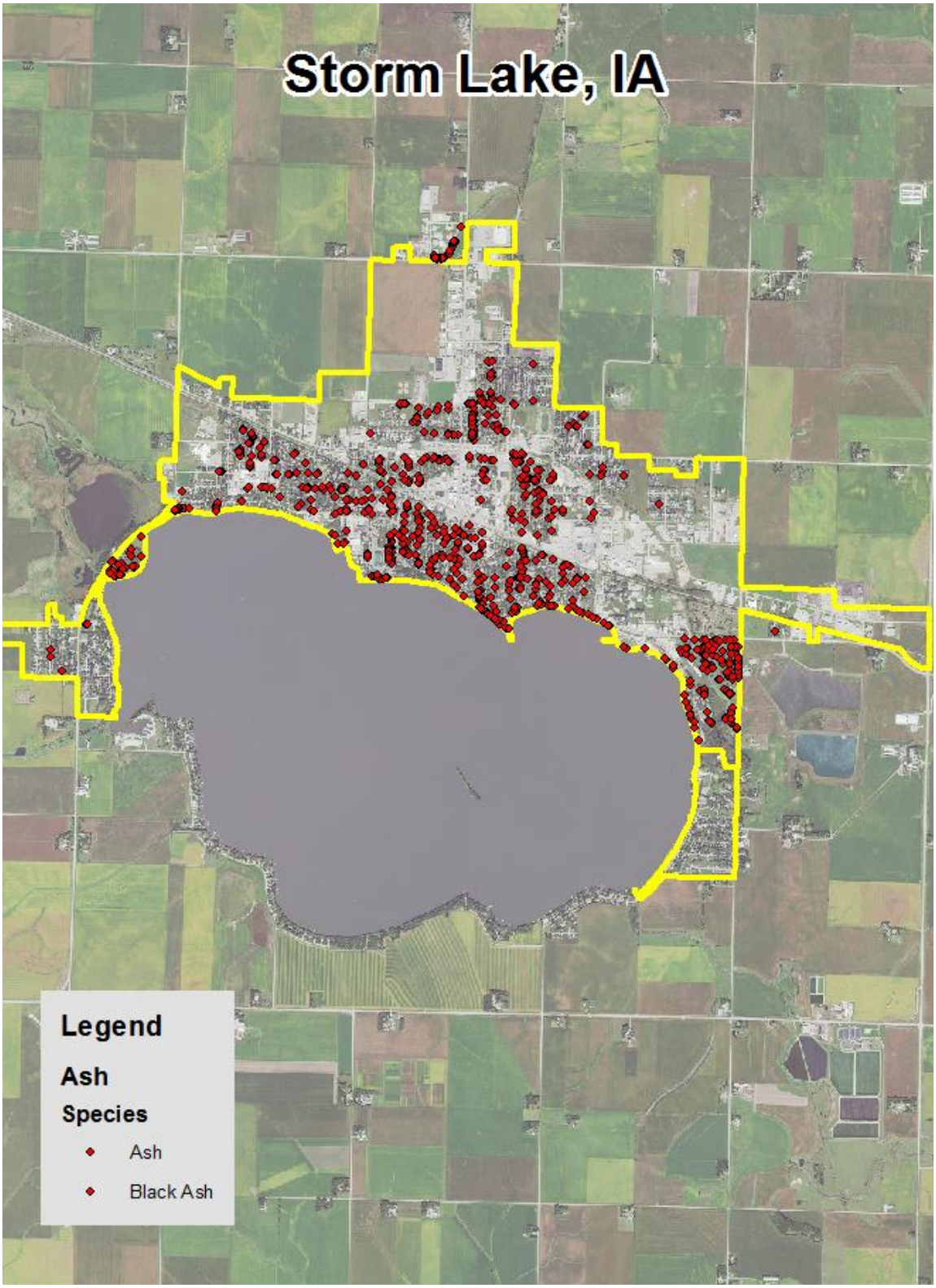


Figure 2: Location of EAB Symptoms

