Winnipeg

Winnipeg Comprehensive Urban Forest Strategy

State of the Urban Forest

Acknowledgments

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TABLE OF CONTENTS

1. Introduction

This Report on the State of Winnipeg's Urban Forest provides an overview on the composition of Winnipeg's urban forest, its value, how it is managed, introduces performance metrics and indicators for sustainable urban forest management, and compares Winnipeg's urban forest management programs and services with other Canadian cities.

The purpose of this document is to provide a baseline and background to inform and help guide the development of the Comprehensive Urban Forest Strategy.

The report is organized into the sections listed below:

1. **Introduction -** a brief overview of why we need urban forests and how they benefit cities
2. **Winnipeg's urban forest resource** — a description of what and where the urban forest is, why it is important and how it benefits the community
3. **Winnipeg's urban forestry program** — a synopsis of the current urban forest services and programs that the City provides in relation to indicators for achieving sustainable urban forest management
4. **Peer city comparison** — a comparative analysis of Winnipeg urban forest management and service metrics compared to information available from other jurisdictions in Canada
5. **Enabling policies**— a description of the current policy context that frames Winnipeg's urban forest management
6. **Key challenges and opportunities** — an overview of some of the major areas that the Comprehensive Urban Forest Strategy will address

A Comprehensive Urban Forest Strategy will provide the 20-year strategic direction for Winnipeg's urban forest.

Urban forestry is the 'art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society'

(Helms, 1998)

Why do cities need urban forests?

When healthy and well-managed, the urban forest produces 'ecosystem services' often defined in four distinct but inter-connected categories:

1. **Cultural services:** how people value the urban forest in our way of life such as for beautification, sense of place, health, spirituality, recreation, and tourism
2. **Regulating services:** the regulation of ecosystem processes like pollination, air and water quality, storm water flow, shade, and cooling. With climate change, the role of trees to mitigate extreme heat and precipitation becomes increasingly important
3. **Supporting services:** habitat, biodiversity, and enabling natural processes to occur that maintain the conditions to support life – supporting services are essential to the production of all other ecosystem services
4. **Provisioning services:** direct products of trees and forests, such as fruits, nuts, or medicines

Ecosystem services, some of which are illustrated in Figure 1, are the product of healthy, functioning ecosystems and organisms that benefit human health and well-being. Nearly 40 years of research provides evidence for the benefits of incorporating nature into cities for human health and well-being[1]. Many cities are looking to the urban forest to help adapt to climate hazards, such as by creating shade to cool spaces during heat waves and capturing rainwater to reduce localized flooding during extreme rainfall. Urban forests are increasingly recognized as an essential part of city infrastructure - a natural asset that delivers ecosystem services throughout communities.

That trees and nature are important to Winnipeg has been evident since Winnipeg's beginnings when residents began planting trees. Perhaps the most famous example is the Wolseley elm, planted around 1860, that became a flashpoint for the community's values. The city developed around the Wolseley elm, and - rather than remove it as the street was built - retained it in the centre of Wolseley Avenue. In 1957, the City ordered it cut down as a traffic hazard, but others in the community considered it a safety feature for slowing traffic and an important community symbol worthy of protection. Several women made national news when they formed a human chain around the tree and prevented City crews from cutting it. While the tree was ultimately removed, it was such an enduring symbol that a new Wolseley Elm was planted in 1995 as a dedication to the original tree and the 'Elm Guard'. Today, the City of Winnipeg has an enviable legacy of mature trees and canopy cover, cared for by skilled staff and green industry professionals, active community partners, and passionate residents.

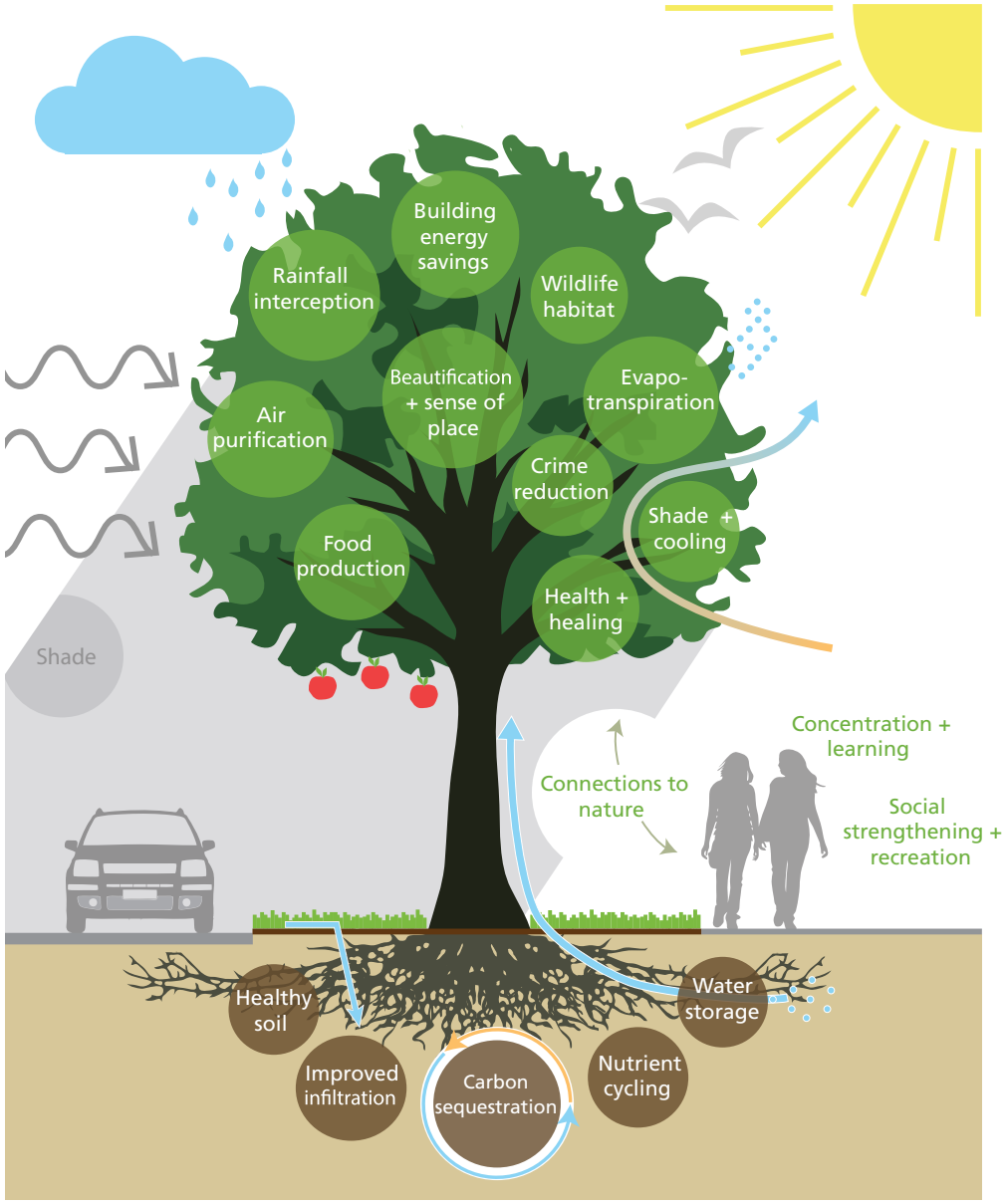


Figure 1: Ecosystem services provided by the urban forest.

[1] Numerous urban forest research studies are summarized on the Green Cities: Good Health website http://depts.washington.edu/hhwb/.

How do cities maximize the benefits from trees?

Trees are City assets just like roads, sewers, and streetlights. But, unlike these hard assets that depreciate in value with time, trees appreciate in value as they grow and age. Trees also deliver more services as they grow. Large, long-lived and healthy trees provide the greatest benefits because they have the largest canopy and most biomass (Figure 2). Planting and managing few large trees, rather than many small trees, is more efficient and beneficial. This is challenging in urban areas due to limited space, so the best approach is to plant the largest possible tree for the site. Ideally, as a tree matures, it is not in damaging conflict with other infrastructure (e.g. overhead wires). In addition to choosing the right tree for the right place, it is essential to design in adequate space to support healthy tree growth when there are opportunities to install new trees.

Asset management is an approach many cities use to plan for and manage existing and new assets to maximize the benefits, reduce risks, and provide a satisfactory level of service for a sustainable cost. Asset management approaches can be used to create and maintain conditions that give urban trees the best possible chance of reaching maturity and delivering value and services to the community over their full life cycle (Figure 3). Understanding the state of the asset is essential information for creating an asset management plan. The next section describes what we know about Winnipeg's urban forest resource, including the city's entire tree canopy and the public tree inventory.

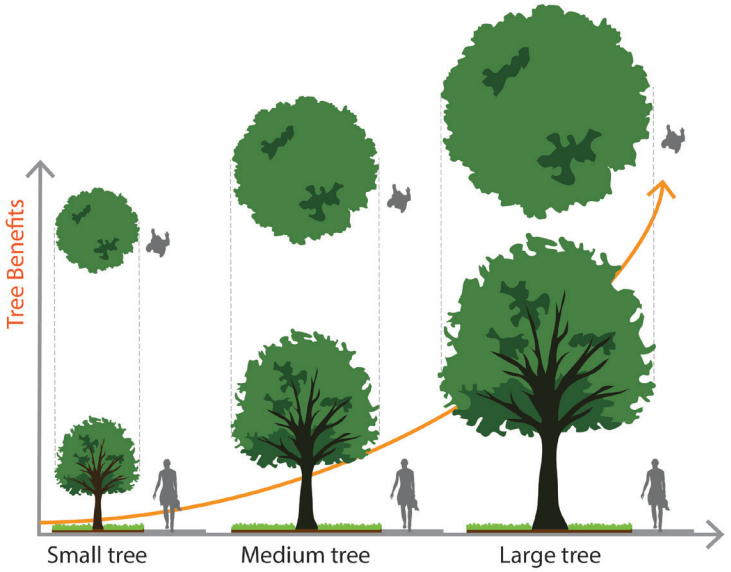


Figure 2: Large, long-lived tree species provide many times the benefits of small tree species over a much longer timeframe when planted in the right place.

A street of healthy, mature elms in Winnipeg.

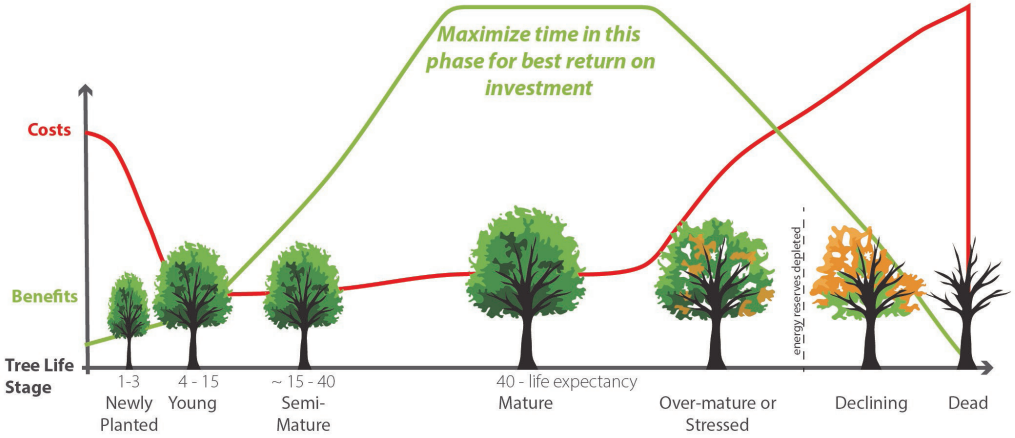


Figure 3: Tree assets should be managed to maximize their healthy, mature life expectancy. Trees cost the most at the start and end of their lives and produce the greatest benefits in the middle. Planning for quality planting sites, tree selection, and maintenance over the whole tree life cycle maximizes life expectancy, minimizes risk and avoids frequent removal and replanting costs.

2. Winnipeg's urban forest resource

Winnipeg's urban forest is the sum total of all trees and associated vegetation, soil, natural processes, and cultural elements on public and private land in and around towns, cities, and other communities(Figure 4).

The urban forest plays a vital role in forming the city's character and identity. Urban tree planting in Winnipeg started before the City's incorporation in 1873 and now large elm and ash trees provide a beautiful and defining natural character to Winnipeg's streets, parks, and neighbourhoods. The City began planting trees in urban parks and boulevards from the late 1800s to develop Winnipeg as a "garden city".

It is hard to imagine Winnipeg without its green canopy of trees stretching to the horizon. Sadly, urban forest loss is a real prospect due to unprecedented combined challenges from Dutch elm disease, emerald ash borer, extreme weather events, and climate change ravaging Winnipeg's tree canopy. In developing a Comprehensive Urban Forest Strategy, the City will be considering the actions required to increase the long-term resilience and sustainability of Winnipeg's urban forest. This section will summarize the state of the urban forest resource in terms of metrics that could inform setting targets and monitoring change over the term of the Strategy.

Winnipeg's extensive urban tree canopy blankets the city's older neighbourhoods.

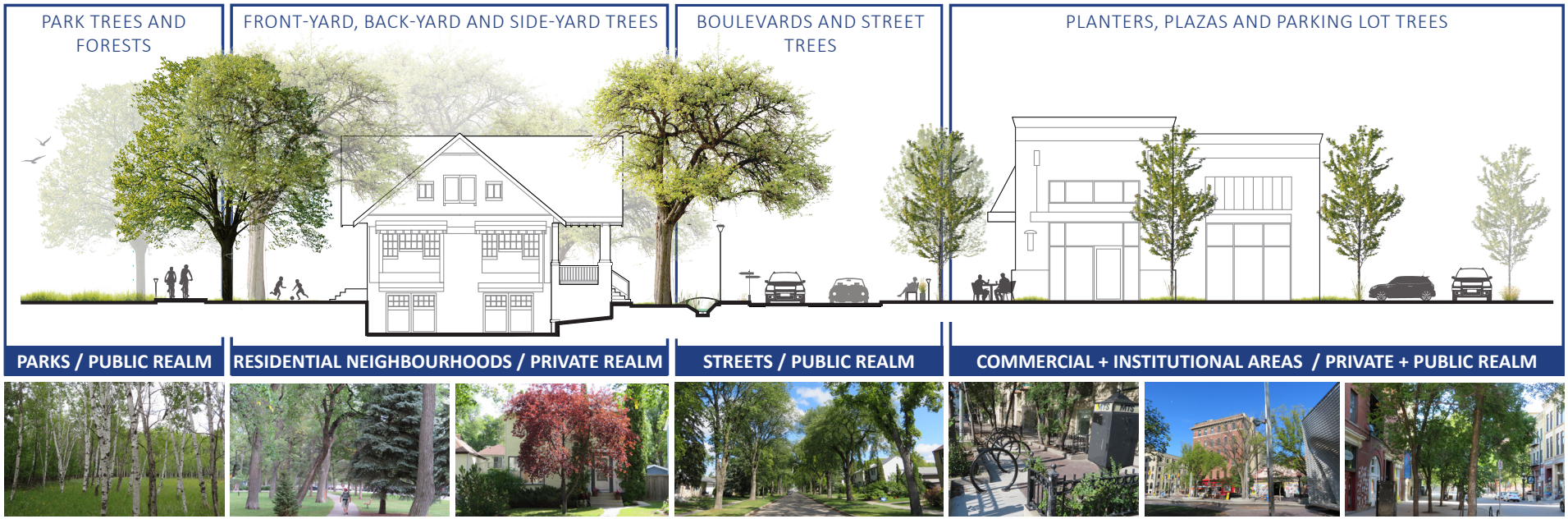
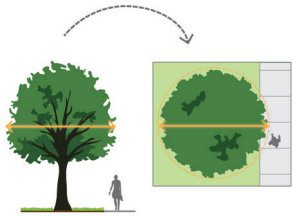


Figure 4: Winnipeg's urban forest includes all trees and associated vegetation, soil, natural processes, and cultural elements.

Winnipeg's 2018 canopy cover was estimated at 17 percent

How much tree canopy does Winnipeg have?

Canopy Cover



Canopy cover is a measure cities commonly use to describe the amount or size of their urban forest. Canopy cover measures the area occupied by tree crowns (upper leafy surface) when viewed from above. It is often expressed as a percent compared to the total area of the city. The USDA's i-Tree Canopy program was used to estimate citywide canopy cover.

Citywide canopy 2018: 17 percent (declined from 18 percent in 2005 - see Figure 5)

The change measured is not statistically significant. Winnipeg's canopy has been relatively stable over the 13-year period measured, which is likely due to:

- The City's Dutch elm disease management program managing the loss of elm canopy
- New development into prairie grasslands resulting in new tree planting
- Stability in the large undeveloped land uses at the edges of the city meaning that canopy changes have comparatively small impact on citywide canopy cover values
- Continued stable maturation of trees in previously developed neighbourhoods with shade tree plantings on boulevards, parkland, and private properties

Despite this apparent stability, elm removals are continually increasing and the removal rate has now surpassed the planting rate. Ash is also under threat due to insect pests. As tree loss accelerates, this decline is expected to become significant. The current distribution of tree canopy within the city boundary is shown in Figure 6.

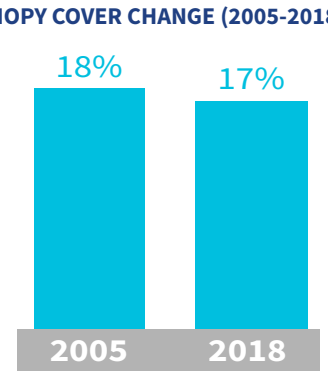


Figure 5: Citywide canopy cover decline from 2005 to 2018.

