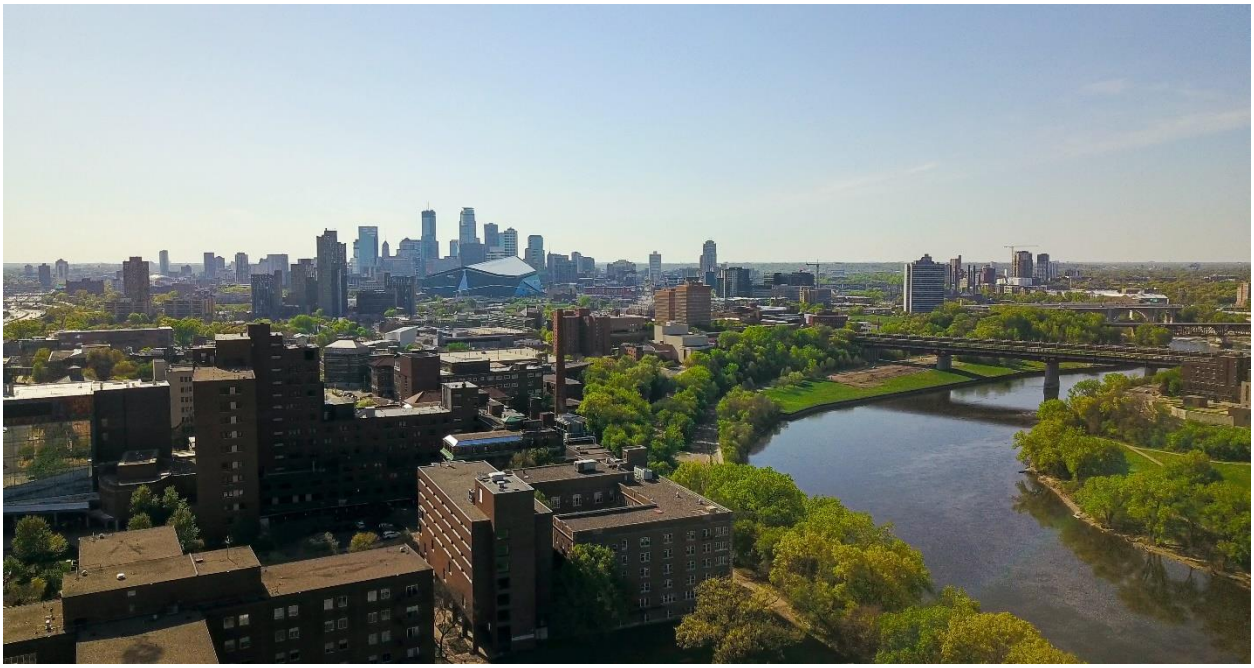

Biochar-Urban Forestry Strategy

MINNEAPOLIS, MINNESOTA BIOCHAR FEEDSTOCK ASSESSMENT

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Prepared for:
City of Minneapolis

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Carbon Neutral Cities Alliance
Nature-Based Climate Solutions

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Introduction

The City of Minneapolis faces a mounting wall of wood waste – logs and tree limbs coming out of the city and its surrounding urban forest, driven largely by the Emerald Ash Borer (EAB) and its decimation of local ash populations. As Hennepin County looks for solutions to its growing wood problem, biochar has emerged as a potential solution to reduce urban forest biomass into a carbon-rich charcoal with the potential to derive economic and environmental value from this waste stream.

This project aims to assess the potential for using urban forest biomass as a feedstock for biochar production within and around the City of Minneapolis. This analysis is one of four municipal case studies completed in coordination with Nature-Based Climate Solutions (NCS) and supported by the Carbon Neutral Cities Alliance (CNCA). Peer assessments from the cities of Boulder, Helsinki, and Stockholm will also be available at the culmination of the project.