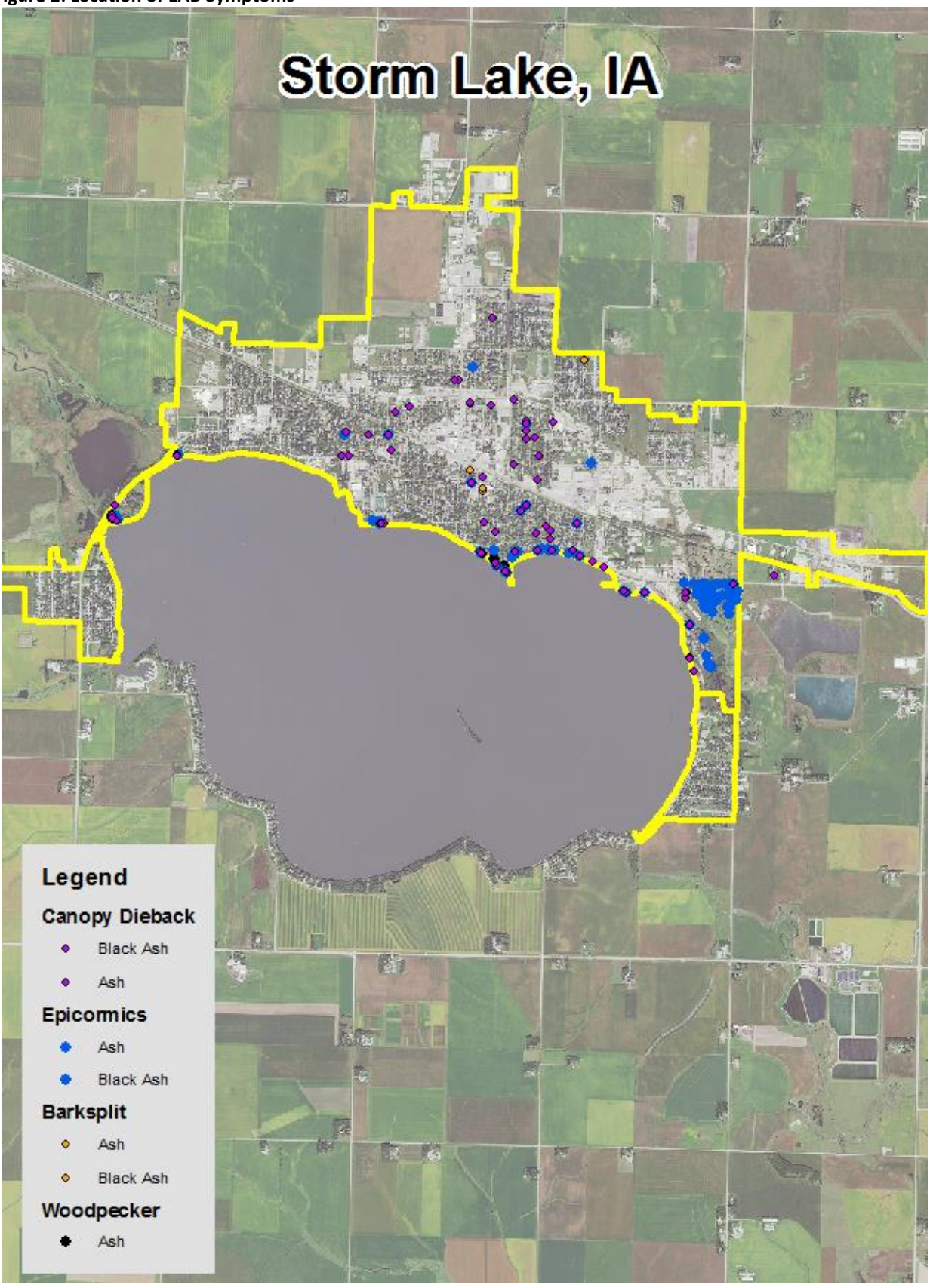


Figure 3: Location of Poor Condition Trees

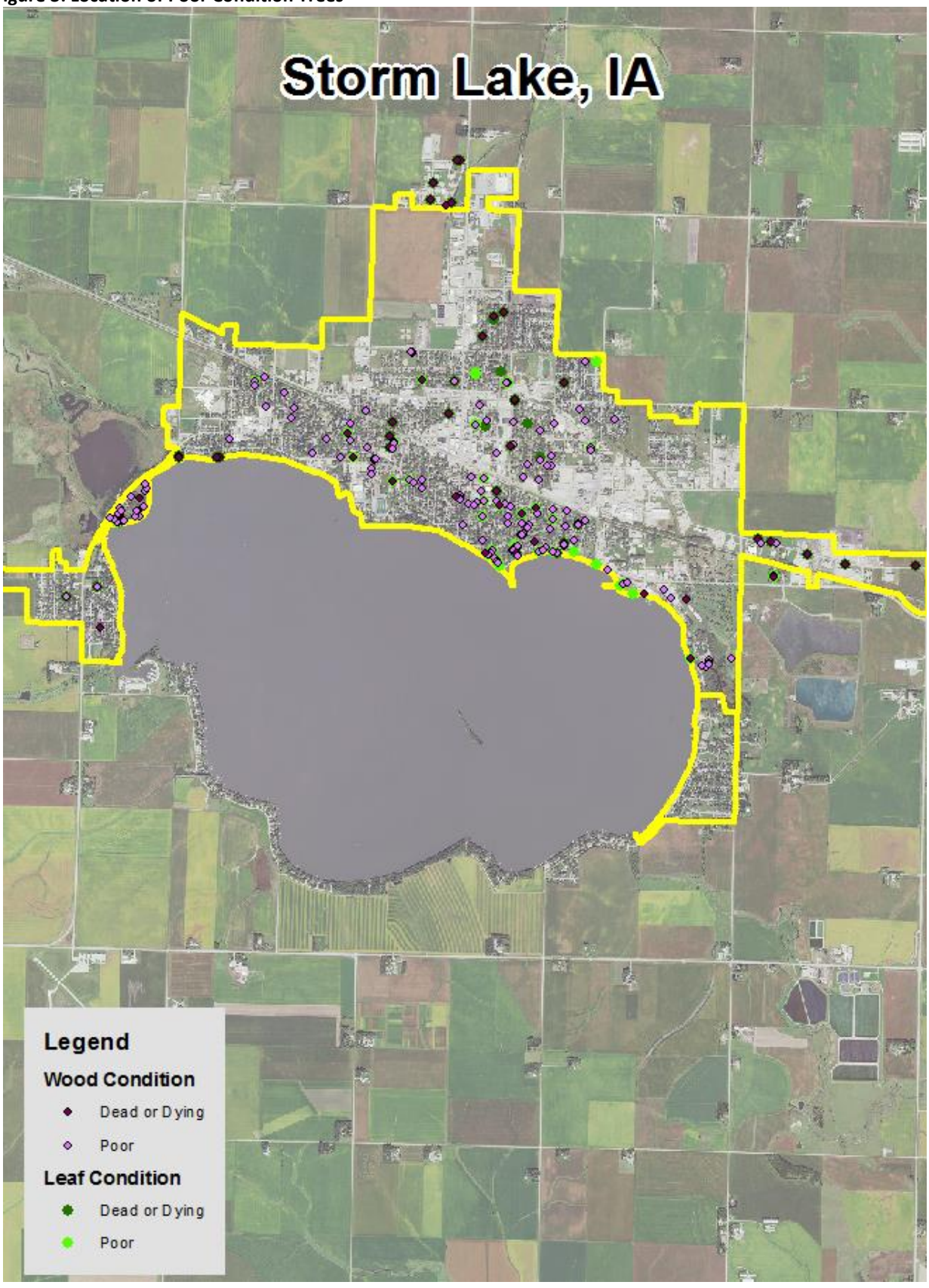