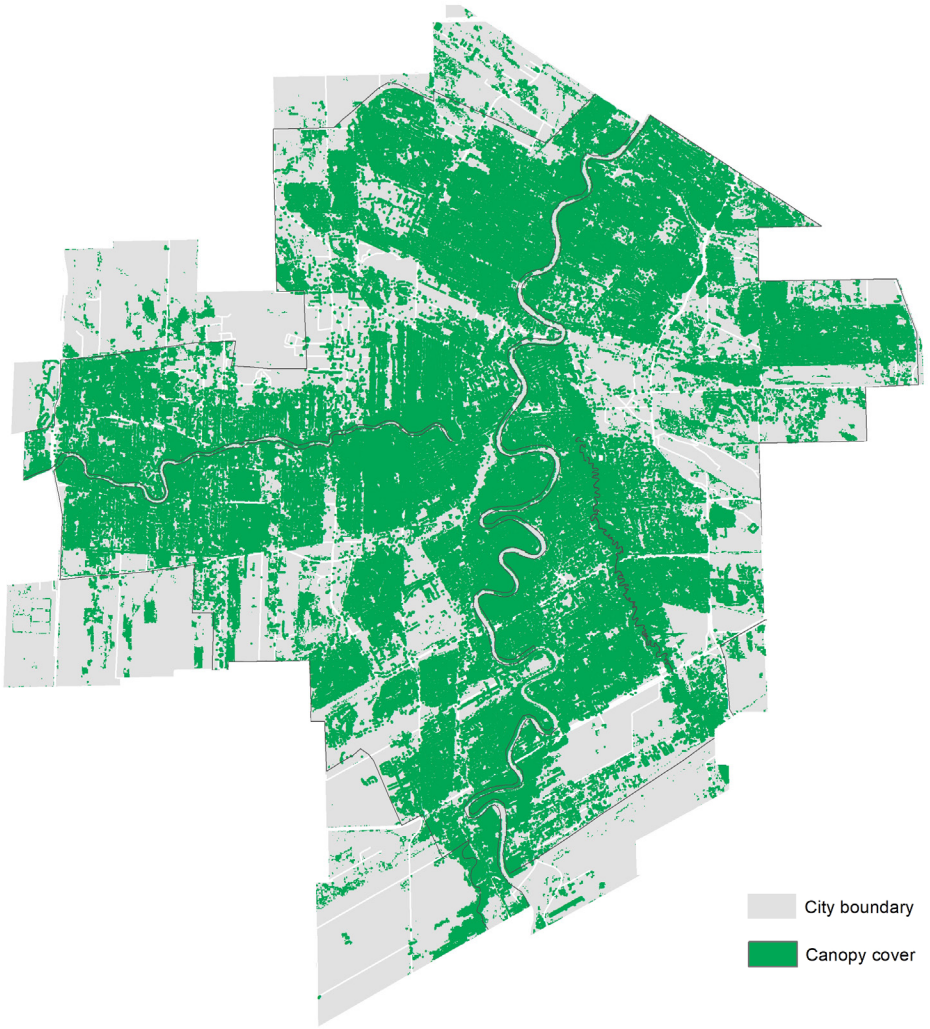
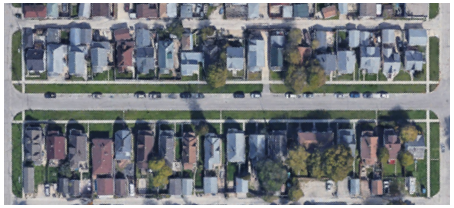


Figure 6: Approximate distribution of trees and canopy across Winnipeg using the City's inventory data and satellite data of tree canopy from the University of Maryland (Hansen et al. 2013).

What does canopy cover look like at street-level?

At street-level, canopy cover varies widely across Winnipeg. The examples in Figure 7 show three different city streets with a range of canopy covers as well as the Google Street View illustration of the canopy cover experienced at the ground level.

~10% canopy cover

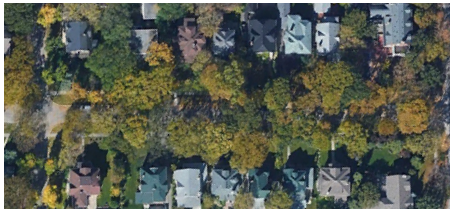


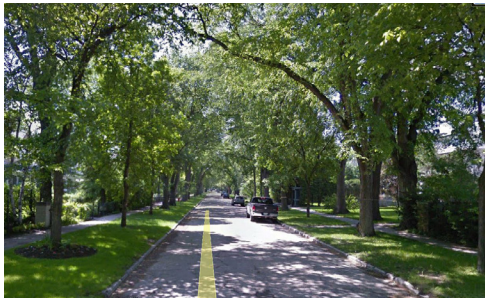
Google Street View

~40% canopy cover

Google Street View

~80% canopy cover





Google Street View

Figure 7: Canopy cover distribution varies across the city.

How does Winnipeg's canopy cover compare to other Prairie cities?

At 17 percent, Winnipeg's tree canopy cover is substantially higher than other Canadian Prairie cities (Figure 8).

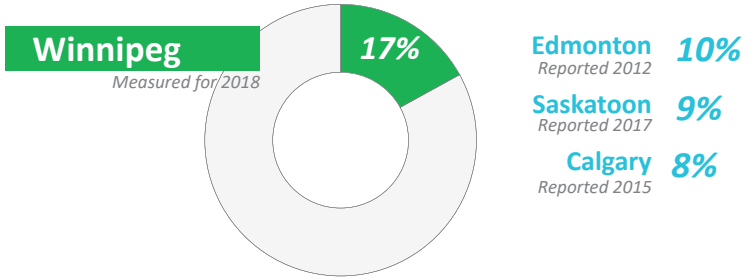


Figure 8: In 2018, Winnipeg's canopy cover was 17 percent.

Many of Winnipeg's older neighbourhoods have streetscapes with high canopy cover.

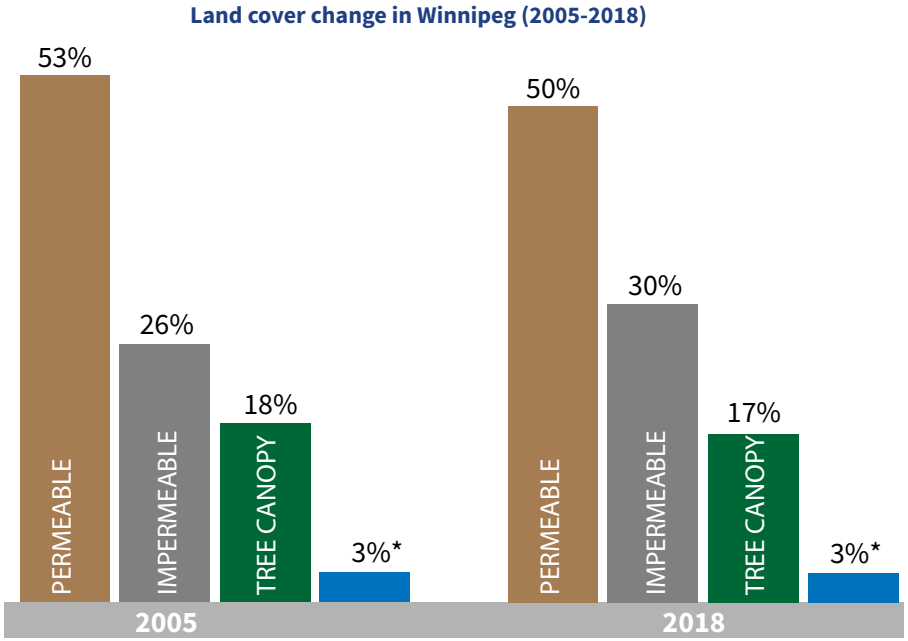
Winnipeg's impermeable cover increased from 26 percent to 30 percent between 2005 and 2018

What are the trends for other types of land cover?

Trends in land cover show how land use is changing over time in Winnipeg. i-Tree Canopy was used to estimate the cover of tree canopy, impermeable land, permeable land, and water (excluding the rivers). The results in Figure 9 show a significant increase in impermeable area and corresponding declines in permeable area and, to a lesser extent, tree cover. In other words, grassland and open green space have been replaced with paved roads and buildings.

Based on observations in i-Tree Canopy, the land cover change in Winnipeg was most often related to urban development into rural prairie lands (Figure 10a). Usually, the land impacted had grass cover but sometimes new developments impacted natural stands of trees. Some tree cover loss was also observed in already developed areas, likely due to Dutch elm disease (Figure 10b). Tree cover gain was observed in a few instances where back yard or street trees were planted. However, tree cover loss was observed six times more often than tree cover gain.

The extent and distribution of permeable and impermeable land cover types can indicate the potential to grow the urban forest. When impermeable surfaces — such as buildings, roads, and surface parking areas — dominate a land area there is less physical space to plant trees and less soil to support tree growth. Impermeable surfaces are often highest and canopy cover lowest in dense urban areas such as downtown and commercial zones.



*Water (excluding rivers)

Figure 9: Land cover change in Winnipeg.

Figure 10a: Examples of change from grassland to impermeable land uses.

Figure 10b: Examples of tree cover loss due to development and Dutch elm disease.

Characteristics and benefits of Winnipeg's urban forest

In 2019, the City of Winnipeg partnered with the University of Winnipeg and Trees Winnipeg to collect data to measure the structure and benefits of **trees on public and private land** in developed areas (Figure 11). The data was entered into the USDA's i-Tree Eco program[2]. The results provide information about the characteristics and value of the estimated three million trees in the urban forest. Key findings from the 2019 i-Tree Eco analysis are included in Table 1 with a summary of monetary values in Table 2.

Table 1: Summary table of whole urban forest key findings from i-Tree Eco analysis.

3,075,000 trees estimated in the city, approximately 60 percent of which are young and only 15 percent are mature or old
The **five most common species** are trembling aspen (*Populus tremuloides - 21%*), green ash (*Fraxinus pennsylvanica - 14%*), bur oak (*Quercus macrocarpa - 11%*), American elm (*Ulmus americana - 10%*), and Manitoba maple (*Acer negundo - 6%*)
In terms of **total leaf area**, which drives many urban forest benefit calculations (e.g., pollution removal, rainwater interception, oxygen production, shading, etc.), American elms supply 31% of the leaf area, followed by green ash (17%). Winnipeg's built up area contains 375.5 square kilometers of leaf surface area.
Tree density is 85 trees per hectare, which is about half the density of trees in Toronto and about the same as Boston, MA.
Most **runoff** is intercepted by American elm, then green ash.
Most **carbon** is stored and sequestered by American elm, then bur oak, and green ash. **Carbon storage value** of $39.2 million ($77 per tonne of Carbon). Carbon storage value is expected to increase as the social cost of carbon receives wider recognition. Increases in Canada's federal carbon price schedule will bring this value to $93 million by 2022.
Trees **reduce energy-related costs** from residential buildings by an estimated $5,800,000 annually, primarily due to reduced heating costs, and avoid 7, 890 metric tons of carbon emissions from fossil-fuel based power plants.
Compensatory value (e.g., estimated cost of compensation to replace each tree with a similar tree) of $3.31 billion.

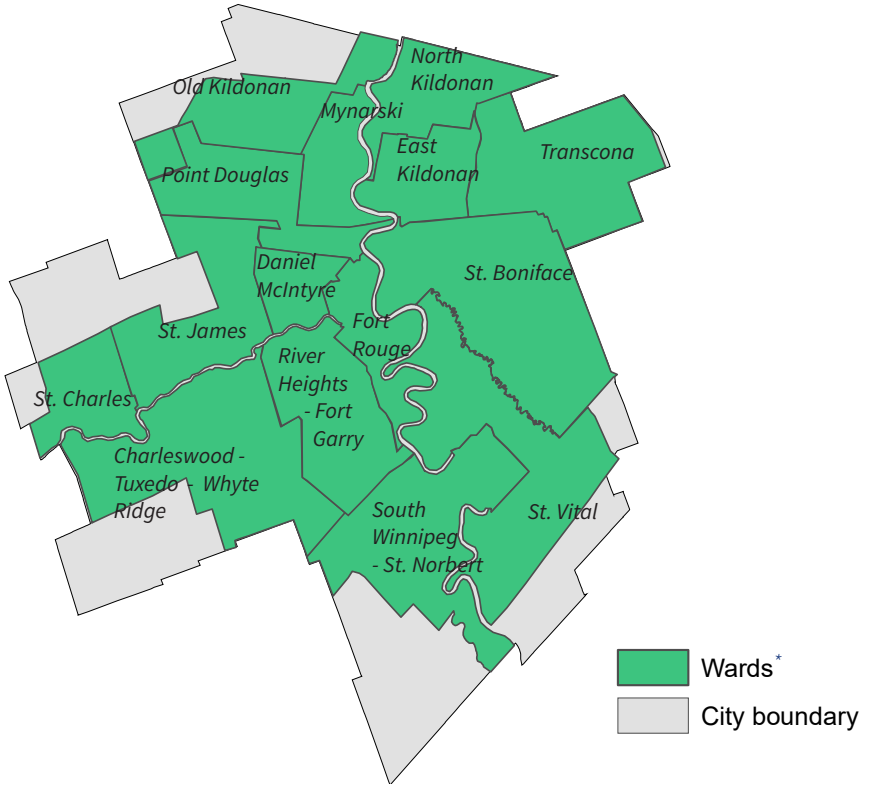


*Figure 11: Winnipeg 2014-2018 Wards. * the ward boundaries shown were adjusted to represent the developed areas of the city for the i-Tree Eco analysis. Note that ward boundaries are those prior to the revised 2018-2022 boundaries.*

Table 2: Summary table of whole urban forest i-Tree Eco monetary values.

Compensatory value	**CAD $ (billion)**
3,075,000 trees on public and private land	3.31
Functional value	**CAD $ (million)**
Carbon storage	39.2
Carbon sequestration (annual)	0.83
Avoided runoff (annual)	3.23
Pollution removal (annual)	4.01
Building energy savings (annual)	5.80
Avoided carbon emissions (annual)	0.61

2 https://www.itreetools.org/tools/i-tree-eco

The highest density of trees is found in the wards of St. Charles, Charleswood - Tuxedo, and South Winnipeg - St. Norbert

Ecosystem services metrics for the whole urban forest and public tree inventory

The City's 2020 inventory of almost 300,000 street and park trees was also run through i-Tree Eco[3] to obtain estimates for ecosystem services. The maps on the following pages show i-Tree Eco results for the whole urban forest and City-owned trees side by side. Figures 12-19 show tree density, compensatory value, structural runoff, and carbon values. Maps for the whole urban forest show values by the developed portion of each ward, while maps for inventoried public trees show values at the finer scale of a city block.

3 i-Tree Eco V6 https://www.itreetools.org/tools/i-tree-eco

Tree density

Tree density refers to the number of trees per hectare in a given area. In Figure 12, tree density is illustrated in the developed portion of each ward. St. Charles, Charleswood - Tuxedo, and South Winnipeg - St. Norbert had the highest density of trees. Transcona and Point Douglas had the lowest density of trees, in part due to greater industrial and commercial lands in these areas. Figure 13 shows the density of City-owned trees at the finer scale of the census dissemination block. At the block scale, City-owned trees were more commonly present in residential areas or parks, with most blocks having a tree density of less than 25 trees per hectare. City-owned tree density is highest in parks.

Tree density - whole urban forest

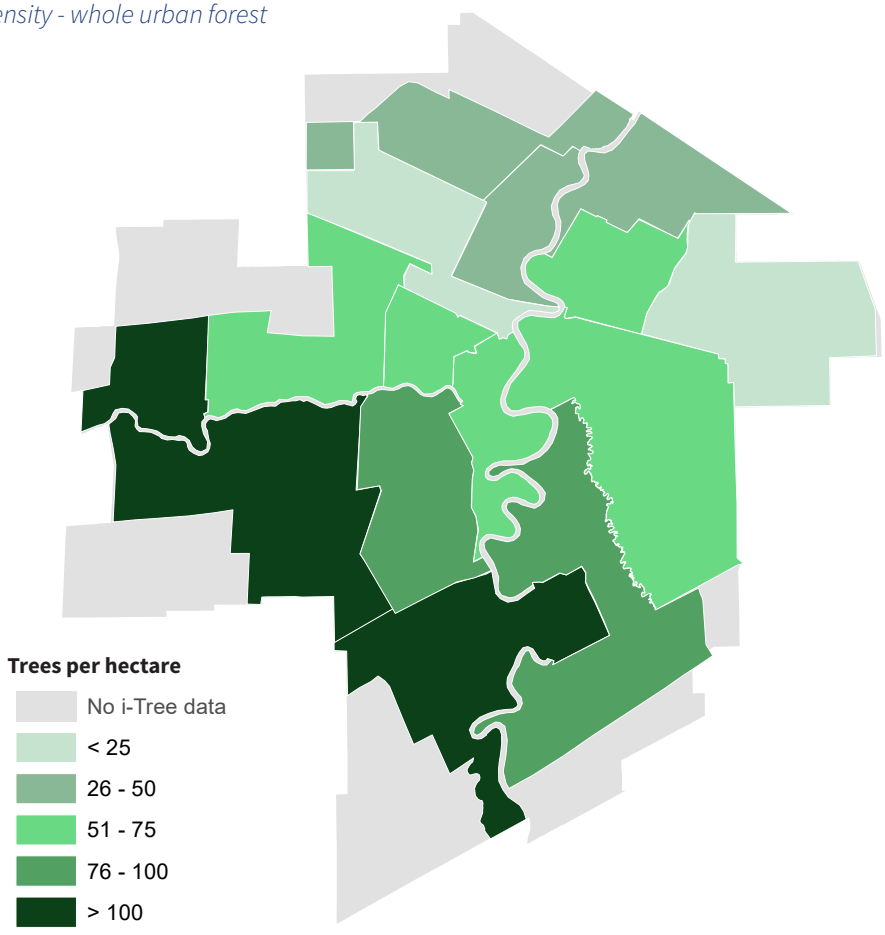


Figure 12: Tree density per hectare for the whole urban forest by ward.