This report draws upon data from the Minneapolis Park & Recreation Board and the Minnesota Pollution Control Agency in order to quantify potential feedstock availability of urban forest residues. A subsequent biochar strategy will explore local application opportunities, as well as estimated environmental impacts from biochar use.

Why Biochar?

Biochar is a carbon-rich solid obtained from pyrolysis of organic matter in a low-oxygen environment. Classified as a negative emissions technology by the IPCC, biochar's long-term carbon sequestration potential has yielded growing awareness as a natural climate solution, with production further incentivized by a burgeoning carbon offsets market. The application of biochar in soil poses several benefits to vegetative growth[1] and plant health, including increased water holding capacity[2] and disease resistance.[3] Additionally, biochar has shown proven efficacy in contaminant remediation and water management.

Critically, biochar presents an opportunity to derive a high-value and environmentally beneficial product from low-value or traditionally wasted material. Biochar can be produced from a variety of feedstocks, including green/yard waste, food scraps, sewage sludge, and wood. Feedstock, along with pyrolysis conditions, plays an important role in determining the quality, pore structure, nutrient content, and characteristics of resulting biochar.

[1] Scharenbroch, B.C. et al. 2013. Journal of Environmental Quality 42 1372-1385 "Biochar and Biosolids Increase Tree Growth and Improve Soil Quality for Urban Landscapes"
[2] Omondi, M et al. 2016. Geoderma 274 28-34 "Quantification of biochar effects on soil hydrological properties using meta-analysis of literature data"
[3] Zwart, D.C. and Kim, S-H. 2012. Hort Science 47 1736-40 "Biochar Amendment Increases Resistance to Stem Lesions Caused by Phytophthora spp. in Tree Seedlings"

Feedstock Potential: Regional Biomass Estimates

The goal of this analysis is to understand the scale of potential production and application of biochar within the City of Minneapolis and the surrounding region. Given the number of upcoming tree removals and overwhelming volume of corresponding wood waste, urban (and peri-urban) forest biomass was chosen as our feedstock of focus. Urban forest biomass – or fresh cut wood residues resulting from tree removal and maintenance work – presents an exciting opportunity for biochar production, given both proximity to centralized infrastructure (relative to traditional harvested wood), and the current cost burden tree care companies face to dispose of their waste stream. A demand for this material by biochar producers could help 1.) **cut disposal costs**, 2.) **reduce waste,** and 3.) **sequester tree carbon** in a semi-permanent charcoal, rather than release greenhouse gasses into the atmosphere.

In order to size the potential volume of wood debris available for biochar feedstock, two sources were considered: material from public trees managed within the City of Minneapolis's urban forest, and biomass generated from tree removals in Hennepin County.

Minneapolis Tree Data

Within the City, the Minneapolis Park & Recreation Board manages all public planting, maintenance, and removal of street and park trees. Since 2014, a targeted Emerald Ash Borer management campaign resulted in a near doubling of annual tree removals, with roughly 40,000 ash trees removed over an 8-year period.[4] 2021 marked the last year of this campaign, with removals beginning to trend toward pre-2014 levels. In total **5,924 trees** were removed from the city landscape, containing an estimated **4,481 metric tons** of woody biomass. [5] Data from 2021 tree removals is summarized in Table 1.

