Valuing the Trees of Hazelwood Park

An i-Tree Eco Assessment
31 August 2018

City of Burnside

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City of Burnside acknowledge our trees stand on Kaurna land

City of Burnside

> **THE TRUE MEANING OF LIFE IS TO PLANT TREES, UNDER WHOSE SHADE YOU DO NOT EXPECT TO SIT**
>
> Nelson Henderson

Acknowledgements

Report commissioned, edited, and approved by Ben Seamark, Coordinator Environmental Assets, City of Burnside. All photos within this report are taken at Hazelwood Park and have been reproduced with the permission of the owners (City of Burnside or Seed Consulting Services).

Prepared by

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Executive Summary

The City of Burnside values the contribution trees make to its City. Trees provide a wealth of benefits including for the health and well-being of people, the environment, native wildlife, local economic prosperity, property values, infrastructure maintenance, water management, and climate change mitigation and adaptation.

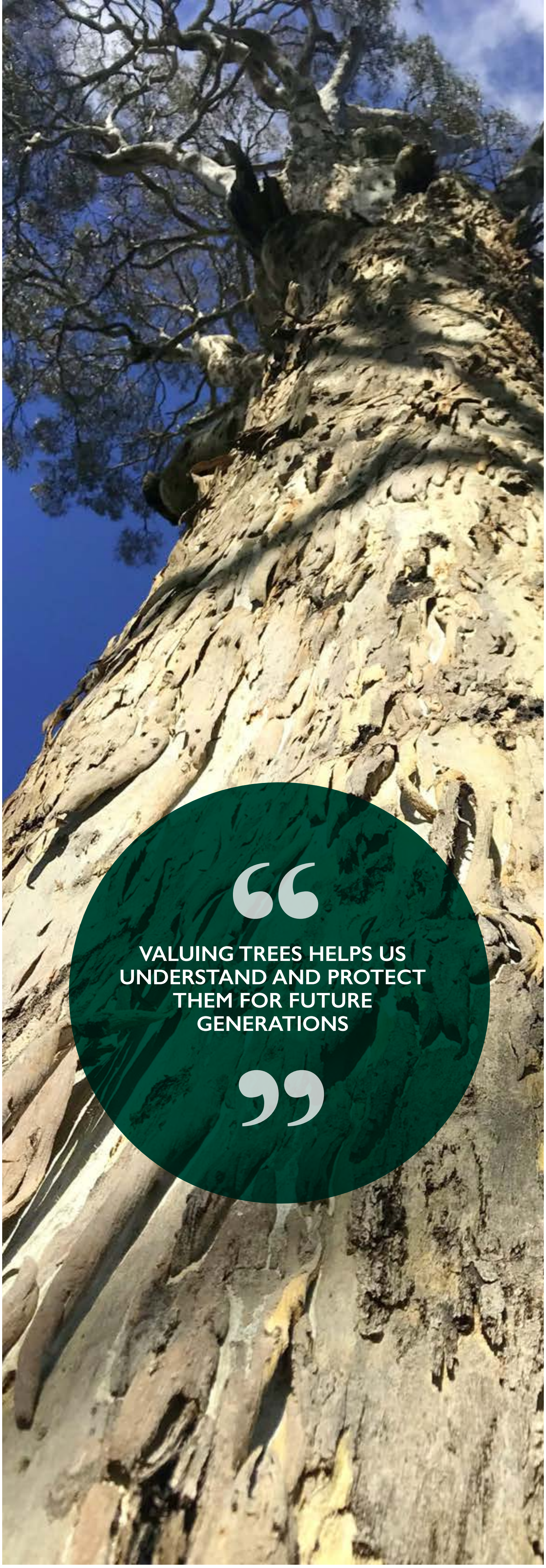
Although some of those benefits provided by trees are intrinsically recognised by members of the community as a whole, the difficulty in measuring these benefits economically limits advocacy for their conservation and investment analogous to other public assets that are monetarily valued. This is particularly important given the political nature of managing natural assets due to the high economic value placed on urban space and associated land-use, coupled with a negative community perception and trends associated with trees (e.g. dropping limbs, leaves, seeds/fruit; landscape trends)

Understanding an urban forest's value economically both in the short- and long-term helps land managers make more informed decisions regarding the management of these community assets and communicating these benefits to the community.

The i-Tree Eco software provides an opportunity to value the economic benefits of trees (see 1.2). An I-Tree Eco assessment was undertaken on 507 trees within Hazelwood Park. This sample of trees measured represent nearly 50% of the Park's tree population; including all Significant and Regulated trees and provides both a replacement (structural) and functional value. Functional values relate to the economic services provided by trees, such as improving air quality.

The current net value of trees studied in Hazelwood Park is calculated at over **$8.78M.** This net value includes a total replacement value of $8,759,836.45, and a total functional benefits value of $30,043.39. Over 80% of the trees' functional benefits was due to the amount of carbon currently stored in the trees, with the remaining nearly 20% being from benefits provided each year (e.g. absorbing carbon, improving air quality). The carbon storage and sequestration (absorption) functions provided by trees are especially important for helping to mitigate climate change.

Whilst the benefits provided by each tree varied based on species, age, size and health. Large, mature, healthy trees were found to provide the highest values, highlighting the importance of these trees for the community and for helping to alleviate climate change.



Trees in Hazelwood Park provide services each year valued at….

Headline Findings

507 trees were measured, equal to 48.19% of trees within Hazelwood Park and included 59 species representing 30 Genera

Structural (replacement) value calculated at = $8,759,836.45

Functional value calculated at = $30,043.39

Functional value included:

- Carbon stored (cumulative service) = 1,070.05 tonnes, valued at $24,397.26
- Carbon sequestered (annual service) = 18.26 tonnes, valued at $416.36
- Air pollution removed (annual service) = 531.65kg, valued at $4,225.21
- Stormwater runoff avoided (annual service) = 442 m^3 valued at $1,004.56

Net economic value of trees assessed = $8,789,879.84

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1. Introduction

The City of Burnside is well-known for its wide, tree-lined streets and the Council places emphasis on the value of its city trees. The City is also custodian of numerous planted public reserves that are highly valued by residents and visitors and contribute to the liveability and popularity of the City as a place to live, work and visit.

Hazelwood Park is one of the City's major reserves and comprises a large diversity of trees, including a high number of significant and regulated native trees, some of which pre-date European settlement.

