Urban Forest Benefits Report

District 13-Union Park, City of Saint Paul, Minnesota

Prepared by Brett Stadsvold and Zach Jorgensen

Street trees are an important portion of the city's green infrastructure that provides shade to homes and buildings, reduces energy consumption, cleans the air, and intercepts and stores rainwater. Trees provide beauty to the landscape that forms unique character to neighborhoods, creates a sense of place and increase home values. This report provides an economic and environmental look at the value street trees provide in the Union Park district of Saint Paul, Minnesota. Residents of Union Park are encouraged to use this report as a tool for planning and management for their neighborhood and individual land.

In 2010 Saint Paul Forestry staff completed the street tree inventory for Union Park cataloging species type, DBH (diameter at breast height), boulevard widths, utility wire conflicts, geographic location and the overall condition of the trees. Street tree data is stored in Davey Treekeeper software with work orders and tree maintenance requests created and stored in the inventory. The economic and environmental benefits of boulevard trees are quantified with iTree Streets software.

Structural changes will occur in Union Park from EAB with the loss of ash trees. Two Alternate population scenarios highlight the reduction in economic and environmental benefits from the loss of all boulevard ash trees, and adjusts the benefits for ash replacement. These scenarios will be discussed later in this report.

Geographic Characteristics

Union Park is located on the western edge of Saint Paul bounded by the Mississippi River on the west, University Avenue to the north, Lexington Avenue on the east, and Summit Avenue on the south. With approximately 1,905 acres, the neighborhood comprises 5.4% of Saint Paul's 35,391 acres.

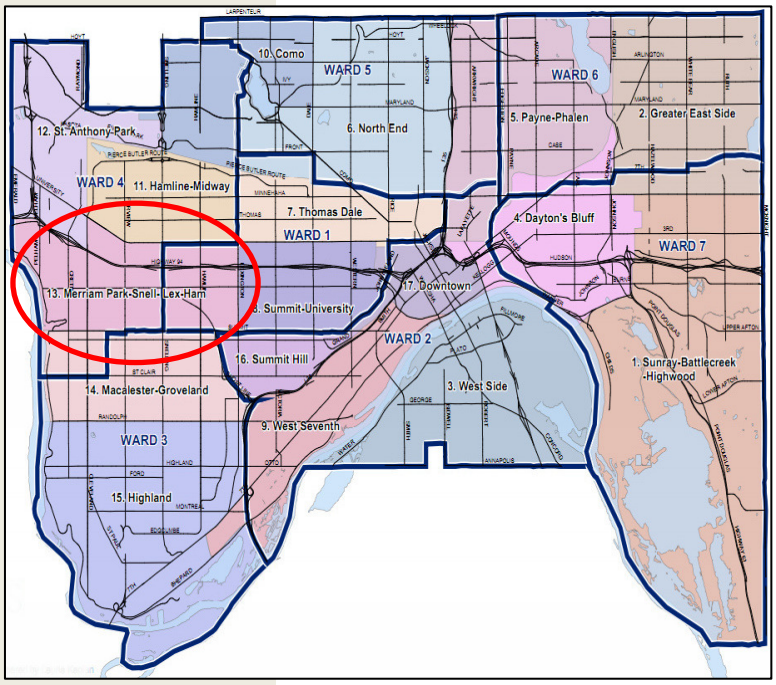


Figure 1: Map of The City of Saint Paul with the Union Park Neighborhood within the red oval.

Neighborhood landmarks include The University of Saint Thomas, Concordia University, Town and Country Golf Club, the Snelling/Hamline Neighborhood Garden and the Dunning Athletic Fields. Key neighborhood tree resources include the bur oak stand in Merriam Park, the maple-basswood and oak forests of the Mississippi River Gorge Regional Park and the parkways of Summit Avenue and Mississippi River Boulevard,.

Boulevards within residential areas provide generous planting areas with boulevards of six to ten feet wide. Smaller planting sites of three to six feet wide exist along transportation corridors of Cretin Avenue, Cleveland Avenue, Fairview Avenue and Snelling Avenue. Marshall Avenue provides large planting sites typically 10 to 20 feet wide with planting medians between Cretin Avenue and Finn Street and between Wheeler Street and Pierce Street. Summit Avenue on the southern border of the district provides wide planting beds for planting less frequently used species like, catalpa and Ohio buckeye.

The University Avenue corridor is a regional commercial hub of big box retailers, restaurants, bars and service providers with a focus on individual motorists. However, construction of the central corridor light rail was underway during the writing of this report with proposed zoning changes that will create more walkable and public transit oriented areas with mixed use, high density development.