Tree density - public tree inventory

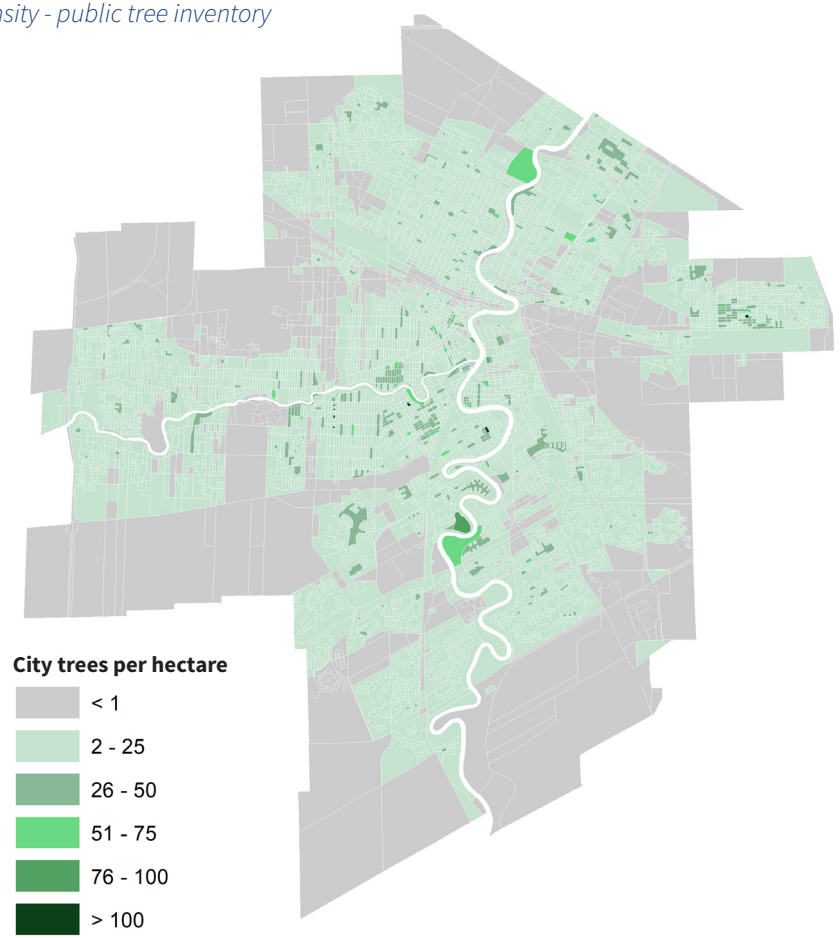


Figure 13: Inventoried public trees per hectare by dissemination block.

The compensatory value of Winnipeg's entire tree population is more than $3 billion

Compensatory value

The estimated compensatory value to replace Winnipeg's entire urban tree population was more than $3 billion dollars. Trees in the public tree inventory had an estimated compensatory value of $640 million. The compensatory value reported by i-Tree Eco was based on the Council of Tree and Landscape Appraisers valuation method using four tree/site characteristics: trunk area (cross-sectional area at diameter at standard height), species, condition, and location to estimate the cost of replacing tree assets. Figure 14 illustrates the compensatory value of the urban forest per hectare in each ward; the wards with the higher numbers of large trees tended to have the highest values. Figure 15 shows the compensatory value of the public tree inventory per hectare by city block; blocks with the highest values tended to be parks or blocks in older neighbourhoods containing higher numbers of mature trees.

Compensatory value- whole urban forest

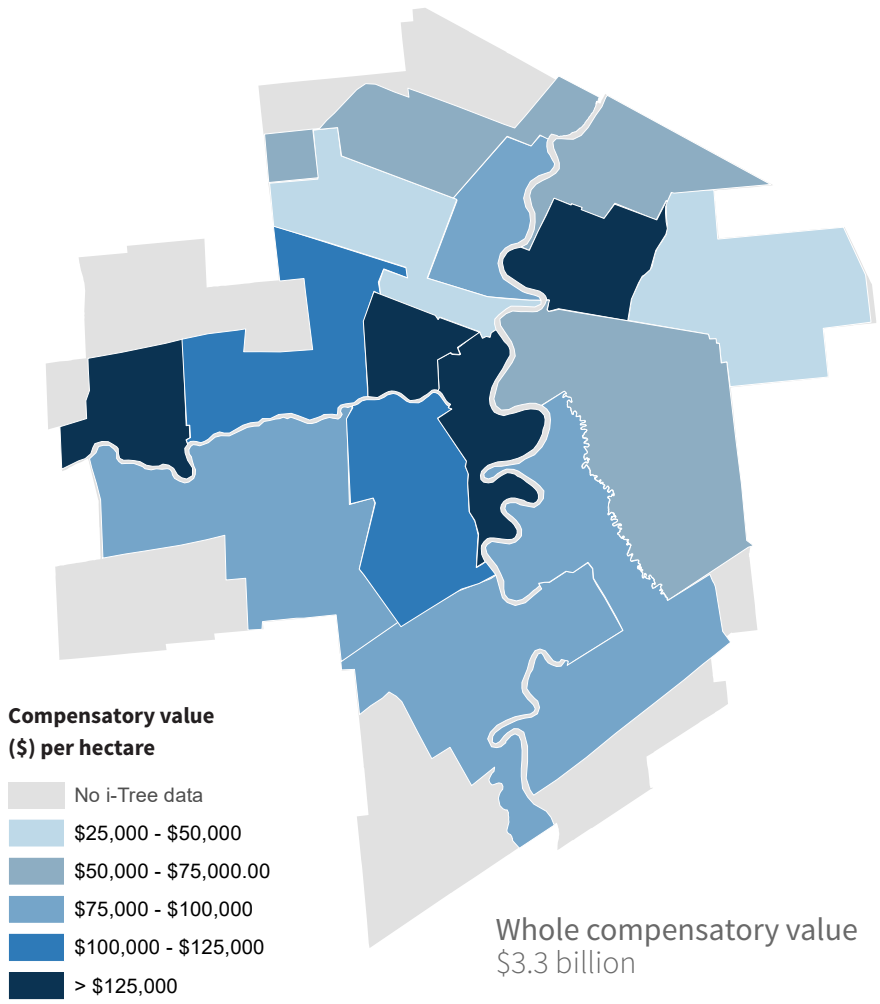


Figure 14: Compensatory value estimated for the whole urban forest of Winnipeg by ward.

Compensatory value - public tree inventory

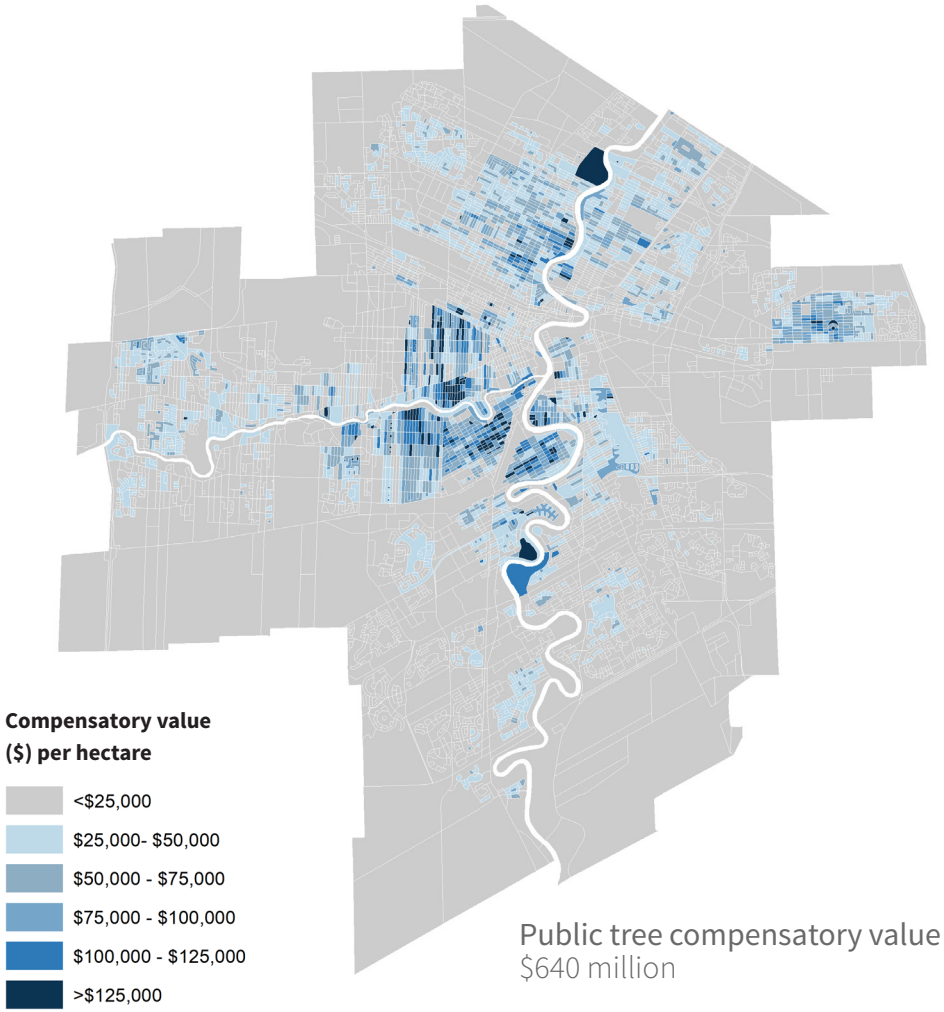


Figure 15: Compensatory value estimated for the public tree inventory by dissemination block.

Trees in Winnipeg prevent $1 million cubic metres of stormwater, or 488 Olympic sized swimming pools of water, from entering the storm system each year

Avoided runoff

Avoided runoff is the total amount of water intercepted by trees that does not become surface runoff and flow into the storm system. The avoided runoff each year was estimated at over one million cubic metres for the entire tree population, the equivalent of 488 Olympic swimming pools. The public tree inventory was estimated to avoid 160 thousand cubic metres of runoff into the storm system. Figure 16 illustrates the annual avoided runoff from the urban forest per hectare in each ward. Figure 17 shows the annual avoided runoff from the public tree inventory per hectare in each city block.

Avoided runoff each year- whole urban forest

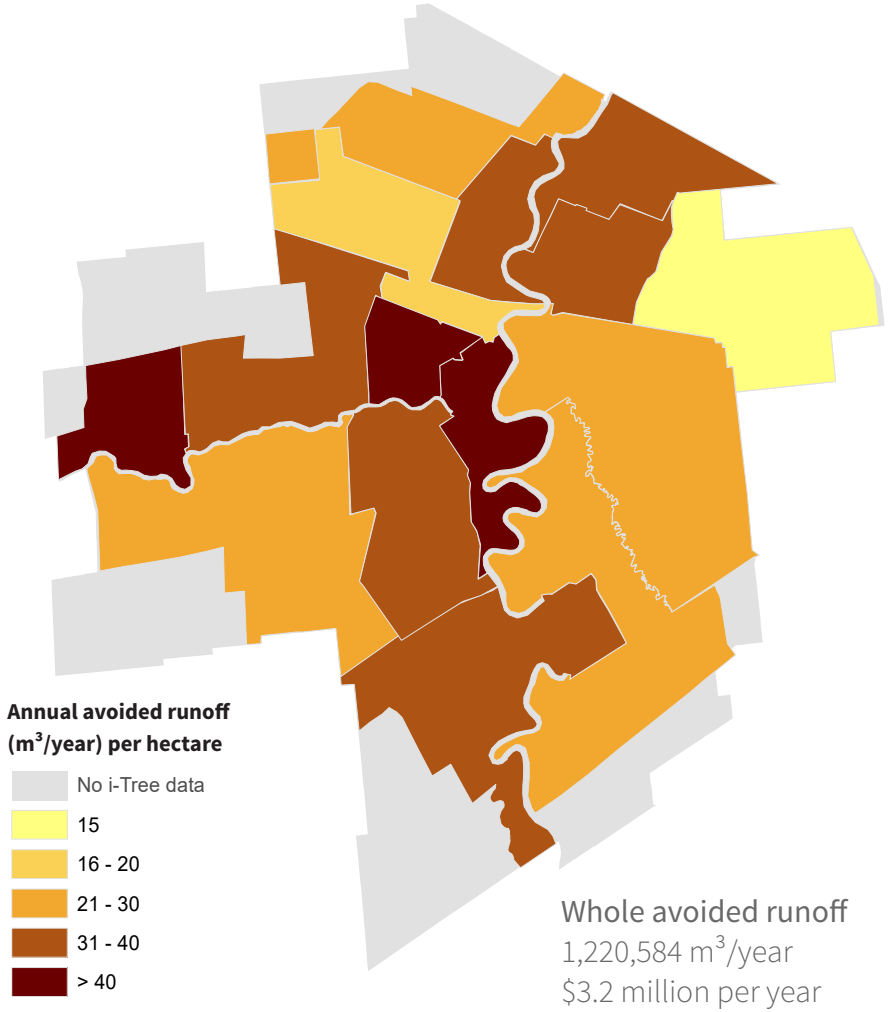


Figure 16: Annual avoided runoff for the whole urban forest of Winnipeg.

Avoided runoff each year- public tree inventory

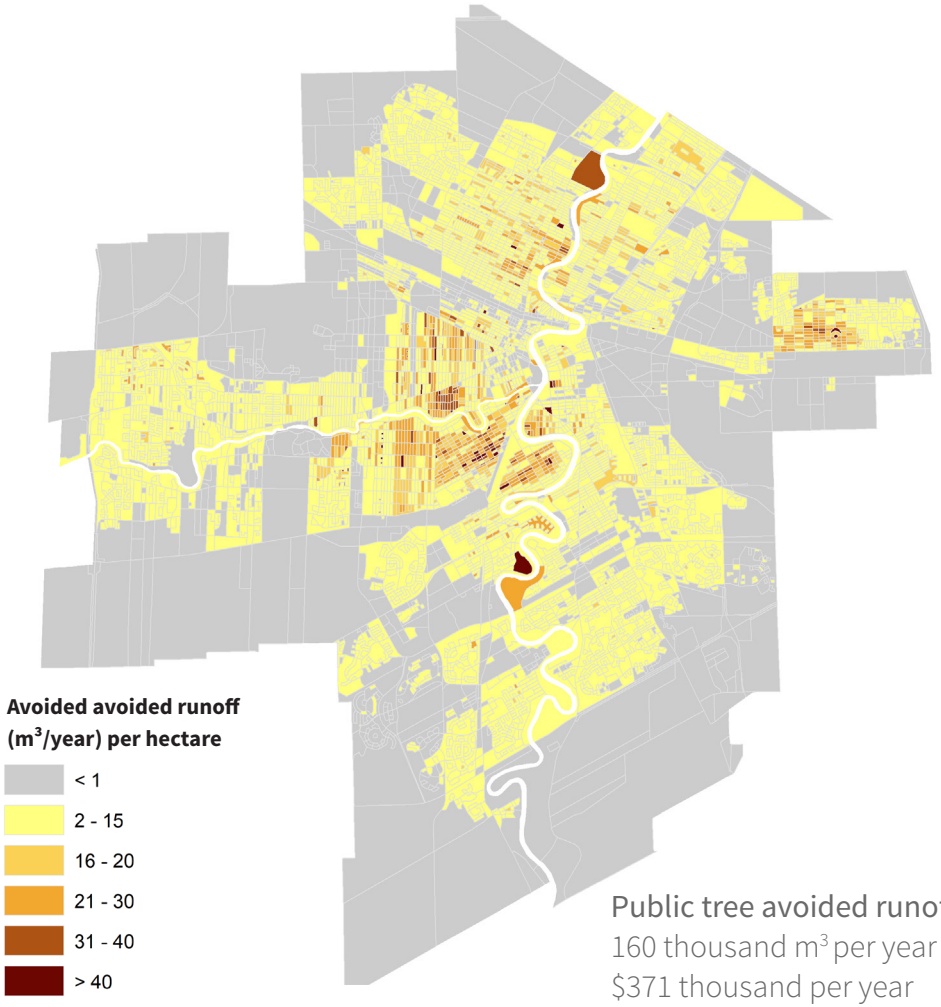


Figure 17: Annual avoided runoff for the public tree inventory.

Winnipeg's whole urban forest stores more than 500 thousand tonnes of carbon valued at almost $40 million

Carbon storage

The estimated carbon stored in the whole urban forest is over 509 thousand tonnes and valued at more than $39 million. Figure 18 shows the carbon storage per hectare in each ward. Carbon storage in the public tree inventory is valued at approximately $7.6 million. Figure 19 illustrates the carbon stored by trees in the public tree inventory per hectare in each city block.

Carbon storage - whole urban forest

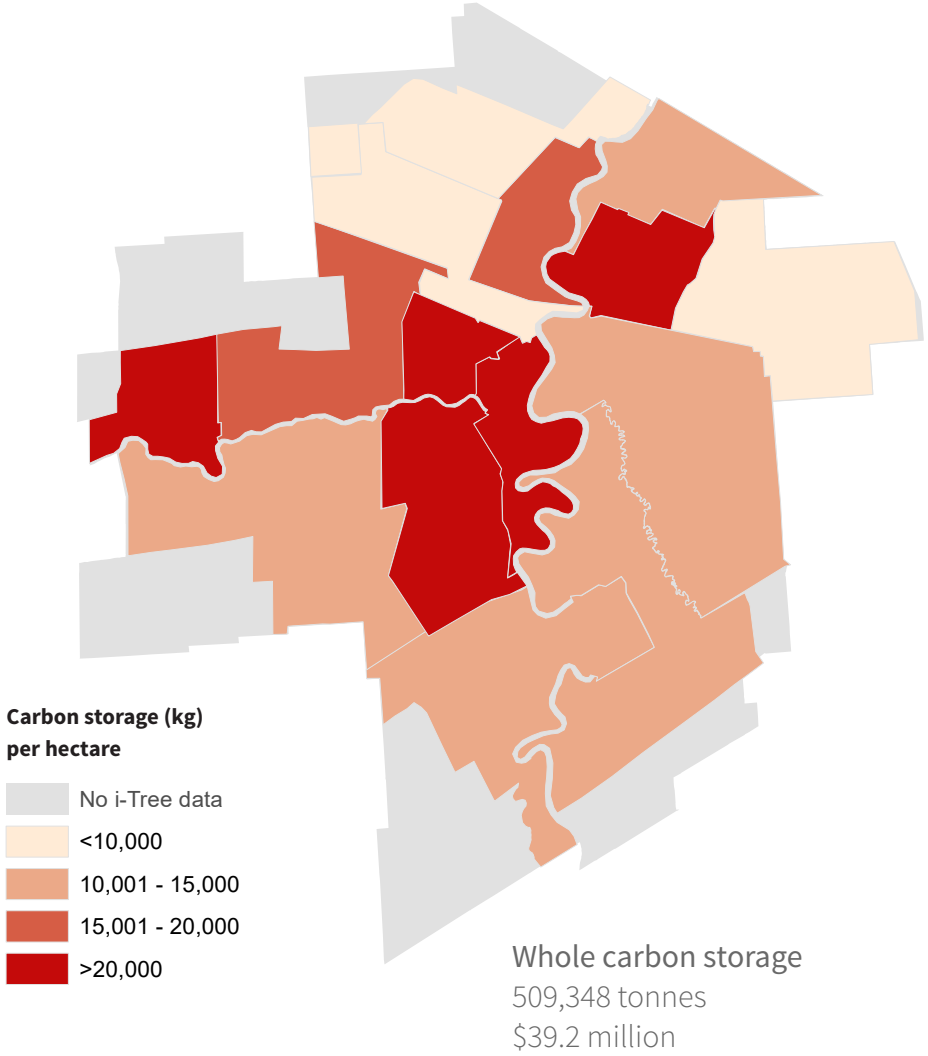


Figure 18: Carbon stored per hectare in the whole urban forest by ward.