Table 1. 2021 Public Tree Removal Data for the City of Minneapolis

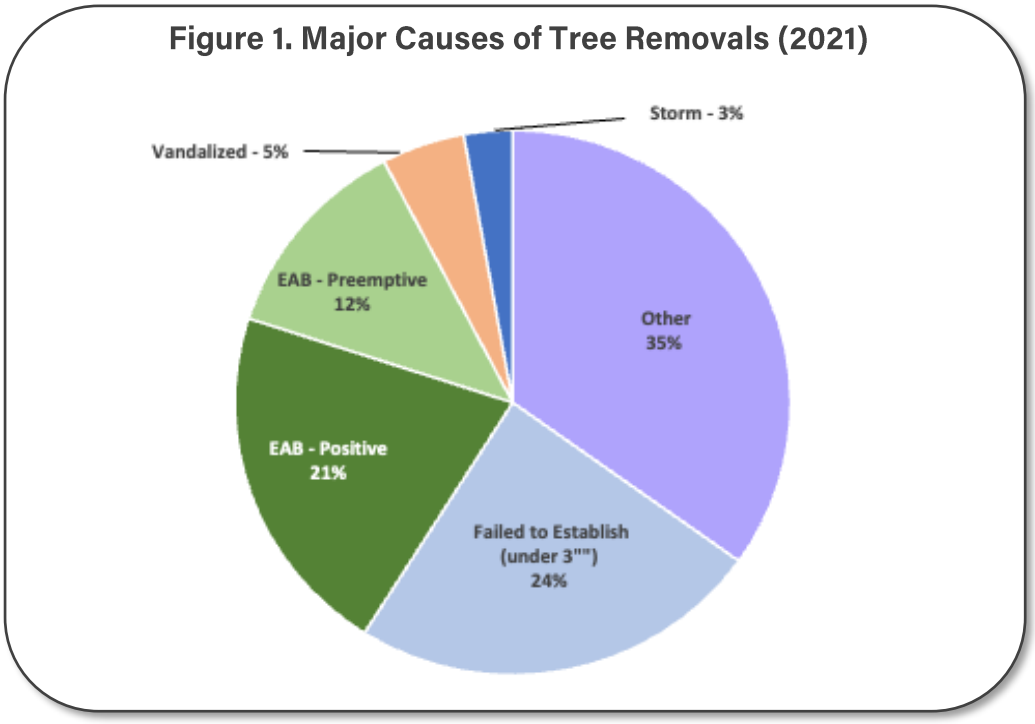
Species	Total Count	Average DBH	% Total Inventory	Above Ground Biomass (kg/tree)	Biomass Total (MT)
Green Ash	1695	18.6	28.6%	1729.3	2931.1
Norway Maple	300	13.9	5.1%	596.4	178.9
Tamarack	193	2.6	3.3%	2.4	0.5
Sugar Maple	191	14.8	3.2%	859.2	164.1
Ash	169	15.6	2.9%	780.9	132.0

[4] Tree removal data and estimates provided by Philip Potyondy & Ralph Sievert of the Minneapolis Park & Recreation Board, and Dustin Ellis, Community Forester for Hennepin County.
[5] Biomass calculations were derived using the USDA Forest Service's CUFR Tree Carbon Calculator. https://www.fs.usda.gov/ccrc/tool/cufr-tree-carbon-calculator-ctcc

Species	Total Count	Average DBH	% Total Inventory	Above Ground Biomass (kg/tree)	Biomass Total (MT)
Littleleaf Linden	149	17.3	2.5%	669.5	99.8
'Espresso' Kentucky Coffee Tree	145	2.8	2.4%	6.8	1.0
American Linden (Basswood)	142	19.9	2.4%	926.0	131.5
American Elm	120	25.0	2.0%	2118.4	254.2
Swamp White Oak	99	6.2	1.7%	79.1	7.8
Other	2721	7.69	46.0%	213.0	579.7
Total / Average	**5,924**	**13.1**	**100%**	**536**	**4,481**

Figure 1 illustrates the major causes of 2021 public tree removals in Minneapolis. Although EAB-related removals account for roughly one-third of all tree loss, it should be noted that other driving causes of tree removal include failure to establish, vandalism, and storm; consequently, biomass will continue to be removed from the city's urban forest upon conclusion of the EAB management campaign.