The Park is well-used and treasured by residents and has a strong and active community stewardship. The Park therefore presents an ideal opportunity to investigate the benefit of trees as a community urban asset, analogous to built infrastructure such as roads, bridges, and buildings are recognised. However, unlike their built counterparts, trees appreciate in value over time, similar to public works of art.

Placing an economic value on the range of benefits provided by trees is, however, highly complex. As such, only a small subset of the benefits provided by trees are currently able to be valued, making the economic estimates provided herein highly conservative. Benefits (or ecosystem services) able to be valued are: carbon stored and sequestered, air pollution removed, and rainfall intercepted (i.e. stormwater avoidance). Examples of benefits not currently able to be rigorously valued include, but are not limited to: biodiversity benefits, historical/cultural value, noise pollution dampening, reduced crime rates, improved built infrastructure lifetimes, and the relationship and value individuals place on trees such as ones they climbed when growing up and remain today.

" UNLIKE OTHER ASSETS, TREES APPRECIATE IN VALUE "

1.1 Objectives

The primary objective of this project was to understand the economic value of trees within Hazelwood Park. This was achieved through an i-Tree Eco assessment of a representative selection of trees in the Park.

Valuing trees economically helps to elevate trees as urban assets, analogous to other built community assets. This is critical to ensure that investment is prioritized to maintain and conserve mature trees. The outputs from this assessment will contribute to:

- development of future Council policies and strategies; and
- increasing community understanding and awareness about the range of benefits provided by trees.

1.2 i-Tree Eco

i-Tree Eco is a scientifically rigorous tool that comprises part of the i-Tree software suite[1] and is applied widely across the world to measure, monitor, and value urban forests. At its core, i-Tree Eco uses measured variables for trees to model each tree's total biomass and condition and estimate the amount of different functional ecosystem services and structural value.

The structural and functional benefit values of an urban forest tend to increase with the number and size of healthy trees[2]. Accordingly, urban forest values can be increased through proper management of trees that promote long-lived and healthy growing trees. However, values and benefits may decrease if trees are mis-managed and the amount of healthy tree cover declines.

The structural value of trees, sometimes referred to as "replacement value", is calculated by i-Tree Eco as a depreciated replacement cost based on the Council of Tree and Landscape Appraisers (CTLA) formulae, which tends to be approximately three-times as conservative as similar estimates calculated in Australia using the Revised Burnley Method[3]. For small trees, a replacement cost based on nursery prices can generally be used[5], but for larger trees, several estimation procedures are used5. The formula incorporates average tree compensatory values, which considers the tree species, size, condition, and location as an estimate of the value of the forest as a structural asset (i.e. the nursery prices of replacing a tree with a similar tree)[4].

Structural values provide an approximate value for a population and are not intended to represent an individual tree's ecosystem services valuation[5]. Rather, structural value is intended to provide a useful management tool by identifying the like-for-like replacement cost of trees[6].

STRUCTURAL VALUE

of a tree is an economic cost based on the tree itself, that is, the cost of replacing a tree with a similar tree. For example, if a 200-year-old eucalypt was lost, what would it cost to replace it with another eucalypt of the same species, age and condition?

Structural attributes calculated as outputs include:

- Species diversity and abundance;
- Composition of native and exotic species;
- Canopy cover and leaf area;
- Size and condition;
- Leaf area index ('importance value'); and
- Structural/replacement value (market value).

FUNCTIONAL VALUES

(i.e. ecosystem services) are based on the ecological functions a tree performs, such as absorbing and storing carbon as it grows, filtering pollutants from the air, and influencing the amount and quality of stormwater runoff by intercepting rainfall.

Functional attributes (i.e. ecosystem services) calculated as outputs include:

- Air pollutants removed per year (carbon monoxide, ozone, nitrogen monoxide, sulfur dioxide, and coarse particulate matter);
- Carbon dioxide sequestered per year;
- Total carbon dioxide stored (not an annual value);
- Avoided stormwater runoff;
- Volatile organic compounds emitted per year; and
- Oxygen produced per year.

Of these functional ecosystem services, the economic (market) value is calculated for carbon stored and sequestered, runoff avoided, and pollution removed.

2. Approach

Tree data collection was completed in June and July, 2018. Deciduous trees formed only a small portion of the trees assessed and were measured before full leaf-off period.

2.1 Tree selection

Council's existing public trees database was used to select trees for assessment. The trees selected included all Significant and Regulated trees, plus a random subset of the remaining tree population which comprised of (59 species) both native and exotic unregulated trees.

The random selection of trees was designed to select trees that represented all species and age classes proportional to their population size in the Park. Stumps, dead trees, and unknown species were excluded from the selection process. All desert ash *(Fraxinus oxycarpa)* were also excluded from the selection process due to their weed status and required removal actions.

2.2 Tree measurements

Each tree was located on ground using a generated map and the following measurements taken, as per i-Tree Eco requirements:

- Tree size, including height, trunk diameter, and canopy spread;
- Tree health, based on canopy density and percentage of missing canopy; and
- Tree growing conditions, based on the amount of sunlight exposure and location relative to roads.

In addition, a record photo of each tree was taken.

2.3 i-Tree Eco modelling and economic valuation analyses

Measured tree data were uploaded to i-Tree Eco (v6) and modelled using available 2011 weather and pollution data. Outputs of the modelling were collated in an Excel spreadsheet together with the input data. The structural and functional economic values were isolated to investigate key trends for the Park's trees and allow for generation of explanatory graphs.

NOTE *that the estimated valuations are highly conservative due to some of the models applied in the Eco software package (i.e. CTLA method), together with Eco only able to currently model a subset of the range of benefits provided by trees.*

3. Results – Ecosystem Services Values

The Council database for Hazelwood Park contains a total of 1,129 records, just under half of which were assessed. Tree data collection was completed in June and July, 2018. Deciduous trees formed only a small portion of the trees assessed and were measured before full leaf-off period.

3.1 Measured trees

507 trees were measured, which represented 48.19% of relevant trees growing in Hazelwood Park (Figure 1). These trees were comprised of 59 species within 30 Genera. Of the 507 measured trees, 258 were significant or regulated, representing 16 species within 8 Genera (Table 1). Of these 258 trees, 157 were significant (9 species, 5 Genera) and 101 were regulated (11 species, 5 Genera) (Table 1).