Carbon storage -public tree inventory

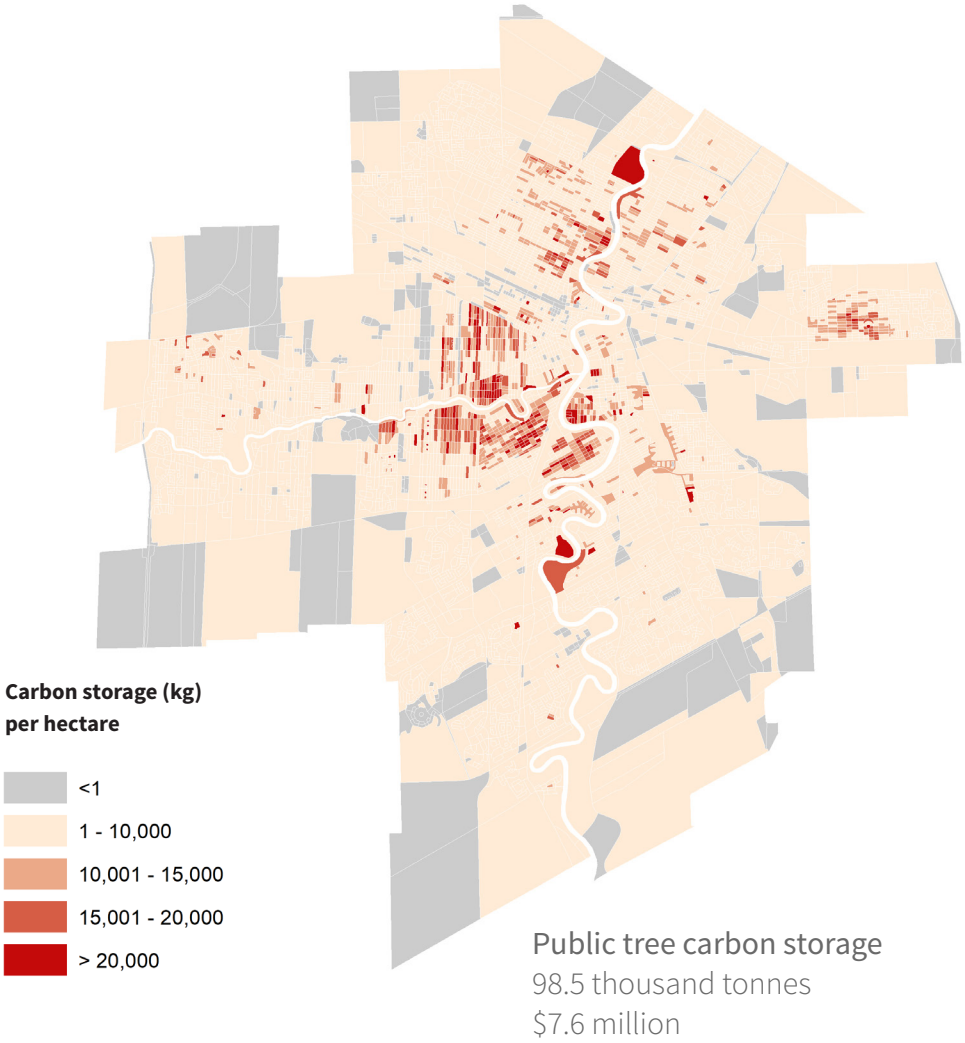


Figure 19: Carbon stored in the public tree inventory by dissemination block.

Winnipeg's whole urban forest removes more than 270 tonnes of pollutants each year, a service valued at an estimated $4 million

Pollution removal and oxygen production

Pollution removal and oxygen production is also estimated by i-Tree Eco. Pollutant removal by trees was estimated for carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone and PM2.5 particulate matter. For trees in Winnipeg, pollution removal is greatest for ozone and PM2.5.

Trees in the whole city are estimated to remove 274.2 tonnes of pollutants per year from the air, a service valued at approximately $4 million per year. Winnipeg trees produce an estimated 14.98 thousand tonnes of oxygen annually.

Trees in the public tree inventory are estimated to remove approximately 31 tonnes of pollutants per year at a value of $446 thousand. Public inventoried trees produce an estimated 3.5 thousand tonnes of oxygen annually.

Trees in Winnipeg improve air quality by removing pollutants and producing oxygen.

Population metrics for trees on public land

On public land, trees can be assigned one of two broad categories: street and park trees or native and naturalized forest. Street and park trees are typically intensively managed by the City, and receive individual attention throughout their life-cycle from planting, through maintenance, and eventually removal. The Urban Forestry Branch is responsible for managing the street and park tree population. By contrast, trees in native and naturalized forest are managed as an ecosystem where natural processes of regeneration and mortality are left to occur with limited management intervention. The Naturalist Services Branch oversees the native and naturalized forest areas. Street and park trees and native forest are both important parts of Winnipeg's whole urban forest and provide different types of services.

Street and park trees

Winnipeg's public tree inventory is almost 300,000 strong, the makeup of which is approximately 69 percent street trees and 21 percent planted park trees. The following sections report some key metrics for Winnipeg's street and park trees based on 2020 inventory data. When best management practices (BMP) guidance has been established for a specific metric, Winnipeg's tree inventory is compared to that metric and highlighted in a blue text box at the top right of the page.

Tree population and distribution

Looking back to 2013, Winnipeg's tree population has remained relatively stable, decreasing by just under 1,000 trees based on the City's 2020 inventory data. Street and park trees are not distributed evenly across the city. The density of City-owned trees is highest in the wards of Mynarski, Fort Rouge - East Fort Garry, River Heights - Fort Garry. Density is lowest in St. James, Old Kildonan, Charleswood - Tuxedo - Westwood, St. Norbert - Seine River, and Daniel McIntyre.

2020 species diversity: green ash species 28 percent, ash genus 33 percent

Species diversity

The public tree inventory population is dominated by elm and ash trees. American elm trees were a long-standing tree of choice because they were native, reliable as a street tree, and also created beautiful arching canopies. The fact that Winnipeg has the largest urban population of American elms in North America is testimony to how successful they have been as an urban tree. With the arrival of Dutch elm disease (DED) in the 1970s, the City began planting more ash trees and initiated its DED management program. At the time, there was very little diversity in shade trees available for planting on streets. The City has recently stopped planting ash due to the arrival of emerald ash borer. With the two most abundant species of urban trees now under threat, the City is seeking reliable alternatives to both elm and ash.

Diversity in species, genus and family is one of the measures commonly applied to the urban forest. At the species level, green ash (28 percent) and American elm (18 percent) greatly exceed the recommended five percent threshold. At the genus level, elm and ash make up 58 percent of the urban canopy as shown in Figure 20, which graphs the dominant genera in Winnipeg's public tree inventory. The remaining 42 percent are primarily composed of linden, maple, spruce, oak, and poplar.

Managing diversity at the neighbourhood or ward scale is also important. All wards of the city favour either elm or ash with some wards such as St. Norbert - Seine River favouring ash over elm by 74 percent (Figure 21). Diversity at the genus level, when measured using the Shannon-Weiner Diversity Index, is highest in St. Vital and lowest in Daniel McIntyre.

Seven genera make up 91 percent of Winnipeg's public tree inventory

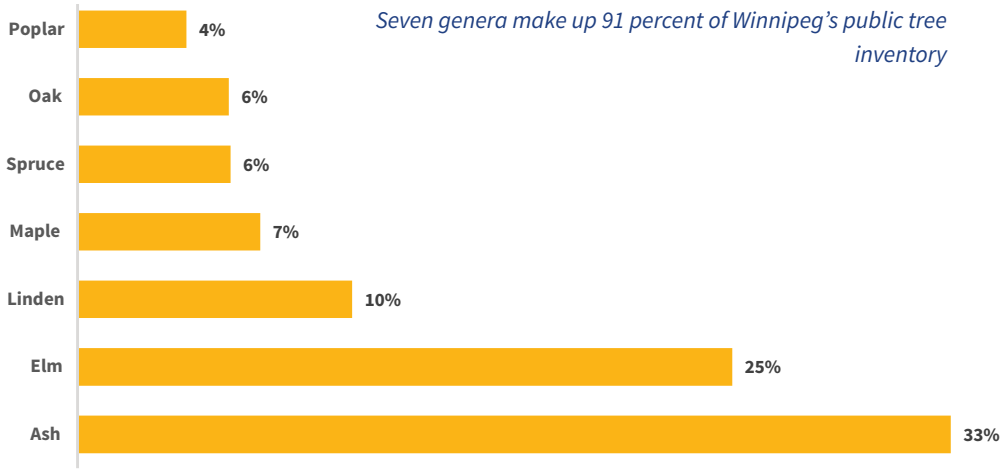


Figure 20: The dominant genera in Winnipeg's public tree inventory (2020).

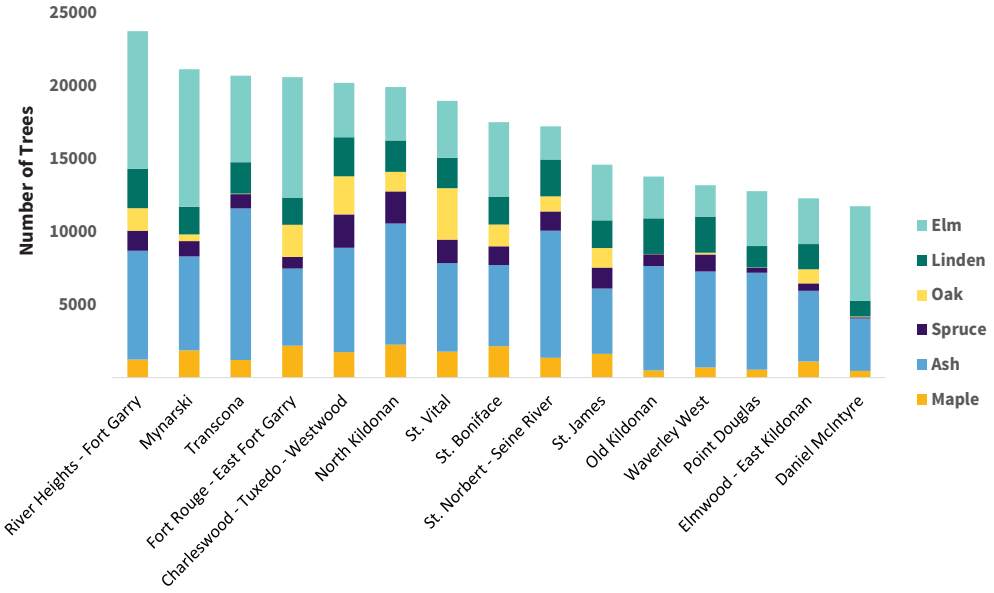


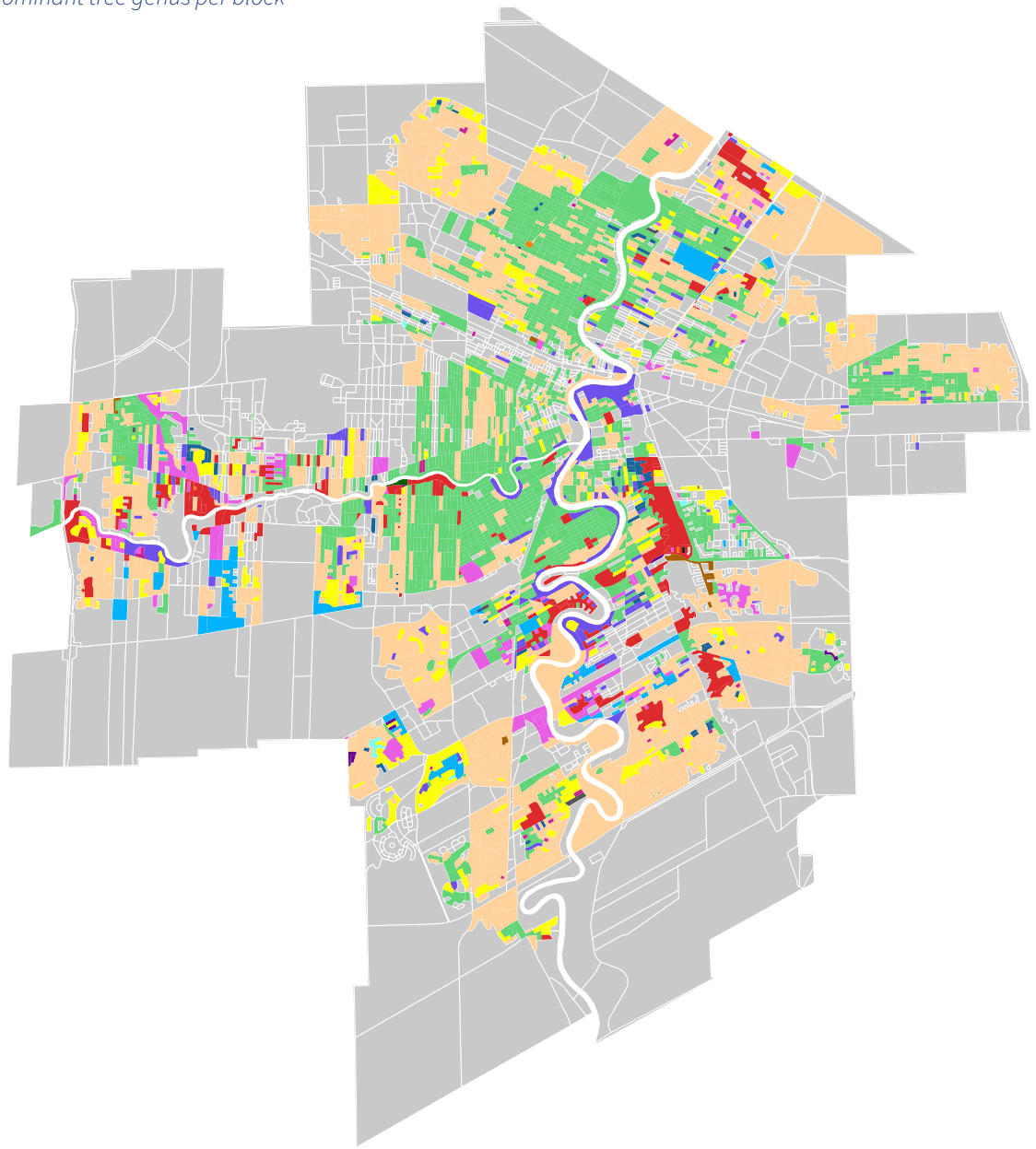
Figure 21: Distribution of dominant genera by ward.

Elm and ash dominate the City's tree population

The map in Figure 22 shows which type of tree, by genus, is most abundant in each city block. Only blocks with more than five City-owned trees per hectare are shown. Discernible patterns are visible and are likely related to the time period of the tree planting.

Blocks with older plantings tend to be dominated by elm, with ash becoming more dominant in plantings from the 1970s onwards. Today, ash is no longer planted by the City and linden, maple, oak, hackberry, poplar, crabapple, tree lilac, and buckeye are planted in higher proportions. Elm is also planted with an effort to plant DED-tolerant varieties in neighbourhoods not dominated by elm.

Dominant tree genus per block



Note: Data mapped for blocks with more than 5 trees per hectare only

Figure 22: Dominant tree genus per city block in Winnipeg.

Size and age diversity

Maintaining a diversity of ages in the urban forest is important for ensuring there is a continuous supply of trees maturing to replace older trees that die or are removed. Tree size is often used as a proxy for age because we rarely know the age of older trees. Figure 23 shows tree size classes, measured by diameter at breast height (DBH), and the percentage of trees in each class in Winnipeg's public tree inventory.

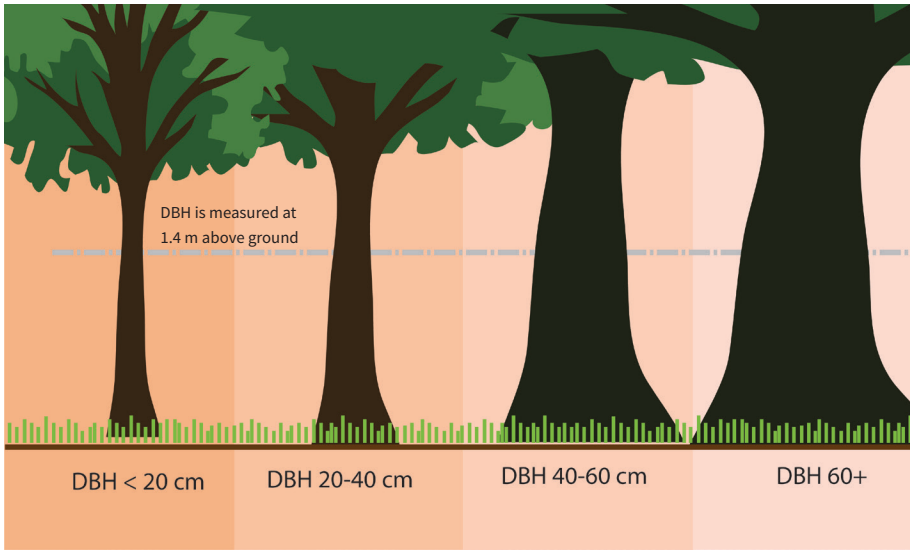


Figure 23: Percentage of trees in each size class in the public tree inventory.

