DUNDEE, IA

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2010 Management Plan
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Executive Summary

Overview:

This plan was developed to assist the City of Dundee with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows communities 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 that kills all species of our native ash trees. There is a strong possibility that over 5% of Dundee's city-managed ash trees could die once EAB becomes established in the community. With proper planning and management, the costs of removing dead and dying trees can be extended over several years mitigating public safety issues.

Inventory and Results:

In the summer of 2011, a street tree inventory was conducted using an integrated Global Positioning System (GPS) data collector. This involved a complete inventory of street trees within the City's Right-of-Way and some parkland. Below are some key findings of the 137 trees inventoried.

- Dundee street trees provide roughly $19,320 of annual benefits, an average of $141 per tree.
- The top three species groups are: Maples (39%), Ash (14%) and Oak (8%).
- Approximately 79% of trees are in need of some type of management.
- For various reasons, 8 trees are recommended for removal.

Recommendations:

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

- Three of the 19 ash trees inventoried is in need of follow up checking because it displays some signs and symptoms associated with EAB.
- All trees should be pruned on a routine schedule- one third of the city every other year.
- Plant a diverse mix of trees that *does not include*: ash, soft maple, autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar and tree-of-heaven.
- Check ash trees with a visual survey yearly.

Introduction

This plan was developed to assist Dundee with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with a great proportion 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 Dundee, these costs can be extended over several years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important component of Dundee's infrastructure and are one of the greatest assets to the community. Through research, it has been shown that trees provide a community with numerous public benefits including: improved air quality, storm water runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and creating a desirable place to live. It is essential that these benefits be maintained for the people of Dundee and future generations through sound urban forestry management.

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

Inventory

In the summer of 2011, a tree inventory was conducted that included the city-owned street trees and some park trees. The tree data was collected using a handheld Global Positioning System (GPS) receiver/data logger. This devise records Geographic Information System (GIS) coordinates with an accuracy of 3 meters. The data can then 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 collector was written to be compatible with a state-of-the-art software suite called i-Tree. This software was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. This software is in the public domain and can be accessed for free.

To quantify the urban forest structure and its benefits, specific data is collected for each tree. This data includes: location, land use, tree species, diameter at 4.5 ft (DBH), recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms of 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 by the data loggers was downloaded and analyzed by software developed by the USDA Forest service called *Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM)*. This is software is also part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis of Dundee's inventory data.

Annual Benefits

Annual Energy Benefits:

Trees conserve energy by shading buildings and blocking winds. Dundee's trees reduce energy related costs by approximately $5,034 annually (Appendix A, Table 1). These savings are both in Electricity (24.4 MWh) and in Natural Gas (3,245 Therms).

Annual Storm water Benefits:

Dundee's trees intercept about 248,827 gallons of rainfall and snow melt per year (Appendix A, Table 2). This interception provides $6,744 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 that emit volatile organic matter (ozone). In Dundee, it is estimated that trees remove 291 lbs. of air pollution (ozone (O_3), particulate matter less than 10 microns (PM_{10}), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $804 (Appendix A, Table 3).

Annual Carbon Benefits:

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change.   Of the 137 trees inventoried, the amount of carbon stored amounts to approximately 901,267 total lbs of CO_2 (Appendix A, Table 4) . Those trees are sequestering about 58,443 lbs of carbon per year (Appendix A, Table 5). The benefits these trees provide from summer shading and from reductions in household wind infiltration in the winter result in approximately 40,971 fewer lbs of CO_2 being released into the atmosphere (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. Dundee receives approximately $5,993 in annual social benefits from its street trees (Appendix A, Table 6).

Financial Summary of all Benefits:

According to the USDA Forest Service i-Tree STRATUM analysis, Dundee's trees provide $19,320 of benefits annually. Benefits of individual trees vary based on size, species, health and location. On average, each of the 137 trees in Dundee's inventory provides approximately $141 annually (Appendix A, Table 7).

Forest Structure

Species Distribution:

There were over 29 different tree species surveyed. The distribution of trees by genus is as follows:

Genus	# of trees	% of total
Maple (*acer*)	54	39.4%
Ash (*fraxius*)	19	13.9%
Oak (*quercus*)	11	8.0%
Spruce (*picea*)	9	6.6%
Elm (*ulmus*)	9	6.6%
Walnut (*juglans*)	7	5.1%
Apple (*malus*)	6	4.4%
Pine (*Pinus*)	6	4.4%
Arborvitae (*Thuja*)	5	3.6%
Eastern Red Cedar (*Juniperus*)	2	1.5%
Cherry (*prunus*)	2	1.5%
White Mulberry (*morus*)	2	1.5%
Redbud (cercis)	1	0.7%
Linden (*tilia*)	1	0.7%
Other evergreens	1	0.7%
Willow (*Salix*)	1	0.7%
Tuliptree (*Liriodendron*)	1	0.7%
	137	100.0%

Size Distribution:

The table below summarizes distribution of surveyed trees by their diameter in inches when measured at 4.5 above the ground.   Trees between 6 to 18 inches in diameter were most abundant (51%). See Appendix A, Figure 2 for a breakdown of size distributions by species.

Size Classes (inches of diameter at 4.5 feet)	# of trees	% of trees
0 - 3	11	8.0%
3 - 6	15	10.9%
6 - 12	34	24.8%
12 - 18	36	26.3%
18 - 24	19	13.9%
24 - 30	7	5.1%
30 - 36	6	4.4%
36 - 42	3	2.2%
42+	6	4.4%
	137	100.0%

Condition: Wood and Foliage:

Leaf condition is a good indicator of the overall health of urban trees. The foliage condition results for Dundee indicated that 81% of the trees were in good health, 14% in fair health, 3% in poor health and 2% dead or dying. (Appendix A, Figure 3). Leaf health is largely a function of climatic factors during the growing season. This year was not too cool or too wet, therefore, leaf diseases were not as much an issue.   I believe several trees are also in decline due to damage from recent City infrastructure projects.

The condition of the wood in urban trees is another important indicator of tree health. The wood forms the structural support system for the leaves and branches.   Extensive decay in the main stem makes a tree structurally unsafe which leads to a tree becoming a safety hazard. In Dundee, 66% of the surveyed trees were in good health, 27% in fair health, 6% in poor health and 1% dead or dying. (Appendix A, Figure 4). The 7% in poor, or dead or dying, condition should be assessed more carefully. Many of these trees with poor wood condition are being recommended for removal due to public safety concerns. The 27% in fair health is to a large extent a reflection of having many maple trees which tend to have problems with decay or cracking in their main stem.   The City already has too many maple trees, so please encourage less planting of this species group.

Management Needs:

Each surveyed tree was assessed for recommended maintenance needs. The following tables list the specific management needs and recommendations. (See Appendix B, figures 3, 4 & 5).

Priority Task	# of trees	% of trees
none	108	78.8%
clean	9	6.6%
remove	8	5.8%
stake/train	5	3.6%
raise	4	2.9%
treat diseases	3	2.2%
	137	100.0%

Maintenance Recommendation	# of trees	% of trees
None	107	78.1%
mature tree (routine)	22	16.1%
young tree (routine)	7	5.1%
mature tree (immediate)	1	0.7%
	137	100.0%

Land Use and Location:

The majority of Dundee's surveyed trees are 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   77%
Park/vacant/other   22%
Small commercial   1%

Location
Front yard   34%
Planting strip   27%
Back yard   17%
Other maintained locations (e.g. parks)   22%

Recommendations

Risk Management:

Hazardous trees can be a significant threat to both people and property. Trees that are dead or dying, or that have 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:

A total of 8 trees are recommended for removal for one reason or another. Of those, 2 tree had poor wood condition or showed signs of severe decay. These trees with severe decay could easily break off or topple over in storms or under ice and snow loads.   3 trees were conifers with needlecast disease problems beyond recovery and 3 trees are either dead or are in the process of dying.