Currently, conditions along University Avenue do not favor trees due to high amounts of impervious surfaces, compacted soils and lack of planting sites. Very few trees exist, but the Central Corridor Light Rail plans include planting trees along the entire stretch of the light rail corridor with structural soil as the

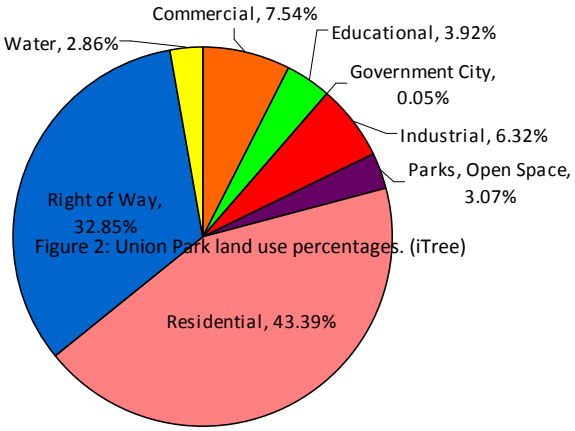


Figure 2: Union Park land use percentages. (iTree)

planting medium, providing substantially more room for root growth and water infiltration. Stormwater will enter the root zone from the street as well as through permeable pavers placed over the root zone providing stormwater treatment and water infiltration sites.

Land Use

Similar to other neighborhoods, Union Park is comprised of a high percentage of residential land (43%) and public right-of-way (ROW) at 33%. Parks and open space, commercial, educational, industrial and government land account for a smaller portion of Union Park's land area. Trees can grow in a variety of locations, but residential land and the public ROW offer the largest area for tree planting.

Forest Structure

In 2010 The City of Saint Paul contracted the University of Minnesota Spatial Analysis Laboratory (SAL) to perform a land cover classification to find the total canopy cover of trees in Saint Paul. The SAL combined 2007 LiDAR (Light Detection and Ranging) data with 2009 Quickbird satellite imagery to construct the classification. Saint Paul has a canopy cover of 32.5%, with canopy covering 32.9% of Union Park.

Land Cover	Saint Paul	Union Park
Tree Canopy	32.5	32.9
Grass/Shrub	22.6	20.6
Impervious	23.9	27.2
Buildings	13.7	16.5
Water	7.1	2.3
Bare Soil	0.2	0.1
	100%	99.7%

Table 1: Land cover percentages for Saint Paul and Union Park. (Jorgensen 2011)

The ROW of Union Park is covered with 37.1% canopy cover, 22% higher than recommended levels for urban residential areas by American Forests. However, later discussion will show how population densities will shift with declines in the ash population. Saint Paul Forestry plants and manages trees in the ROW, while private land owners manage their land. Figure 4 shows the greatest area for additional tree canopy exists within residential land of Union Park.

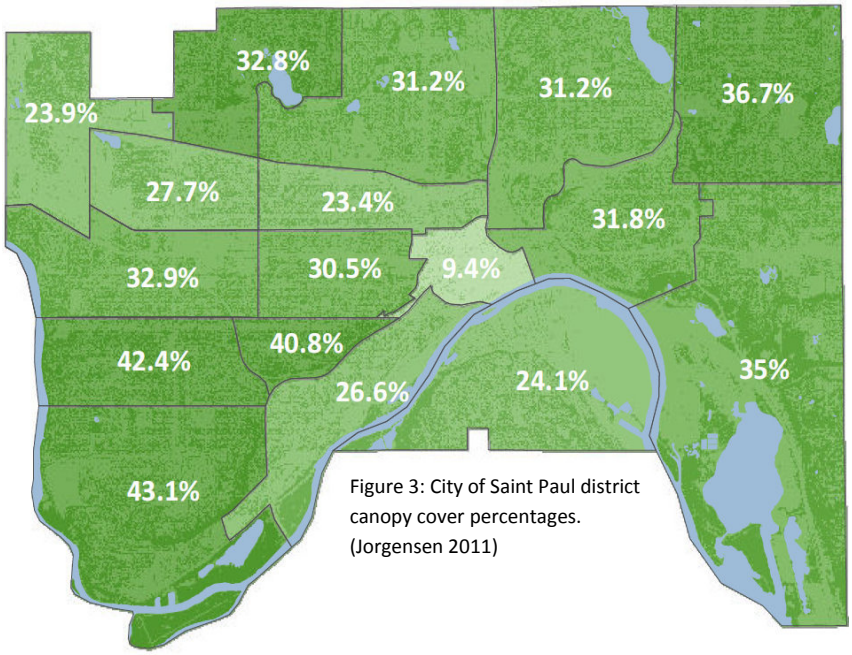


Figure 3: City of Saint Paul district canopy cover percentages. (Jorgensen 2011)