Figure 1. Major Causes of Tree Removals (2021)



At present most wood debris generated through maintenance and removal activity is sent to a wood processing site leased by an external company (Precision Landscape & Tree) that processes the material

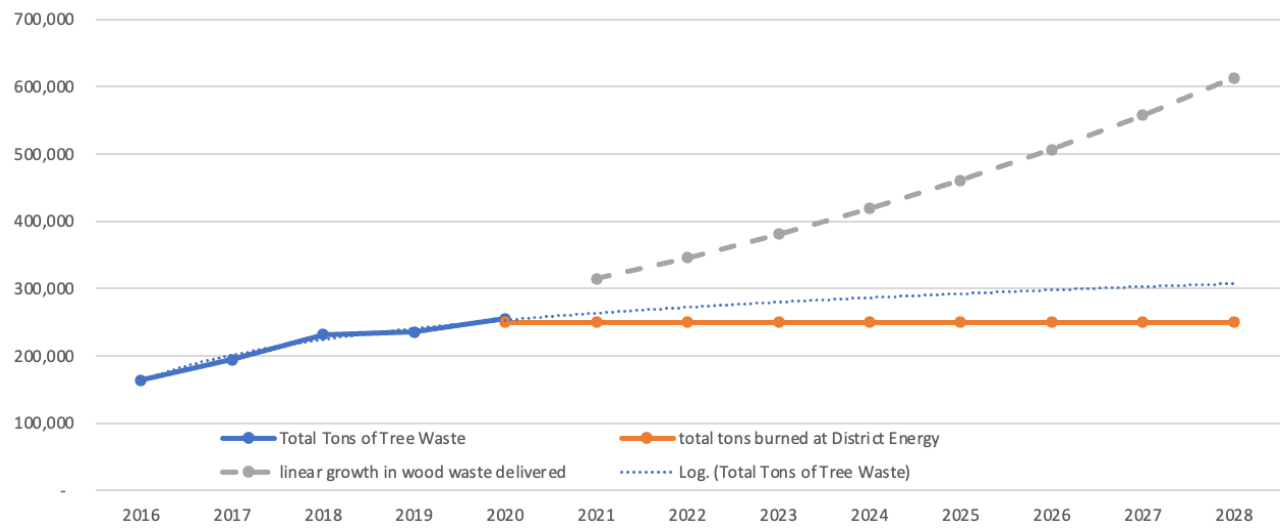
into biofuel or wood chips for landscape application. A portion of material is sold to Wood from the Hood to be milled into lumber products. Site constraints are a concern, as there is little room in the current system for additional wood storage or processing.

A pilot ARTi biochar unit being reviewed by the City of Minneapolis can process 16 tons of green wood into 4 tons of biochar across 2 lines daily. Total processing potential for the unit is estimated at 3,200 tons of green biomass annually, but will vary depending on run time.[6] Under this scenario, two 2-line units would be required to manage biomass from Park Board tree removals, generating an estimated **1,120 tons of biochar annually** from the Park Board's 4,481 metric tons of wood biomass. These totals exclude biomass generated by private tree care activities.

Hennepin County Biomass

In addition to public and private tree work within the City of Minneapolis, Hennepin County and the surrounding region present a huge source of potential biomass feedstock for biochar production. While the City's EAB campaign has concluded, the County faces management of nearly 1 million ash trees situated on public and private landscapes. From 2016 to 2020, an average **56,148 tons of tree waste** were recorded annually in Hennepin County.[7] Figure 2 summarizes the state-wide volumes and projected growth of tree waste in Minnesota, driven largely by EAB management activities.

Figure 2. Wood Waste Projections (Minnesota)



Courtesy of Anne Jackson, Minnesota Pollution Control Agency

[6] Based on manual operation and 200 days run time/year (per ARTi website, https://www.arti.com/reactors/)
[7] Data from state-wide Minnesota Pollution Control Agency data.

While Ever-Green Energy's District Energy St. Paul facility serves as the largest wood biomass processor in the region, the company has no current plans to scale production to meet the estimated increases in regional wood waste. And although transportation costs may ultimately limit the geographic scope of unified wood waste capture across the region, development of biochar systems in and around the City of Minneapolis may help manage a portion of the growing volumes of wood waste, while capturing economic and environmental value.