Pruning Cycle:

Proper pruning can extend the life and improve the overall health of trees, and can reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning (stake/train), crown cleaning (clean), crown raising (raise), and crown reduction (reduce). 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. Staking and training is recommended for younger trees so they can develop good architecture. It is recommended that all trees be pruned on a routine schedule every five to seven years.

Priority Task	# of trees	% of trees
none	108	78.8%
clean	9	6.6%
remove	8	5.8%
stake/train	5	3.6%
raise	4	2.9%
treat diseases	3	2.2%
	137	100.0%

Planting:

Most of the planting over the next six years should replace the trees that are recommended for removal. It is recommended to plant two trees for every tree removed since survival rates will not be 100%. It is not essential that the new trees be planted in the same location as the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Dundee.

Since most insects and diseases target a particular genus (e.g. ash) or species (e.g. green ash) of trees, it is important to always plant a diverse mix of species. Current diversity recommendations advise that any genus (e.g. maple, oak or ash) not make up more than 20% of the urban forest.   Any single species (e.g. silver maple, sugar maple, white oak or bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with Maple (39%) (Appendix A, Figure 1). Maples should not be planted until this percentage is dramatically 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: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, and willow. I noticed that white poplar was recommended in your City Tree Ordinance. This tree can become invasive so should probably be taken off of your list.

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 death and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Emerald Ash Borer (EAB) Plan

Ash Tree Removal:

Ash trees in poor condition and displaying signs and symptoms of EAB should be considered for removal (Appendix B, Figure 2). *City ownership of the tree recommended for removal should be verified prior to any removal*

EAB Quarantines:

EAB is an extremely destructive plant pest and it is responsible for the death and decline of many millions ash trees throughout the Eastern United States and Canada. Ash in both forestlands and urban settings constitutes a very significant portion of the canopy cover. 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 its spread beyond its known locations 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 urban 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 your budget permits, all removed ash trees should be replaced. All trees should meet the restrictions in your city's ordinance (Appendix C). The new plantings should be a diverse mix and should not include ash, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

Postponed Work:

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

Private Ash Trees:

It is strongly recommended that private property owners start removing ash trees on their property as trees are infested with Emerald Ash Borer. Trees that are on private property are part of Dundee's urban forest. Private property owners should be given direction to the proper species to plant, spacing, and location. Dundee has a city ordinance for trees.

Budget

<u>Purposed Budget Increase:</u>

EAB could potentially kill all of the ash trees in Dundee within a decade after its arrival.   It is recommended that the City apply for grants to fund replacement tree planting. 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.   There were a total of 19 ash trees surveyed. We recommend removing the 3 ash trees showing signs and symptoms of possible EAB infestation (Appendix B, Figure 2). We also recommend removing the 3 trees showing signs they are dying (Appendix B, Figure 3). You should replant 2 trees for everyone removed. Finally, we recommend that the City adopt a policy of allocating somewhere between $2 to $4 per capita per year into a forestry budget to be used for planting, removals and maintenance of Dundee's urban forest.

Recommended Budget: <u>$5,100</u>.

FY 2011 Budget
     Removal: $500
     Planting: $200
     Routine trimming: $100
     Watering & Maintenance: $50

FY 2012 Budget
     Removal: $500
     Planting: $200
     Routine trimming: $100
     Watering & Maintenance: $50

FY 2013 Budget
     Removal: $500
     Planting: $200
     Routine trimming: $100
     Watering & Maintenance: $50

FY 2014 Budget
     Removal: $500
     Planting: $200
     Routine trimming: $100
     Watering & Maintenance: $50

FY 2015 Budget
     Removal: $500
     Planting: $200
     Routine trimming: $100
     Watering & Maintenance: $50

FY 2016 Budget
     Removal: $500
     Planting: $200
     Routine trimming: $100
     Watering & Maintenance: $50

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species

12/7/2011

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	5.7	435	751.3	736	1,171	(N/A)	19.7	23.3	43.37
Sugar maple	5.1	386	655.7	643	1,029	(N/A)	13.9	20.4	54.15
Green ash	3.0	230	395.5	388	617	(N/A)	11.7	12.3	38.58
Siberian elm	1.2	92	159.7	157	248	(N/A)	5.8	4.9	31.05
Black walnut	1.5	114	182.3	179	293	(N/A)	5.1	5.8	41.82
Apple	0.4	33	67.6	66	99	(N/A)	4.4	2.0	16.50
Pin oak	1.4	109	193.2	189	298	(N/A)	3.7	5.9	59.65
Northern white cedar	0.2	16	36.4	36	52	(N/A)	3.7	1.0	10.39
Norway maple	0.7	52	92.7	91	143	(N/A)	2.9	2.8	35.62
Red maple	0.1	9	18.7	18	28	(N/A)	2.9	0.6	6.92
Scotch pine	0.3	21	42.7	42	63	(N/A)	2.9	1.3	15.81
White oak	1.2	88	158.8	156	243	(N/A)	2.9	4.8	60.84
Ash	0.2	19	39.9	39	58	(N/A)	2.2	1.2	19.31
Spruce	0.1	9	19.7	19	28	(N/A)	2.2	0.6	9.36
Black spruce	0.3	19	35.6	35	54	(N/A)	2.2	1.1	18.04
Eastern red cedar	0.1	7	15.9	16	23	(N/A)	1.5	0.5	11.47
White mulberry	0.2	16	28.5	28	44	(N/A)	1.5	0.9	21.77
Norway spruce	0.0	1	1.3	1	2	(N/A)	1.5	0.0	0.93
Eastern white pine	0.3	25	44.3	43	69	(N/A)	1.5	1.4	34.32
Bur oak	0.5	38	65.1	64	102	(N/A)	1.5	2.0	50.77
Other street trees	1.8	136	240.1	235	371	(N/A)	6.6	7.4	41.23
Citywide total	24.4	1,854	3,244.9	3,180	5,034	(N/A)	100.0	100.0	36.74

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

12/7/2011

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	77,297	2,095	(N/A)	19.7	31.1	77.59
Sugar maple	50,275	1,363	(N/A)	13.9	20.2	71.71
Green ash	23,718	643	(N/A)	11.7	9.5	40.17
Siberian elm	8,133	220	(N/A)	5.8	3.3	27.55
Black walnut	11,288	306	(N/A)	5.1	4.5	43.70
Apple	1,536	42	(N/A)	4.4	0.6	6.94
Pin oak	17,353	470	(N/A)	3.7	7.0	94.06
Northern white cedar	2,212	60	(N/A)	3.7	0.9	11.99
Norway maple	3,990	108	(N/A)	2.9	1.6	27.03
Red maple	660	18	(N/A)	2.9	0.3	4.47
Scotch pine	4,373	119	(N/A)	2.9	1.8	29.63
White oak	11,941	324	(N/A)	2.9	4.8	80.91
Ash	1,335	36	(N/A)	2.2	0.5	12.06
Spruce	1,240	34	(N/A)	2.2	0.5	11.20
Black spruce	3,055	83	(N/A)	2.2	1.2	27.60
Eastern red cedar	1,318	36	(N/A)	1.5	0.5	17.86
White mulberry	735	20	(N/A)	1.5	0.3	9.96
Norway spruce	97	3	(N/A)	1.5	0.0	1.32
Eastern white pine	7,573	205	(N/A)	1.5	3.0	102.63
Bur oak	4,056	110	(N/A)	1.5	1.6	54.96
Other street trees	16,642	451	(N/A)	6.6	6.7	50.12
Citywide total	248,827	6,744	(N/A)	100.0	100.0	49.22