Large, old trees are not distributed evenly across the city (Figure 24). Fifty percent of Winnipeg's largest trees are found in five wards: Fort Rouge - East Fort Garry, St. Boniface, Mynarski, Daniel McIntyre, and River Heights - Fort Garry. The other 10 wards contain the remaining 50 percent.

Small, young trees follow a similar pattern, with 55 percent of young trees found in five wards: Waverley West, North Kildonan, Transcona, St. Norbert - Seine River, and St. Vital.

Average tree size class by block based on DBH (trunk diameter measured at 1.4 metres above the ground)

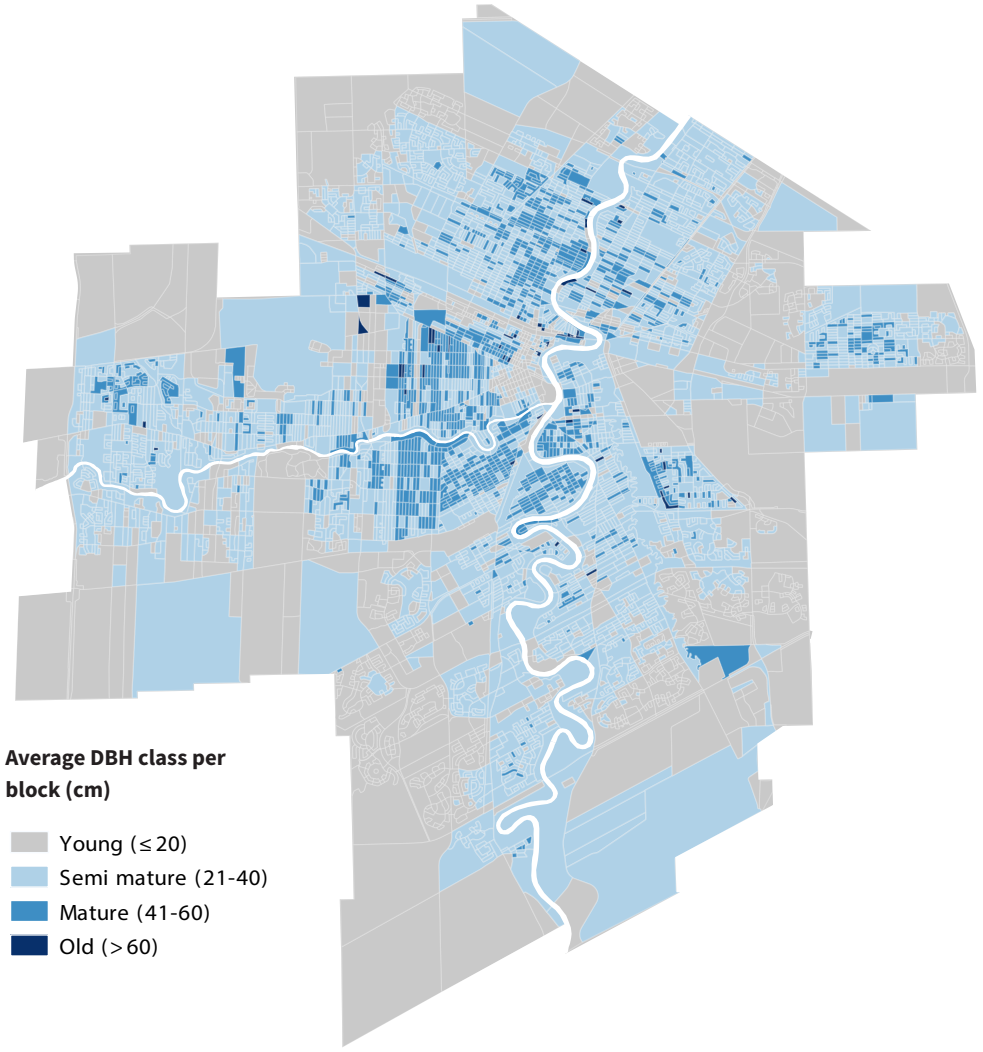


Figure 24: Average size of public inventory trees by city block in Winnipeg.

Tree condition

Condition ratings are used to report on the health and structure of urban trees. Health is typically determined by the appearance of foliage, new growth, and anticipated life expectancy. Structure is determined by the condition of the roots, trunk, and crown in terms of decay, damage, or defects that might impact the trees service life. Trees in excellent and good condition have no or only minor health and structural issues, and can be expected to remain in the landscape for a long time. Trees in fair or poor condition will have signs of dieback in the crown, visible decay, obvious pest problems, or may have structural defects that are likely to lead to tree or branch failure in the future unless corrective action is taken. Corrective actions commonly involve watering, pruning, or removal. Trees that are in fair or poor condition, or that are dead, require more management intervention than trees in good or excellent condition.

The City's current tree inventory indicates that approximately 94 percent of street and park trees are in fair, good, or excellent condition and six percent are in poor or dead condition (Figure 25). Figure 26 shows where the trees that are dead, poor, or fair condition are distributed across the city. Several factors are impacting tree condition in Winnipeg at the moment. DED and cottony ash psyllid are impacting elm and ash, respectively. Warm, dry summers in 2018 and 2019 likely exacerbated these health issues by increasing tree drought stress. The 2019 October snow-storm damaged 10 percent (30,000) of the City's public trees and many of those left in the landscape potentially have structural defects requiring assessment and action.

In terms of dead trees, most are ash (23 percent) followed by poplar (15 percent), elm (13 percent), and oak (11 percent). For the dominant genera, the proportion of trees in fair, good, and excellent condition is relatively consistent with the pattern shown in Figure 25. However, lindens stand out as having a higher proportion of their population in good and excellent condition.

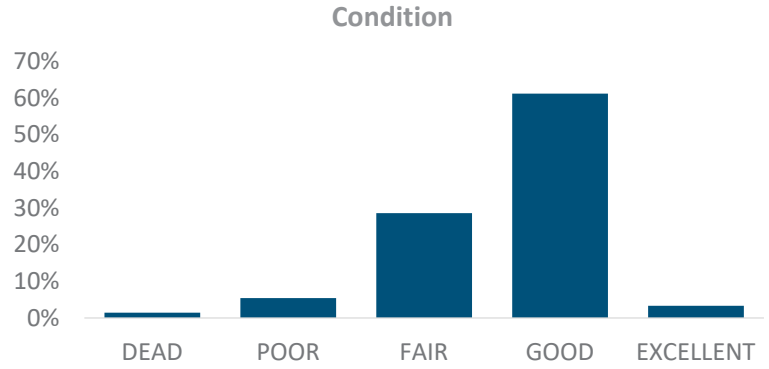


Figure 25: The overall distribution of tree condition for the public tree inventory.

Trees in dead, poor, and fair condition per hectare by block

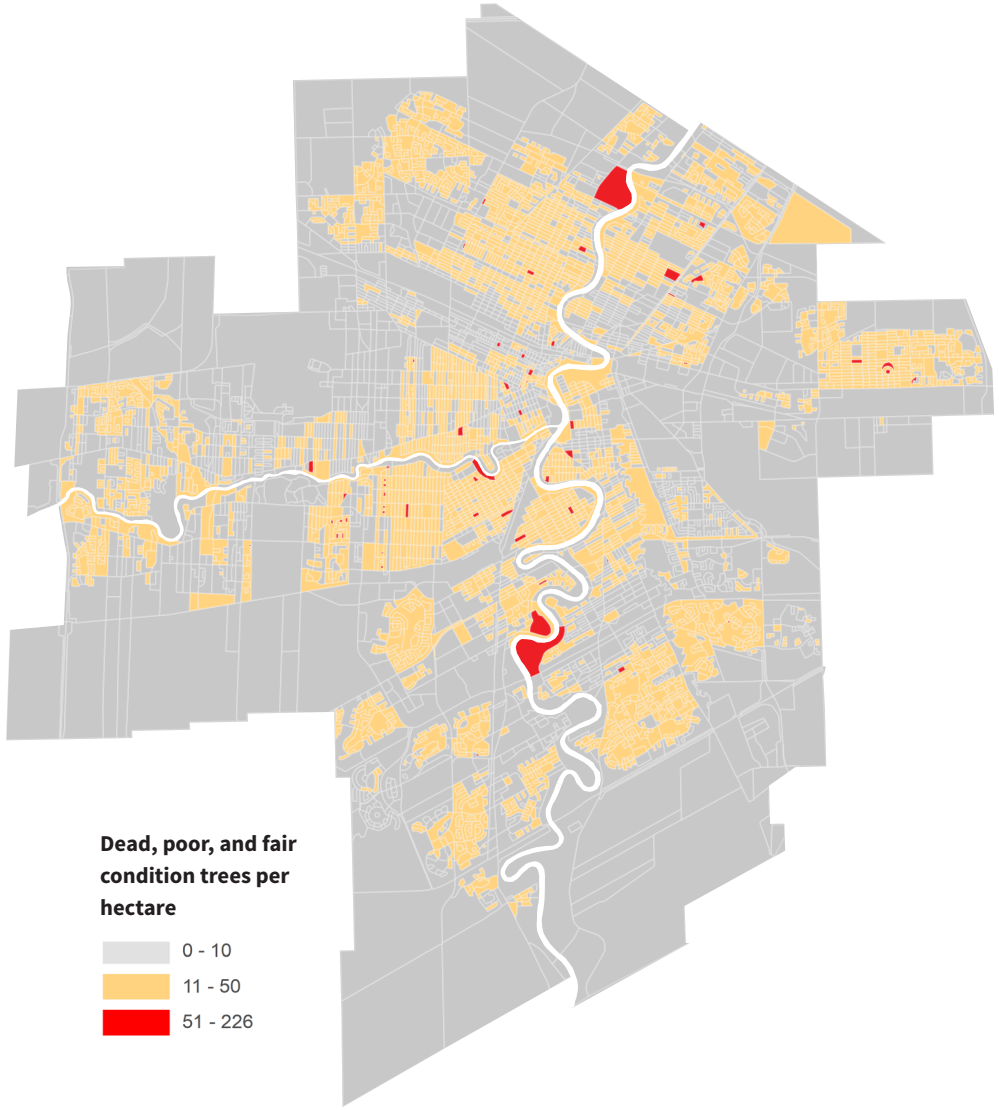


Figure 26: Distribution of trees in dead, poor, and fair condition by dissemination block in Winnipeg.

City property is estimated to have approximately 26,000 vacant sites to plant new trees, and up to 14,500 sites to plant replacement trees

Distribution of vacant potential tree planting sites

Figure 28 illustrates the number of vacant potential planting sites per block for new trees (not replacement trees). Historically, only 60 percent of vacant sites have been assessed as suitable for tree replacement. Considering this result, a high level estimate of 26,000 planting sites may be suitable for new tree plantings. Replacement tree planting opportunities have not been mapped as these sites change annually as trees are removed and replacement trees are planted. From 2013 to 2019, approximately 30,000 street and park trees were removed, and only 15,500 were replaced; up to 14,500 potential replacement tree planting sites may exist across the city. These estimates are tempered by factors such as conflicts with services, inadequate soil volume to support healthy trees, or repeated mortality due to road salt or poor soil conditions (Figure 27) that reduce the suitability of vacant or replacement tree sites for tree planting.

Figure 27: An example of a vacant planting sites in Winnipeg.

Vacant planting sites per block

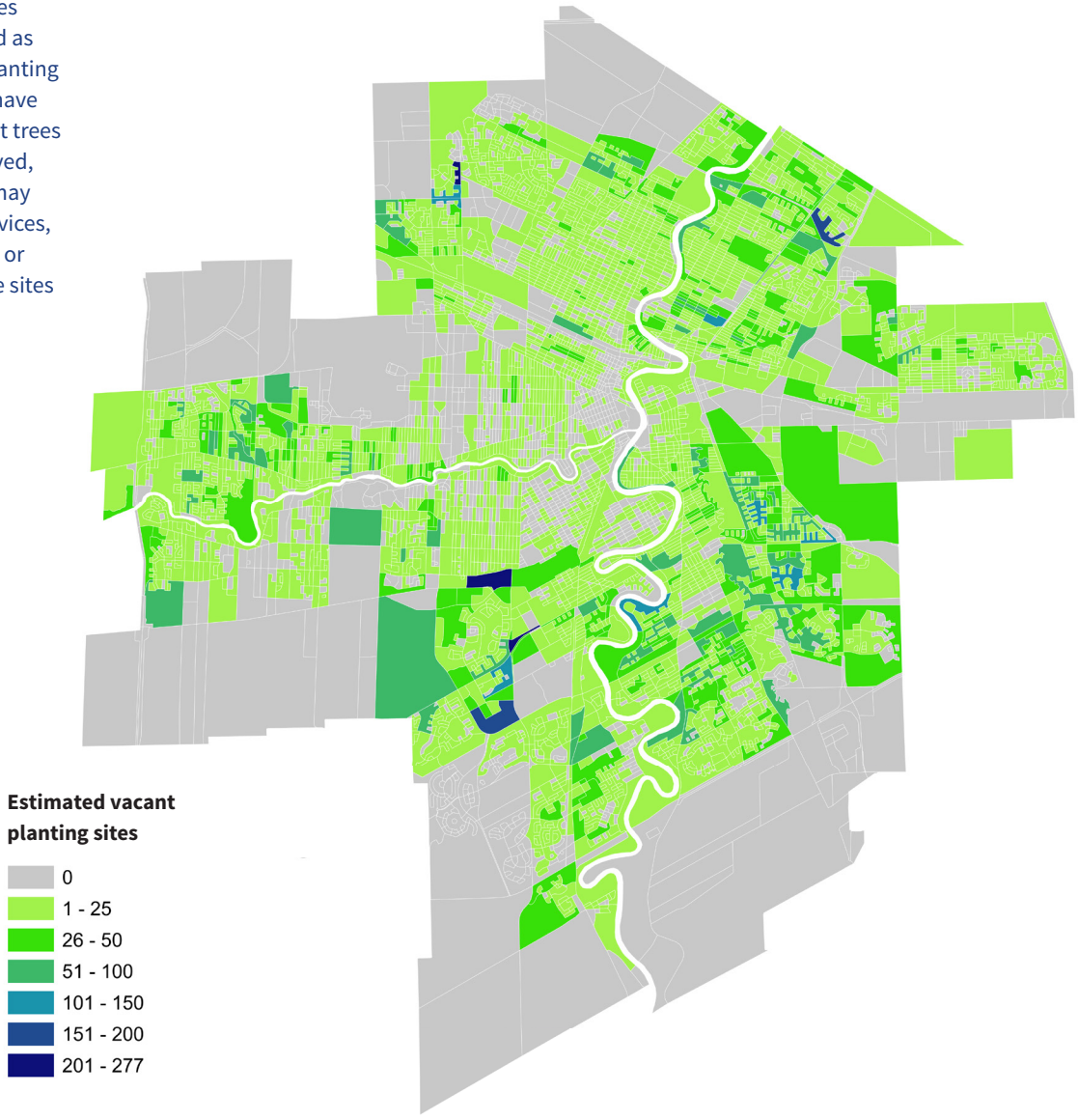


Figure 28: Approximate vacant planting sites by dissemination block in Winnipeg.

City natural areas

Hundreds of thousands of uninventoried native and naturalized forest trees grow in Winnipeg's natural areas. While Winnipeg is located in the Tall Grass Prairie portion of the Prairies Ecozone dominated by grasses and herbaceous plants, several forest types are also common in the city. Winnipeg has three main native forest types; riverbottom forest, aspen forest, and oak forest. The following descriptions come from Winnipeg's Ecologically Significant Natural Lands Strategy[4].

Riverbottom forests

Winnipeg is located in the Red River Valley at the point where the Assiniboine and Red Rivers meet. Riverbottom forests are riparian habitats and can generally be divided into riverbank, floodplain, and terrace sections. The riverbank is the edge of a waterway, and is dominated by willow and cottonwood trees. The floodplain is dominated by green ash (*Fraxinus pennsylvanica*), basswood (*Tilia americana*), American elm (*Ulmus americana*), and Manitoba maple (*Acer negundo*), while the terrace is dominated by bur oaks (*Quercus macrocarpa*), which prefer drier sites. These forests depend on the Red River to deposit silt and replenish soil with nutrients, and in return they stabilize streams and riverbanks against erosion and filter urban stormwater runoff before it enters the river.

Aspen forests

Aspen forests are the most common forest type throughout Winnipeg and its surrounding region. Dominated by trembling aspen trees, these forests also contain bur oak trees in dry areas and balsam poplar in low lying wet areas. Manitoba maple and green ash trees also make occasional appearances in these forests. Aspen forests are typically mixed with openings of native prairie sometimes referred to as 'aspen parkland'. Grassland openings that are undisturbed still contain relatively intact native tall-grass or mixed-grass prairie vegetation.

Oak forests

Bur oak forests occur on very dry sites where flooding rarely occurs. Historically, their formation and maintenance was often dependent on wildfire. Thick stands of pure oak are not common in Winnipeg; oaks are more often mixed in with aspen forests.

A stand of trembling aspen in Bois-Des-Esprits.

A stand of bur oak in Bois-Des-Esprits.

4 City of Winnipeg. 2007. Ecologically Significant Natural Lands (ESNL) Strategy & Policy. City of Winnipeg.

The Urban Forestry Budget is projected to grow to 12.5 million by 2023

3. Winnipeg's urban forestry program

The previous section presented the diverse characteristics and benefits of Winnipeg's urban forest resource on both private and public land. This section describes the City's urban forestry program to manage street and park trees on public land. The City's Urban Forestry Branch delivers services and programming within approved operating budgets and capital funding.

