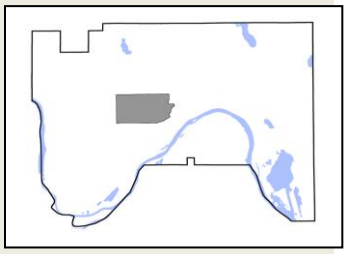
Urban Forest Benefits Report

District 8 | Summit-University



The Summit-University neighborhood is located west of downtown Saint Paul between University Avenue, Marion Street, Summit Avenue, and Lexington Parkway. The neighborhood is a mix of single and multi-family housing with large commercial properties located along University Avenue. At 1,157 acres the district accounts for approximately 3.2% of the city's 35,931 acre land area.

Multi-family residential land and public road right of way account for the largest percentage of land use in Summit-University. A 2011 tree canopy assessment found that District 8 has a canopy cover of 30.5% of land area, 2% lower than the city average of 32.5%. Current canopy cover can be linked to a number of factors including the presence of Interstate 94 and large commercial properties located south of University Avenue that limit land available for tree planting as well as a mix of residential property types that provide a range of yard and boulevard space to support tree planting.

A comprehensive street tree inventory update was completed in 2013 cataloging the boulevard trees of District 8. 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 significant structural changes resulting from the potential spread of emerald ash borer into the Summit-University 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:

Summit-University Benefits Summary

District area	1,157 acres
Number of street trees	6,172
Canopy area	103*/140** acres
Energy reduction	$177,658
Carbon sequestered	1,987,144 pounds
Total carbon stored	24.2 million pounds
Avoided carbon emissions	1,796,418 pounds
Air pollutants removed	1,862 pounds
Air pollutants avoided	11,382 pounds
Stormwater runoff avoided	8.13 million gallons
Aesthetic/Other benefits	$217,619
Total annual benefit	$680,039

Table 1: Benefits summary

*Canopy provided by public boulevard trees growing on public land.
**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

Tree diversity levels in Summit-University are in line with current recommendations though ash and maple represent a larger share of tree canopy.

Analysis of the 6,172 street trees cataloged as part of the 2013 Summit-University street tree inventory update reveals that three tree genera, maple, ash, and linden comprise 61% of the street tree population. Maple and ash are equally represented and as a genera represent 24% and 23% of the street tree population followed by linden (14%) and honeylocust (10%). Green ash is the primary tree comprising 21% of the street tree population followed by Norway maple and its many cultivars at 11%. 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.

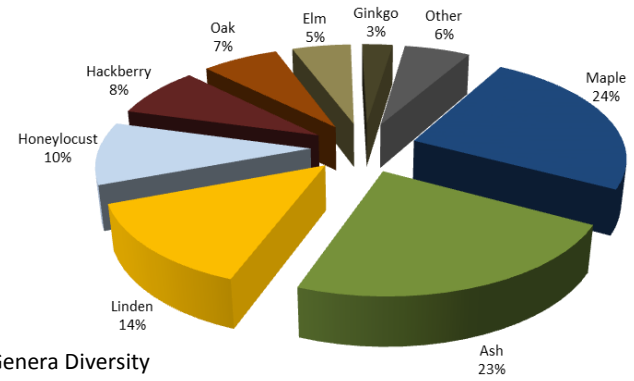


Figure 1: Genera Diversity

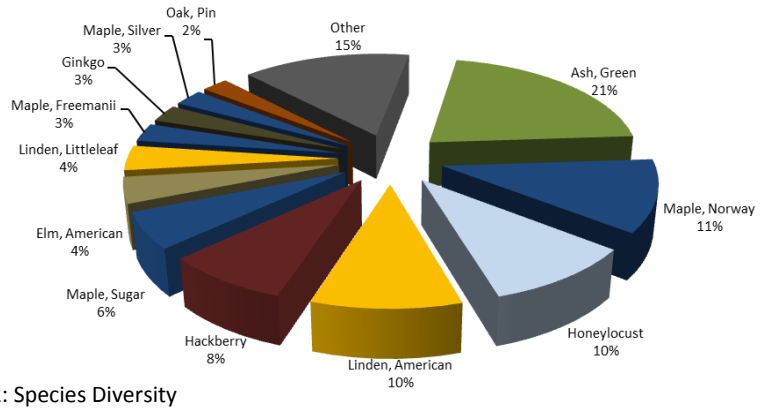


Figure 2: Species Diversity

Size Distribution

The size distribution of trees, determined by measuring the trunk diameter 4.5' above ground level (DBH), reveals a maturing tree canopy with an average trunk diameter of 12.5". Two diameter classes, 10"-12" and 13"-15", show an increased number of trees and account for one third of the street tree population at 15% and 19% respectively. Trees under 3" DBH currently account for 14% of the population though these numbers will increase as District 8 is scheduled to be planted in 2014 which will increase the number of 2" diameter trees in the street tree inventory. Mature trees over 19" and above in diameter account for 17% of district street trees.

