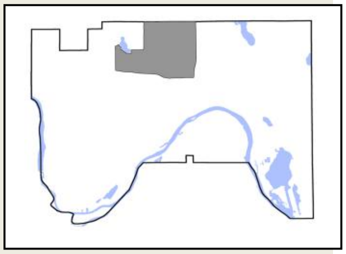
Urban Forest Benefits Report

District 6 | North End



The North End planning district includes the neighborhoods south of Lake Como and east of Dale Street to Interstate 35E. The district is primarily residential with a commercial corridor along Rice Street and two areas of industrial land located south of Front Avenue and west of Interstate 35. At 2,705 acres the district accounts for approximately 7.5% of the city's 35,931 acre land area.

A 2011 tree canopy assessment found that District 6 has a total canopy cover of 31.2%, 1.3% below the city average of 32.5%. The public right of way, which includes street trees, has a canopy cover of 38% and provides 30% of the total district tree canopy. Current canopy cover can be linked to a number of factors associated with urban land use that influence the space available for tree establishment and the site conditions that support tree growth. In addition to residential, industrial, and commercial lands District 6 has significant areas of open space including active and passive use park lands and three cemeteries as well as transportation corridors that include residential streets with planting boulevards and wide planting medians along Wheelock Parkway.

A comprehensive street tree inventory update was completed in 2013 cataloging the boulevard trees of District 6. The resulting inventory data including the species, size, and condition of each tree was entered into i-Tree Streets[1] to analyze the structural and functional characteristics of the urban forest including species and age diversity, the level of environmental benefits being provided by street trees, and the associated economic value of these benefits. With the possibility of structural changes resulting from the potential spread of emerald ash borer into the North End neighborhood, the environmental benefits of the ash tree population were also calculated to determine the mid-term impact on forest benefits associated with a rapid loss of the district's ash trees. The following results are a summary of the findings:

District 6 Benefits Summary

District area	2,705 acres
Number of street trees	9,632
Canopy area	132*/256** acres
Energy reduction	$234,702
Carbon sequestered	2.87 million pounds
Total carbon stored	30.2 million pounds
Avoided carbon emissions	2.36 million pounds
Air pollutants removed	2,455 pounds
Air pollutants avoided	14,979 pounds
Stormwater runoff avoided	10.4 million gallons
Aesthetic/Other benefits	$195,512
Total annual benefit	$796,910

Table 1: Benefits summary

*Canopy provided by public boulevard trees as measured by iTree.
**Total public right of way canopy cover identified by the 2011 canopy assessment. This figure includes canopy extending over the public right of way that originates from trees planted on private property.

[1] Tree benefit model developed by the USDA Forest Service

Forest Structure

Tree Genera and Species Distribution

Analysis of the 9,632 street trees cataloged as part of the 2013 District 6 street tree inventory update reveals that three tree genera, maple, ash, and linden comprise 57% of the street tree population. Maple account for the largest share and as a genera represent 28% of the street tree population followed by ash at 15% and linden at 14%. Norway maple is the most widely planted tree species comprising 17% of the street tree population followed by green ash at 14%. Species including river birch, Kentucky coffeetree, oak, elm, and other canopy trees are currently underutilized and could be more widely planted to support species diversity goals.

