

Urban Forest Benefits Report

District 11-Hamline-Midway

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The Hamline-Midway Neighborhood Planning District (District 11) is located in the north-central region of Saint Paul, north of University Avenue and west of Lexington Avenue. At approximately 1,228 acres, the neighborhood comprises 3.4% of the city's 35,931 acres. Trees form an important part of the landscape element with tree canopy covering 27.7% of land in the Hamline-Midway neighborhood. While many of these trees are privately owned and cared for, the city is responsible for the boulevard street trees in the public right of way. Street trees provide valuable benefits to District 11 residents by sequestering carbon dioxide, regulating temperature extremes, and cleansing the air and water, to name a few.

In the summer of 2010, Saint Paul Forestry completed an inventory of street trees in Hamline-Midway. iTree¹ software was used to assess the structure of the urban forest and calculate the annual environmental benefits provided by the street tree canopy of District 11.

This report summarizes the species, size, and land use distribution of Hamline-Midway's trees, and details the relative importance of specific types of trees to the overall canopy. The benefits of the trees included in the assessment include carbon sequestration and storage, reductions in energy use, removal and avoidance of air pollutants, stormwater mitigation, and aesthetic benefits. The following results are a summary of the findings:

Hamline-Midway Street Tree Benefits Summary	
District land area	1,228 acres
Number of street trees	5,662
Canopy area	79.3 acres
Energy reduction	\$151,250
Carbon sequestered	1.7 million pounds
Total carbon stored	17.4 million pounds
Air pollutants removed	1,419 pounds
Air pollutants avoided	9,133 pounds
Stormwater runoff avoided	6.2 million gallons
Aesthetic/Other benefits	\$135,300
Total annual benefit	\$506,960

Table 1: Benefits Summary

This report also outlines the effects of a decline of the street tree population due to loss of ash from the invasive insect emerald ash borer (EAB). Several EAB response options are evaluated based on cost and environmental benefits. Based on the results of this assessment, this report offers a set of recommendations for the improvement of Hamline-Midway's street tree canopy and the environmental benefits generated by trees.

¹ Tree benefit model available through the USDA Forest Service

Species Distribution:

Hamline-Midway has 5,662 boulevard trees with the five most common tree types including maple (42%), ash (20%), linden (11%), honeylocust (5%), and ginkgo (4%). Together, these five genera of trees form 78% of the total population of street trees. Other tree types such as oak, elm, hackberry, and

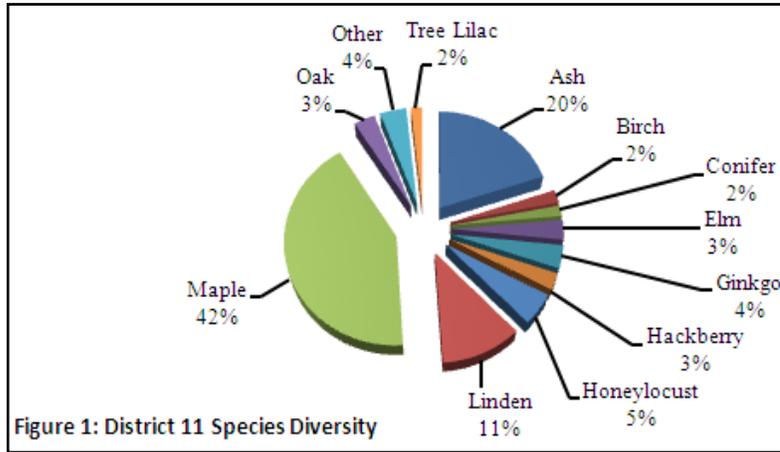


Figure 1: District 11 Species Diversity

and ornamental trees including serviceberry, hawthorn, and crab apple comprise a small percentage of District 11's street trees and should be planted more frequently in suitable planting sites to increase species diversity. Alternatives to Norway maple should be considered whenever possible, because Norway maple accounts for 27% of Hamline-Midway's tree population. Planning for increased species diversity will promote the stability of the urban forest and help prevent future canopy losses from diseases like Dutch elm and pests like emerald ash borer. Saint Paul has adopted the Street and Park Tree Master Plan to plan for species diversity. The plan recognizes that a single genus should not represent more than 30% of the tree population and includes details for sequencing trees and planting multiple species on the same block.