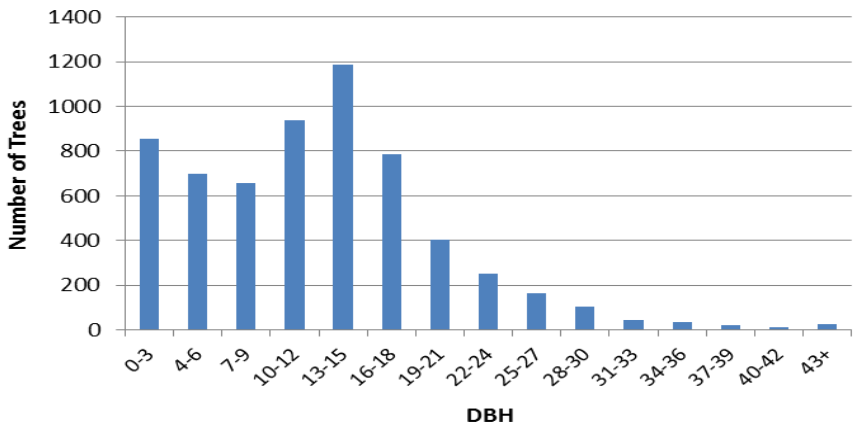


Figure 3: Size distribution as measured by tree diameter 4.5 feet above ground (DBH)

Further analysis of the seven 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 4.4% 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 23% 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.

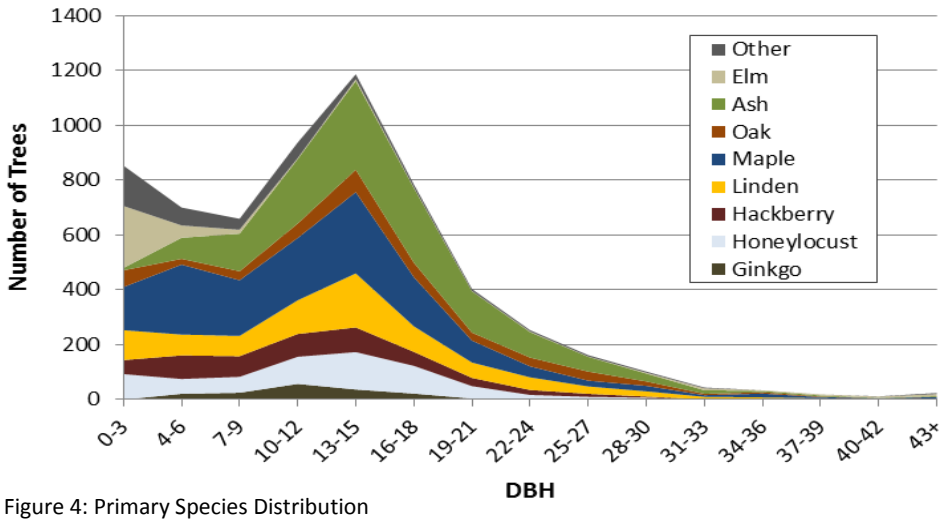


Figure 4: Primary Species Distribution

While overall tree species diversity levels meet current recommendations, maple and ash comprise 47% of the street tree inventory. Calculated by size category these two species account for 19% of all trees 0”-3”, 47% of trees 4”-6”, 51% of trees 7”-15”, 56% of trees 16”-24”, and 43% of all trees 25” and above. The percentage of maple and ash trees in the District 8 canopy will shift significantly as ash are removed due to emerald ash borer and a variety of other tree types are planted.

Tree condition ratings in District 8 are favorable with 59% of boulevard trees rated in good condition, 33% rated in fair condition, and 7% considered to be in poor condition. Ash trees rated less favorably in overall condition with 35% in good, 60% in fair, and 5% rated in poor condition.