“KEEPING TREES HEALTHY IS IMPORTANT TO INCREASE BENEFIT VALUES”

Table 1. Count of significant (trunk circumference >3m) and regulated (trunk circumference 2-3m)trees within Hazelwood Park.

SPECIES	COMMON NAME	SIGNIFICANT	REGULATED
Genus: Araucaria			
A. bidwillii	Bunya pine	1	0
A. cunninghamii	Hoop pine	1	0
Genus: Corymbia			
C. calophylla	Marri	0	2
C. maculata	Spotted gum	0	2
Genus: Cupressus			
C. macrocarpa 'Aurea'	Monterey cypress	1	0
Genus: Eucalyptus			
E. camaldulensis	River red gum	117	55
E. cladocalyx	Sugar gum	21	14
E. leucoxylon	SA blue gum	13	22
E. melliodora	Yellow box	0	1
E. microcarpa	Grey box	0	1
E. tricarpa	Red ironbark	0	1
Genus: Ficus			
F. macrophylla	Moreton Bay fig	1	1
F. rubiginosa	Port Jackson fig	1	0
Genus: Olea			
O. europaea	European olive	0	1
Genus: Pinus			
P. brutia	Calabrian pine	0	1
Genus: Quercus			
Q. robur	English oak	1	0

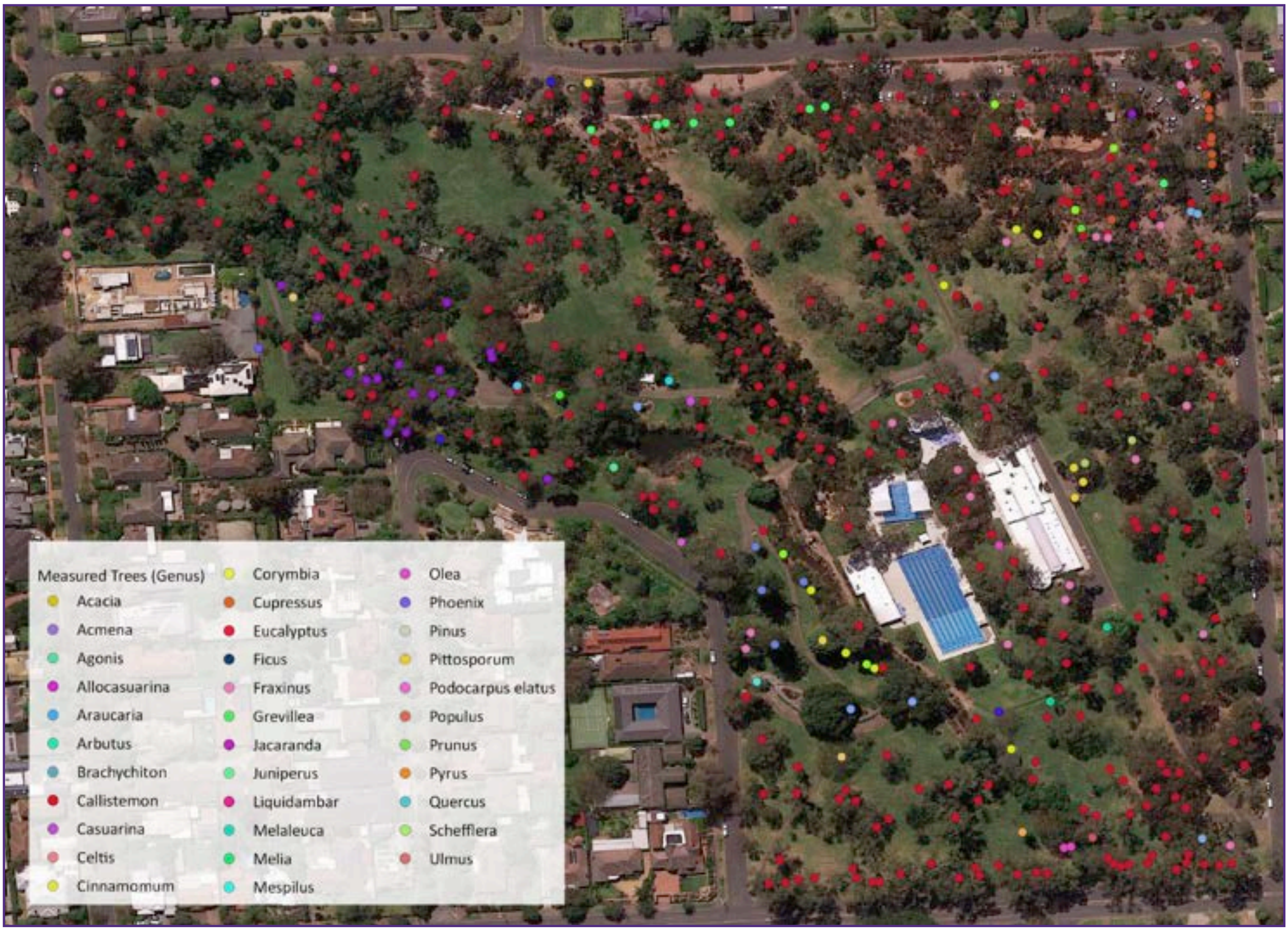


Figure 1. Context map of Hazelwood Park showing location of the 507 trees measured. Trees are categorised by Genus.

3.2 Benefit values

The current total benefits value (structural value + functional ecosystem services) of the 507 trees assessed is $8,789,879.84, including annual functional benefits of $5,646.13. Many tree benefits relate directly to the amount of woody biomass and healthy canopy and leaf surface area. As such, the following valuation results refer to trunk circumference, estimated leaf surface area, and/or canopy area of specific high valued individual trees.

3.2.1 Structural Value

Overall, the 507 trees are estimated to have a **current structural value of $8,759,836.45. Significant and regulated trees** comprise 90.7% of this value ($7,941,839.27).

The **greatest overall structural value for a species** was for the river red gums *(Eucalyptus camaldulensis)* which together had a structural value of over $5.84M, followed by the sugar gums *(E. cladocalyx)* at over $1.06M, and the SA blue gums *(E. leucoxylon)* at over $1.03M. However, these were also the most abundant species measured, and some of the largest trees recorded.