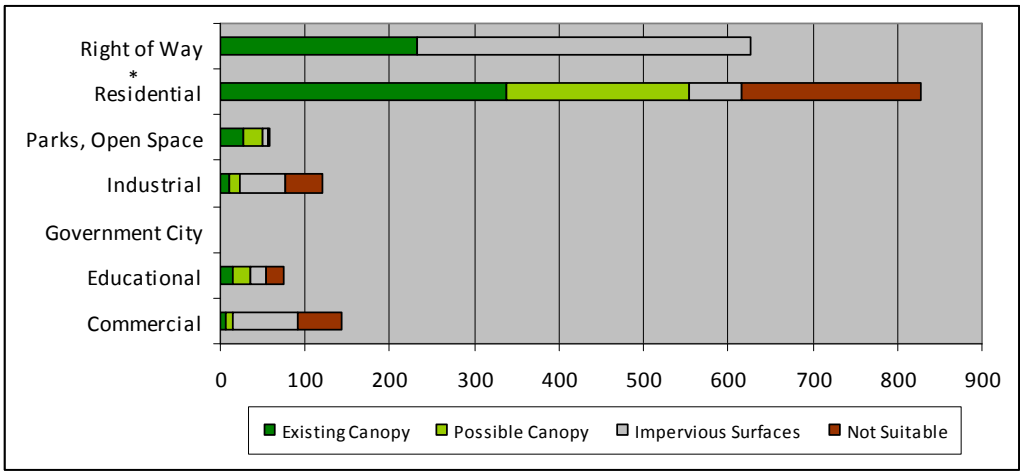


Figure 4: Possible canopy cover per land use in Union park. (Jorgensen 2011)
*Vacant sites in the right-of-way are unknown.

Genera Distribution:

Union Park has 8,245 boulevard trees (Figure 5) with three genera comprising two- thirds of the boulevard tree population (maple 37%, ash 16%, and linden 14%). Crabapple, elm, gingko, hackberry, honeylocust, oak and conifers make up smaller individual percentages, but help diversify the population.
Planning for increased diversity will be vital to the long term stability of the urban forest and will reduce the future threats from widespread canopy loss. Current recommendations for diversity suggest the use of no more than 10% of any specie, 20% of any genera and 30% of any family to guard against wide-spread devastation similar to the elm decline from Dutch elm disease in the 1970's.

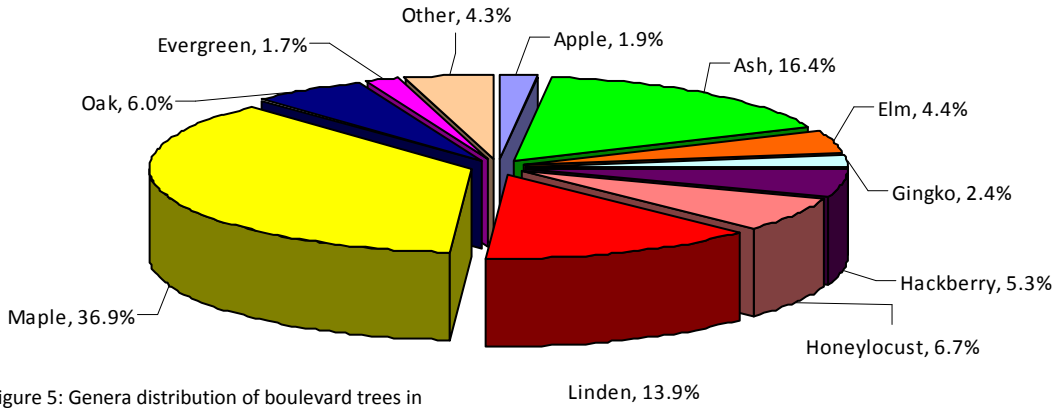


Figure 5: Genera distribution of boulevard trees in Union Park. (iTree)