Figure 4: Location of Trees With Recommended Maintenance

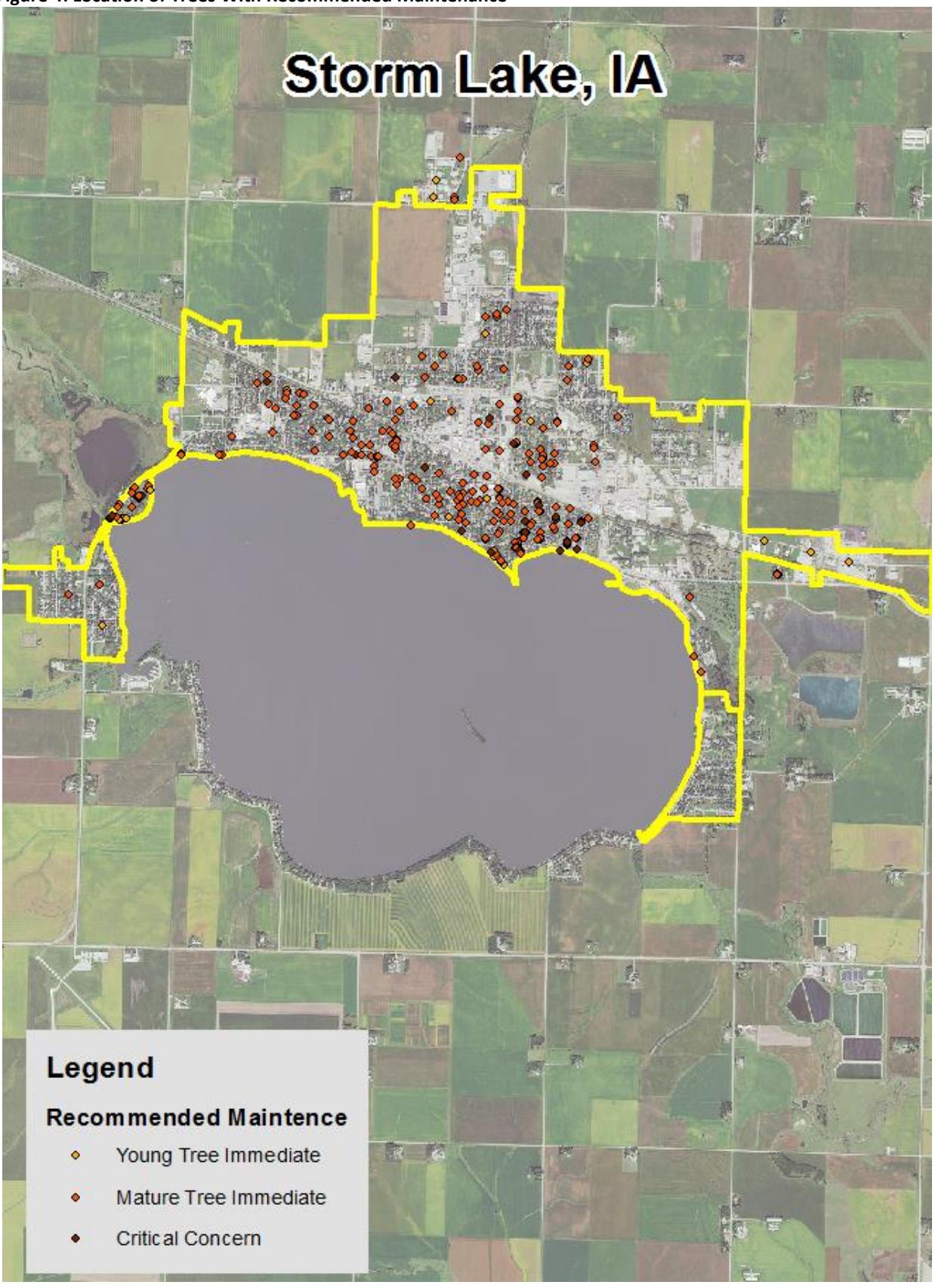
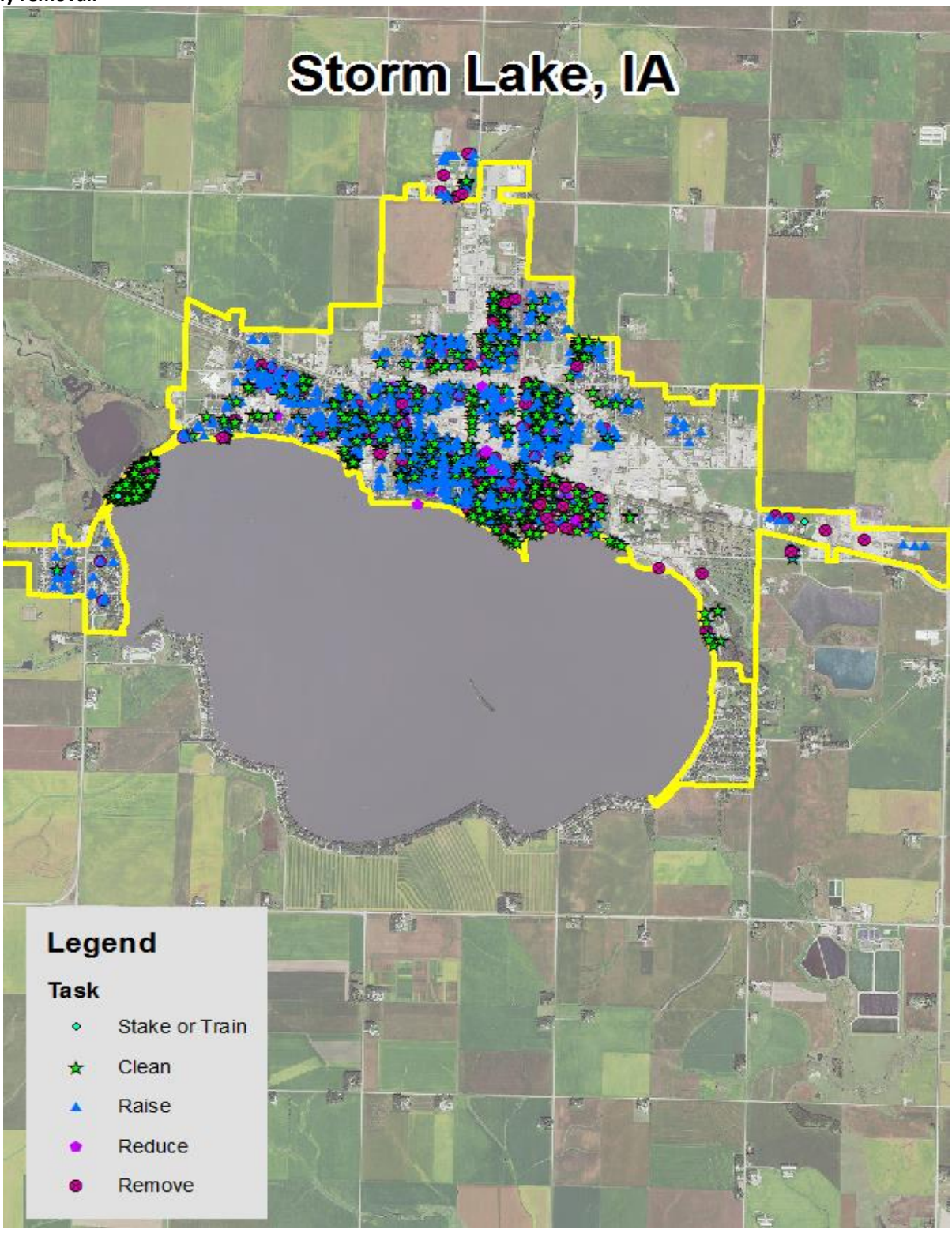


Figure 5: Maintenance Tasks- *City ownership of the Trees recommended for removal should be verified prior to any removal.