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

12/7/2011

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	13.0	2.2	6.5	0.6	70	27.0	4.0	3.8	25.9	169	-7.3	-28	75.6	212 (N/A)	19.7	7.84
Sugar maple	6.8	1.2	3.4	0.3	37	23.9	3.5	3.4	23.1	150	-5.4	-20	60.1	167 (N/A)	13.9	8.77
Green ash	2.1	0.3	1.2	0.1	11	14.3	2.1	2.0	13.7	89	0.0	0	35.7	101 (N/A)	11.7	6.30
Siberian elm	0.6	0.1	0.4	0.0	4	5.7	0.8	0.8	5.5	36	0.0	0	14.0	39 (N/A)	5.8	4.92
Black walnut	1.0	0.2	0.6	0.0	6	7.0	1.0	1.0	6.8	44	0.0	0	17.6	50 (N/A)	5.1	7.09
Apple	0.3	0.1	0.2	0.0	2	2.1	0.3	0.3	2.0	13	0.0	0	5.3	15 (N/A)	4.4	2.50
Pin oak	3.2	0.6	1.6	0.1	17	6.8	1.0	0.9	6.5	43	-5.9	-22	14.9	38 (N/A)	3.6	7.58
Northern white cedar	0.2	0.0	0.2	0.0	1	1.1	0.2	0.1	1.0	7	-0.6	-2	2.1	6 (N/A)	3.6	1.11
Norway maple	0.5	0.1	0.3	0.0	3	3.3	0.5	0.5	3.1	20	-0.2	-1	8.1	23 (N/A)	2.9	5.69
Red maple	0.1	0.0	0.0	0.0	0	0.6	0.1	0.1	0.6	4	0.0	0	1.4	4 (N/A)	2.9	1.01
Scotch pine	0.5	0.1	0.4	0.1	3	1.4	0.2	0.2	1.3	9	-1.8	-7	2.3	5 (N/A)	2.9	1.24
White oak	1.4	0.2	0.7	0.1	7	5.5	0.8	0.8	5.2	34	0.0	0	14.6	42 (N/A)	2.9	10.43
Ash	0.1	0.0	0.1	0.0	1	1.2	0.2	0.2	1.1	8	0.0	0	2.9	8 (N/A)	2.2	2.72
Spruce	0.1	0.0	0.1	0.0	1	0.6	0.1	0.1	0.5	4	-0.4	-1	1.2	3 (N/A)	2.2	1.00
Black spruce	0.3	0.1	0.3	0.0	2	1.2	0.2	0.2	1.1	8	-1.0	-4	2.4	6 (N/A)	2.2	1.99
Eastern red cedar	0.1	0.0	0.1	0.0	1	0.5	0.1	0.1	0.4	3	-0.7	-3	0.6	1 (N/A)	1.5	0.62
White mulberry	0.2	0.0	0.1	0.0	1	1.0	0.1	0.1	0.9	6	0.0	0	2.6	7 (N/A)	1.5	3.63
Norway spruce	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0 (N/A)	1.5	0.05
Eastern white pine	0.9	0.2	0.7	0.1	6	1.6	0.2	0.2	1.5	10	-4.2	-16	1.2	0 (N/A)	1.5	-0.06
Bur oak	0.4	0.1	0.2	0.0	2	2.3	0.3	0.3	2.3	15	0.0	0	5.9	17 (N/A)	1.5	8.38
Other street trees	2.9	0.5	1.5	0.1	16	8.5	1.2	1.2	8.1	53	-1.9	-7	22.1	62 (N/A)	6.6	6.85
Citywide total	34.8	5.9	18.6	1.7	192	115.6	16.9	16.1	110.7	723	-29.5	-111	290.8	804 (N/A)	100.0	5.87

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

12/7/2011

Species	Total Stored CO_2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	323,451	2,426	(N/A)	19.7	35.9	89.85
Sugar maple	198,656	1,490	(N/A)	13.9	22.0	78.42
Green ash	68,535	514	(N/A)	11.7	7.6	32.13
Siberian elm	17,357	130	(N/A)	5.8	1.9	16.27
Black walnut	34,144	256	(N/A)	5.1	3.8	36.58
Apple	5,952	45	(N/A)	4.4	0.7	7.44
Pin oak	86,037	645	(N/A)	3.7	9.6	129.06
Northern white	846	6	(N/A)	3.7	0.1	1.27
Norway maple	9,450	71	(N/A)	2.9	1.1	17.72
Red maple	1,151	9	(N/A)	2.9	0.1	2.16
Scotch pine	3,894	29	(N/A)	2.9	0.4	7.30
White oak	43,675	328	(N/A)	2.9	4.9	81.89
Ash	2,420	18	(N/A)	2.2	0.3	6.05
Spruce	516	4	(N/A)	2.2	0.1	1.29
Black spruce	1,687	13	(N/A)	2.2	0.2	4.22
Eastern red cedar	554	4	(N/A)	1.5	0.1	2.08
White mulberry	3,215	24	(N/A)	1.5	0.4	12.06
Norway spruce	5	0	(N/A)	1.5	0.0	0.02
Eastern white pine	10,833	81	(N/A)	1.5	1.2	40.62
Bur oak	12,130	91	(N/A)	1.5	1.4	45.49
Other street trees	34,817	576	(N/A)	6.6	8.5	63.97
Citywide total	901,267	6,760	(N/A)	100.0	100.0	49.34

Table 5: Annual Carbon Sequestered

Annual CO$_2$ Benefits of Public Trees by Species

12/7/2011

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	23,687	178	-1,553	-5	-12	9,609	72	31,738	238 (N/A)	19.7	31.9	8.82
Sugar maple	10,528	79	-954	-4	-7	8,536	64	18,106	136 (N/A)	13.9	18.2	7.15
Green ash	6,626	50	-329	-3	-2	5,076	38	11,370	85 (N/A)	11.7	11.4	5.33
Siberian elm	1,919	14	-83	-2	-1	2,031	15	3,865	29 (N/A)	5.8	3.9	3.62
Black walnut	3,086	23	-164	-1	-1	2,521	19	5,442	41 (N/A)	5.1	5.5	5.83
Apple	656	5	-29	-1	0	724	5	1,350	10 (N/A)	4.4	1.4	1.69
Pin oak	4,578	34	-413	-1	-3	2,407	18	6,570	49 (N/A)	3.7	6.6	9.86
Northern white cedar	194	1	-4	-1	0	359	3	548	4 (N/A)	3.7	0.6	0.82
Norway maple	1,220	9	-45	-1	0	1,142	9	2,315	17 (N/A)	2.9	2.3	4.34
Red maple	174	1	-6	-1	0	206	2	373	3 (N/A)	2.9	0.4	0.70
Scotch pine	311	2	-19	-1	0	473	4	764	6 (N/A)	2.9	0.8	1.43
White oak	2,819	21	-210	-1	-2	1,939	15	4,547	34 (N/A)	2.9	4.6	8.53
Ash	544	4	-12	-1	0	416	3	948	7 (N/A)	2.2	1.0	2.37
Spruce	109	1	-2	-1	0	195	1	301	2 (N/A)	2.2	0.3	0.75
Black spruce	168	1	-8	-1	0	425	3	584	4 (N/A)	2.2	0.6	1.46
Eastern red cedar	80	1	-3	0	0	164	1	241	2 (N/A)	1.5	0.2	0.90
White mulberry	306	2	-15	0	0	346	3	635	5 (N/A)	1.5	0.6	2.38
Norway spruce	7	0	0	0	0	12	0	19	0 (N/A)	1.5	0.0	0.07
Eastern white pine	187	1	-52	0	0	557	4	692	5 (N/A)	1.5	0.7	2.60
Bur oak	1,105	8	-58	0	0	834	6	1,881	14 (N/A)	1.5	1.9	7.05
Other street trees	4,494	34	-368	-2	-3	3,001	23	7,125	53 (N/A)	6.6	7.2	5.94
Citywide total	62,796	471	-4,326	-27	-33	40,971	307	99,414	746 (N/A)	100.0	100.0	5.44