Size Distribution:

The age structure of boulevard trees measured by trunk diameter reveals an even distribution of trees between one and six inches with a downward trend as diameter increases from 18 inches. Overall, 88% of street trees are 18 inches or less in diameter with the largest percentage between 13 and 15 inches. Trees above 19 inches comprise 12% of the population while those larger than 24 inches represent only 3% of street trees.

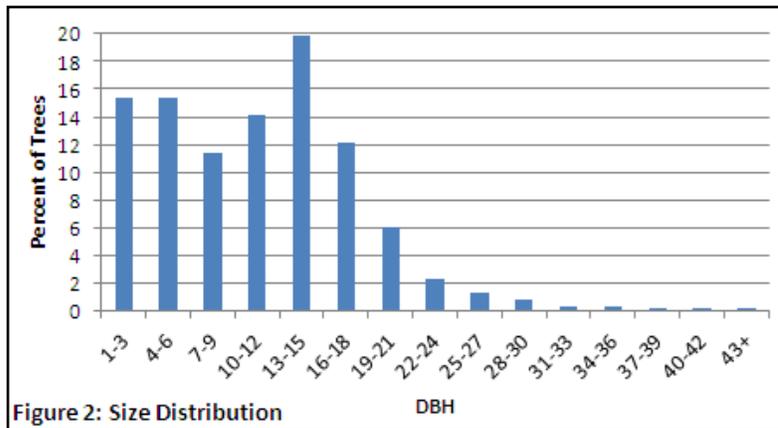


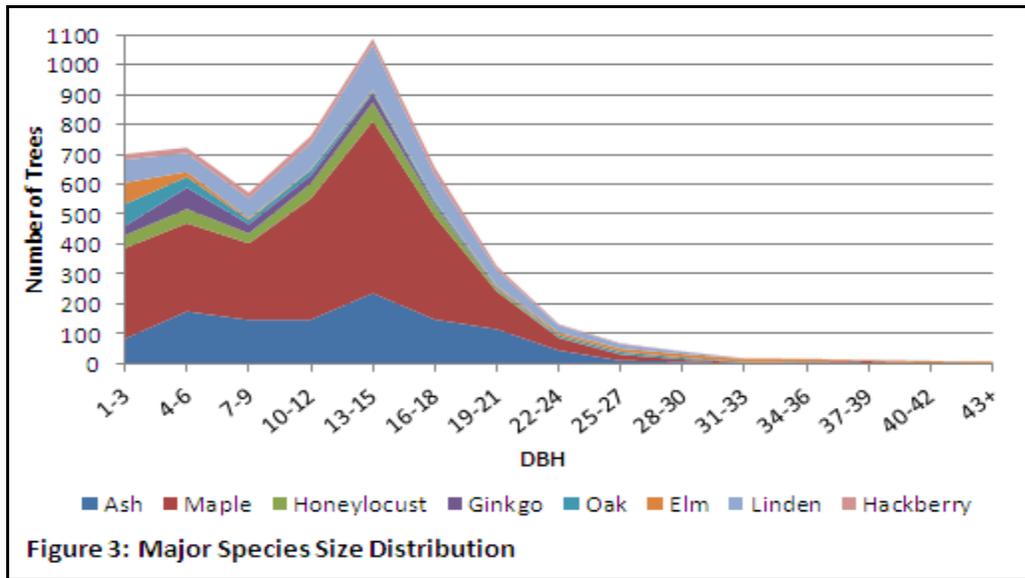
Figure 2: Size Distribution

Trees above 19 inches comprise 12% of the population while those larger than 24 inches represent only 3% of street trees.

Closer examination of the 8 most common species shows that with the exception of ash and ginkgo, most species are being planted to maintain species diversity similar to current levels, with varied populations across size categories. Changes that can be expected include: the loss of ash trees across all size categories due to the introduction of the emerald ash borer, the loss of fruiting ginkgo trees (the fruit emits an unpleasant odor as they decay), and an increase in elms as a percentage of the canopy due to the availability of Dutch elm disease resistant cultivars. Maples will slowly become a smaller part of the street tree canopy as Saint Paul integrates plans for species diversity.