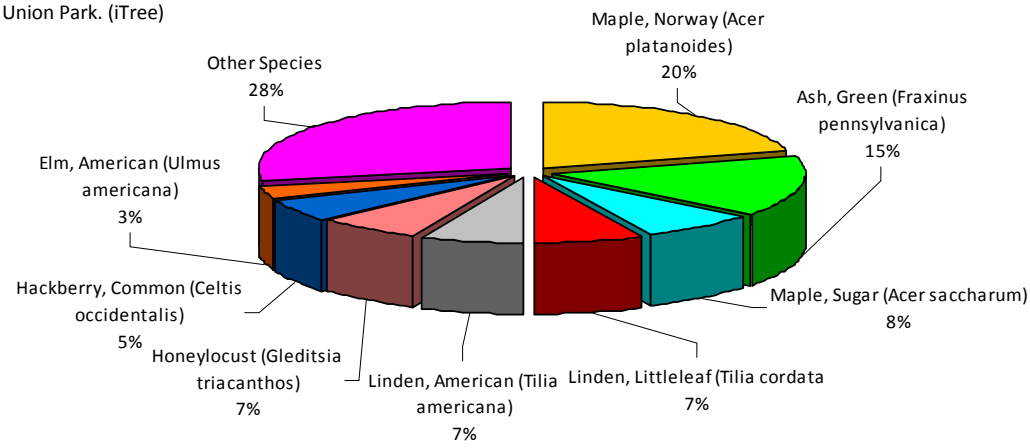
The loss of ash trees due to the emerald ash borer would shift forest diversity, increasing the maple population to 44% of the street tree canopy.

Species Distribution:

A species level analysis (Figure 6) displays a population much closer to the desirable 10% maximum per specie. Norway maple and green ash are the only two species above recommended planting levels, but will see declines from EAB in ash and stem girdling roots in Norway maple. Saint Paul foresters are currently replanting vacant boulevard sites with Dutch elm disease resistant varieties of American elm and hybrid elms. Under utilized species in the district such as river birch, swamp-white oak, Japanese tree lilac are proven performers in urban landscapes that are also used. Additional species are planted more closely related to the characteristics of the planting site.

Photo by: Brett Stadsvold

Figure 6: Species distribution of boulevard trees in Union Park. (iTree)



Size Distribution

The age structure of boulevard trees measured in diameter size reveals a population dominated by 10 to 18 inches (DBH), followed by trees less than nine inches (DBH). Street trees ranging from 10 to 18 inches account for half of the population. Trees greater than 18 inches represent 14 percent with trees greater than 24 inches comprising only six percent of the population.

Mean Diameter:

12 inches

Median Diameter:

12.2 inches

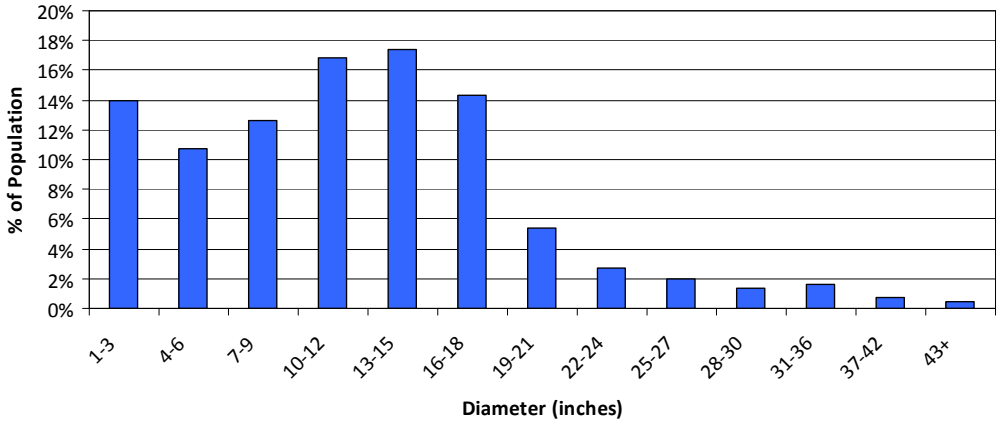


Figure 7: Size distribution of Union Park boulevard trees. (iTree)

Further examination of the 7 most common species shows that all species are being planted to maintain species diversity similar to current levels. Additionaly, Dutch elm disease resistant elms have been planted to further increase diversity. Small populations of larger elm trees still remain despite the multiple waves of Dutch elm disease to pass through Saint Paul. Varieties of freeman maple and red maple are being planted to supplement the loss of Norway maple. Maples will likely continue to dominate the boulevards of Union Park due to the popularity of fall leaf colors, but other tree species need to be considered to diversify the landscape.