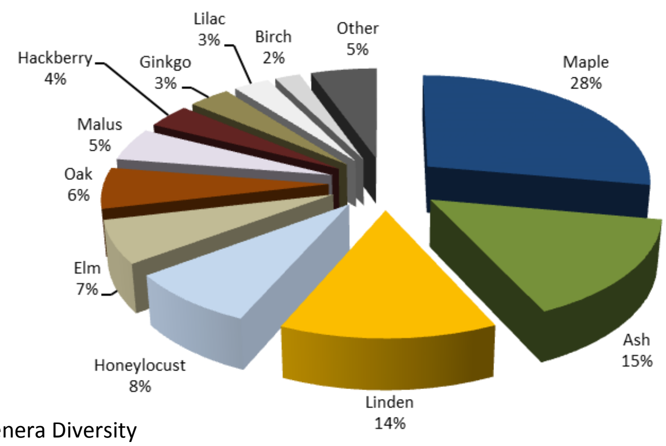


Figure 1: Genera Diversity

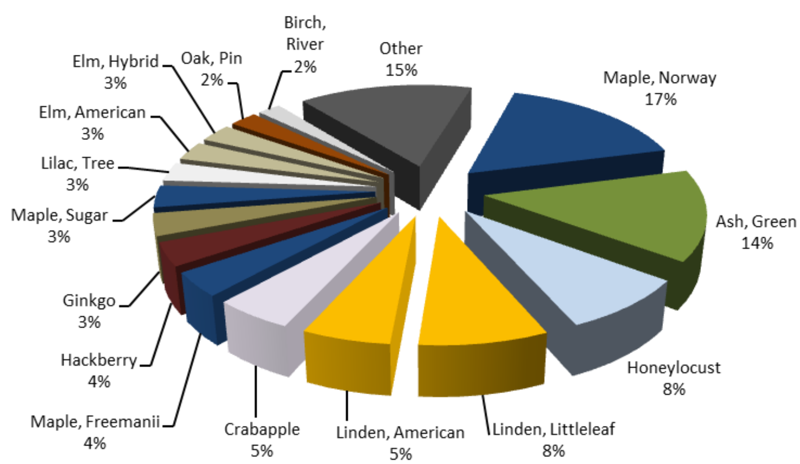


Figure 2: Species Diversity

Size Distribution

The size distribution of trees, determined by measuring the trunk diameter 4.5' above ground level (DBH), reveals a mix of newly planted and maturing tree canopy with an average trunk diameter of 11". Two diameter classes, 0"-3" and 13"-15", show a greater percentage of trees and account for 37% of the street tree population at 21% and 16% respectively. The increased number of trees less than 3" DBH is the result of district wide tree planting in 2012 as part of the City's rotational planting schedule. Mature trees 19" and above in diameter account for 13% of district street trees.

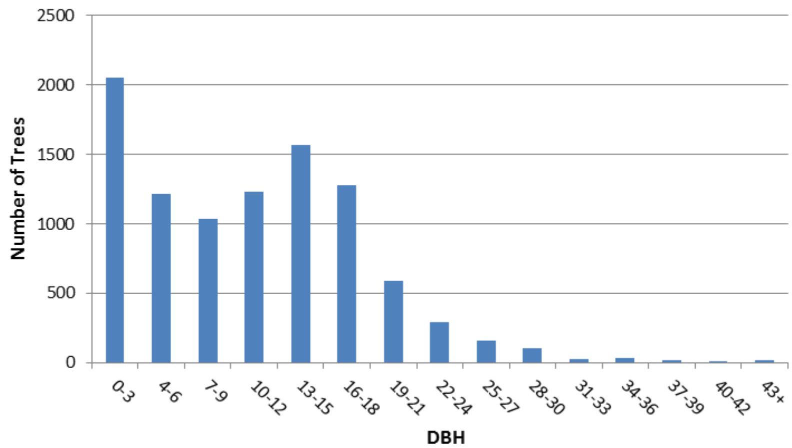


Figure 3: Size distribution as measured by tree diameter 4.5 feet above ground (DBH)

Further analysis of the nine most widely planted genera reveals that current tree diversity ratios are likely to shift over time:

- Dutch elm disease (DED) lead to the dramatic loss of elm trees in Saint Paul and for years no new elm trees were planted. The subsequent development of new varieties of DED resistant elms has resulted in an uptick in the percentage of elm trees within the urban forest. Elm trees 0"-6" in diameter represent 5.3% of the district's street trees while all other elms account for only 1% of the street tree population.

- Due to the 2009 discovery of emerald ash borer (EAB) in Saint Paul, ash trees are no longer planted on city boulevards. Combined with the probable loss of mature ash trees as EAB spreads, the replacement of ash trees with other species will significantly reduce the ash tree population from its current level of 15% of the street tree population.

- New and underutilized tree types will continue to be selected and planted to increase species diversity on the public right of way.