If significant and regulated trees are removed from the assessment, the greatest overall species structural value is still from river red gums ($235,950.51), followed by SA blue gums ($222,225.82) and European olives *(Olea europaea,* $89,943.53). However, these species values are still correlated with abundance, with these three species being the most abundant of the non-significant or regulated trees.

The **greatest average structural value per tree** was calculated to remove the abundance bias. In Hazelwood Park, the two Moreton Bay fig *(Ficus macrophylla)* trees had the highest average structural value per tree ($41,023.17), followed by the single hoop pine (*Araucaria cunninghamii;* $36,208.66), and single English elm ($36,082.55). Comparatively, river red gums were valued at an average of $22,759.12 per tree, sugar gums an average of $27,236.82 per tree, and SA blue gums an average of $12,642.49 per tree.

The **greatest structural values for individual trees** was $64,875.89 for a significant river red gum with a trunk circumference of 8.6m and leaf area of 3,185m^2 (Asset ID #1961), and $64,245.23 for a significant Moreton bay fig with a trunk circumference of 7.6m leaf area of 2,069m^2 (Asset ID #34500) (Plate 1; Figure 2). These were also the only two trees measured with an individual structural value greater than $60,000. The top 10 trees with the greatest individual structural values contributed $584,653.14 to the total structural value of trees measured (Figure 2). Comparatively, the lowest individual tree structural value was $3.99 for a juvenile SA blue gum with a 0.25m trunk circumference and leaf area of 0.2m^2 (Asset ID #34872). The lowest structural value for a river red gum was $50.44, for a tree with a 0.17m trunk circumference and leaf area of 7.4m^2 (Asset ID #35228).

THE HIGHEST VALUE FOR A SINGLE TREE WAS

$64,875.89

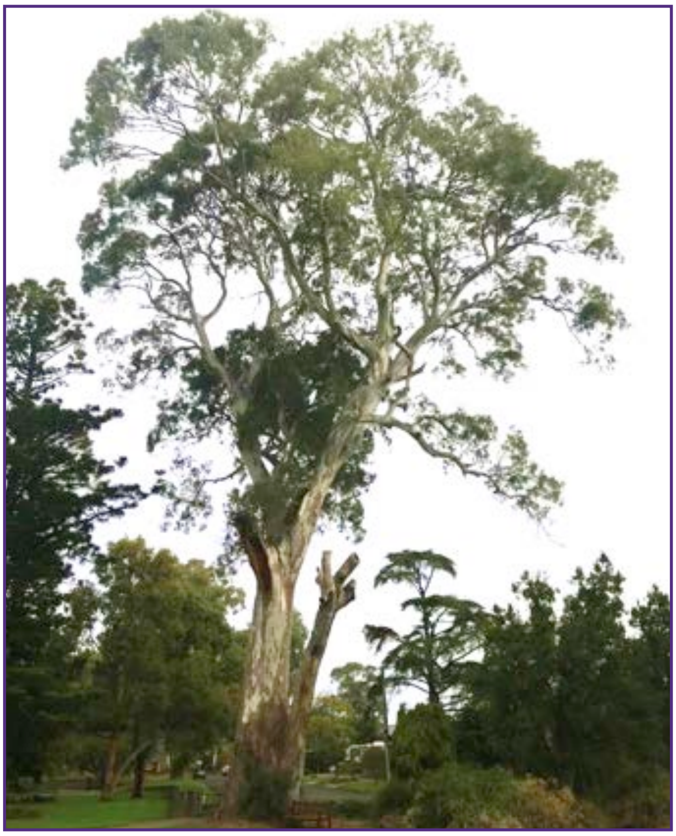


Plate 1. The two trees (of the 507 measured) with the highest individual structural values: river red gum (top right) with a structural value of $64,875.89, and Moreton Bay fig (bottom right) with a structural value of $64,245.23.