Land Use + Planting Site Locations

Residential land use, represented in yellow and brown, accounts for 51% of district land area and contains over 94% of city managed boulevard trees.

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

Land use analysis within District 8 measured land area as 51% residential, 5% commercial, 3% park land, and 35% public right of way (interstate 94 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 94% of trees found on residential boulevards and the remaining 6% found along commercial corridors.

Tree planting sites in the district’s residential neighborhoods are located primarily on turf covered boulevards. Commercial corridor planting sites range from sidewalk cutouts used near the intersection of Western and Selby Avenues to a structural soil tree trench and pervious paver system along University Avenue that was installed as part of the Central Corridor LRT project. 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 4 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 8 has a land area of approximately 1,157 acres and a total tree canopy cover of 30.5% as measured by the 2011 city wide canopy assessment. Canopy cover over the public right of way, which includes street trees, was identified as 35%, or 140 acres of tree cover on 405 acres of right of way land, 103 canopy acres of which is provided directly by street trees. Street trees contribute approximately 29% 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 8, green ash received the highest importance value rating of 25.9 points due to the large number of these trees planted on the public right of way and total leaf area and canopy cover values approaching three times those of other tree types. Norway maple received the second highest importance value of 11.2 points followed by honeylocust with 11 points.

Japanese tree lilacs (RI value of 0.8), 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	1,306	21.2	3,693,300	29.7	1,201,201	26.9	25.9
Norway Maple	729	11.8	1,263,978	10.2	523,488	11.7	11.2
Honeylocust	616	10	1,350,166	10.9	548,375	12.3	11
Linden, American	598	9.7	1,122,652	9.0	370,678	8.3	9
Hackberry	503	8.1	809,341	6.5	392,716	8.8	7.8
Sugar Maple	356	5.8	557,354	4.5	231,238	5.2	5.1
Linden, Littleleaf	244	4	575,091	4.6	167,167	3.7	4.1
Silver Maple	163	2.6	610,762	4.9	163,665	3.7	3.7

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

Canopy Benefits

Annual Benefits:

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

The 6,172 street trees planted in District 8 provide an estimated $680,039 worth of environmental services to the residents of the Summit-University neighborhood and form an important part of Saint Paul's green infrastructure system. This represents an average annual economic value of $110.18 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.

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 pin oak ($174.41/tree), silver maple ($165.99/tree), and honeylocust ($160.16/tree). Japanese tree lilac contribute one of the smaller environmental benefits at $14.06/tree. Green ash and honeylocust trees provide the largest overall contribution of benefits to the Summit-University neighborhood at $183,634 and $98,658 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 the demand and expense for cooling and heating services.

In District 8 this environmental service totals $177,658 per year in electricity and natural gas savings, reducing electricity demand by 1,071 MWh per year and natural gas usage by 142,284 Therms, or nearly 14.2 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 northern pin oak ($44.27/tree) and pin oak ($41.99) provide the largest per tree benefit. As a group, green ash provide the largest cumulative benefit ($47,372) followed by Norway maple ($23,032), two trees that are widely planted across District 8. 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 Summit-University remove an estimated 1,862 pounds of air pollutants annually. These trees also reduce energy consumption, avoiding the release of 11,382 pounds of emissions each year. The estimated economic value of these services is $35,925. Northern pin oak ($9.82/tree), green ash ($7.49), and pin oak ($7.01/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 3,460 pounds of air pollutants.

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 8 store an estimated 12,114 tons of carbon and sequester 1,057 tons each year.

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 8 are storing 24.2 million pounds (12,114 tons) of carbon with an estimated economic value of $181,709. The biomass of green ash trees comprises the largest share of carbon storage within the district at 7.5 million pounds, or 31% of total stored carbon followed by American linden at 2.8 million pounds, or 11.6% of the total. Individually, silver maple ($65.11/tree) and Northern pin oak ($55.91/tree) store the largest amount of carbon per tree due to the mature size of these species within the street tree population.