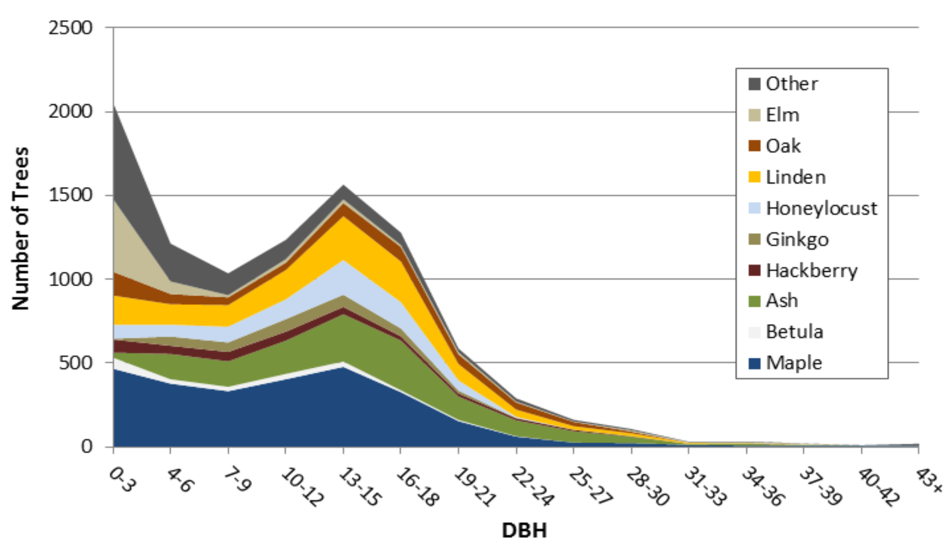
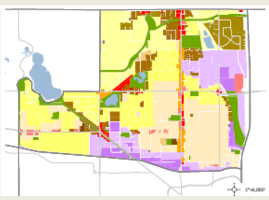


Figure 4: Primary Species Distribution

The two most widely planted tree genera are maple and ash which together comprise 43% of the street tree inventory. Calculated by size category these two tree types account for 24% of all trees 0"-3", 44% of trees 4"-6", 47% of trees 7"-9", 49% of trees 10"-18", and 53% of all trees 19" and above. The percentage of maple and ash trees in the District 6 canopy will shift as ash are removed due to emerald ash borer and a variety of other tree types are planted to enhance species diversity.

Tree condition ratings in District 6 are favorable with 62% of boulevard trees rated in good condition, 33% rated in fair condition, and 5% considered to be in poor condition. Ash trees rated slightly less favorable in overall condition with 51% in good, 46% in fair, and 3% rated in poor condition.



Residential land use, represented in shades of yellow and brown, and the associated public right of ways contain 91% of the city managed boulevard trees of District 6

Map Key:
Green-Park Land
Purple-Industrial
Red/Pink-Commercial
Yellow/Brown-Residential

Land Use + Planting Site Locations

Land use analysis within District 6 measured land area as 50% residential, 12% industrial, 3% commercial, 6% park land, and 25% public right of way (interstate 35 corridor, streets, sidewalks, and boulevards) with the remaining defined as other land uses (2011 Canopy Assessment). The existing street tree population is primarily located in residential areas with 91% of trees found on residential boulevards, 6% on boulevards adjacent to industrial zones, and 3% along commercial corridors.

Tree planting sites in the district's residential neighborhoods are located on turf covered boulevards. Boulevard planting sites in commercial and industrial areas include both sidewalk cutouts and turf depending on the street corridor design and use requirements for adjacent properties. Boulevard width and soil volumes available for tree growth are influenced by the surrounding land use and right of way width. Residential turf boulevards range in size from as little as 3 feet wide to 15 feet or more while commercial planting sites can vary widely. Wider boulevards typically provide greater soil volumes and better soil conditions that support tree growth and health.

Canopy Cover

District 6 has a land area of approximately 2,705 acres and a total tree canopy cover of 31.2% as measured by the 2011 city wide canopy assessment. Canopy cover over the public right of way, which includes street trees, was identified as 38%, or 256 acres of tree cover on 676 acres of right of way land, 132 canopy acres of which is provided directly by street trees as modeled by iTree. Street trees contribute approximately 16% of the district's overall canopy cover.