Urban forestry budget

Figure 29 shows the urban forestry approved service-based budgets from 2016 to 2021. The annual urban forestry budget has increased by seven percent in the last five years primarily due to capital budget increases allocated to Dutch elm disease management and tree planting, and partly to emerald ash borer and cottony ash psyllid response. The overall budget is projected to grow by another two percent, to 12.5 million, by 2023. Dutch elm disease control and tree pruning and removal account for more than 80 percent of the budget, with tree planting accounting for about 20 percent.

As noted above, in addition to the annual operating budget, urban forestry receives capital funding for specific projects and to augment regular services. That funding varies from year to year and supports projects such as reforestation improvement, or reducing the backlog of Dutch elm disease removals. From 2020 to 2024, the City has committed $25 million in capital funding to urban forest enhancement and reforestation.

Despite Winnipeg's increased capital funding levels, maintenance, removal and planting rates are falling behind planned targets due to factors not yet accounted for in budgets, such as:

- Comprehensive emerald ash borer management planning
- Increasing tree removal rates
- Growing tree replacement deficit
- Delayed pruning cycle
- Added inventory of young trees inherited from new developments (higher maintenance costs are associated with young trees due to watering and pruning requirements)
- High numbers of services calls for demand pruning and storm response

Customer service calls

The City of Winnipeg tracks customer service levels related to the services delivered by the Urban Forestry Branch. Data on customer service 311 calls in 2020 (Figure 30) shows that more than 10,000 calls were received that year. More than 50 percent of calls relate to pruning, hazard tree or sick/dead tree service requests.

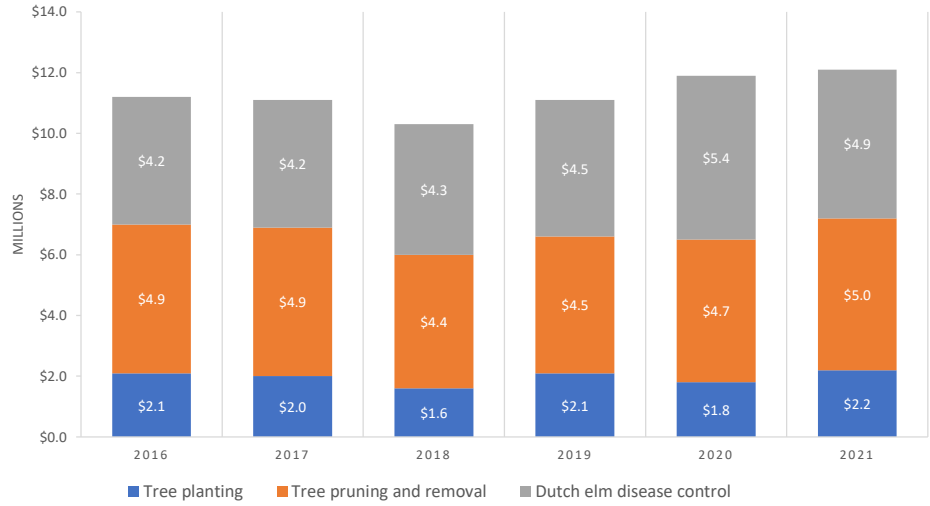


Figure 29: Urban forestry approved service-based budgets from 2016 to 2021.

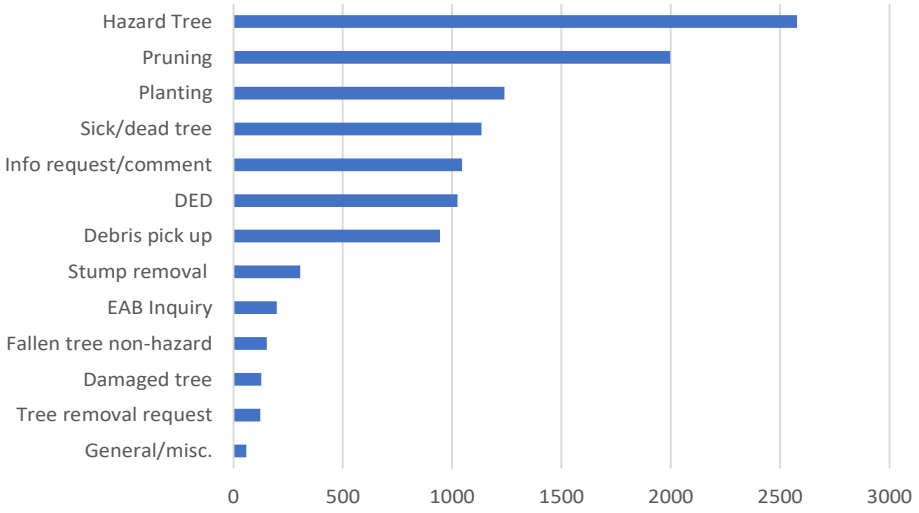


Figure 30: The number of urban forest related 311 service calls in 2020 by broad category of service request.

Urban forestry services

Winnipeg's Urban Forestry Branch is responsible for managing all aspects of inventoried trees along streets and in parks. The Branch also manages Dutch elm disease surveillance and subsequent removals on public and private properties including natural areas, and partners with the City's Naturalist Services Branch on tree risk assessment and removals of natural forest trees as necessary. As shown in Table 3, the state of Winnipeg's urban forestry programs and services has been reviewed under five themes of urban forest management, along with their associated services. The following sections outline key service indicators provided as part of Winnipeg's urban forestry services.

Table 3: Table of urban forestry programs and services reviewed and associated services.

Urban Forestry Branch Core Services				
Planning	Planting	Management	Protection	Engagement
• Budgeting and service delivery • Developing an annual work plan • Reporting to Council • Procuring bids and equipment • Developing long-term strategic plans	• Planting trees • Assessing planting sites • Administering planting contracts • Procuring nursery stock • Maintaining the civic nursery as a holding area for delivered stock • Contributing to review and approval of Downtown enhancement planting sites • Contributing to review and approval of developer tree planting on public land • Assuming responsibility for developer-planted trees two years post-planting	• Maintaining the tree inventory • Conducting risk inspection • Coordinating and conducting removal and pruning (including administering contracts for supplementary services) • Responding to resident service requests • Managing emergency/storm response	• Advising on protection of public trees • Developing and maintaining tree protection standards • Appraising City trees • Administering tree removal guidelines	• Participating in media interviews and outreach • Sitting on external committees • Providing technical input to project-specific public engagement programs (such as community tree planting) • Partnering with other agencies on education, community tree planting, and outreach

Pruning cycle

The City tracks the percentage of City trees pruned annually and the pruning cycle (how frequently every tree on an average is inspected and pruned if needed). Table 4 shows those figures for 2013 to 2019. The percentage of trees pruned per year has been declining and the pruning cycle has lengthened as more resources have been allocated to increases in DED, priority tree removals, and emergency response. Pruning cycle is a standard used as a performance indicator in the industry.

Tree condition and survival rates

Tree condition is an indicator of the health and structure of a tree. A tree in poor condition is generally expected to have a shorter life expectancy than a tree in good condition. The condition rating can provide a broad indicator for trees that are likely to require replacement in the near term. Currently, one percent of the public tree population is dead, while five percent is in poor condition. There is particular concern over newly planted tree survival rates in the downtown and in new developments where poor planting technique and soil conditions can ultimately lead to early tree death. Winnipeg's removal rate has been between one and two percent of the public tree population per year since 2013. However, the condition profile and removal rate could worsen dramatically if EAB becomes more active in the region.

Preventative maintenance such as rapid removal of DED infested trees, young tree watering, and a best practices pruning cycle are proactive ways to maintain a tree population in good condition, and could reduce the annual removal rate.

Table 4: The percentage of trees pruned in each year and the resulting pruning cycle for the years 2013 to 2017.

Year	Percentage of Trees Pruned Annually Meeting Best Practice **Target: 14%**	Tree Pruning Cycle (cycle on which each tree is pruned on average) **Target: 5 - 7 years**
2013	8	13
2014	8	12
2015	6	17
2016	5	22
2017	4	27
2018	4	27
2019	3	31

In 2020, 19 percent of boulevard and park trees removed were replanted

Removal and replacement levels

On average, City crews remove 9,000 trees per year - half of which are due to DED removals on private property (Figure 31). The average annual public tree removal rate has increased over the last two years from 4,300 trees per year to more than 5,500. Roughly 40 percent of removals on public land are due to DED, with the remainder due to risk, other tree health issues, or conflict with infrastructure. The recent increase in removal rates is primarily due to the combined effect of drought, cottony ash psyllid infestations, and an increase in declining trees caused by the backlog of DED-infested trees in the landscape.

Planting on streets and in parks has remained steady with a five-year average of 2,000 trees planted per year (just 52 percent of the tree removal rate). It is estimated that, since 2013, more than 14,500 trees remain un-replaced - a deficit that is growing by an average of 2,000 trees per year. In 2020, the ratio of boulevard and park trees planted for those removed was at 19 percent. Up to 40,600 planting sites are estimated to exist on boulevards and in parks when the estimated number of vacant planting sites (Figure 28) and outstanding replacement trees are combined.

Despite the replacement deficit, the total tree population has been fairly stable since 2013 (fluctuations of one to two percent) because many new trees have been added with development. This stability suggests that trees and canopy are being lost in older parts of the city, and gained in more recently developed areas.

Equity considerations

Areas of higher needs were identified in the 2020 Defining Higher Needs Neighbourhoods report to the Standing Policy Committee on Protection, Community Services and Parks. Higher needs neighbourhoods were identified using 2016 Census data using a Market Basket Measure of low income. The City's public tree inventory was compared with this higher needs 2016 census data by ward. Several correlations were found between the two datasets:

- The number of large trees (60 cm or greater) increases in wards with increasing population density
- Diversity in the genus of trees decreases with increasing population density and population of visible minorities
- The total number of trees, trees per person and diversity of trees increases with increasing median income, and decreases with population of visible minorities
- Prevalence of large trees and lower diversity of tree species in areas with high population density tends to reflect the dominance of mature elm canopies in inner city neighbourhoods

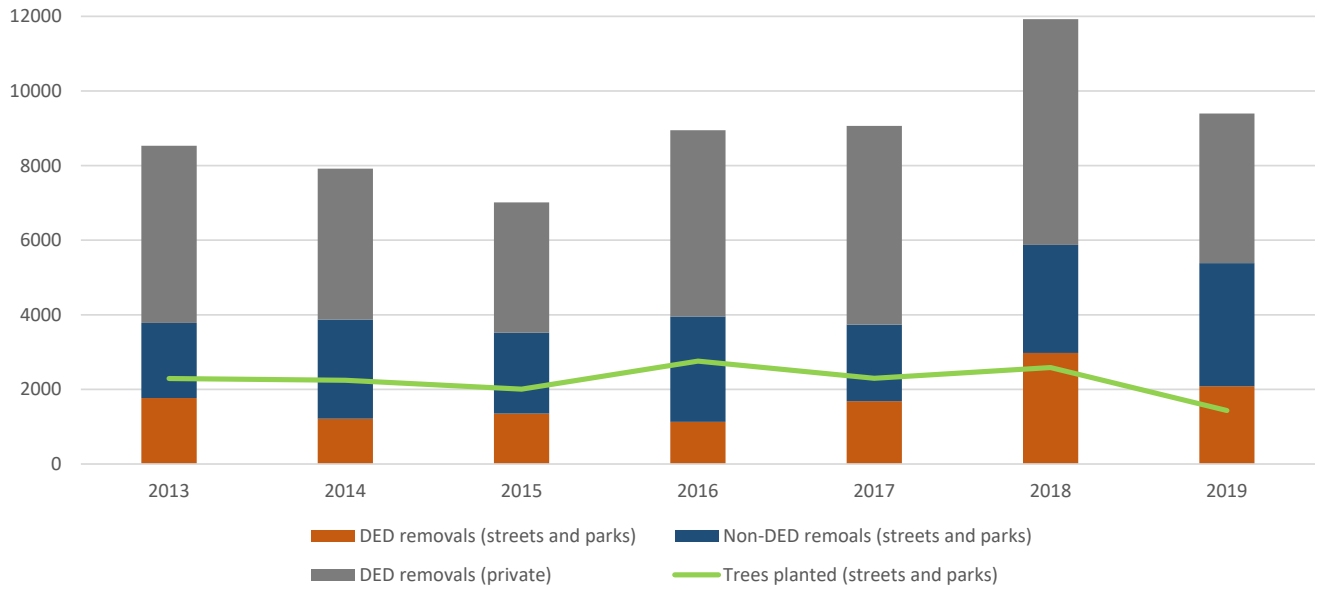


Figure 31: Annual rates of removal and replacement in City streets and parks.

Winnipeg's urban forest sustainability report card

Winnipeg's urban forestry program and services have been evaluated within an urban forest sustainability model first proposed by Clark et al (1997) and recently updated in Leff (2016). These models define a set of performance indicators to establish the current and optimal state of urban forest programs. In some cases, indicators have been adapted to better reflect Winnipeg's urban forest context and direction for the Comprehensive Urban Forest Strategy. Optimal conditions provide a benchmark to measure against but are not a commitment by any stakeholder to achieve that rating. Most actions will require further study to understand what level of service is achievable and what level of performance the City will ultimately strive for. The ratings are summarized in Figure 32. Overall, the City's program rates as fair to good, with significant strengths evident in areas of management and partnership. There are gaps in tree protection, and in the capacity of the program to deliver improvement in any area given backlogs in planting and maintenance, and the uncertainty of future tree removal requirements related to EAB.

Legend

Poor
Fair
Good
Optimal

Target	Rating
PLAN	
Awareness of the urban forest as a community resource	Fair
Interdepartmental and inter-agency cooperation on Comprehensive Urban Forest Strategy implementation	Good
Clear and defensible urban forest canopy assessment and goal	Fair
Green infrastructure asset valuation	Fair
Municipal-wide biodiversity or green network strategy	Good
Municipal urban forestry program capacity	Fair
Urban forest funding to implement the Strategy	Fair
PLANT	
City tree planting program design, planning and implementation	Fair
Development requirements to plant trees on private land	Fair
Streetscape specifications and standards for planting trees	Fair
Equity in planting program delivery	Poor
Forest restoration and native vegetation planting	Good
Stock selection and procurement in cooperation with nurseries	Fair
Ecosystem services targeted in tree planting projects and landscaping	Fair
MANAGE	
Tree inventory	Optimal
Knowledge of trees on private property	Optimal
Natural areas inventory related to elm and ash	Good
Maintenance of publicly-owned, intensively managed trees	Fair
Extreme weather response planning	Good
Tree risk management	Fair
Pest and disease management as it pertains to DED and EAB	Optimal
Waste biomass utilization	Optimal
PROTECT	
Regulating the protection and replacement of private and City trees	Poor
Regulating conservation of sensitive ecosystems, soils or permeability	Poor
Internal protocols guide City tree or sensitive ecosystem protection	Fair
Interdepartmental cooperation on Strategy implementation	Good
Standards of tree protection and tree care observed during development or by local arborists and tree care companies	Poor
Cooperation with utilities on protection (and pruning) of City trees	Good
PARTNER	
Citizen involvement and neighbourhood action	Optimal
Involvement of large private and institutional landholders	Good
Urban forest research	Good
Regional collaboration	Good

Figure 32: Winnipeg's Urban Forest Report Card summary of ratings.

4. Peer city comparison

Benchmarking against other, similar sized cities can be useful in understanding how levels of service and resourcing are affecting urban forestry programs. In Table 5, Winnipeg is compared to four Canadian municipalities of similar land area and population density (Calgary, Edmonton, Saskatoon, and Surrey) as well as to three higher density, high profile cities (Montreal, Toronto, and Vancouver).

Table 5: The City of Winnipeg's levels of service compared to similar sized cities throughout Canada.

	Winnipeg	Calgary	Edmonton	Saskatoon	Montreal	Toronto	Surrey	Vancouver
CONTEXT	PRAIRIES ECOZONE				MIXED WOOD PLAINS ECOZONE		PACIFIC MARITIME ECOZONE	
Population (2016 census)	705,244	1,239,220	812,201	246,376	1,704,694	2,731,571	517,887	675,218
Population density (people/km^2)	1,519	1,501	1,361	1,080	4,662	4,334	1,637	5,400
Land area (km^2)	464	826	685	228	366	630	316	115
PLANNING								
Canopy cover	17%	8%	10%	9%	20%	28%	28%	23%
City tree population (inventoried street and park trees)	301,402	502,559	371,537	104,000	310,248	1,140,000 est. on pruning cycle	103,985	145,534 (streets only)
Approximate urban forestry budgets (CAD millions)	$12 (2020 service-based budget, includes public planting and DED costs for private elm trees)	$15 (2020 Urban forestry service plan net operating budget - excludes planting, which is funded through capital budget)	$12 (2019, uncertain if it includes planting)	$4 (2020 operating budget urban forest expenses including planting plus $150,000 capital budget for ash psyllid removal and planting)	$16 (approx.)	$65 (2020 operating budget, excludes planting)	$5 (uncertain if it includes planting)	$6 (2020 operating budget- excludes planting. 2020 capital budget of $3.1 million for planting)
Approx. budget (excl. tree planting) as an average $ per tree	$34 ($15 per tree if DED control is excluded)	$30 (No DED)	$32 (No DED, may include planting)	$38 (No DED, may include planting)	Not comparable due to borough system	$57 (includes DED and EAB control)	$48 (no DED, may include planting)	$41 (no DED)

Table 6: Continued

	Winnipeg	Calgary	Edmonton	Saskatoon	Montreal	Toronto	Surrey	Vancouver
Approx. budget (total operating) as an average $ per person	$17 ($9 if DED control is excluded)	$12 (excl. planting)	$15	$16	Not comparable	$24	$10	$9 (excl. planting)
Tree inventory	Streets & landscaped parks	Streets & landscaped parks	Streets & landscaped parks	Streets & landscaped parks	Streets & landscaped parks	Street trees only	Streets & landscaped parks	Street trees only
Pruning cycle (2017)	31 years	Shifting to proactive	7 years, elms every 4	7 years for boulevard trees, once every 13 years for park trees	7 years	7 years (young trees 3 years)	Streets: 5 years Parks: 10 years (young tree pruning cycle separate)	Not reported
Major pest (DED/EAB) management programs	DED, EAB not yet funded	No	No	No	DED/EAB	DED/EAB	No	No
Urban Forest Management Strategy/Plan	In development	Calgary… A city of trees Park Urban Forest Strategic Plan (2007)	Urban Forest Management Plan (2012)	In development	Le Plan d'action Canopee 2012-2021	Sustaining and Expanding the Urban Forest: Toronto's Strategic Forest Management Plan 2012-2022	Shade Tree Management Plan (2016)	Urban Forest Strategy (2018 Update)

5. Enabling policies

Section five presents policies that enable Winnipeg urban forest management activities and a brief discussion on tree protection by-laws and industry standards applied by the City of Winnipeg in urban forest management.