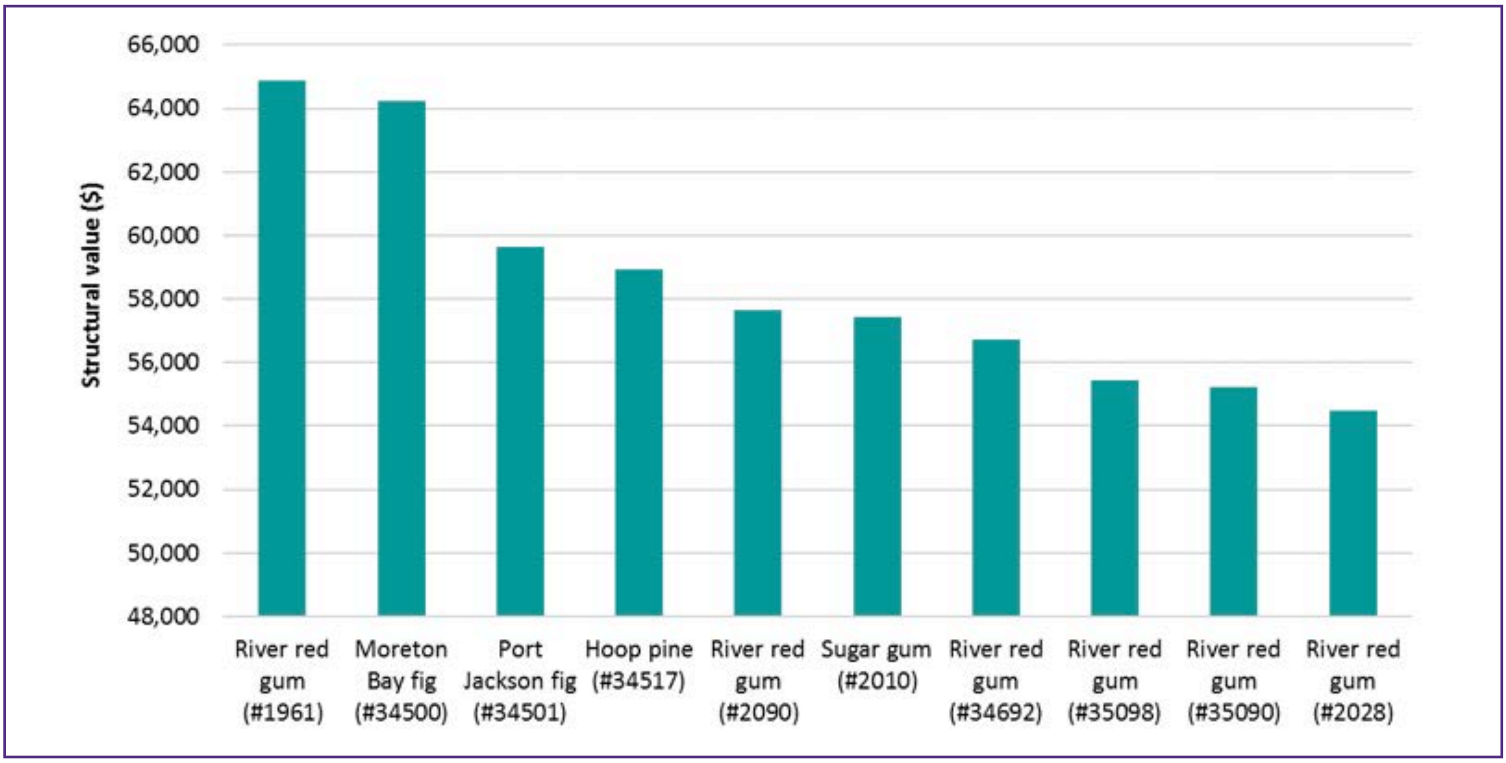


Figure 2. Structural value for the top 10 individual trees with the highest structural values (the two highest value trees are shown in Plate 1). Number in parentheses is the tree Asset ID as per the Council's tree database.

3.2.2 Functional values

The 507 trees assessed are estimated to have a **current total functional value of $30,043.39.** Over 80% of this value is attributed to carbon stored in the trees' biomass, which is an estimated cumulative value over the trees' life to date, rather than an estimate annual value. The remaining 19% of total functional value is comprised of annual ecosystem services, specifically the amount of: air pollution removed, carbon absorbed (sequestered), and stormwater avoided (rainfall intercepted). Combined annual ecosystem services for all measured trees was valued at $5,646.13. **Significant and regulated trees** comprise 92.1% of the total functional value ($27,665.48), including $4,812.66 of annual ecosystem services (85.2%).

The **greatest total functional value for a species** was provided by the river red gums which together had a functional value of $20,437.32, followed by the SA blue gums at $3,691.59, and the sugar gums at $3,541.80; with values again correlating to relative species abundance.

The **greatest average total functional value per tree** was $148.56 provided by the hoop pine, followed by the English oak (*Quercus robur*, $140.10), and Moreton Bay figs ($111.60). Comparatively, each river red gum provided an average functional value of $79.52 per tree, $45.02 for each of the SA blue gums, and an average of $90.82 for each sugar gum tree.

The greatest total functional values for individual trees were $194.15 for a significant SA blue gum with a trunk circumference of 4.7m and a leaf area of 3,564m^2, (Asset ID #36798), followed by two significant river red gums (Asset ID #35199, $192.87 and Asset ID #1961, $190.59) with respective trunk circumferences of 4.7m and 8.6m2, and leaf areas of 3,470m^2 and 3,185m^2 (Plate 2; Figure 3). Comparatively, the lowest functional value provided by individual trees was $0.10 by two juvenile blackwoods *(Acacia melanoxylon)*, both with trunk circumferences of approximately 0.1m and leaf areas of approximately 4m^2 (Asset IDs #34895, #34897). The lowest functional value provided by a river red gum was $0.12 by two trees both with 0.08m trunk circumferences and leaf areas of approximately 5-6m^2 (Asset IDs #34758, #35137).

The 10 individual trees with the greatest total functional values were all significant trees, predominantly river red gums, but also a SA blue gum and Port Jackson fig (Figure 3). Together these 10 trees have a functional value of $1,820.

Plate 2. The three trees (of the 507 measured) with the greatest individual functional values: SA blue gum (left) with a functional value of $194.15, and river red gums (middle and right) with functional values of $192.87 and $190.59, respectively.