Importance Value

iTree assigns a relative importance value (RI) to compare the environmental, economic, and social benefits provided by each tree species based on current population size and characteristics. RI values are determined by calculating the percentage of the total street tree population that each tree type represents for the number of trees, leaf area, and canopy cover and then averaging these three numbers. The resulting number provides an indication of which tree species have the greatest capacity to mitigate stormwater, improve air quality, shade buildings and provide other benefits.

Within District 6, green ash received the highest importance value rating of 19.9 points due to the large number of ash planted on the public right of way and total leaf area and canopy cover value of these trees. Norway maple received the second highest importance value of 17.1 points followed by honeylocust with 10.3 points.

Japanese tree lilacs (RI value of 1.23), and other small ornamental tree types receive lower RI values due to the relatively small leaf surface area and small population size of these trees in the urban forest. While these characteristics reduce the ability of ornamental trees as a whole to intercept large volumes of stormwater or sequester and store large amounts of carbon, their value and use should not be overlooked. Smaller trees are able to be planted in locations larger trees cannot while simultaneously providing additional aesthetic and design benefits.

	Number of Trees	Percent of Trees	Leaf Area (ft2)	Percent of Total Leaf Area	Canopy Cover (ft2)	Percent of Total Canopy Cover	Relative Importance Value
Green Ash	1,361	14.1	3,739,344	24.5	1,206,231	20.9	19.9
Norway Maple	1,593	16.5	2,485,721	16.3	1,065,072	18.5	17.1
Honeylocust	799	8.3	1,555,920	10.2	713,508	12.4	10.3
Linden, Littleleaf	768	8	1,624,508	10.7	497,392	8.6	9.1
Linden, American	528	5.5	630,581	4.1	229,522	4	4.5
Pin Oak	234	2.4	758,684	5	276,700	4.8	4.1
Silver Maple	166	1.7	874,275	5.7	238,673	4.1	3.9
Hackberry	348	3.6	435,843	2.9	221,726	3.9	3.4
Sugar Maple	329	3.4	455,304	3	181,499	3.2	3.2

Table 2: Trees with the 8 highest relative importance values on a 100 point scale

Canopy Benefits

Annual Benefits:

The 9,632 street trees planted in District 6 provide an estimated $796,910 worth of environmental services to the residents of the North End neighborhood and form an important part of Saint Paul's green infrastructure system. This represents an average annual economic value of $82.74 per tree and is significant considering that these values only account for trees found along the public right of way and do not include the substantial number of trees planted in parks or on private property.

Refer to page 9 for a complete list of the environmental and economic benefits provided by the street trees in the North End neighborhood.

When accounting for the five primary benefits iTree uses to calculate these values including energy, air quality, carbon sequestration and storage, stormwater, and aesthetics the trees with the largest per tree economic benefit are silver maple ($207.31/tree), pin oak ($157.72/tree), and honeylocust ($130.85/tree). Japanese tree lilac contribute one of the smaller environmental benefits at $11.00/tree. Green ash and Norway maple trees provide the largest overall contribution of benefits to the North End neighborhood at $166,780 and $145,300 respectively.

Planting trees on the west and east sides of buildings to provide summer shade and to the north to decrease winter winds can reduce energy demand. While street trees often provide less direct shading to homes, they reduce ambient urban air temperatures and wind speeds increasing energy savings across Saint Paul.

Energy Savings

One of the most direct benefits urban trees provide to residents is their ability to alter microclimates within the metropolitan region and reduce energy usage for property owners. By providing shade in the summer and reducing wind speed in the winter trees reduce energy demand and the expense of cooling and heating services.

In District 6 this environmental service totals $234,702 per year in electricity and natural gas savings, reducing electricity demand by 1,408 MWh per year and natural gas usage by 188,830 Therms, or nearly 18.9 million cubic feet of natural gas. While these are calculated estimates, the savings provided are substantial and reduce the amount of carbon released into the atmosphere from the production and use of these energy sources.