Appendix C: Storm Lake Tree Ordinances

The City's current code reads as follows:

Chapter 10-5
TREES

10-5-1 Definitions
10-5-2 Requirements For Planting
10-5-3 Parking Area Planting
10-5-4 Certain Trees Prohibited
10-5-5 Removal Of Trees Infected With Dutch Elm Disease
10-5-6 Obstruction of Enforcement
10-5-7 Municipal Infraction
10-5-8 Maintenance Responsibility-new

10-5-1 Definitions

Corner lot shall mean a lot situated at the junction of two (2) or more streets. Parking area shall mean the area between the established street and front line of the corner.

This section can be amended to include the following definitions: This will be based on items in the ordinance. Common definitions could include, topping, street tree, prune, parkway or buffer.

10-5-2 Requirements For Planting

Every tree planting in the parking area of a lot within the City shall be planted so as to be:

(A) Twenty feet (20') from the corner of a corner lot, and

(B) Fifteen feet (15') from both side lot lines of a lot other than a corner lot, and

(C) Twenty-five feet (25') from any other tree, and

(D) Two and one-half feet (2 ½') or thirty inches (30") from the sidewalk.

Amendments could include additional language:

Example From: *Mauston, WI*
Spacing- The spacing of Street Trees will be in accordance with the three species size classes defined in this ordinance, and no trees may be planted closer together than the following: Small Trees, 15-20 feet; Medium Trees, 25-30 feet; and Large Trees, 40 feet; except in special plantings designed by a landscape architect and approved by the _____Tree Board.
Distance from Curb and Sidewalk- The distance trees may be planted from curbs or curb lines and sidewalks will be in accordance with the three species size classes defined in this ordinance.

No trees may be planted closer to any curb or sidewalk than the following: Small Trees, 2 feet; Medium Trees, 3 feet; and Large Trees, 4 feet. No tree may be planted in any boulevard without the permission of the Director of Public Works. The Board shall develop and implement a system for permitting such plantings, and shall from time to time review the effectiveness of the permitting process.
(1) Planting Permit Process Completion and submission of planting permit shall be at no cost to applicant. Failure to submit a completed permit application prior to planting is a violation of this ordinance. The DPW or designee will review and either approve or deny submitted permit applications.
(2) Planting Permit Application Information. At a minimum, the permit application form shall include: reference to this ordinance, including minimum distances, prohibited species, a diagram of suggested placement relative to the buildings on the lot, property owner contact information, applicant contact information if different, instructions to applicant regarding marking proposed planting locations.
Distance from Street Corners and Fire Hydrants-No Street Tree shall be planted closer than 25 feet to any street intersecting corner. The DPW may require more than 25 feet at his discretion to ensure public safety. This shall be measured from the point of nearest intersecting curbs or curb lines. No Street Tree shall be planted closer than 10 feet of any fire hydrant, driveway entrance or street sign.

Conflict resolution between tree and structures

Example from: *ISA: Guidelines for Developing and Evaluating Tree Ordinances*
Where sidewalk or curb damage due to tree roots occurs, every effort shall be made to correct the problem without removing or damaging the tree. The city forester shall be responsible for developing or approving corrective measures in consultation with the city engineer.

10-5-3 Parking Area Planting

Every tree planted on the parking area shall be planted on a straight line parallel to the street.

The example from Mauston, WI above mentions distance between trees and distances from sidewalks and curbs. Storm Lake could combine these sections.