Table 6: Annual Social and Aesthetic Benefits

## Annual Aesthetic/Other Benefits of Public Trees by Species

12/7/2011

Species	Total ($) Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	1,976 (N/A)	19.7	33.0	73.19
Sugar maple	1,120 (N/A)	13.9	18.7	58.97
Green ash	671 (N/A)	11.7	11.2	41.96
Siberian elm	214 (N/A)	5.8	3.6	26.78
Black walnut	300 (N/A)	5.1	5.0	42.88
Apple	37 (N/A)	4.4	0.6	6.13
Pin oak	357 (N/A)	3.7	6.0	71.45
Northern white cedar	60 (N/A)	3.7	1.0	11.99
Norway maple	131 (N/A)	2.9	2.2	32.69
Red maple	30 (N/A)	2.9	0.5	7.49
Scotch pine	85 (N/A)	2.9	1.4	21.19
White oak	235 (N/A)	2.9	3.9	58.68
Ash	65 (N/A)	2.2	1.1	21.78
Spruce	37 (N/A)	2.2	0.6	12.20
Black spruce	67 (N/A)	2.2	1.1	22.47
Eastern red cedar	43 (N/A)	1.5	0.7	21.34
White mulberry	18 (N/A)	1.5	0.3	8.77
Norway spruce	12 (N/A)	1.5	0.2	5.76
Eastern white pine	47 (N/A)	1.5	0.8	23.54
Bur oak	104 (N/A)	1.5	1.7	51.77
Other street trees	385 (N/A)	6.6	6.4	42.78
Citywide total	5.993 (N/A)	100.0	100.0	43.75

Table 7: Summary of Benefits in Dollars

Total Annual Benefits of Public Trees by Species ($)

12/7/201

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	1,171	238	212	2,095	1,976	5,692	(±0)	29.5
Sugar maple	1,029	136	167	1,363	1,120	3,814	(±0)	19.7
Green ash	617	85	101	643	671	2,117	(±0)	11.0
Siberian elm	248	29	39	220	214	751	(±0)	3.9
Black walnut	293	41	50	306	300	989	(±0)	5.1
Apple	99	10	15	42	37	203	(±0)	1.0
Pin oak	298	49	38	470	357	1,213	(±0)	6.3
Northern white cedar	52	4	6	60	60	181	(±0)	0.9
Norway maple	142	17	23	108	131	422	(±0)	2.2
Red maple	28	3	4	18	30	82	(±0)	0.4
Scotch pine	63	6	5	119	85	277	(±0)	1.4
White oak	243	34	42	324	235	878	(±0)	4.5
Ash	58	7	8	36	65	175	(±0)	0.9
Spruce	28	2	3	34	37	104	(±0)	0.5
Black spruce	54	4	6	83	67	215	(±0)	1.1
Eastern red cedar	23	2	1	36	43	104	(±0)	0.5
White mulberry	44	5	7	20	18	93	(±0)	0.5
Norway spruce	2	0	0	3	12	16	(±0)	0.1
Eastern white pine	69	5	0	205	47	326	(±0)	1.7
Bur oak	102	14	17	110	104	346	(±0)	1.8
Other street trees	371	53	62	451	385	1,322	(±0)	6.8
Citywide Total	5,034	746	804	6,744	5,993	19,320	(±0)	100.0

Species Distribution of Public Trees (%)

12/7/2011
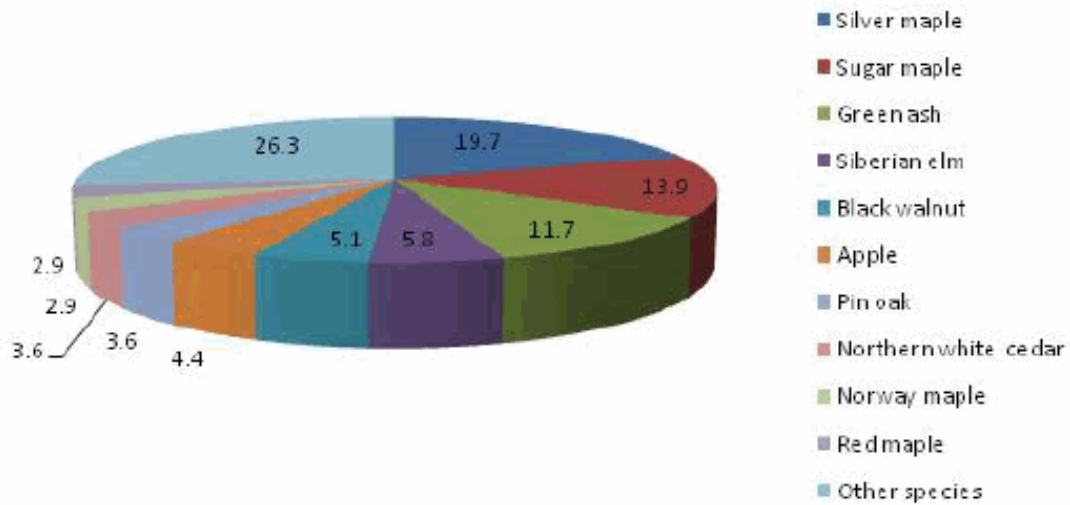
Species	Percent
Silver maple	19.7
Sugar maple	13.9
Green ash	11.7
Siberian elm	5.8
Black walnut	5.1
Apple	4.4
Pin oak	3.6
Northern white cedar	3.6
Norway maple	2.9
Red maple	2.9
Other species	26.3
Total	100.0