Trees with large canopies including silver maple ($44.07/tree) and pin oak ($42.87) provide the largest per tree benefit. As a group, Norway maple provide the largest cumulative benefit ($47,292) followed by green ash ($47,140), two trees that are widely planted across District 6. Unsurprisingly, small trees provide a lower energy saving. Their role should not be overlooked however, as they provide effective shade in areas where larger species may not have room to grow including near residential air conditioner units adjacent to homes and on boulevards with overhead utility lines.

Air Quality

Urban air quality can be impaired due to pollutants, particulate matter, and the urban heat island effect which can increase the formation of ozone. Trees help mitigate air pollution by removing pollutants through deposition on leaf surfaces and by altering local microclimates, reducing energy demand and emissions associated with energy production.

Boulevard trees in the North End remove an estimated 2,455 pounds of air pollutants annually. These trees also reduce energy consumption, avoiding the release of 14,979 pounds of emissions each year. The estimated economic value of these services is $47,060. Silver maple ($9.77/tree), green ash ($7.16), and pin oak ($7.14/tree) provide the greatest per tree environmental and economic benefit. As a group, green ash trees provide the largest benefit removing and preventing the release of 3,442 pounds of air pollutants followed by Norway maple at 3,441 pounds.

Trees release Biological Volatile Organic Compounds (BVOC) which can increase urban ozone levels at higher ambient temperatures and in the presence of particulate matter (Owen). However, while BVOC emissions from trees may cause increases in localized ozone production, the presence of trees is beneficial in the urban environment and may actually reduce overall ozone levels by lowering air temperatures and altering wind patterns which effect air pollution levels and ozone formation (Nowak 2000).

Boulevard trees in District 6 store an estimated 15,111 tons of carbon and annually sequester 1,434 tons.

Carbon Sequestration and Storage

Trees in the urban landscape play an important role in the mitigation of atmospheric carbon levels. The community forest reduces atmospheric carbon in two primary ways:

1. by sequestering carbon through photosynthesis and storing it as plant biomass
2. by mitigating local microclimates and avoiding the carbon emissions generated from the production and use of energy used to heat and cool buildings (tree canopy lowers ambient air temperatures in the summer and reduces wind speeds in the winter, reducing overall energy demand).

Currently, street trees in District 6 are storing 30.2 million pounds (15,111 tons) of carbon with an estimated economic value of $226,670. The biomass of green ash trees comprises the largest share of carbon storage within the district at 7.65 million pounds, or 26% of total stored carbon followed by Norway maple at 5.1 million pounds, or 17.5% of the total. Individually, silver maple ($91.40/tree) and pin oak ($54.29/tree) store the largest amount of carbon per tree due to the mature size of these species within the street tree population.