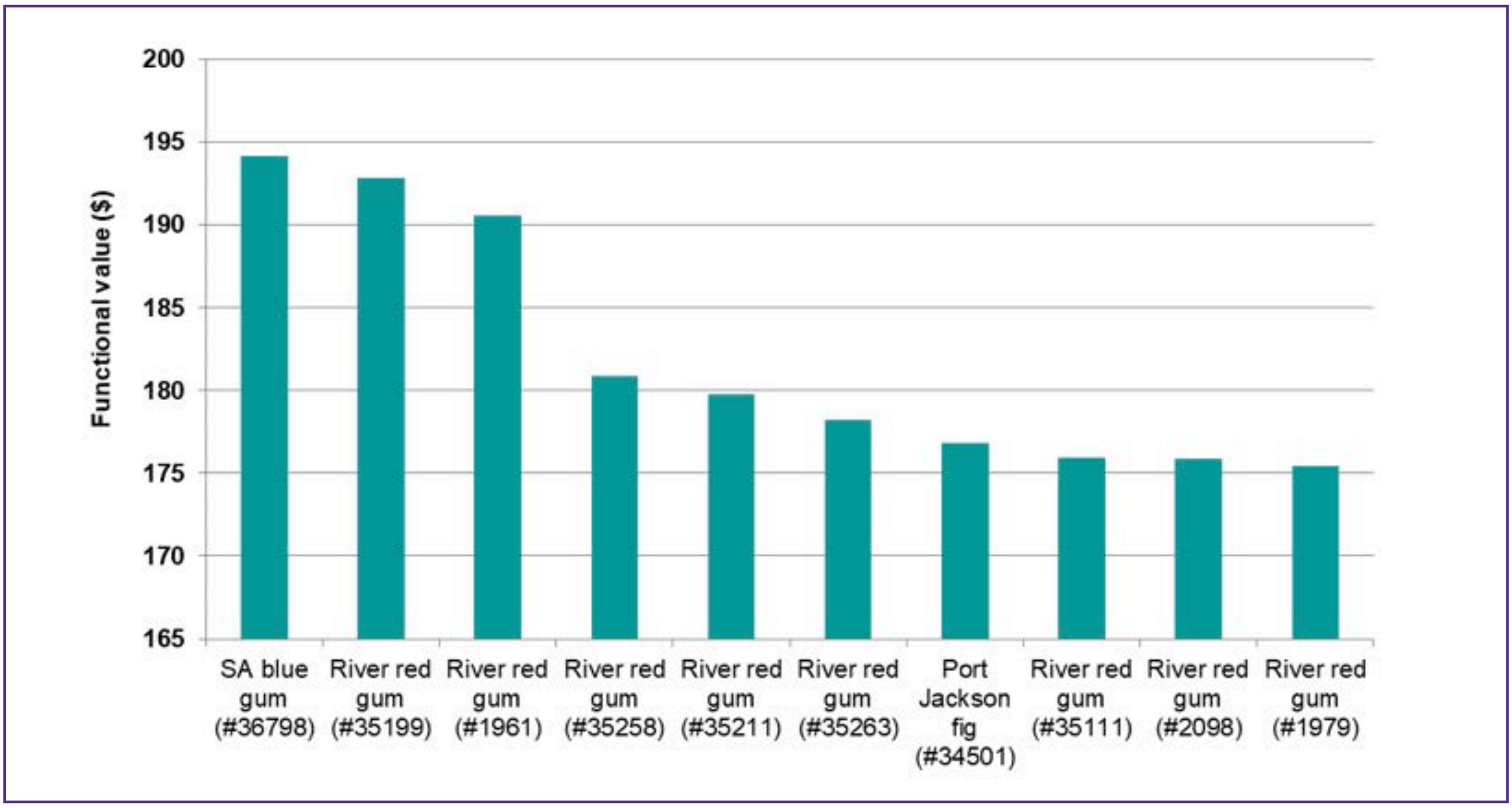


Figure 3. Functional value for the top 10 trees with the greatest individual functional value. Number in parentheses is the tree Asset ID as per the Council's tree database.

Air pollution removed

A range of pollutants contribute to decreased air quality, including some volatile organic compounds (VOCs) produced by trees. In urban areas air quality is particularly poor given the high concentration of pollutant sources, such as: vehicle exhaust emissions, solvent use, domestic heating, and industrial processes[7].

Of the main anthropogenic-produced pollutants, those considered in the i-Tree Eco assessment are: carbon monoxide (CO), ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2), and fine and coarse particulate matter (e.g. dust, smoke).

The impacts of decreased air quality are varied but often significant, including decreased human health and plant functioning, degraded ecosystem functioning, and increased infrastructure damage[8]. This is particularly problematic as most people now live and work in urban centres.

Trees have been shown to make a significant contribution to directly and indirectly improving air quality. For example, directly removing pollutants from the air and reducing air temperature, and indirectly reducing energy consumption in buildings (e.g. through shading) which results in decreased demands on power plants and so decreased emissions.

Overall, the 507 trees measured are estimated to remove 531.65kg of pollutants per year, with an associated value of $4,225.21[9]. Pollution removal was greatest for ozone (O3), with 310.44kg removed each year, valued at $2,446.91, followed by nitrogen dioxide (NO2) with 211.95kg removed each year, valued at $249.38 (Figure 4).

The **greatest annual pollution removal by a species** was provided by the river red gums which together remove 319.69kg of air pollution each year, valued at $2,541.15.

The **greatest average annual pollution removed per tree** was from two Moreton Bay figs, with each tree removing an average 2.33kg of pollution each year, valued at $18.52 per tree, followed by the two

“TREES IN THE PARK MAKE A SIGNIFICANT CONTRIBUTION TO IMPROVING AIR QUALITY” bunya pines (*Araucaria bidwillii;* 2.2kg of pollution per tree, valued at $17.54), the single hoop pine (2.12kg; $16.83), and the two Port Jackson figs (2.02kg; $16.06). Comparatively, the river red gums remove an average of 1.25kg of pollution each year per tree, valued at $9.95 per tree. This is indicative of the number of juvenile river red gums in the Park, which will provide increased service benefits as they grow and mature.

The **greatest amount of pollution removed annually by an individual tree** was 5.63kg, valued at $44.79, which was for a significant SA blue gum (Project ID #36798) (Plate 2). This SA blue gum had a trunk circumference of 4.7m and a leaf surface area of approximately 3,564m^2. Comparatively, the tree currently providing the lowest amount of pollution removal per year was juvenile SA blue gum (Asset ID #34872) which was estimated to remove 0.3g of pollution per year at a negligible dollar value. This tree had a trunk circumference of 0.25m but an estimate 97% of its canopy had been defoliated leaving an estimated leaf surface area of only 0.2m^2 (Plate 3). This highlights the importance of maintaining healthy growing trees with a thriving and full canopy if ecosystem services are to be maximised.

Plate 3. The ability for a tree to clean the air of pollutants relies heavily on a tree's leaf surface area, with a higher leaf surface area enabling greater air cleaning services. This juvenile SA blue gum currently provides the least amount of air pollution removal services per year due to an estimated 97% canopy loss resulting from herbivore and/or insect predation.