The loss of ash trees due to the emerald ash borer would shift forest diversity, increasing the maple population to 53% of the street tree canopy

Maples are currently the most commonly planted type of tree. Of trees less than three inches in diameter, the number of maple trees is equal to the number of trees represented by the next five most common species.



Land Use

Land use within Hamline-Midway has been identified as 63% residential, 29% industrial, 6% commercial, and 2% park land.² District 11’s high concentration of industrial land limits the area available for planting because many industrial operations areas require wide streets, large buildings, and large parking lots. Street tree distribution is highest in residential areas (92%) followed by small commercial (3.4%) and industrial (3.0%).

Tree planting sites are located primarily on turf covered boulevards in both residential and industrial areas with the exception of the large commercial area of Snelling Avenue, and small areas of Hamline, University, Asbury, Edmund, and Blair avenues, where sidewalk cutouts exist. Boulevards are generally wide and support good tree growth. A few narrow planting boulevards of 1-4 feet are located along Hamline Ave, the south end of streets connecting to University Ave, and near industrial buildings on Fairview Ave. Eighty percent of the trees in District 11 are planted in strips that are 8 feet wide or greater. These locations can support trees that require larger rooting zones and better soil conditions such as oak, hackberry, serviceberry, and other ornamental trees.

Canopy Cover

Hamline-Midway occupies approximately 1,228 acres of land in Saint Paul. While streets are a significant percentage of overall land use, boulevards and street trees are a small portion of the overall urban forest. In January of 2011, Saint Paul and the University of Minnesota completed a classification of the city’s land cover using satellite imagery. Classification reveals that District 11 private and public trees together provide 340 acres of vegetative canopy, covering approximately 27.7% of District 11. Of the 340 acres of canopy, 122 acres are in the city right-of-way along the boulevard. Right-of-way trees account for 35.8% of Hamline-Midway’s canopy and 9.9% of the total land area. Tree cover is heavier in the residential neighborhoods of the district and less in the industrial areas where large buildings and transportation infrastructure restrict available tree planting locations.³

² Zoning maps available through public works GISmo tool at <http://gis.ci.stpaul.mn.us/gis/gismo>

³ For more information about Hamline-Midway’s tree canopy, download Saint Paul’s *Urban Tree Canopy Assessment 2011 Atlas* at <http://www.stpaul.gov/index.aspx?NID=4581>



Trees with a large total leaf surface area and broad canopy spread provide the greatest benefits.

Norway maple is the most important tree species while maples are the most important genus in District 11 based on population size and canopy area.

Importance Value

In order to compare the relative economic value of the environmental benefits contributed by each species of tree an importance value is assigned by iTree. This number is determined by averaging the total number of trees, the total leaf area, and the overall canopy cover provided by each species.

Within Hamline-Midway, maples received the highest importance value rating of 41.7 points due to their large presence in the urban canopy, 2,396 trees representing 42% of canopy cover and 3.64 million square feet of leaf area. Ash was rated second with an importance value of 21.9 and a leaf area of 2.16 million square feet. Despite the relatively small number of American elm trees in District 11, this species was ranked fourth due to the large amount of canopy coverage they provide (5.5%) and large leaf area approaching 778,000 square feet, or 8.5 % of the district total.

Japanese tree lilacs and crabapple trees received the lowest value with .6 each. This is primarily due to their small leaf area and structure which is less able to intercept large volumes of stormwater or sequester and store large amounts of carbon. However, their value in the landscape should not be overlooked because they are able to be planted in locations unsuitable for larger trees and provide additional aesthetic and design benefits.

Tree Type	Number of Trees	Percent of Total Trees	Leaf Area (ft ²)	Percent of Total Leaf Area	Canopy Cover (ft ²)	Percent of Total Canopy Cover	Importance Value
Maple	2396	42.3	3,639,419	39.9	1,506,683	43.6	41.7
Ash	1125	19.8	2,160,051	23.7	769,559	22.3	21.9
Linden	632	11.2	1,100,887	12.1	353,733	10.2	11.2
Elm	175	3.1	777,189	8.5	179,516	5.2	5.5
Tree lilac	95	1.7	4,461	0.0	7,424	0.2	0.6
Crabapple	70	1.2	12,474	0.1	12,993	0.4	0.6

Table 2: Top four and lowest two ranked importance values

Annual Benefits

Street trees provide a total of \$506,960 worth of annual environmental services to residents in District 11 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 public right-of-way and does not include the large population of trees planted in parks or on private property. This represents an average annual economic value of \$89.47 per tree annually.