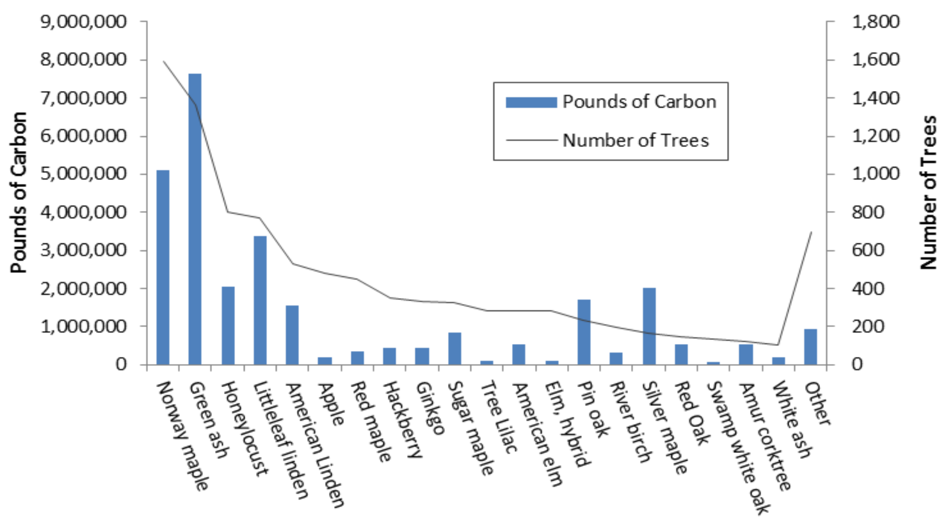


Figure 5: Carbon storage per species

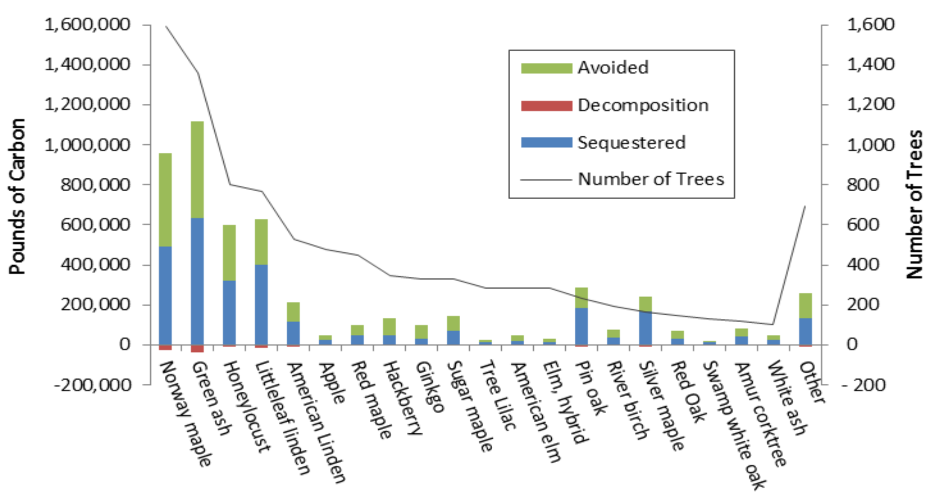


Figure 6: Annual carbon sequestration per species population

The annual uptake of atmospheric carbon in the North End neighborhood through sequestration captures 2.87 million pounds of carbon each year with an estimated economic value of $21,517. Most of this is stored as woody biomass though 145,516 pounds, or 5%, is returned to the atmosphere via decomposition. Green ash trees sequester 636,563 pounds of carbon annually, or about 22% of the district total followed by Norway maple at 490,003 pounds.

In addition to sequestering carbon directly from the atmosphere, trees provide shade and mitigate local microclimates reducing energy demand and avoiding an estimated 2.36 million pounds of carbon emissions that would otherwise be released to heat and cool buildings. Green ash trees again provide the largest benefit, leading to the avoidance of 480,353 pounds of carbon followed by Norway maple at 468,648 pounds.

Trees in District 6 reduce atmospheric carbon by 5.07 million pounds annually through sequestration and pollution avoidance at an economic value of $38,025. Silver maples ($10.39/tree) provide the largest per tree benefit due to their large size followed by pin oak ($8.88/tree).

Stormwater

Street trees in District 6 intercept 10.4 million gallons of rainfall, reducing runoff and improving local water quality. Combined with other stormwater best management practices to capture and infiltrate rain fall, trees are an integral part of an effective green infrastructure system.

Trees are a multi-functional green infrastructure element in the landscape and an effective stormwater management tool that has the ability to intercept significant amounts of rainfall before it falls on impervious surfaces and becomes runoff. Preventing stormwater runoff has multiple economic and environmental benefits that include water quality improvements, reduced pollutant loads entering local water bodies, increased infiltration rates, and volume load reductions on storm sewer infrastructure.

Currently, boulevard trees in District 6 intercept an estimated 10.4 million gallons of stormwater annually with an estimated economic value of $281,610. Tree species with a large canopy including silver maple ($93.51/tree) and pin oak ($56.62/tree) provide the greatest per tree benefit due to the amount of leaf surface area and canopy spread available to capture rainfall. Green ash trees provide the greatest overall contribution to stormwater reductions intercepting over 2.4 million gallons, or 23%, of the total volume captured by the street tree canopy.