Figure 1: Species Distribution

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

12/7/2011

Figure 2: Relative Age Class
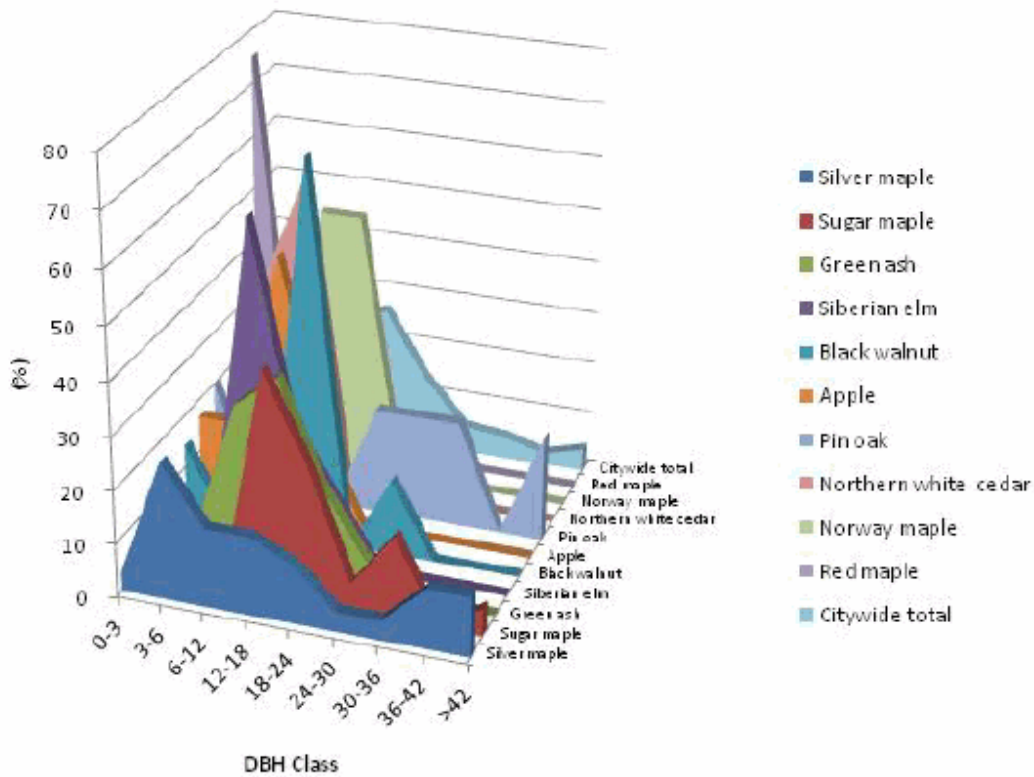
Species	DBH class (in)								
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Silver maple	3.7	25.9	14.8	14.8	11.1	3.7	3.7	11.1	11.1
Sugar maple	0.0	5.3	0.0	42.1	26.3	5.3	15.8	0.0	5.3
Green ash	0.0	6.3	31.3	37.5	18.8	6.3	0.0	0.0	0.0
Siberian elm	0.0	0.0	62.5	25.0	12.5	0.0	0.0	0.0	0.0
Black walnut	14.3	0.0	0.0	71.4	0.0	14.3	0.0	0.0	0.0
Apple	16.7	16.7	50.0	16.7	0.0	0.0	0.0	0.0	0.0
Pin oak	20.0	0.0	0.0	0.0	20.0	20.0	20.0	0.0	20.0
Northern white cedar	0.0	40.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0
Norway maple	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0
Red maple	75.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0
Citywide total	8.0	10.9	24.8	26.3	13.9	5.1	4.4	2.2	4.4

Functional (Foliage) Condition of Public Trees by Species (%)

12/7/2011

Citywide total

Dead or Dying 2%
Poor 3%
Fair 14%
Good 81%

Legend:
- Dead or Dying
- Poor
- Fair
- Good
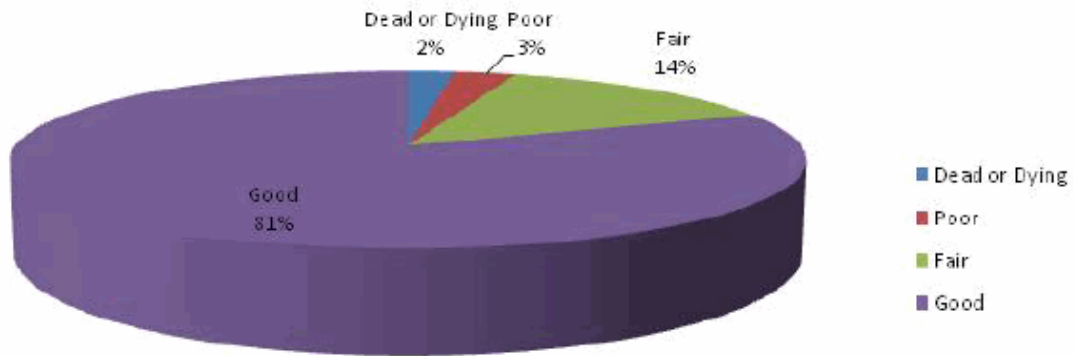
Figure 3: Foliage Condition

Structural (Woody) Condition of Public Trees by Species (%)

12/7/2011

Citywide total

Dead or Dying 1%
Poor 6%
Fair 27%
Good 66%

Legend:
- Dead or Dying
- Poor
- Fair
- Good
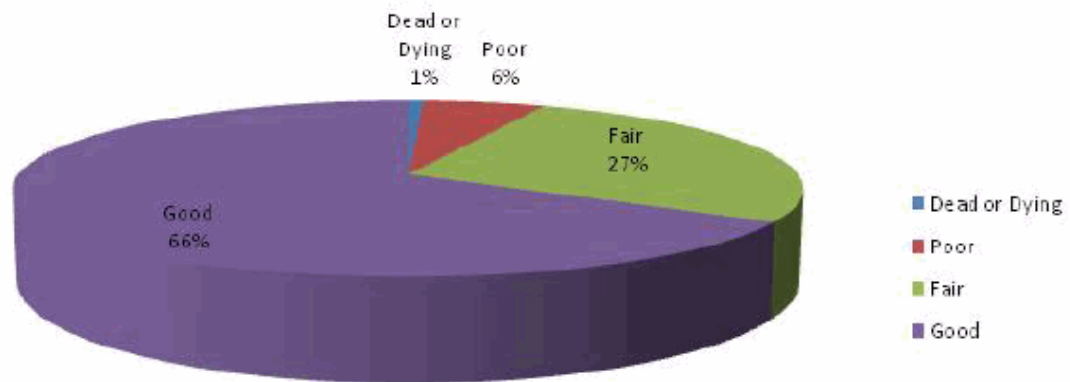
Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

12/7/2011
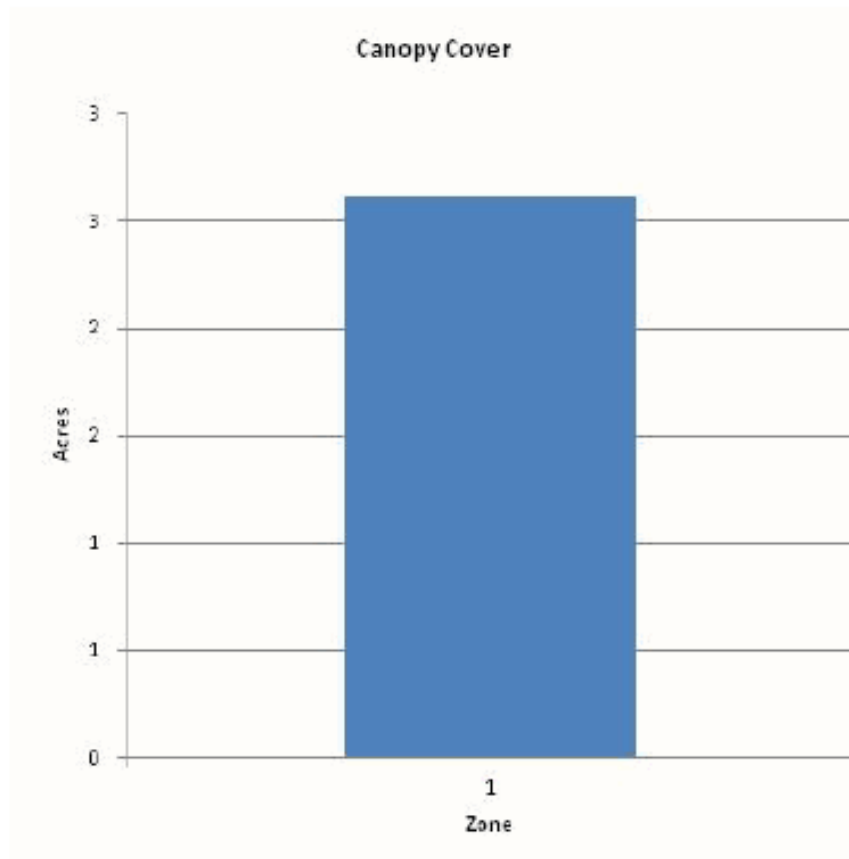
Zone	Acres	% of Total Canopy Cover
1	3	100.0
Citywide total	3	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	3		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