When accounting for the five primary benefits iTree uses to calculate these values including energy, air quality, carbon, stormwater, and aesthetics the trees with the largest economic benefit are silver maple (\$168.75/tree), American elm (\$116.64/tree), honeylocust (\$113.67/tree), and littleleaf linden (\$113.46/tree). Japanese tree lilacs contribute the smallest environmental benefit valued at \$7.77/tree. As a population, maple and green ash are the largest providers of environmental benefits due to their large population size.

Energy Savings

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

Refer to page 9 for a complete list of environmental and economic benefits provided by street trees in District 11

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.

In Hamline-Midway this environmental service totals \$151,250 per year in energy and natural gas savings, reducing energy demand by 859 MWh per year, and natural gas usage by 114,000 Therms. The energy saved annually by District 11 trees would meet the average annual electricity demand of 89 Minnesota homes⁴(EIA). While these are estimates, the savings provided are substantial and reduce the amount of carbon released into the atmosphere from utilizing these energy sources.

Trees with the largest canopies including silver maple (\$39.35/tree), hackberry (\$34.32/tree), and American elm (\$33.13) provide the largest per tree benefit while maples provide the largest cumulative benefit due to their wide spread planting across the neighborhood. Unsurprisingly, small trees provide the smallest energy saving. Their role should not be overlooked because they provide effective shade in areas where larger species may 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.

Boulevard trees in Hamline-Midway remove 1,419 pounds of air pollutants through deposition while also reducing energy demand eliminating the release of 9,133 pounds of emissions annually at an estimated value of \$25,454 per year. Silver maple (\$7.82/tree) and American elm (\$7.42/tree) provide the greatest environmental and economic benefit followed by hackberry (\$6.23/tree), Norway maple (\$5.99/tree), bur oak (\$5.94/tree), and littleleaf linden (\$5.71/tree). Most of this value is generated by avoiding the production of harmful emissions.

Trees do release biological volatile organic compounds (BVOC) which can increase 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 that 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.

Currently, street trees in Hamline-Midway are storing 17.4 million pounds (8,695 tons) of carbon with an estimated economic value of \$130,416. Norway maple biomass comprises the largest share of carbon storage within the district at nearly 2,364 tons, or 27% of total stored carbon followed by green ash at 1,764 tons, or 20% of the total. Individually, silver maple (\$55.81/tree) and American elm (\$55.30/tree) provide the greatest carbon storage per tree due to their large size at maturity.

⁴ Residential average monthly electricity consumption in Minnesota in 2009 was 802KWh (EIA)

Boulevard trees in District 11 currently store 17.4 million lbs. of carbon and annually sequester 1.7 million lbs. Per tree, elm and silver maple sequester and store the most carbon due to their large size at maturity.