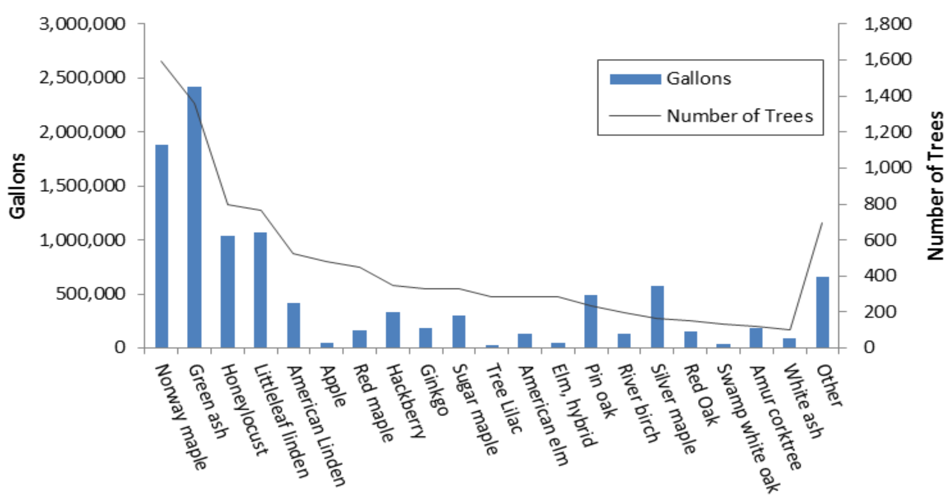


Figure 7: Stormwater runoff reductions per species population

District 6 | North End
Street Tree Canopy Assessment Results

	Current Benefits	Ash Tree Population**	% Ash
District Land Area (does not include water surface area)	2,705 acres	2,705 acres	
Number of Street Trees	9,632	1,471	15%
Street Tree Canopy Area*	132 acres	29 acres	22%
Percentage of Land Cover	4.9%	1.1%	
Annual Energy Reductions			
Electricity	1,408 MWh	299 MWh	21%
Natural Gas	188,830 Therms	39,121 Therms	21%
Annual Economic Value	$234,702	$49,203	21%
Carbon Reductions			
Stored in Street Trees	30.2 million pounds	7.86 million pounds	26%
Sequestered Annually	2.87million pounds	663,872 pounds	23%
Avoided Annually	2.36 million pounds	501,577 pounds	21%
Annual Economic Value	$264,695	$67,361	25%
Annual Removal of Air Pollutants			
Ozone	1,405 pounds	240 pounds	17%
Nitrogen dioxide	238 pounds	38 pounds	16%
Particulate matter (PM10)	748 pounds	128 pounds	17%
Sulfer dioxide	64 pounds	11 pounds	17%
Annual Air Pollutants Avoided			
Nitrogen dioxide	6,689 pounds	1,411 pounds	21%
Particulate matter (PM10)	976 pounds	207 pounds	21%
VOC's	932 pounds	197 pounds	21%
Sulfer dioxide	6,383 pounds	1,355 pounds	21%
Annual Economic Value	$47,060	$10,151	22%
Stormwater Mitigation			
Runoff reductions	10.4 million gallons	2.51 million gallons	24%
Annual Economic Value	$281,610	$67,994	24%
Aesthetic/Other Benefits			
Annual Economic Value	$195,512	$38,701	20%
Total Net Annual Benefit	$796,910	$174,485	22%

*Tree canopy as calculated by iTree. Does not include all right of way canopy cover as measured by the 2011 canopy assessment

**Figures represent the number of ash trees and associated benefits that could be affected by the emerald ash borer.

Aesthetic and Other Benefits

Trees provide a myriad of social, environmental, and economic benefits, many of which are difficult to quantify through standard economic measures. iTree accounts for these less tangible benefits in the aesthetic/other benefits category which measures tree canopy effects on property values and neighborhood aesthetics. Street trees in District 6 contribute an estimated $195,512 annually to the economic value of the neighborhood with silver maple ($49.58/tree) and honeylocust ($49.30/tree) identified as the top two trees followed by pin oak ($42.21/tree) and littleleaf linden ($33.16/tree). The overall economic benefit of forest cover to property values including that on private property is likely much greater as tree canopy has been shown to increase home prices up to 6% of market value (Dwyer 1992, Sander 2010).