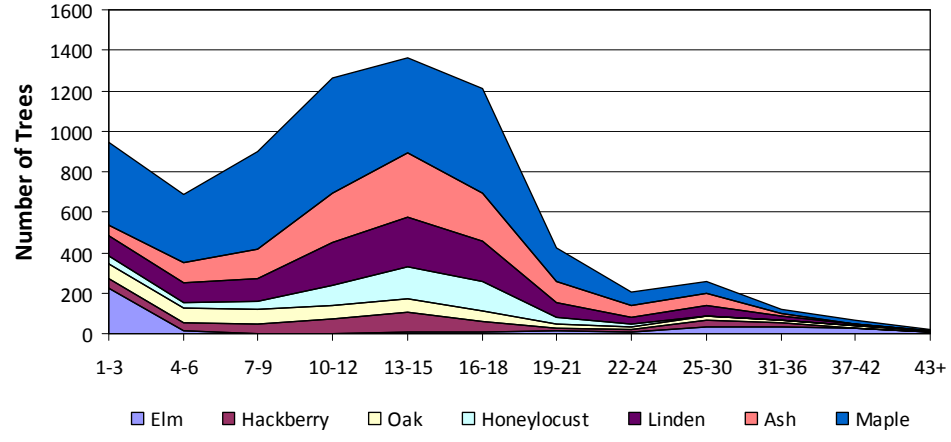


Figure 8: Major species size distribution. (iTree)

Union Park Total Annual Benefits

District land area	1,905 acres
Number of street trees	8,245
Canopy area	626.7 acres
Energy reduction	$257,273
Carbon sequestered	2.4 million pounds
Total carbon stored	26.6 million pounds
Air pollutants removed	2,085.1 pounds
Air pollutants avoided	13,217
Stormwater runoff avoided	9.1 million gallons
Aesthetic/Other benefits	$312,282.00
Total annual benefit	$891,353

Table 2: Average annual street tree benefits for Union Park. Benefits are calculated in iTree Streets software, derived from the 2010 Union Park street tree survey in Davey Treekeeper.

Planting trees that provide afternoon shade and reduce winter winds can reduce energy demand in buildings. While street trees provide less direct shading, they reduce urban air temperatures and wind speeds.

Annual Benefits

Street trees annually provide $891,353 worth of environmental services to Union Park and form an important part of the green infrastructure network of Saint Paul. This value is substantial considering that it accounts for trees found along the ROW and does not include the large population of trees planted in parks or on private property. This represents an average annual economic value of $108.11 per tree.

iTree quantifies benefits with five primary criteria including energy, air quality, carbon, stormwater and aesthetics. The clear winner for the most valuable tree in Union Park is silver maple with average annual benefits per tree at $245.85, followed by honeylocust ($177.37/tree), northern hackberry ($132.25/tree), green ash ($130.08/tree) and northern pin oak ($125.01). Silver maples are rapid growers, but require intensive management that limits their use in an urban environment.

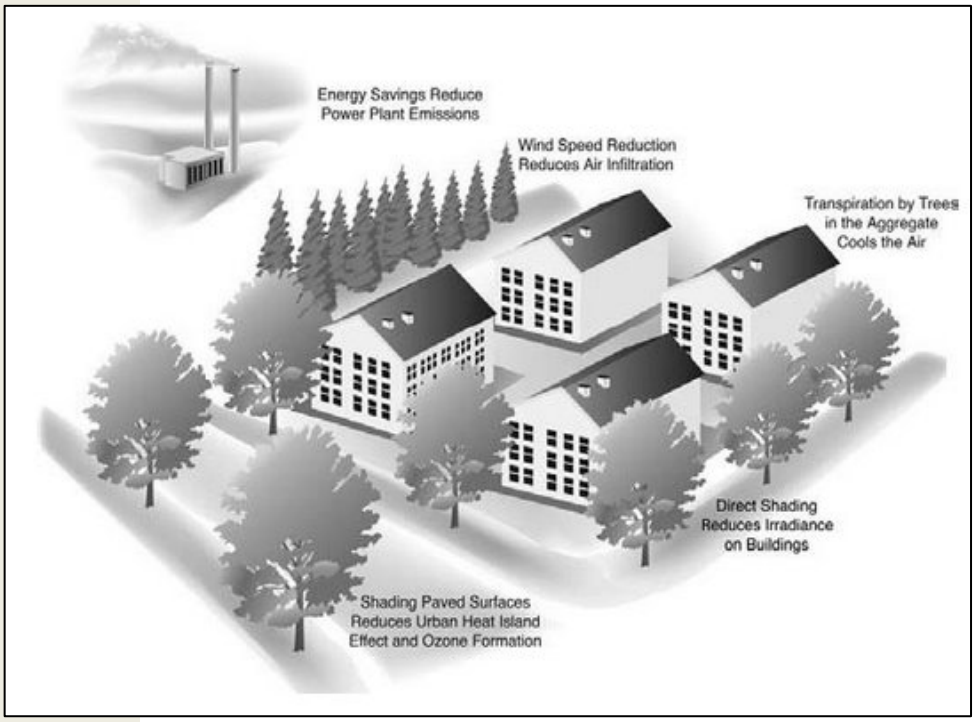


Figure 9: The right tree in the right place will reduce energy requirements and reduce power plant emissions. (graphic courtesy of National Tree Benefits Calculator)

Energy Savings

The most direct benefit of urban trees is the ability to mitigate microclimate conditions within the metropolitan region and reduce energy expenses for property owners. Trees reduce cooling and heating services by providing shade in the summer months and reducing wind speeds in the winter.