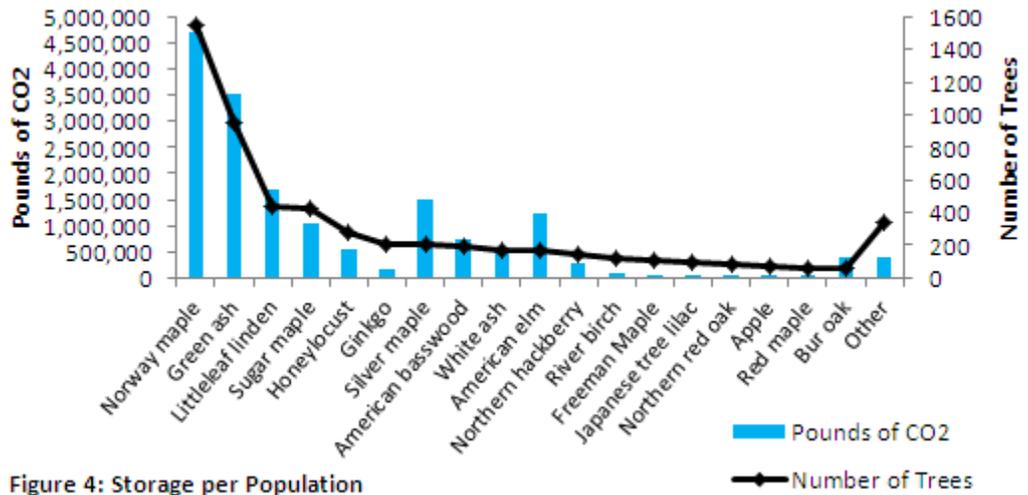


Figure 4: Storage per Population

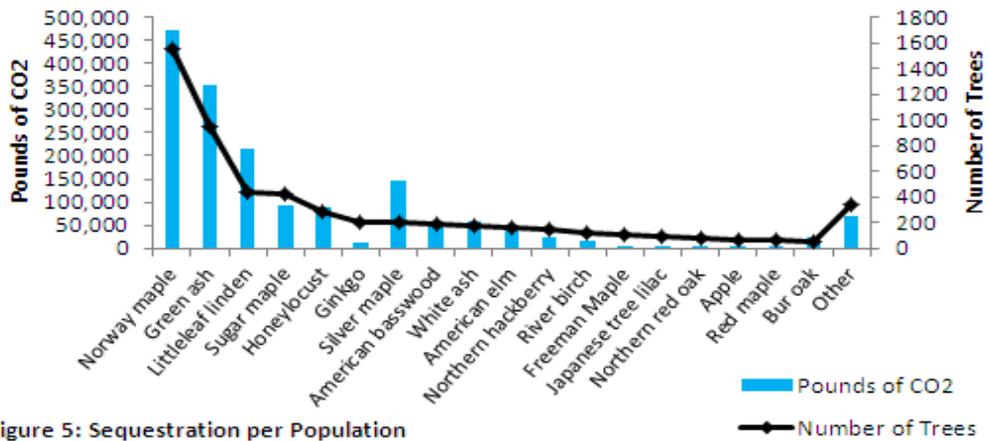


Figure 5: Sequestration per Population

Annual uptake of atmospheric carbon in District 11 sequesters 1,682,724 pounds of carbon each year with an estimated economic value of \$12,620. Most of this is stored as woody biomass with 83,754 pounds (5%) returned to the atmosphere via decomposition. Silver maples again provide the largest per tree benefit due to their fast growth rate and large size followed by littleleaf linden of which the population in Hamline-Midway is comprised primarily of large, mature trees. Norway maples, as a group, sequester the most carbon at 471,429 pounds annually, or 29.6% of the district total.

In addition to sequestering carbon directly from the atmosphere, trees provide shade and mitigate local microclimates reducing energy demand, avoiding an estimated 1,440,703 pounds of carbon emissions from power plants that would otherwise be released to produce this energy. In total, the trees in Hamline-Midway reduce atmospheric carbon by nearly 3.03 million pounds annually through sequestration and pollution avoidance at an economic value of \$22,733.

With an increased awareness of the role carbon plays in global climate change and the potential ramifications extending from increased atmospheric carbon levels, these benefits should be considered in the development of a more sustainable Saint Paul.

Stormwater

Trees are an important part of Saint Paul’s green infrastructure system and have the ability to intercept significant amounts of rainfall before it falls on impervious surfaces and becomes runoff. Preventing runoff has multiple economic and environmental benefits that include: water quality improvements by reducing pollutants entering local water bodies, increased infiltration rates, and volume load reductions on stormwater infrastructure. Tree canopies are most effective at reducing runoff from small rain events as well as the initial rainfall of larger storm events.

Currently, trees in Hamline-Midway intercept an estimated 6.2 million gallons of stormwater annually with an economic value of \$168,842. Trees with a large canopy, including silver maple (\$66.12/tree) and American elm (\$49.38/tree) provide the greatest per tree benefit due to the amount of leaf area and canopy spread available to capture rainfall. The greatest contribution to stormwater reductions are provided by Norway maple (\$30.99/tree), which as a group intercepts 1,775,656 gallons or 28.5% of the total stormwater volume intercepted.