Emerald Ash Borer

Emerald ash borer has the potential to reduce the environmental benefits provided by the street trees of District 6 by 22%, or nearly $174,485 annually.

Emerald ash borer (EAB) was initially discovered in Saint Paul in the Saint Anthony Park neighborhood in May of 2009. Prior experience from communities in Michigan, Ohio, and Illinois suggest that once EAB is found it cannot be eliminated. Continued infestations and subsequent tree removal will reduce, and potentially eliminate ash trees from the urban forest.

Ash trees comprise 15% of all street trees in District 6. The majority (68%) of ash trees are between 10”-24” DBH with canopies that provide significant benefits to the community. The loss of these trees without a planned response to EAB would have a noticeable impact on the capacity of the urban forest to provide ecosystem benefits to the community and alter the structure and character of the streetscape. The City’s Emerald Ash Borer Management Plan has been implemented to mitigate the impact of EAB through removal, replacement, and treatment strategies (refer to www.stpaul.gov/forestry for more information).

To better understand the potential impact EAB may have in District 6, the economic benefits that ash trees provide were analyzed and compared to those of the complete street tree population. Results suggest that ash trees play a significant role in providing ecological benefits to the North End neighborhood:

- Annual economic benefits would decrease by $174,485 or 22%.
- Carbon stored in woody biomass would decrease by 7.86 million pounds and the carbon sequestered by street trees annually would decline by 663,872 pounds.
- Annual stormwater interception would decrease by 2.51 million gallons.
- Removal of air pollutants would decrease by 417 pounds annually.

Goals

This report is an initial measurement of the environmental and economic benefits provided by the street trees in District 6. The data found within can assist with the coordination of species selection and planning of tree planting projects to maximize future benefits while mitigating short term changes that may be caused by forest pests such as emerald ash borer. Additionally, it provides a baseline data set to measure changes in subsequent environmental benefit studies.

Goals for the North End community forest include:

- Promote the proactive replacement of ash trees with a diverse mix of species to build urban forest resiliency and maintain canopy cover in anticipation of the spread of emerald ash borer and loss of mature ash trees.

- Encourage property owners to plant trees on their property, expanding urban tree cover and the associated benefits that the community forest provides to residents. Residential yards often provide enhanced growing conditions over those found on city boulevards and are able to support a diverse variety of tree species not typically planted as street trees including fruit and nut bearing varieties.

- Continue to enhance tree species diversity within the public right of way.

- Promote the long term health and survival of the existing canopy through routine maintenance and by encouraging residents to water trees during dry periods as large trees provide the greatest environmental and economic benefit to the community.

Appendix

The following values were used to determine the economic benefits provided by the street tree canopy of District 6

- Electricity was calculated at $0.07819/kWh based on the average of summer and winter rates quoted by Xcel Energy on December 12, 2013. www.xcelenergy.com

- Natural gas was calculated at $0.66/therm representing the average cost of natural gas based on data available from CenterPoint Energy on December 12, 2013. www.centerpointenergy.com

- Median home value was calculated as $129,490 based on real estate estimates from Trulia.com and Zillow.com on January 6, 2014.

- Economic values for air pollution and stormwater interception were based on data available in iTree, calibrated to conditions found in the Midwest by the software. These values are:

CO_2 ($/lb)	0.0075
PM10 ($/lb)	2.84
NO_2 ($/lb)	3.34
SO_2 ($/lb)	2.06
VOC ($/lb)	3.75
Stormwater interception ($/gallon)	0.0271

- Operational costs of city tree management were not entered into iTree due to the multi-year rotational nature of tree care across the city and the inaccuracy of dividing the total annual budget to one individual district. This necessarily limits this report to quantifying only the benefits received from the urban forest without balancing against the costs. Once the city wide inventory is complete a full cost/benefit study will be generated.

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This report was completed in January 2014 based on street tree inventory data collected 2010-2013.