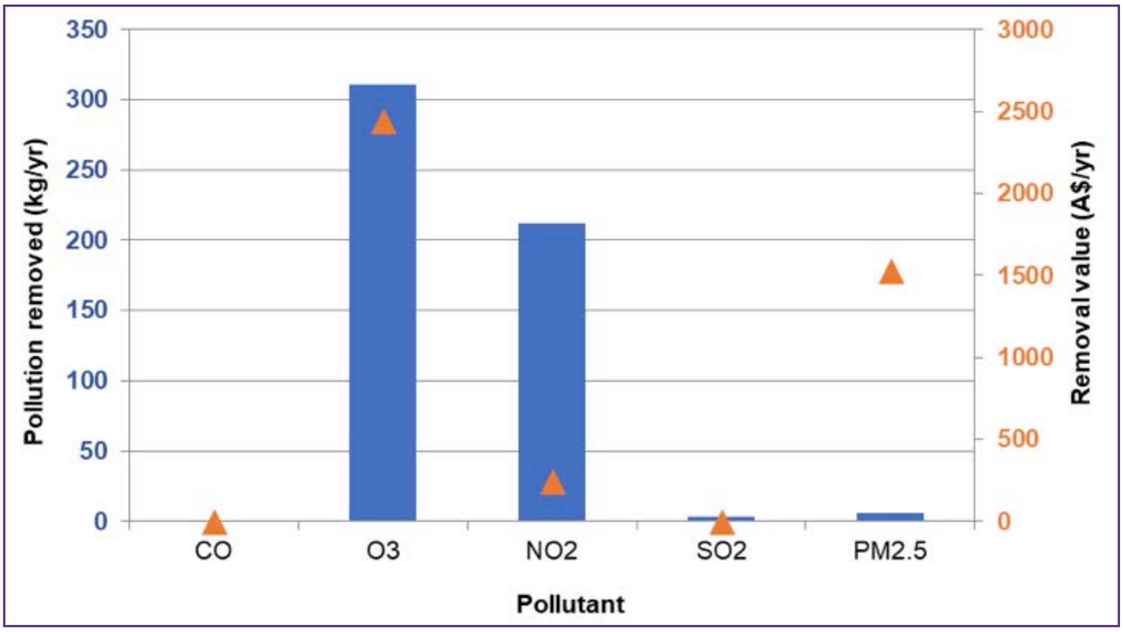


Figure 4. Amount (kg) (■) and dollar value ($) (▲) of pollutants removed per year by the 507 tees trees in Hazelwood Park. CO = carbon monoxide ($20 per tonne); O3 = ozone ($7,890 per tonne); NO2 = nitrogen dioxide ($1,180 per tonne); SO2 = sulfur dioxide ($430 per tonne); PM2.5 = fine particulate matter ($274,040 per tonne).

Carbon storage and sequestration

Climate change is a key issue of local, regional and global concern.

Urban trees can play a key role in helping to mitigate climate change impacts by sequestering atmospheric carbon (from carbon dioxide) in their tissue and by altering energy use in buildings through shading, which lowers air temperatures, and in turn can reduce carbon dioxide emissions from fossil fuel-based power plants.

As trees grow they increasingly reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. Conversely, when trees die and decay, much of their stored carbon is released back to the atmosphere. As trees mature, their growth rates slow and canopy/leaf density tends to thin. This has led to long-held assumptions that the amount and rate of carbon sequestration offered by older trees will decline.

However, a 2014 study published in Nature[10] showed that for most species, the rate of carbon accumulation continues to increase as trees mature. That is, as trees age they continue to actively fix (rather than simply store) substantial amounts of carbon compared to smaller trees, and they appear to do so at a faster rate. This is explained by ongoing increases in total leaf area which outpace declining rates of productivity per unit of leaf area and counteract declines in leaf density. Accordingly, maintaining a healthy growing and mature tree population will ensure more carbon is stored than released.

Overall, the 507 measured trees in Hazelwood Park are estimated to currently store 1,070.05 tonnes of carbon valued at $24,397.26.[11] **Significant and regulated trees** comprise 85.5% of this overall value ($3,614.19).

The **greatest species contribution to carbon storage** was from the river red gums which together store 748.22 tonnes valued at $17,059.49, followed by the sugar gums which store over 127.31 tonnes valued at $$2,902.65, and the SA blue gums which store 121.61 tonnes valued at $2,772.76.

The **greatest average amount of carbon stored per tree** was 5.55 tonnes stored by the hoop pine and valued at $126.51, followed by the English oak (5.28 tonnes; $120.5), and the Moreton Bay figs (3.85 tonnes; $87.71 each). Comparatively, the river red gums store and average of 2.9 tonnes of carbon per tree, valued at $66.38 per tree.

The **greatest amount of carbon stored by an individual tree** was 6.18 tonnes valued at $140.82 for a significant river red gum (Asset ID #1961; Plate 3). This tree's 8.6m trunk circumference was the largest of all trees measured in the Park. The 10 trees with the greatest individual carbon storage values were all significant river red gums, except for one significant SA blue gum; together they stored 6.09 tonnes of carbon valued at $1,389.27 (Figure 5).

The least amount of carbon currently stored by a tree in the Park was in two juvenile river red gums (Asset ID #35137 and 34758) which each currently store 0.8kg of carbon at a value of $0.02. These two trees also had the smallest trunk circumference of the trees measured in the Park (0.08m) indicating the importance of protecting and growing large, mature trees with high woody biomass for storing carbon.

In addition to the carbon stored, the Park's trees also sequester (absorb) carbon each year as they grow.

> "HEALTHY TREES ABSORB AND STORE MORE CARBON"