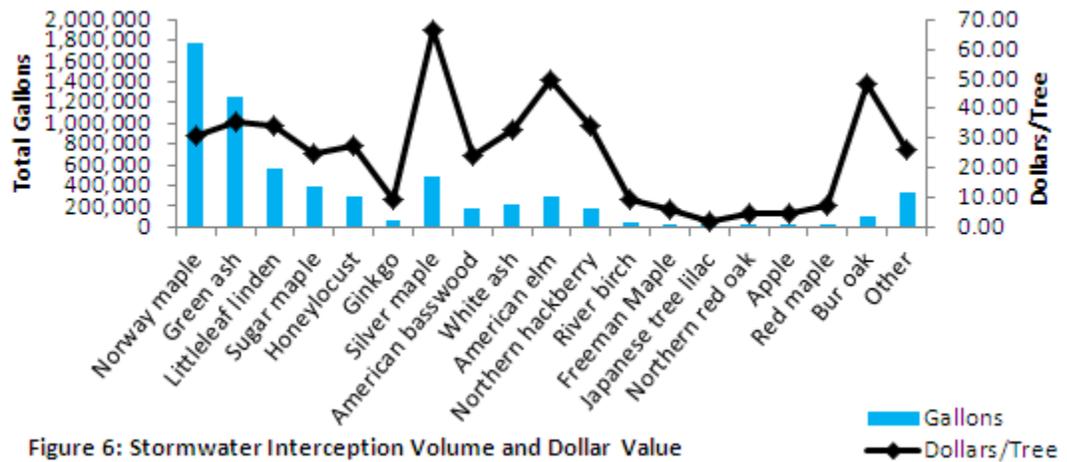


Figure 6: Stormwater Interception Volume and Dollar Value

Aesthetic and Other Benefits

Trees provide a myriad of social, environmental, and economic benefits, many of which are difficult to quantify through typical measures. In order to account for these additional benefits, including increased property values, and neighborhood aesthetics iTree calculates an aesthetic/other value. Street trees in District 11 contribute an estimated \$135,300 annually to the value of the neighborhood, with silver maple (\$47.45/tree), honeylocust (\$45.45/tree), and littleleaf linden (\$37.85) identified as the top three trees according to this analysis. These were followed by white ash (\$32.95/tree), green ash (\$32.95/tree), bur oak (\$25.34/tree), hackberry (\$22.92/tree), Norway maple (\$22.40/tree), and sugar maple (\$19.69/tree).

Emerald Ash Borer

In 2009, the invasive pest emerald ash borer (EAB) was discovered in Saint Anthony Park, a neighborhood located along the western border of Hamline-Midway. Later that year a single EAB infested tree was discovered on Howell Street in Hamline-Midway. As communities in Michigan, Ohio, and Illinois have experienced in recent years, EAB will dramatically alter the canopy structure of the urban forest and impact the environmental benefits provided by the forest. Without a coordinated response, EAB will have the potential to spread across the city.

Hamline-Midway will experience a significant decline in tree canopy in coming years as ash currently comprise 20% of the street tree population (see page 2). Continued infestation will require removal of otherwise healthy trees. The City of Saint Paul is working to reduce the spread

of EAB by piloting a variety of management strategies that include removal and replacement of ash, insecticide treatment, and public education efforts.

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 Hamline-Midway. 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. The following are the results of a change to the urban forest.

Scenario 1: Saint Paul removes all ash trees without planting any replacement trees (table 3).

- Results in a diversity shift such that maples would represent more than half of the street tree population.
- Annual environmental and economic benefits of the street tree canopy would decline as follows:
 - Decrease in economic benefits by \$116,000 or nearly 23%
 - 400,000 pound reduction in carbon sequestration
 - 1.5 million gallon increase in stormwater run-off
 - Decrease of 2,241 pounds in removal and avoidance of air pollutants
 - Aesthetic and other factors would decline by approximately \$31,845

Scenario 2: All boulevard ash trees are removed and replaced with a diverse selection of 2 inch caliper trees (table 3).