The Trees of Union Park reduce electrical usage by 1,242 mWh and gas consumption by 166,320 Therms, resulting in annual savings of $257,273. These numbers are estimates, but keep in mind that carbon releases into the atmosphere from coal fired power plants and the burning of natural gas for heat are substantially reduced with the presence of large shade trees in the community.

It may be common sense that trees with the largest canopies provide the greatest benefits, but do not overlook the importance of smaller trees in the landscape like Japanese tree lilac. Smaller trees provide shade, beauty, and habitat in areas where larger shade trees do not have room to grow.

Air Quality

Urban air quality is often reduced due to pollutants, particulate matter, and the urban heat island effect which can increase the formation of ozone. Trees are able to mitigate air pollution through deposition and by altering local microclimates, reducing energy demand and the emissions associated with its production.

Photo by: Brett Stadsvold

Boulevard trees in Union Park remove 2,085 pounds of air pollutants through deposition while also eliminating the release of 12,764.7 pounds of emissions annually at an estimated value of $41,721. Silver maple ($9.23/tree), honeylocust ($6.84/tree) and northern pin oak ($6.71/tree) provide the greatest environmental and economic benefit.

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

Carbon Sequestration and Storage

Reducing carbon emissions is one of the critical environmental issues facing urban areas. A well maintained urban forest is able to mitigate atmospheric carbon levels by sequestering carbon dioxide and storing it in plant biomass.

Street trees in Union Park are storing 26.6 million pounds (13,321 tons) of carbon with an estimated economic value of $199,810. Union Park currently benefits from green ash storing 2,501 tons of carbon, followed by Norway maple with 1,713 tons, both trees combining to store 30.7% of all carbon stored. Individually, silver maple ($81.39/tree) and American basswood ($36.93/tree) provide the greatest amount of storage per tree due to their large size at maturity.

Species	Energy ($)	CO2 ($)	Air Quality ($)	Stormwater ($)	Aesthetic/ Other ($)	Total ($)
Silver maple	52.45	9.74	9.23	85.86	88.57	245.85
Honeylocust	42.48	5.44	6.84	33.54	89.07	177.37
Northern hackberry	43.56	3.95	7.12	38.76	38.86	132.25
Green ash	36.60	5.04	6.01	37.51	44.91	130.08
Northern pin oak	40.05	4.67	6.71	36.48	37.10	125.01
Littleleaf linden	30.77	4.90	4.95	27.90	52.25	120.76
American elm	33.62	3.31	6.62	42.97	31.24	117.76
White ash	29.55	4.14	4.88	29.15	49.04	116.76
American basswood	31.62	4.20	4.71	32.49	30.80	103.81
Norway maple	33.15	3.96	5.34	27.20	33.54	103.18
Sugar maple	27.61	3.22	4.24	23.78	29.38	88.22
Northern red oak	24.40	2.58	3.49	22.52	17.11	70.09
River birch	16.46	2.00	2.50	11.38	19.40	51.73
Red maple	14.17	1.69	2.33	11.36	19.26	48.82
Siberian elm	10.18	1.28	1.83	12.72	18.09	44.10
Ginkgo	17.66	1.62	2.82	10.62	8.51	41.23
Freeman maple	7.49	0.96	1.02	6.81	19.65	35.93
Apple	5.74	0.58	0.79	2.12	2.25	11.48

Table 3: Summary of average annual benefits per street tree in Union Park (itree).

Total Street Tree Benefits

Table 3 provides an overview of the average annual benefits per tree. Silver maple is a fast growing tree that provides significant amounts of shade and water storage, providing greater annual benefits than any other tree in Union Park. Keep in mind that this data only represents the street tree population of Union Park and is based on tree count and tree size. Other districts in Saint Paul will have varied results for per tree benefits.

Emerald Ash Borer

Emerald ash borer (EAB) was discovered in the South Saint Anthony Park neighborhood in May of 2009 and has begun to impact the urban forest of Saint Paul. Prior experience from communities in Michigan, Ohio and Illinois suggest that continued infestations, tree senescence and tree removal for community safety will reduce and potentially eliminate the ash tree population in this neighborhood. Boulevard ash trees have been removed from Union Park for EAB sampling with no positive findings. Saint Paul Forestry is using various tactics for managing EAB by selective removal and the treatment of high value boulevard ash trees.