12/7/2011
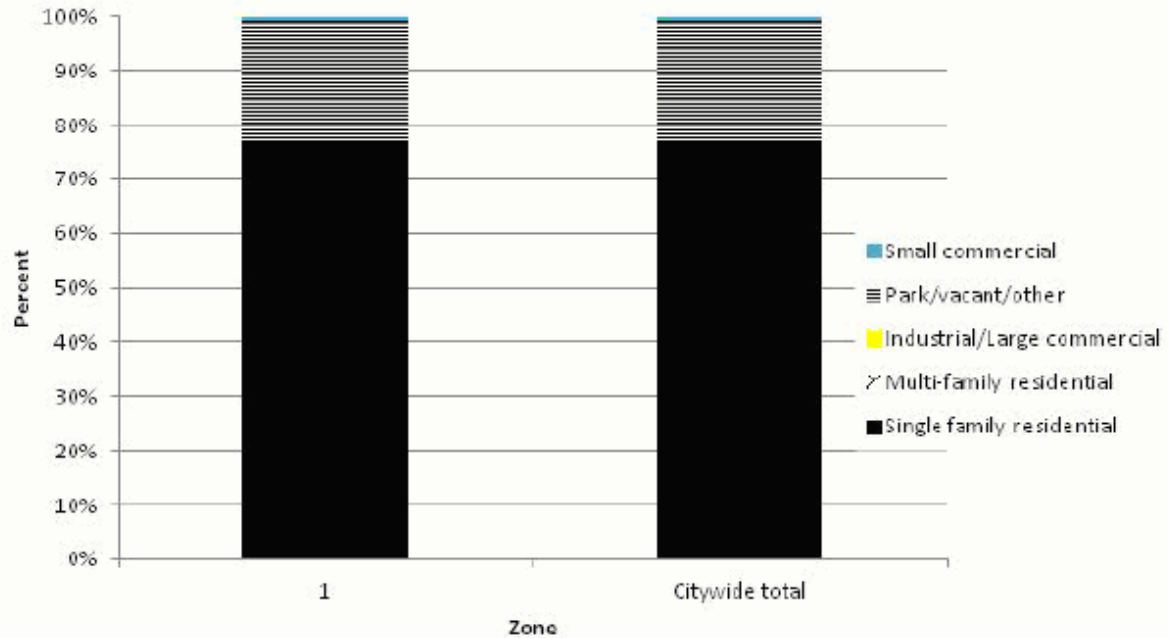
Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	77.4	0.0	0.0	21.9	0.7
Citywide total	77.4	0.0	0.0	21.9	0.7

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)
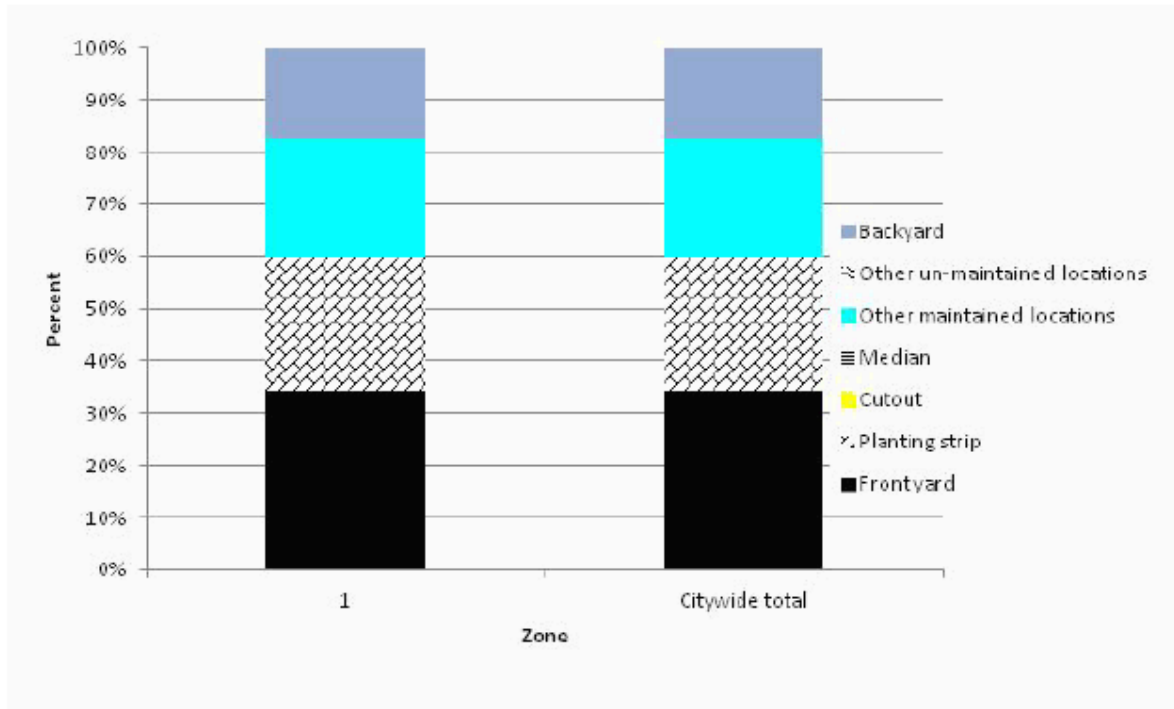
Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	34.3	25.5	0.0	0.0	22.6	0.0	17.5
Citywide total	34.3	25.5	0.0	0.0	22.6	0.0	17.5