- New trees are planted that will produce substantial benefits in the future Current benefits derived from mature ash trees are not preserved.
- Current benefits derived from mature ash trees are not preserved.

Table 3: ash tree management scenarios

	Current	Ash Trees Removed*	Ash Removal and Replanting**
District Land Area (acres)	1,228	1,228	1,228
Number of Street Trees	5,666	4,541	5,666
Canopy Area (acres)	79.3	61.6	61.95
Percentage of Land Cover	6.50%	5.00%	5.04%
Annual Energy Reductions			
Electricity (MWh)	858.9	668.2	672.3
Natural Gas (Therms)	114,384	89,827	90,565
Annual Economic Value	\$151,250	\$118,356	\$119,232
Carbon Reductions			
Stored in Street Trees (million pounds)	17.4	13.4	13.4
Sequestered Annually (million pounds)	1.7	1.3	1.3
Avoided Annually (million pounds)	1.4	1.1	1.3
Annual Economic Value	\$22,733	\$17,392	\$18,026
Annual Removal of Air Pollutants			
Ozone (pounds)	806.8	681	681.1
Nitrogen dioxide (lbs.)	136.8	116.7	116.7
Particulate matter (.lbs)	438.2	367.4	367.9
Sulfur dioxide (lbs.)	36.8	31.2	31.2
Annual Economic Value	\$4,472	\$3,772	\$3,774
Annual Air Pollutants Avoided			
Nitrogen dioxide	4,075	3,178	3,199
Particulate matter	595.3	463.8	466.8
VOC's	568	442.4	445.2
Sulfur dioxide	3,895	3,030	3,049
Annual Economic Value	\$25,454	\$19,835	\$19,962
Stormwater Mitigation			
Runoff reductions (gallons)	6,229,903	4,768,256	4,782,415
Annual Economic Value	\$168,842	\$129,229	\$129,612
Aesthetic/Other Benefits			
Annual Economic Value	\$135,301	\$103,456	\$105,230
Total Annual Benefit	\$506,960	\$390,949	\$394,207

*Figures represent the potential loss of ash trees due to the emerald ash borer

**Figures represent initial values achieved by the removal of ash and replanting with a diverse selection of 2 inch DBH trees.

Recommendations

This report is an initial measurement of the environmental and economic benefits provided by the street trees of Hamline-Midway. The data found within can assist with coordinating species selection and planning of tree planting activities to maximize future benefits. Additionally, it provides a baseline data set to measure progress for subsequent environmental benefit studies and to compare directly with the city wide canopy assessment currently under development.

Recommendations include:

- Increase tree cover in industrial areas, which comprise 29% of the land area of District 11 but only 3% of the canopy, by informing businesses about appropriate trees for industrial zones 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.
- Improve boulevard soil conditions when planting by amending existing soils with compost and consider planting practices that loosen compacted soils where practical. Improved soil conditions increase tree establishment success by promoting a supportive root zone.
- Encourage long-term carbon storage through wood utilization programs that produce durable wood products and construction materials.
- Increase species diversity by planting trees suited to the wide boulevards found in District 11 including birch, Kentucky coffeetree, oaks, serviceberry, elm, and hackberry. Limit the planting of maple to acceptable replacement levels as these currently form 42% of the canopy.
- Support and expand the efforts of the Hamline-Midway Environmental Group, a community group promoting better tree care through community education and tree planting programs for residents.
- Promote the long-term health and survival of existing trees as large trees provide the greatest environmental and economic benefit to the community.

Appendix

Values used to determine the value of the street tree canopy in Saint Anthony Park are as follows.

- Electricity was \$0.0669/kWh based on the average of summer and winter rates quoted by Xcel Energy on July 6, 2010
- Natural gas was \$0.76/therm based on the 36 month average available from CenterPoint Energy on December 15, 2010
- Median home value was entered as \$155,000 based on local real estate numbers for 2010 sales data and estimated home values. This number is imperfect but represents a number that accounts for current resale values and estimated home values across the neighborhood.
- Values for air pollution and stormwater interception were based on the information in iTree which has been calibrated to the Midwest by the program. 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 street trees without balancing against the costs. Once the complete canopy assessment is complete, a full cost benefit calculation can be estimated.

References

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