To better understand the potential impacts, two alternative scenarios were assessed in iTree to calculate the effects EAB will have on the environmental benefits provided by the street tree canopy of Union Park. The first scenario removed all ash trees from the inventory representing a complete loss of boulevard ash. The second scenario also removed all ash trees, but includes the replacement of a diverse selection of two inch caliper trees, representing a situation similar to the structured removal program currently utilized across the city to reduce the ash population in advance of the borer.

Emerald ash borer has the potential to reduce the environmental benefits provided by the street trees of District 13 by 21%, or $189,748 annually (iTree).

Results (table 4) suggest that ash trees play a significant role in providing ecological benefits to the Union Park neighborhood and their potential loss would considerably reduce the environmental and economic value of the street canopy including:

- Annual economic benefits would potentially decrease from $894,856 to $705,108, or about 21% with only a slight increase with the initial planting of new trees, with the exception of aesthetics.
- Total carbon stored in woody biomass would decrease by 2,491 tons and the amount of carbon sequestered by street trees annually could decline by 259 tons.
- Annual stormwater interception would be reduced by 1.8 million gallons.
- Removal of air pollutants would decrease by 268 pounds per year.
- Annual aesthetic and other factors would decline by approximately $61,012

Accompanying a reduction in economic and environmental benefits will be a structural change in the urban forest. Maple will account for 44% of the street tree population of Union Park, significantly higher than the 20% recommended genus level supporting canopy diversity and providing an opportunity for insect or disease problems in the future. One such threat is the Asian longhorn beetle, currently established in the eastern United States. This species is known to cause significant damage to maple trees and could heavily impact Union Park. Planned reforestation is critical in maintaining and increasing species diversity and the benefits provide to the urban ecosystem.

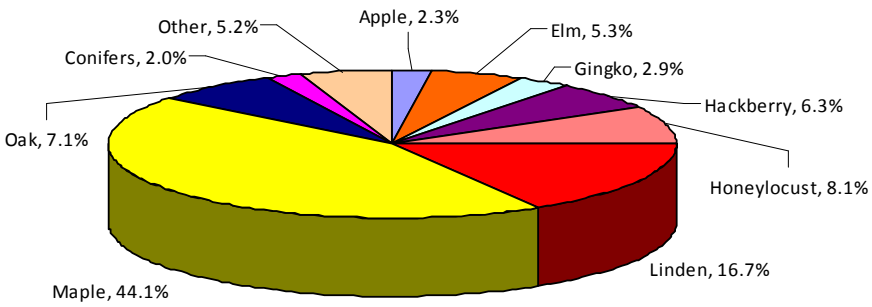


Figure 10: Union Park tree populations without ash trees. (iTree)

Union Park
Street Tree Benefits Results

	Current	Ash Trees Removed	With Ash Replacement
District Land Area (acres)	1,905	1,905	1,905
Number of Street Trees	8245	6887	8245
Canopy Area of Right of Way (acres)	231.9	193.7	193.7
% Canopy of Right of Way (ROW)	37.1%	31.0%	31.0%
Annual Energy Reductions			
Electricity (kWh)	1243.02	1000.61	1004.84
Natural Gas (Therms)	166491.01	135483.31	142164.37
Annual Economic Value	$257,506.70	$193,112.87	$199,844.01
Carbon Reductions			
Stored in Street Trees (lbs.)	26641981.77	21423321.08	21654103.46
Sequestered Annually (lbs.)	2404613.02	1886910.56	1959165.00
Avoided Annually (lbs.)	2085010.56	1678397.73	1752583.37
Annual Economic Value	$32,616.73	$25,889.99	$26,969.93
Annual Removal of Air Pollutants			
Ozone (lbs.)	1190.61	1033.18	1038.49
Nitrogen dioxide (lbs.)	201.09	175.93	176.83
Particulate matter (lbs.)	640.01	551.48	559.13
Sulfer dioxide (lbs.)	53.78	46.72	46.96
Annual Air Pollutants Avoided			
Nitrogen dioxide (lbs.)	5905.03	4767.35	4983.75
Particulate matter (lbs.)	862.17	695.08	726.22
VOC's (lbs.)	822.56	662.91	692.52
Sulfer dioxide (lbs.)	5636.57	4537.78	4738.42
Annual Economic Value	$41,473.00	$33,730.00	$35,096.18
Stormwater Mitigation			
Runoff reductions (gallons)	9154404.43	7314213.35	7506938.07
Annual Economic Value	$248,101.61	$198,228.96	$203,452.16
Aesthetic/Other Benefits			
Annual Economic Value	$315,158	$254,146	$229,573
Total Annual Benefit	$894,856.04	$705,107.82	$694,935.47
$ per capita	**$48.62**	**$38.31**	**$37.76**

Table 4: Comparison of annual benefits of current Union Park street tree population to the loss of all boulevard ash trees and ash replacement. (iTree and Ramsey County)

Recommendations

This report is an initial measurement of the environmental and economic benefits provided by the street trees of Union Park. The data found within this report can assist with coordinating species selection and planning of tree planting activities to maximize future benefits. Future benefit reports will be based on this report for means of comparison and to measure progress.