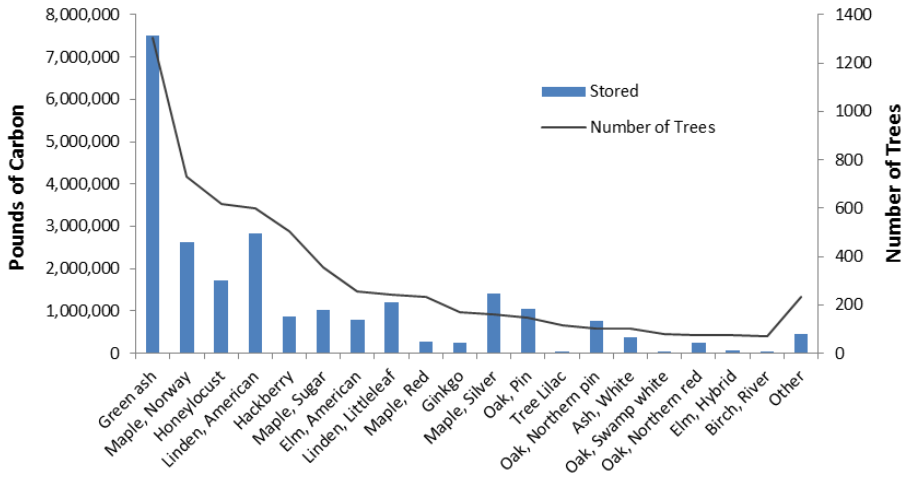


Figure 5: Carbon storage per species

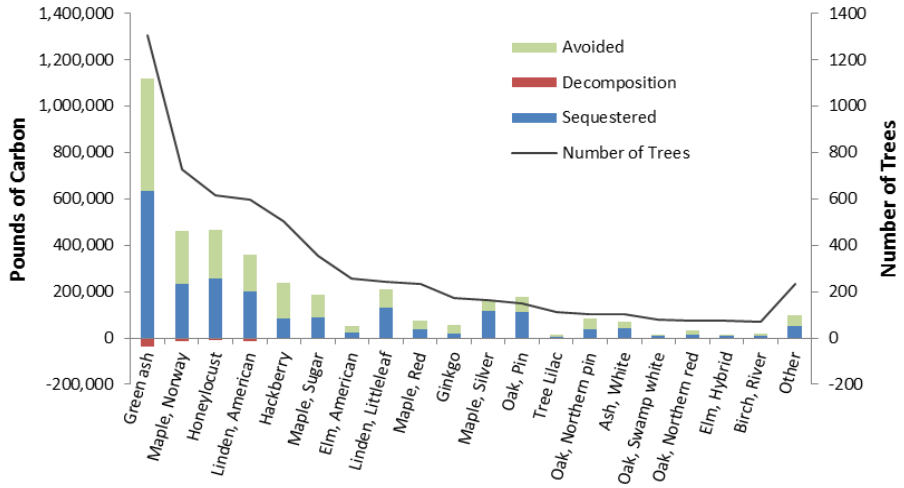


Figure 6: Carbon sequestration per species population

The annual uptake of atmospheric carbon in Summit-University through sequestration captures 2.1 million pounds of carbon each year with an estimated economic value of $15,856. Most of this is stored as woody biomass though 116,525 pounds, or 5.5%, is returned to the atmosphere via decomposition. Pin oaks ($8.75/tree) provide the largest per tree benefit due to their large size followed by green ash ($6.20/tree). The total population of green ash trees sequester 633,441 pounds of carbon annually, or about 30% of the district total.

In addition to sequestering carbon directly from the atmosphere, trees provide shade and mitigate local microclimates reducing energy demand and avoiding an estimated 1.8 million pounds of carbon emissions that would otherwise be released to heat and cool buildings. Trees in District 8 reduce atmospheric carbon by 3.78 million pounds annually through sequestration and pollution avoidance at an economic value of $28,377.

Stormwater

Street trees in District 8 intercept 8.13 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 the Summit-University neighborhood intercept an estimated 8.13 million gallons of stormwater annually with an estimated economic value of $220,461. Tree species with a large canopy including silver maple ($65.51/tree) and northern pin oak ($61.54/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 contribution to stormwater reductions intercepting over 2.4 million gallons, or 29%, of the total volume captured by the street tree canopy.