10-5-4

Certain Trees Prohibited

Box elder, cottonwood, poplar and Chinese elm trees shall not be planted in the parking area.

Add additional tree species would be Black walnut, willow, evergreens, European White poplar and any other tree species taken from the master list of tree species already found in Storm Lake.

10-5-5 Removal of Trees (remove-Infected With Dutch Elm Disease).

In accordance with Section 364.12, Code of Iowa, any owner, occupant, or person in charge of any property shall remove at his own expense any tree, brush, wood or debris infected with

Dutch Elm disease found thereon when so specified by the Clerk. Said owner, occupant or such persons shall be given written notice by the Clerk to remove said tree, brush, wood or debris within thirty (30) days from date of such written notice. If such owner, occupant or person fails to comply with said notice, the Council may cause the same to be removed and the cost assessed against the property.

Add more language for Gypsy Moth (an insect), Emerald Ash Borer (an insect), Asian Long Horn Beetle (an insect), Oak Wilt (a disease), evergreen needles blights (diseases), Pine Wilt (a nematode) of Scotch pine, and other invasive problems.

Also add language for storm damaged trees.

Add, Duty to Abate Dangerous Trees
If there is a danger that all or a substantial portion of such tree or trees located on private property might fall on any public alley, street or other public property this will be sufficient evidence that such tree or trees constitute a nuisance.

When a dangerous tree exists on public property the city manager of his designee shall abate said nuisance.

The City Managers designee is defined as ….. and is either a forester, a city employee or …

Abatement of Nuisances – look at section 8.56.070 of Sioux City's Tree Ordinance.

10-5-6 Obstruction Of Enforcement

It shall be unlawful for any person to hinder, obstruct, or otherwise interfere with the agents or employees of the City while engaged in carrying out the provisions of Section 10-5-5 upon order of the Council made thereunder.

10-5-7 Municipal Infraction

A violation of any on the provisions of this Chapter shall constitute a Municipal infraction subject to the penalties and alternative relief authorized by Title 1, Chapter 20 of the Code and by Section 364.22 of the Code of Iowa.

NEW
10-5-8 Maintenance Responsibility

It shall be the duty and responsibility of every person owning or occupying property within the City of_____, to keep all trees on that property trimmed in such a manner that there is a clearance of at least fourteen (change to 18) feet above any street or alley, and a clearance of at least seven feet over any sidewalk. It shall also be the duty and responsibility of every person owning or occupying any real property within the City of _____to keep all trees on that property trimmed in such a manner that they do not obstruct the view of any traffic sign or device for vehicle traffic in the direction controlled by that traffic sign or device.

Damaging or Removing Trees from Parkway or Streets

Any Permits Required?

Topping

Topping shall mean the cutting of the branches and/or trunk of a tree in a manner which will substantially reduce the overall size of the tree area so as to destroy the existing symmetrical appearance or natural shape of the tree in a manner which results in the removal of main lateral branches leaving the trunk of the tree in a stub appearances. No property owner or his agent shall cause any tree on his property to be topped.

Clearance

All trees and shrubs on public or private property, which have branches overhanging a public street or sidewalk, shall have said branches trimmed to a clearance height of 14 feet on the street side and 10 feet on the sidewalk side.

Removals

Example from: *ISA: Guidelines for Developing and Evaluating Tree Ordinances*
Any person desiring to cut, move or remove a tree or protected tree within the city of _____shall apply to the Superintendent for a permit. A permit is not required for pruning as herein defined. The application for the permit shall be made on the form provided by the Superintendent for this purpose and shall include the number, location and type(s) of the tree(s) to be cut, moved or removed and the reason for such action. The applicant may submit an arborist's report or other expert evidence for consideration. The application shall be accompanied by any required fee to cover the cost of processing as set in the current City fee schedule. Fees shall be waived for applications made by a department of the City of _____on its own behalf.

The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

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

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