Goals for Union Park:

- Increase tree cover in industrial and commercial areas whenever possible. Although industrial and commercial areas only account for 14% of the districts land area, few if any trees exist in theses areas. Encourage creating partnerships with property owners and the use of innovative planting methods within existing boulevards including engineered soils to mitigate pollution, stormwater runoff, and carbon emissions produced in these areas.

- Track the efficacy of the structural soil planting beds in supporting healthy trees in a highly urban environment along the Central Corridor Light Rail Project and implement similar design elements in other redevelopment projects in Saint Paul.

- Improve boulevard soil conditions when planting by amending existing soils with compost and consider planting practices that loosen compacted soils including the use of spading machines where practical. Improved soil conditions increase tree establishment success by promoting a supportive root zone.

- Continue planting a diverse selection of tree species, but also take into account total benefits per tree when selecting a tree species. For instance, honeylocust provides significantly more benefits annually than any other tree as they increase in size (figure 11). Underutilized species mentioned above should be planted more readily, while avoiding use of large quantities of maple that currently form 37% of the street tree canopy.

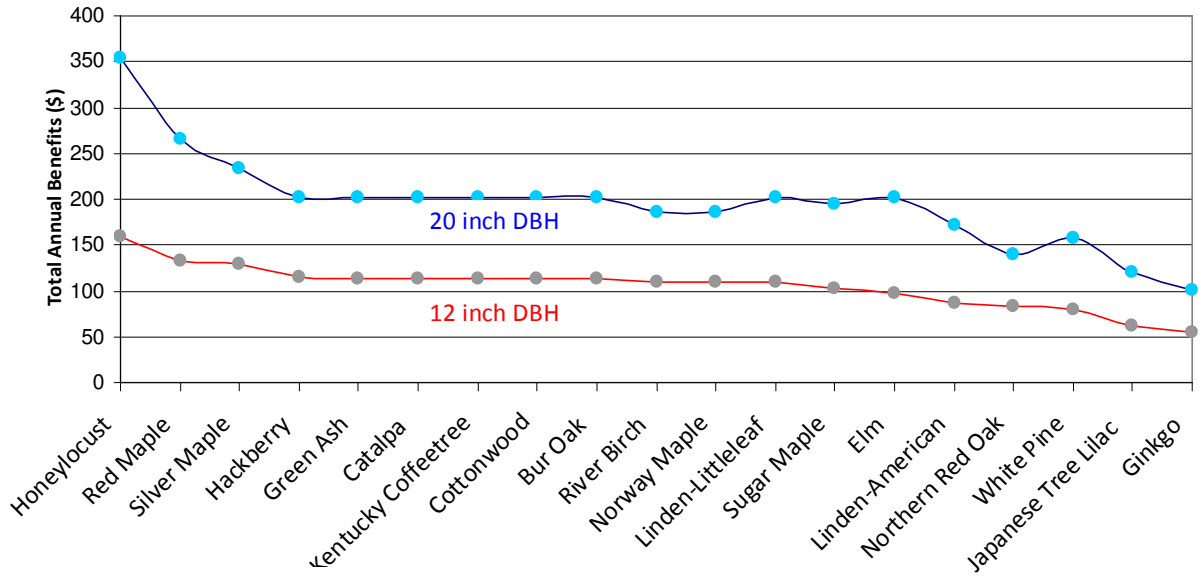


Figure 11: Comparison of total average annual benefits by species for 12" and 20" diameter trees in Saint Paul. (National Tree Benefits Calculator)

Appendix

Values used to determine the value of the street tree canopy in Union Park are as follows:

- Electricity rates are $0.0942/kWh based on weighted averages for 2011 summer and winter rates.
- Natural gas rates are $0.713401/therm based on weighted averages for 2011 summer and winter rates.
- Median home value of $210,900 is based on August 1, 2011 Zillow.com home value index data for May 2011.
- Values for air pollution and stormwater interception is based on the default information in loaded in iTree, calibrated to the Midwest. 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

- Population for Union Park of 3,986
- Operational costs of city tree management were not entered into iTree due to fluctuating budgets from year-to-year. This report is limited to only the benefits derived from the street trees of Union Park and does not balance out the costs of managing the street trees.

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