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping
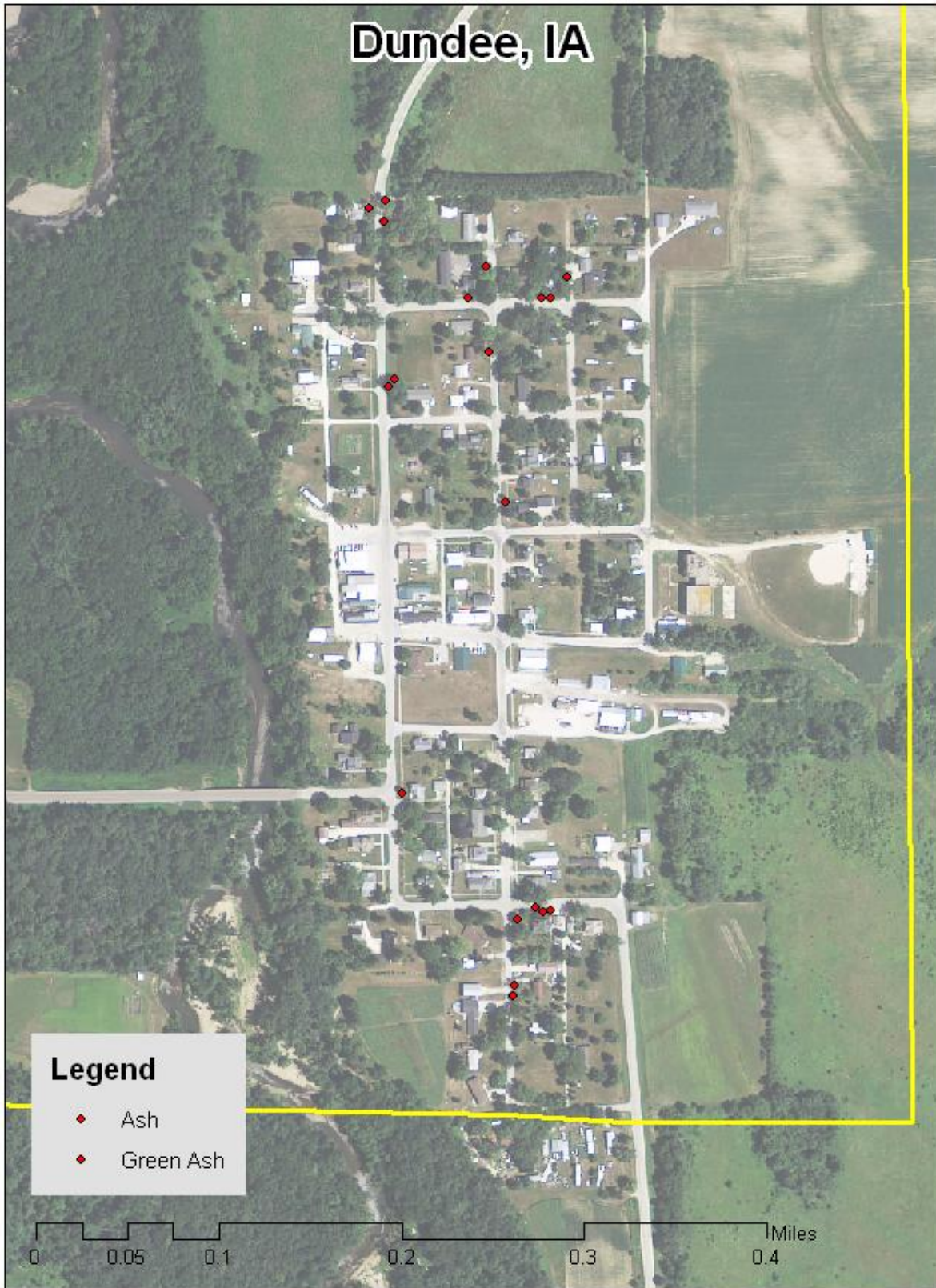
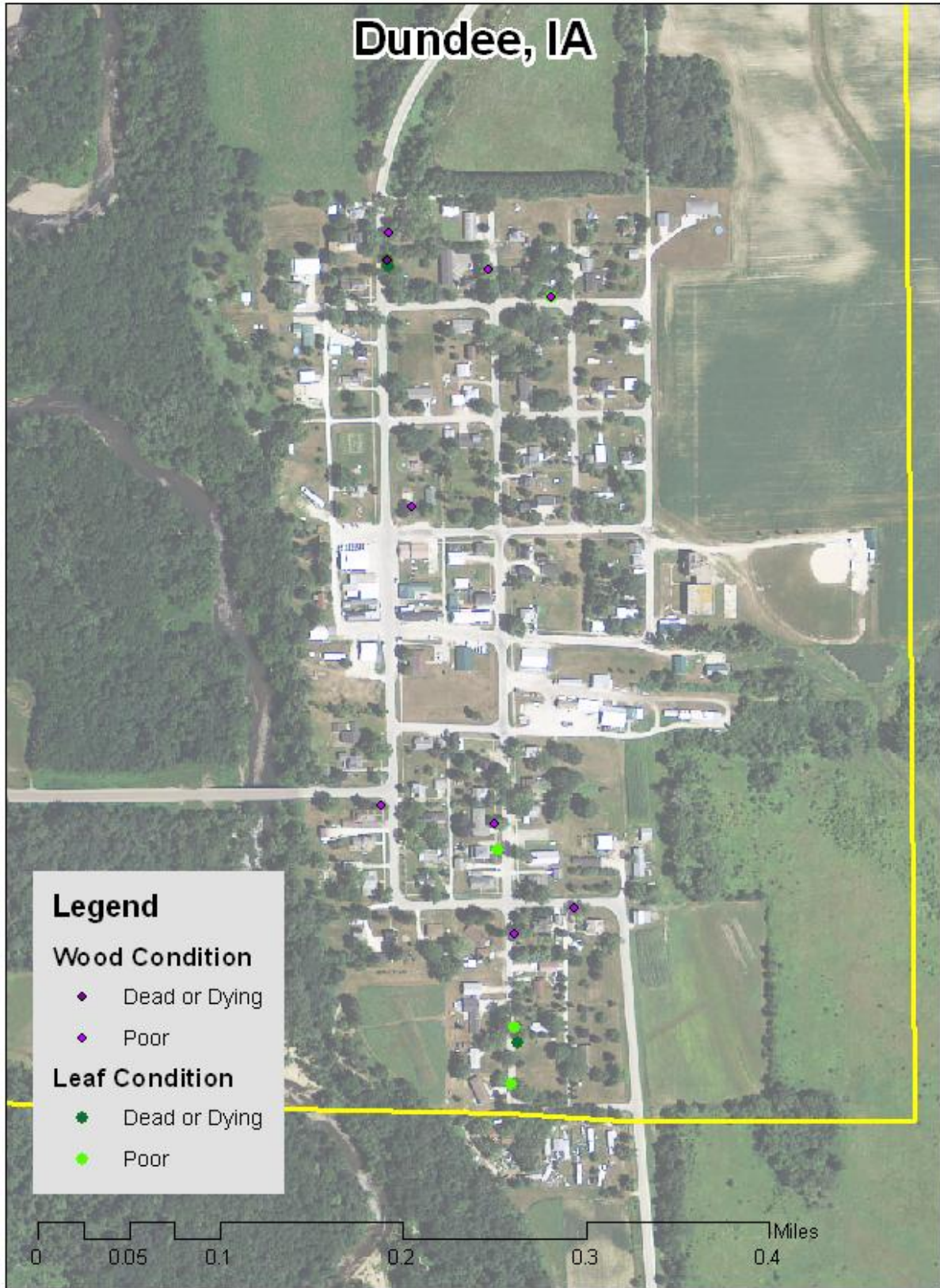**Figure 1: Location of Ash Trees**