Winnipeg's urban forest policy context

Bylaws, policies, and guidelines are tools to implement the various plans and strategies on the ground. An extensive background review was conducted of Winnipeg's plans and policies relevant toward developing Winnipeg's Comprehensive Urban Forest Strategy.

Figure 33 outlines the three pieces of **enabling legislation** that primarily define the City's powers to act on issues related to urban forest management including the City of Winnipeg Charter (S.M. 2002, c. 39), Forest Health Protection Act (C.C.S.M. c. F151), and the Planning Act (C.C.S.M. c. P80).

Guiding policy and plans, such as OurWinnipeg, provide broad direction and support for the Comprehensive Urban Forest Strategy. They provide key directions that lay the groundwork for development and help inform the Strategy.

Associated strategies and plans, such as the Ecologically Significant Natural Lands Strategy, complement and will be complemented by the implementation of the Comprehensive Urban Forest Strategy. They guide key components and elements that impact the urban forest, such as infill construction and transportation, and can both directly and indirectly support the Comprehensive Urban Forest Strategy goals.

Bylaws and policies aim to regulate and enforce guiding and associated policies, strategies and plans by establishing key requirements and metrics for work around trees. Bylaws such as the Zoning By-law (No. 200/2006), establish general requirements for landscaping during development and presents a credit system for trees retained.

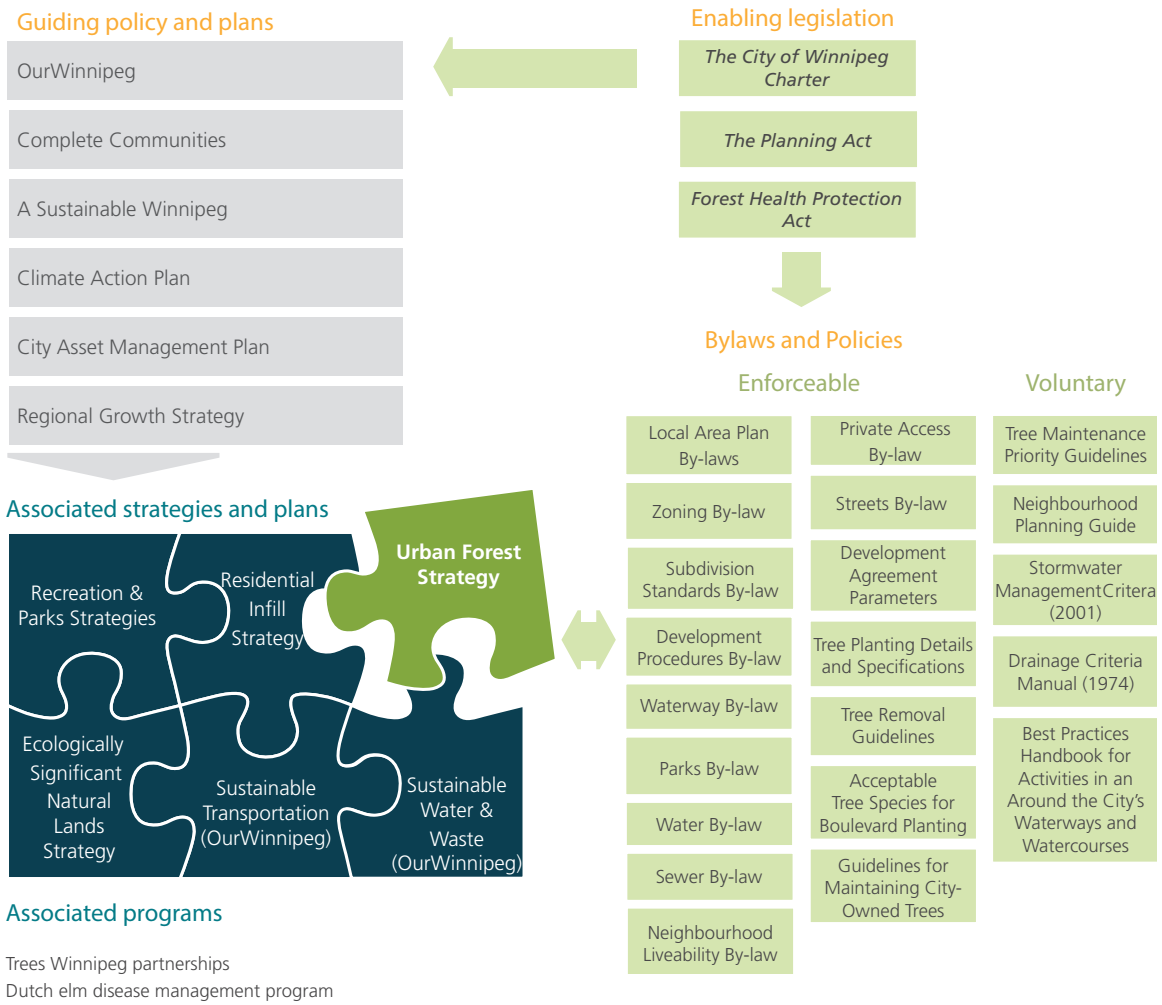
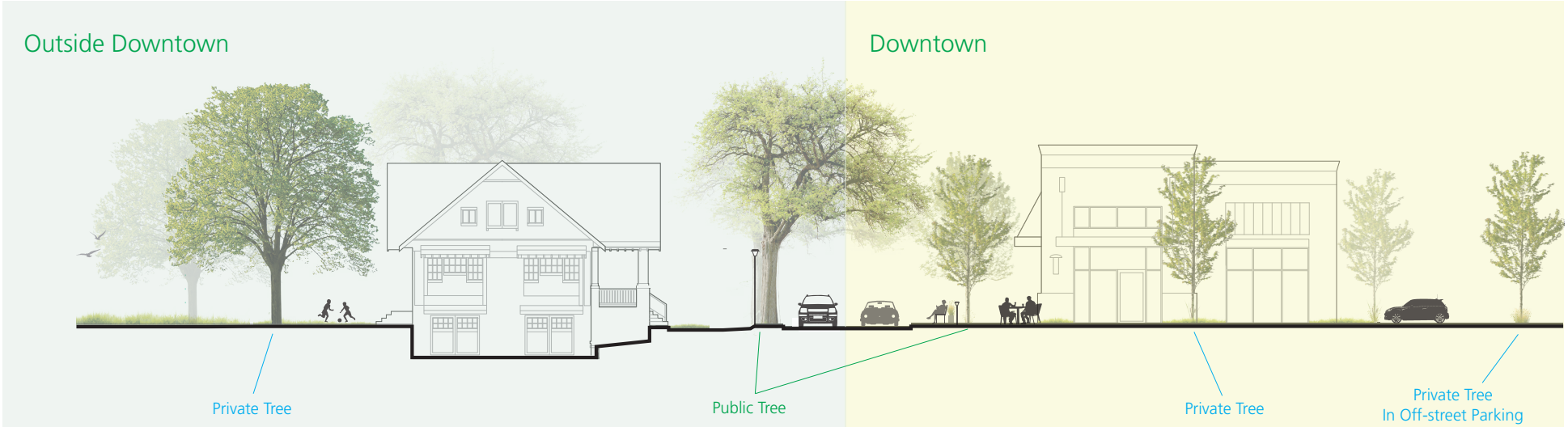


Figure 33: Enabling legislation that define urban forest management and powers to act and the policies and plans currently in place in Winnipeg.

Figure 34 describes how various Winnipeg bylaws and policies regulate planting, retention, removal and maintenance of trees on public and private land.



	Private Tree	Public Tree	Private Tree	Private Tree In Off-street Parking
Tree Planting	The **Zoning Bylaw** requires tree planting outside of one- or two-family residential zones. 1 tree per 30 ft. of frontage is required. Required trees may be clustered. 1 tree per 300 sq. ft. of parking lot interior landscape area is required in addition to the frontage requirement.	Public trees may be planted by the City or its delegates or by a developer as required within a **Development Agreement**. The **Tree Planting and Maintenance Specification** applies to all trees planted, whether by a developer or the City or its delegates. Planting by the City or its delegates downtown and on regional streets is guided by the **Tree Planting Details & Specifications Downtown Area and Regional Streets**. A **Development Agreement** typically requires developers to complete boulevard tree planting as part of an application under the **Subdivision Standards Bylaw** or **Zoning Bylaw.** Tree numbers are guided by the **Boulevard Tree Planting Guidelines as Required Under Development Agreements**, and are subject to **Boulevard Planting Concept Plan** approval. Species must conform with the **Acceptable Species for Boulevard Planting**. Trees planted this way remain the responsibility of the developer until final acceptance by the City.	The **Downtown Zoning Bylaw** may require a development application to include a **Landscape Plan**. There is no specific requirement for tree planting, unless the permit relates to an off-street parking facility. **Urban Design Review** may consider and make recommendations for landscaping.	The **Downtown Zoning Bylaw** requires a development application for an off-street parking facility to incorporate tree planting as part of a **Landscape Plan**. The Bylaw contains specifications that must be followed for tree siting, species selection, and maintenance.
Tree Retention or Removal	The **Zoning Bylaw** offers an incentive for tree retention. Credit towards landscaping requirements will be given for each tree greater than 2.5 inches (6 cm) DBH retained. No requirements for tree protection are specified.	The **Boulevard Tree Planting Guidelines as Required Under Development Agreements** specify only trees that have been in the ground for two growing seasons will be considered for final acceptance. Removal and replanting during the maintenance period requires notification to the City. Trees impacted by construction receive protection under the **Tree Planting and Maintenance Specification** or **Tree Planting Details & Specifications Downtown Area and Regional Streets**. **Tree Removal Guidelines** apply whenever a request for the removal of a public tree is made to Urban Forestry, under the authority of the **Private Access Bylaw, Neighbourhood Liveability Bylaw** and **Parks Bylaw**. Public trees approved for removal are replaced by Urban Forestry per the ratios and compensation outlined by the guidelines. Requests to remove trees larger than 30 cm diameter may be declined, subject to further consultation with the City Forester.	The **Downtown Zoning Bylaw** has no provisions guiding the retention and removal of trees during development.	The **Downtown Zoning Bylaw** has no provisions guiding the retention and removal of trees during development.
Tree Maintenance	The **Zoning Bylaw** requires owners to maintain required trees in healthy growing condition. Additionally, all private tree owners have a responsibility under the **Neighbourhood Liveability Bylaw** and **Streets Bylaw** to manage their trees for public safety and nuisance hazards.	Trees provided under a **Development Agreement** must be maintained by the developer under the required terms until final inspection and acceptance by the City. The **Tree Planting and Maintenance Specification** applies. Private tree owners may arrange maintenance under the **Guidelines for Maintaining City-Owned Trees**. The City attempts to follow a block program under the **Tree Maintenance Priority Guidelines**.	All private tree owners have a responsibility under the **Neighbourhood Liveability Bylaw** and **Streets Bylaw** to manage their trees for public safety and nuisance hazards.	The **Downtown Zoning Bylaw** contains requirements for tree maintenance to preserve sightlines between public streets and adjacent properties, drainage, and encroachment on walkways.

Figure 34: Bylaws and policies that currently regulate the planting, retention, removal, and maintenance of Winnipeg's trees on public and private land.

Tree protection bylaws

The City currently does not have a tree bylaw. However, two City bylaws act to regulate trees through development, namely:

1. The Zoning By-law influences the space that will be available to retain or plant trees on private land, and can also include landscaping requirements for development
2. The Subdivision Standards By-law provides the authority for Development Agreement Parameters which outline the space and requirement for trees in streets by controlling soil volume, boulevard widths, spacing, and the location of utilities

Winnipeg's current Zoning By-law establishes landscaping requirements for developments to plant a tree on private lots for every 30 feet of linear street frontage (excludes Downtown). Owners can get planting credits for trees that were retained through development. There are no requirements for tree retention on private land in relation to the Subdivision Standards By-law.

Tree bylaws tend to have consistent components that define what is protected, reasons why removal would be permitted, measures for protecting retained trees, and requirements for tree replacement (Figure 35). The Appendix provides a comparison between several Canadian cities and how their tree bylaws address each of these components.

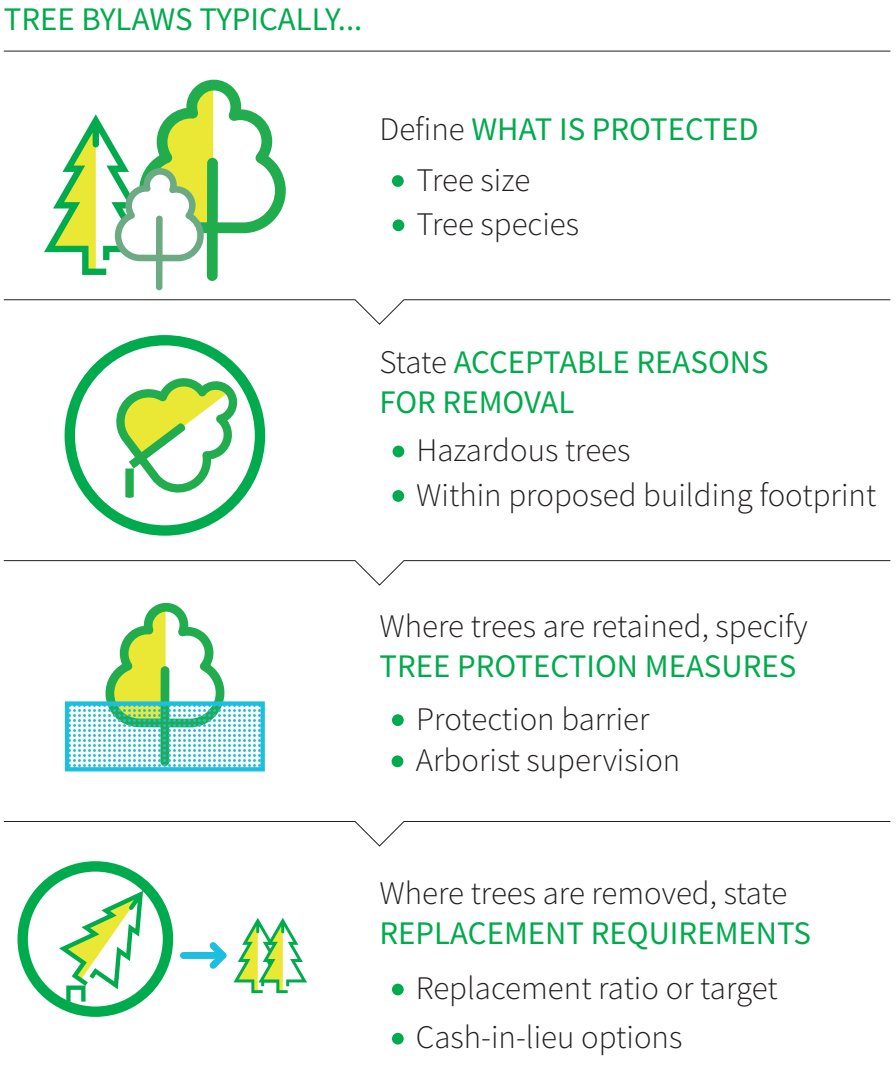


Figure 35: Tree bylaws typically have standards identified for protection, removal, and replacement.

Tree care industry standards and best practices adopted by the City of Winnipeg

A number of Winnipeg's policies and procedures have been implemented based on tree care industry best practice from across Canada and North America. Table 6 describes the most pertinent and valuable resources that Winnipeg has at its planning disposal.

Table 6: Industry standards and best practices most pertinent to the City of Winnipeg.

Publisher	Standard	Detail
International Society of Arboriculture (ISA)	Best Management Practices	The ISA publishes best management practices on many subjects in tree care, maintenance, and urban forestry applications. Certified arborists are encouraged by the ISA to follow all applicable best management practices.
American National Standards Institute	Z133, A300	The American National Standards Institute releases and updates the accepted industry standards for safety in arboriculture operations (Z133) and tree care(A300). ANSI Z133 covers criteria in general safety, electrical hazard, use of vehicles and mobile equipment, power tools, hand tools, climbing, and other procedures for workers engaged in arboriculture. A300 contains ten parts addressing the major aspects of arboriculture planning and practice, including pruning, soil management, tree planting and establishment, protection during construction, tree risk assessment, and integrated pest management.
Council of Tree and Landscape Appraisers	The Guide for Plant Appraisal	The Guide, now in its 10th edition, outlines industry standards and protocols for tree appraisal. Winnipeg applies the Guide when requests to remove significant trees are made under the City's Tree Removal Guidelines.
Canadian Nursery Landscape Association	Canadian Landscape Standard, Canadian Nursery Stock Standard	The Association publishes standards in common use for landscape construction and nursery stock. Winnipeg incorporates the Canadian Nursery Stock Standard into its Tree Planting and Maintenance Specification and procurement of nursery stock.

6. State of specific challenges

A comprehensive background on the state of the urban forest has been presented thus far. However, there are specific issues in the management of Winnipeg's urban forest that are particularly complex at a higher level. The state of these challenging issues listed below are briefly presented in this section:

1. Pests and diseases
2. Climate change and climate hazards
3. Urbanization, development, and tree protection
4. Asset and program management sustainability

Pests and diseases

In Winnipeg, Dutch elm disease continues to be the cause of significant tree mortality, with upwards of 6,000 American elm trees per year being removed from public and private land.