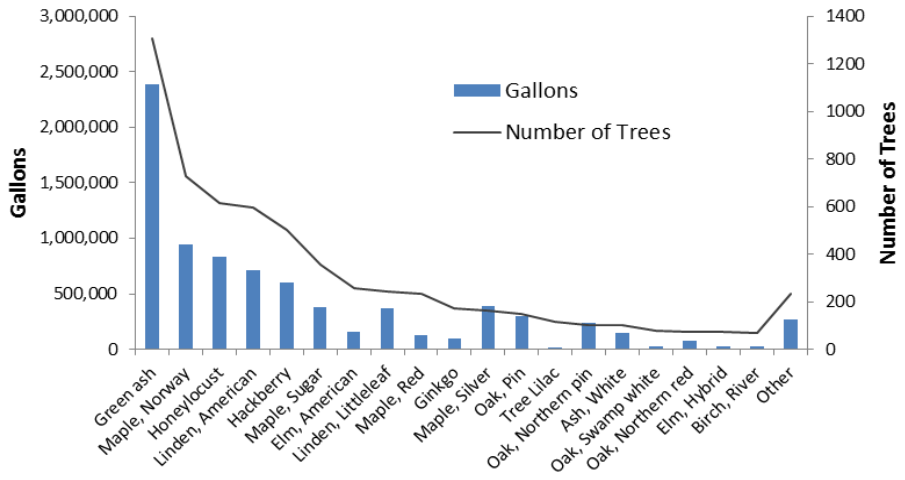


Figure 7: Stormwater runoff reductions per species population

District 8-Summit-University
Street Tree Canopy Assessment Results

	Current Benefits	Ash Tree Population**	% Ash
District Land Area (does not include water surface area)	1,157 acres	1,157 acres	
Number of Street Trees	6,172	1,407	23%
Street Tree Canopy Area*	103 acres	29 acres	28%
Percentage of Land Cover	8.9%	1.6%	18%
Annual Energy Reductions			
Electricity	1,071 MWh	307 MWh	29%
Natural Gas	142,284 Therms	39,719 Therms	28%
Annual Economic Value	$177,658	$50,204	28%
Carbon Reductions			
Stored in Street Trees	24.2 million pounds	7.9 million pounds	32%
Sequestered Annually	2.11 million pounds	674,293 pounds	32%
Avoided Annually	1.8 million pounds	514,566 pounds	28%
Annual Economic Value	$210,086	$67,734	32%
Annual Removal of Air Pollutants			
Ozone	1,070 pounds	246 pounds	23%
Nitrogen dioxide	180 pounds	39 pounds	22%
Particulate matter (PM10)	564 pounds	131 pounds	23%
Sulfer dioxide	48 pounds	11 pounds	23%
Annual Air Pollutants Avoided			
Nitrogen dioxide	5,076 pounds	1,444 pounds	28%
Particulate matter (PM10)	742 pounds	212 pounds	29%
VOC's	708 pounds	202 pounds	29%
Sulfer dioxide	4,856 pounds	1,391 pounds	29%
Annual Economic Value	$35,925	$10,396	29%
Stormwater Mitigation			
Runoff reductions	8.1 million gallons	2.54 million gallons	31%
Annual Economic Value	$220,461	$68,809	31%
Aesthetic/Other Benefits			
Annual Economic Value	$217,619	$58,230	27%
Total Net Annual Benefit	$680,039	$196,249	29%

*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 8 contribute an estimated $217,619 annually to the economic value of the neighborhood with honeylocust ($78.05/tree) and pin oak ($61.17/tree) identified as the top two trees followed by silver maple ($55.95/tree) and littleleaf linden ($51.02/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 8 by 29%, or nearly $196,249 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 23% of all street trees in the Summit-University neighborhood. The majority of ash trees are between 10”-21” 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 8, 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 Summit-University neighborhood:

- Annual economic benefits would decrease by $196,249 or 29%.
- Carbon stored in woody biomass would decrease by 7.9 million pounds and the carbon sequestered by street trees annually would decline by 674,293 pounds.
- Annual stormwater interception would decrease by 2.54 million gallons.
- Removal of air pollutants would decrease by 427 pounds annually.

Goals

This report is an initial measurement of the environmental and economic benefits provided by the street trees in District 8. 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 Summit-University 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 improved 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 8

- 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 $192,083 based on real estate estimates from Saint Paul Real-Estate/ReMax Results, Trulia, and Zillow on December 12, 2013.

- 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:

CO2 ($/lb)	0.0075
PM10 ($/lb)	2.84
NO2 ($/lb)	3.34
SO2 ($/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 December 2013 based on street tree inventory data collected 2010-2013.