Figure 2: Location of EAB symptoms
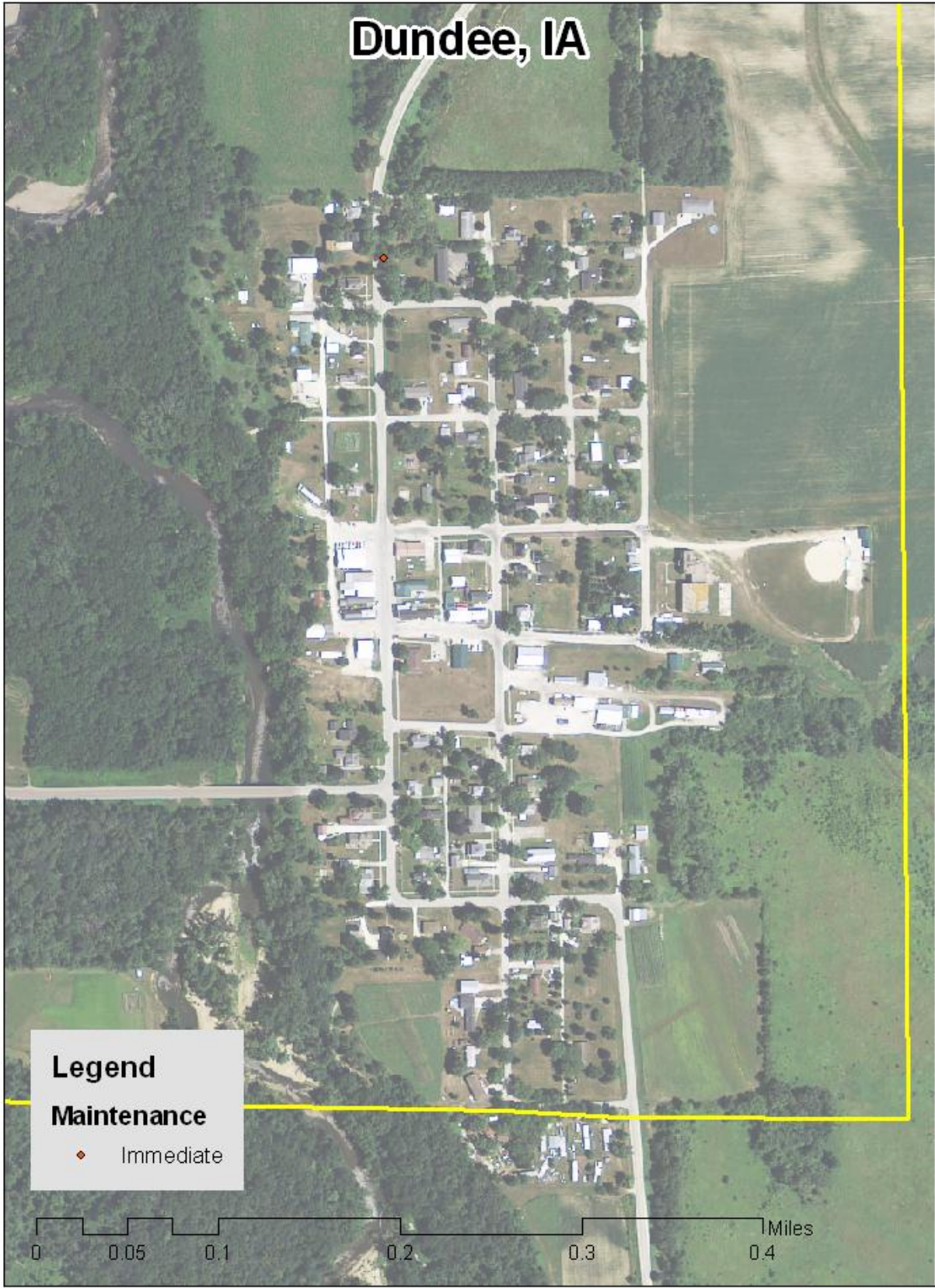
Figure 3: Location of Poor Condition Trees

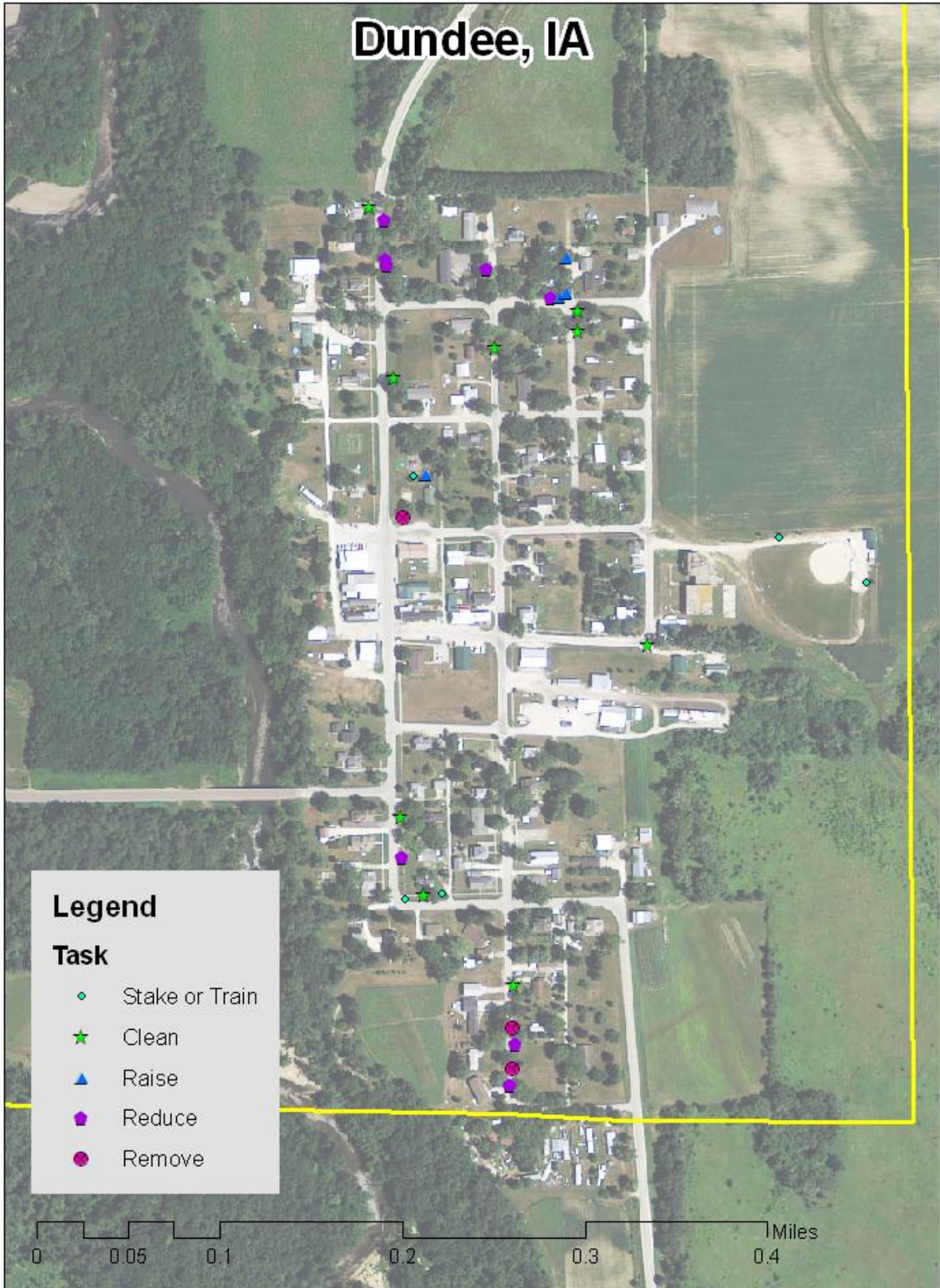**Figure 4: Location of Trees with Recommended Maintenance**

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

Appendix C: Dundee's Tree Ordinances

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 515-281-5918.