There are approximately 52,000 American elms in the City's tree inventory, representing more than 37 percent of the total leaf area and carbon stored in the inventoried urban forest. American elm removal rates in the last two years have averaged 2,500 street and park trees per year (7,500 if you include private land). Historically, the target annual loss rate due to disease to prevent exponential increases in DED and depletion of the American elm population is no more than two percent. the City has partnered with researchers to develop a prioritized rapid removal protocol to slow the spread of DED over time and allow more efficient management of DED.

Leaves affected by Dutch elm disease (left) and the orange dot used to mark a diseased elm tree to be removed (right)

Ash is now under threat with the 2017 detection of Emerald ash borer and cottony ash psyllid. Approximately 10,000 of Winnipeg's black ash trees are at risk of cottony ash psyllid. EAB has not yet started to cause widespread mortality and the population is likely still building up. In other parts of North America, EAB has caused 100 percent overstory ash mortality within 10 years of detection, with worth noting that Winnipeg is the northernmost and coldest location where EAB has been detected in North America and there is a possibility that EAB population growth will be slower in Winnipeg as a result[5].

The City has nearly 100,000 ash trees in its inventory, representing 26 percent of the total leaf area and 16 percent of the carbon stored in the inventoried urban forest. Many more are found in natural areas and on private land. Ash killed by EAB tend to fall over within two years of mortality and must therefore be removed soon after death to mitigate risk. Doing nothing would overwhelm the City's capacity to remove dead trees, so the City has outlined a strategy called "Slowing Ash Mortality" or SLAM[6]. The approach involves proactive removal of dead and declining ash trees, as well as treating infected ash with insecticides to kill the EAB and limit the growth of the beetle population. Since 2009, the City has been reducing the number of ash trees planted and altogether stopped planting ash trees in 2016.

A significant threat for natural areas is the long-term succession pathway from ash to a new dominant species. Elm have already been diminished from the overstory and, once the ash overstory dies an orphan cohort of ash will be left in the understory with no fresh seeds in the seedbank. Trees as small as 2.5-cm diameter can be attacked by EAB[7] and so regenerating ash may be killed before setting seed. If both ash and elm are eradicated from riverbottom forests then invasive species such as European buckthorn could take over. The broader ecological implications of this scenario have not yet been widely studied in our region.

Oak decline has impacted the large bur oak population over the past few decades with expanding development and urban sprawl. The gypsy moth has been detected in Winnipeg but has not become established. A number of other pests and disease affect trees in Winnipeg including cankerworm, elm spanworm, and elm scale which affect trees at varying levels from year to year. A significant potential pest threat present in North America, but not yet established in Winnipeg is the Asian long-horned beetle, which has a wide invasive range and can cause widespread tree mortality.

5 Orlova-Bienkowskaja, M.; Bienkowsi, A. 2020. Minimum Winter Temperature as a Limiting Factor of the Potential Spread of Agrilus planipennis, an Alien Pest of Ash Trees, in Europe. Insects. 11(258)

6 Poland, Therese M.; McCullough, Deborah G. 2010. SLAM: A multi-agency pilor project to Slow Ash Mortality caused by emerald ash borer in outlier sites. Newsletter of the Michigan Entomological Society. 55(1&2).

7 Dobesberger, E.J. 2002. Emerald ash borer, Agrilus planipennis: pest risk assessment. Canadian Food Inspection Agency, Plant Health Risk Assessment Unit. Nepean, Ontario.

Winnipeg has been responding to these challenges through:

- Long-standing dedicated DED management program for American elms on public and private property
- EAB response treating ash on public property where resources allow and ash removals
- Diversifying tree species planted (ash no longer being planted)
- Community and research partnerships

Climate change and climate hazards

Trees provide services, such as shade and cooling and rainwater interception, that can help cities adapt to climate change. However, trees are also vulnerable to climate change impacts. According to modelling prepared by the Prairie Climate Centre, Winnipeg can anticipate the average annual temperature to warm by 2.6 -6.9 °C by 2080 (business-as-usual emissions scenario, RCP 8.5). Temperatures will increase in all seasons and the frequency of heatwaves is expected to double. Precipitation is likely to increase during winter, spring, and fall, while remaining constant or slightly decreasing in summer. Figure 36 summarizes the major changes and impacts expected due to climate change.

Relative to the historic baseline, increases in temperature are substantially more than the predicted increase in annual precipitation, which may increase tree drought stress. Higher temperatures will drive other impacts including earlier spring thaws and later fall snowfalls, with heavier, wetter snow that can damage trees. Growing seasons will lengthen, but benefits for trees may be complicated by more variable weather and other effects.

Climate warming will affect the lifecycles of pest insects. Growing Degree Days are a common measurement of the cumulative thermal energy available through the year for plant or insect development. Growing Degree Days Base 10 °C (DD10) are frequently used to predict the emergence and behavior of insect populations. For example, EAB adults emerge after about 400-500 DD10, with peak emergence around 1,000 DD10. Between 1950 and 2013 Winnipeg's DD10 has fluctuated between about 800 and 1,200 and it is likely that EAB often needs two years to complete its life cycle. Under the RCP 8.5 scenario, DD10 it is projected to increase to more than 2,000. For EAB, this will mean that adults emerge earlier and consistently reach peak emergence, lay eggs earlier, and will likely complete their life cycles in one year instead of two. Overwintering success will also increase as minimum winter temperatures in the City rise from -37 to -25 ℃.

Climate warming is also associated with increased likelihood of high winds, flash floods, hail, convective storms, drought, and wildfires. Storm damage will be exacerbated where trees are weakened by drought or increased pest activity. Following the snowstorm of October 2019, heavy wet snow damaged approximately 30,000 trees, and trees in poorer condition saw greater branch loss and damage.

Prairie Climate Center modelling projects Winnipeg's average annual temperature to warm by 2.6 to 6.9 degrees Celsius by 2080

One of approximately 30,000 trees damaged during the October, 2019 storm

One of approximately 30,000 trees damaged during the October, 2019 storm.

In the first two weeks of storm cleanup, 1,700 tonnes of debris or 121 dump truck loads was transported.

CHANGES TO...

TEMPERATURES
Much warmer winters, many more hot days

GROWING SEASONS
Frost-free period longer by 40 days. DD10 increases from 1042 to 1725.

PRECIPITATION
Slight increase overall, wetter springs, drier late summers

EXTREME WEATHER
Potential changes in frequency and intensity of extreme weather events.

MOISTURE AVAILABILITY
Increased rates of evaporation and transpiration may create drier conditions during the growing season.

WILL LIKELY CAUSE...

MORE EXTREME WEATHER EVENTS
Heat, extreme precipitation, flooding, icestorms or other events may happen more often leading to more tree damage.

MORE PESTS AND INVASIVE SPECIES
Pests may reproduce more rapidly and more often. Trees and ecosystems may be more vulnerable to attack and invasion.

DROUGHT MORTALITY
Less moisture availability may increase drought mortality and urban trees may need more water to establish.

Figure 36: Changes due to climate change will likely cause challenges to the urban forest..

Urbanization, development, and tree protection

Winnipeg is growing. OurWinnipeg, the City's municipal development plan, anticipates the City's population will increase to 850,000 by 2031. Growth will be accommodated via a mix of new housing at the urban edge and infill housing in established neighbourhoods. OurWinnipeg is a blueprint for sustainable community development and seeks to encourage densification to improve community amenities and servicing costs.

Urbanization and development are an inevitable requirement for growing cities. Some of the typical challenges trees face due to urbanization and development include:

- Poor growing conditions in urban streetscapes
- Removal or damage due to streetscape upgrades, infrastructure renewal/conflicts, building redevelopment, infill, or new construction

As cities grow, areas become more urbanized with more impermeable surfaces to accommodate more people, street furniture, signage, and all the other features of a busy and vibrant public realm. The increase in hard surfaces in urban areas often creates challenging conditions for trees by absorbing more heat, draining water away from trees, requiring clearance pruning, and reducing the soil that roots can grow in. The use of de-icing salts on these hard surfaces also damages trees.

Development often requires trees to be removed or pruned to accommodate construction, and the work itself can cause physical tree damage that shortens the life expectancy of trees in the landscape. Development is both a cause of canopy loss and a source of growth as trees are planted into developments. Trees are also often physically damaged by construction activities. Trees, housing, and infrastructure are integral components of a sustainable city, and policy for each needs to be coordinated to ensure objectives are feasible and can be met.

Winnipeg has several policies that respond to these challenges:

- Zoning By-law requires one tree per frontage in residential areas and credits tree retention in lieu of planting
- Development Agreements require boulevard tree planting
- Tree Planting and Maintenance Specifications require protection of City trees during development
- City Tree Removal Guidelines help to guide when City trees can or cannot be removed
- Guidelines for maintaining City trees provide parameters for who can work on City trees
- Water sensitive urban design strategies to reduce runoff using natural amenities

Tree damaged by poor pruning for new apartment building, not designed around the existing tree canopy (left). Inadequate tree protection led to blvd. damage during streetscape upgrades (right)

Downtown tree planted into soil vault with restricted soil volume and extensive impermeable surface (left) and trees damaged during construction (right)

Cities in some parts of Canada use tree bylaws to regulate the protection and replacement of trees on private or public land. Tree bylaws typically function so that trees of a certain type (e.g., size, species, location) are protected and cannot legally be removed unless the owner obtains a tree permit. As of the fall of 2019, tree bylaws that regulate private trees were in place in local governments across British Columbia, Ontario, Québec, and Prince Edward Island. See the Appendix for a city comparison overview for six cities in British Columbia and Ontario.

The ability for local governments to regulate tree removal and replacement is controlled by provincial legislation, which explains why tree bylaws vary across the country in terms of whether or not they apply on private land. Where local governments elect to adopt a tree bylaw, they may do so for a variety of reasons and in ways that best respond to their local conditions and community values. Often, tree bylaws are enacted to regulate tree removals and require tree replacements in order to safeguard community tree benefits.

Winnipeg is growing, both through new development at the urban fringe and with densification of existing urban areas. New development can result in both gain (e.g., where trees are added to what was prairie) and loss (e.g., where aspen forest is cleared). Densification of existing urban areas with infill development often means existing trees have to be removed and trees on neighbouring properties may be damaged. Council has directed the public service to consider a tree protection bylaw for private properties.

New developments adjacent to natural areas

Densification of existing urban areas with infill development

Managing trees as assets

Trees are living assets that appreciate in value as they age due to their ability to deliver more services as they grow. A key objective of urban forest and asset management is to maximize the benefits produced from trees for the least cost, and so we need the trees in our landscape to be healthy and long-lived.

Winnipeg manages an inventory of 300,000 boulevard and park trees, plus an even greater number of forest trees in natural areas. Inventoried trees are managed intensively, in that they are individually planted, pruned, and maintained for health and risk until the end of their life. The bulk of the costs associated with a City's urban forest management program are typically related to managing inventoried trees. Management of trees in natural areas is typically not part of the City's urban forestry programs other than DED management. The City's Naturalist Services Branch oversees natural and naturalized forested areas, including reforestation and afforestation. Management of the areas is limited to addressing high risks to public safety as necessary and pursuing preservation in the case of construction or developing in collaboration with the Urban Forestry Branch. Afforestation efforts will increase over the next 10 years through the Mayor's Million Tree Challenge.

Asset management focuses on maximizing benefits and minimizing the risk for the least cost. Winnipeg's inventoried trees are being removed at more than twice the rate of replacement on average and the maintenance pruning cycle is at 31 years. The number of tree removals has been rising because of higher rates of diseased or pest infested trees. Storm damage is not an annual concern, however, some years have seen an increase in removals such as the 2019 storm with 600 trees damaged.

An asset management framework can help clarify the cost of managing an individual tree (or other type of natural asset) from installation to removal. These costs are typically matched to define levels of service and performance targets. Costs can then be calculated out to the whole population to more accurately estimate the budgets needed to meet the levels of service and performance targets set. Asset management involves:

- Inventorying what we have and its condition
- Identifying life cycle costs
- Budgeting for management and replacement of assets over their life cycle

Municipalities are increasingly incorporating trees into their asset management systems as a means of accounting for their life-cycle costs, maintenance cycles, and replacement time frames, as well as their asset value. Some municipalities are also exploring integrating other natural assets into these same frameworks. The Winnipeg Comprehensive Urban Forest Strategy will explore how Winnipeg's urban forestry program can be more effectively integrated into the City's asset management program.

Final remarks

On December 12, 2017, in response to a report on the additional resources required for Dutch elm disease (DED) management (September 2017) and the detection of Emerald Ash Borer (EAB), Council approved the Urban Forest Enhancement Capital Project which supported the creation of the City of Winnipeg Comprehensive Urban Forest Strategy. This Report prefaces the development and finalization of the Strategy, and summarizes what we know so far about Winnipeg's urban forest canopy and management.

Winnipeg's urban forest faces significant challenges from insects and diseases which threaten the dominant species in its urban tree population. Additionally, climate change and urban development continue to place pressure on the urban tree canopy.

These combined challenges threaten the urban forest's capacity to provide beneficial ecosystem services like shade and cooling, improved air quality, rainwater interception, and habitat connectivity, which are key components of our City's resilience to climate change. The City's capacity to maintain the urban forest is also challenged as staff and budgets struggle to keep up with the demands for disease management, urban development, pruning and tree removals, and replanting.

Winnipeg's Comprehensive Urban Forest Strategy is an opportunity to establish a long-term vision for Winnipeg's urban forest, and to develop clear guidance and measurable outcomes for the funding and levels of service required to sustain an urban forest that is resilient to current and future challenges.

Appendix - City comparison overview of tree protection policies

The table below provides a comparison of similar sized cities across Canada where approaches have been used. The selected comparison cities have a population of 500,000 to three million people and have a tree by-law that regulates private trees. This comparison includes six cities from British Columbia and Ontario, presented alphabetically in the table below.

Description	Brampton (2012)	Mississauga (2013)	Ottawa (2021)	Surrey (2006)	Vancouver (2018)	Toronto (2015)
Property application	Specific private tree bylaw (also have Woodlot Conservation By-law)	Specific private tree bylaw	Separate sections for protection of trees on municipal property and private tree protection	Applies to public and private properties	Applies to public and private properties	Separate sections on protection of trees on city streets and private tree protection
Protected tree definition	**≥30 cm**	**≥15 cm** -includes species of interest, heritage or significant tree, sensitive lands, where significant vistas would be compromised	**≥10 cm** for properties ≥1 ha, **≥50 cm** for properties ≤1 ha	**≥30 cm** -includes species of interest, significant trees, sensitive lands, replacement trees	**≥20 cm** -includes replacement trees	**≥30 cm** -includes heritage or significant tree, sensitive lands, where significant vistas would be compromised, where flood or erosion control would be compromised, boundary or neighbouring tree considerations
Reasons to permit removals	N/A	Conflict with pool enclosure or parking, no negative impact to flooding/slopes, heritage lot if not relevant to heritage, removal is acceptable to City.	Causing structural damage to load bearing structures/ roof, required to remediate contaminated soil, will be relocated, required for utilities/water/ sewer, no reasonable alternative as per GM	Interfering with infrastructure, farming, inappropriate location.	Construction access, interference with drainage/sewer.	Causing structural damage to load bearing structures/ roof, inappropriate location and cannot be routinely maintained due to site restrictions, required to remediate contaminated soil, will be relocated, required for utilities/water/sewer, no reasonable alternative as per GM.
Replacements	Ratio at City discretion, no cash-in-lieu, no density target. Guidance - GM may impose species, size and location	Ratio at City discretion, no cash-in-lieu, no density target. GM may impose species, size and location.	Ratio as determined by GM: **1:1 to 3:1** based on property size and development; **1:1** for dead/hazardous ash, no cash-in-lieu, no density target. Guidance provided for size.	Ratio **2:1**, cash-in-lieu $400 - 700 per tree, no density target. Guidance for the location (proximity to buildings) and size and species may be at the discretion of the GM.	Ratio **1:1** for planting large tree; 2:1 for planting small tree, cash-on-lieu $1000 per tree, density target 55-200 trees per ha dependent on lot size. Guidance re: species, timing and size.	Replacement and two years maintenance on site or other location upon plan approval by GM. Cash-in-lieu equal to 120% of cost of replanting and 2 years maintenance; no density target.

Description	Brampton (2012)	Mississauga (2013)	Ottawa (2021)	Surrey (2006)	Vancouver (2018)	Toronto (2015)
Securities	None	Replacement only: cost of planting + 2 yrs maintenance (at GM discretion)	Replacement only; amount at GM discretion	**Replacement:** $400 - $800 per replacement tree re: caliper size/height or size as per GM. **Tree protection**: $3,000-10,000 on size/species (development context only)	Replacement only: $500-750 per replacement tree re: caliper size	Tree Protection and Replacement: amounts not specified (at GM discretion).
Fees and fee structure	$50	**$0** hazard/dead/dying **$320 + $71** per additional tree (up to $1,433) base fee (up to 5 removals) + per additional tree removed up to max amount.	**$150** with no development. **$500** for development application.	**$84 + $33** per additional tree - no subdivision proposed - base fee + per additional tree removed. **$110 - $554** with subdivision based on lot size and zoning.	**$82 + $236** per additional tree - base fee + per additional tree	**$252.83 - $758.52** per tree, Schedule with Fees and Charges
Penalties for offences	**$100,000** max + continuing offences can exceed	**$25,000** first conviction, up to **$50,000** subsequent for individual. Corporation up to **$50,000 f**irst and **$100,000** subsequent conviction + additional penalties.	**$500 - $100,000** max and liable to special fine that may exceed $100,000	**$40 - $10,000**; additional $1000 per tree of $10,000 per significant tree	**$500 - $10,000** per offence	**$500 - $100,000** max per tree and liable to special fine of $100,000
Authority	Community Services	Community Services	Public Works and Planning/City Forestry inspections	Planning and Development	Planning	Parks, Forestry and Recreation
Enforcement	Municipal Bylaw Enforcement Officer	Municipal Bylaw Enforcement Officer	Municipal law Enforcement Officer	Bylaw Enforcement Officer	Bylaw Enforcement Officer	Parks, Forestry and Recreation

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