OLDER, HEALTHY TREES PROVIDE HIGHER BENEFIT VALUES

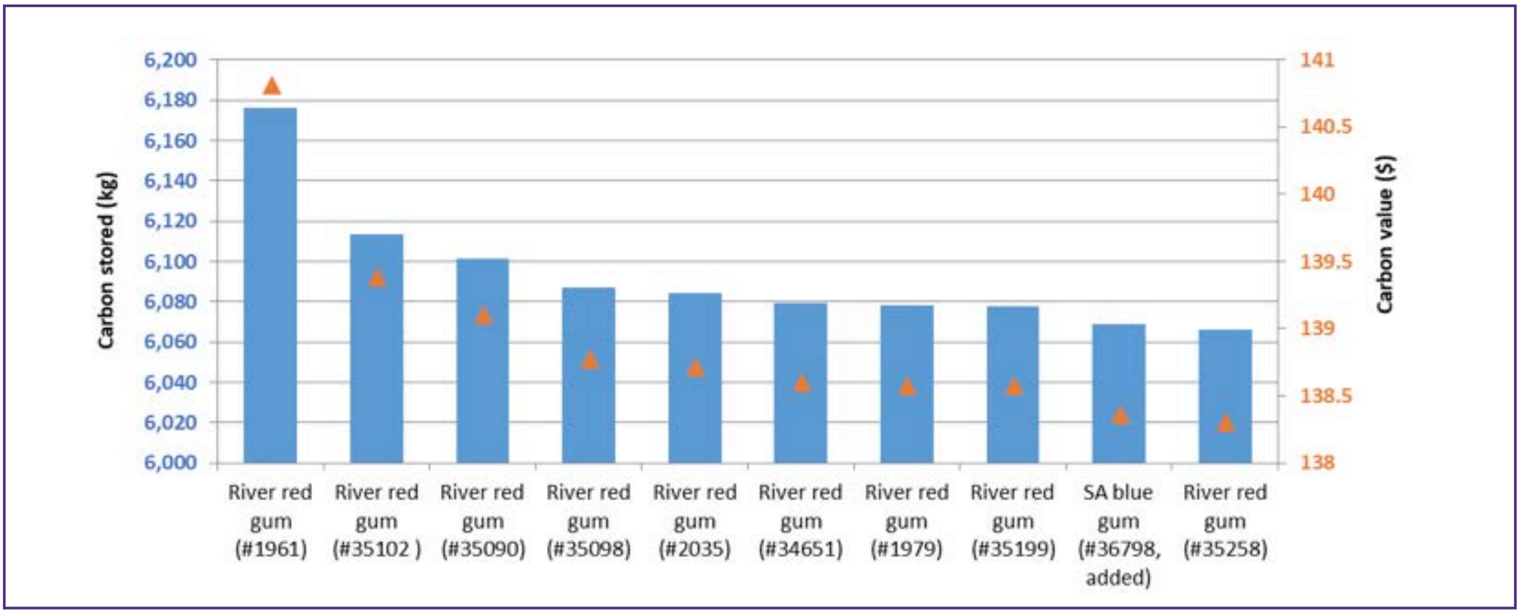


Figure 5. Estimated stored carbon (tonnes) (■) and associated value ($) (▲) for the 10 trees in Hazelwood Park with the greatest individual storage amounts. Number in parentheses is the tree Asset ID as per the Council's tree database.

Overall, the trees measured currently sequester 18.26 tonnes of carbon each year, valued at $416.36[11]. **Significant and regulated trees** comprise 81.4% of this overall value ($339.16).

The **species absorbing the greatest amount of carbon per year** were the river red gums which together sequester over 10.2 tonnes carbon each year, followed by the SA blue gums at 3.15 tonnes, and the sugar gums at 2.68 tonnes.

The **greatest average carbon absorbed per year,** per tree was 84.95 kg by the Marri, valued at $1.94, followed by the sugar gums (68.72kg; $1.57 each), and the red ironbark (63.9 kg; $1.46 each). Comparatively, the abundant river red gums sequester an average of 39.69 kg of carbon per tree per year, valued at $0.91 per tree.

The **greatest amount of carbon absorbed per year by an individual tree** was 112.6 kg, valued at $2.57, by a significant sugar gum (Asset ID #35052), and by a significant river red gum (Asset ID #2002; Plate 3). Another significant sugar gum (Asset ID #1977) also provided almost the same service, absorbing 112.4 kg of carbon per year at a value of $2.56. These three trees all had heights greater than 30m and trunk circumferences greater than 3.15m. The 10 trees with the greatest individual annual carbon sequestration values were all significant river red gums and sugar gums, which together sequester 1.09 tonnes valued at $24.88 (Figure 6).

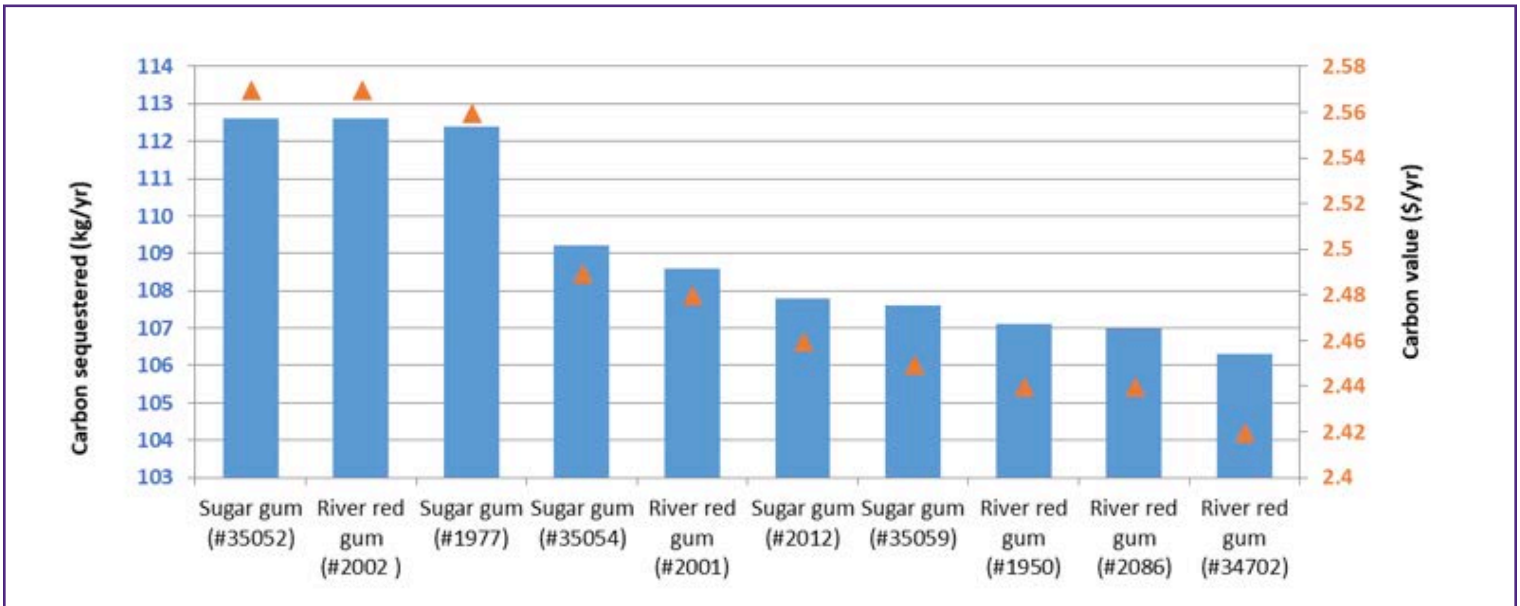


Figure 6. Estimated carbon sequestered (kg) (■) per year and associated value ($) (▲) for top 10 trees in Hazelwood Park with the greatest sequestration amounts. Number in parentheses is the tree Asset ID as per the Council's tree database.

Plate 4. Significant river red gum (left) and sugar gum (Eucalyptus cladocalyx) (right) that respectively provide the highest current carbon storage (6.18 tonnes valued at $140.82) and annual carbon sequestration (112.6kg, valued at $2.57) benefits.

Avoided stormwater runoff

Regulating stormwater runoff entering natural and public water sources is a key issue in many urban areas, particularly regarding minimising discharge rates and reducing pollutants.

The significant extent of impervious surfaces in urban areas increases the amount of surface runoff, yet urban trees can aid in reducing stormwater runoff by their leaves and branches intercepting a portion of the rain that falls, and by their root systems promoting infiltration and storage of water in the soil. Reducing the volume of runoff during a storm event helps to minimise both soil erosion, and potential and peak flow levels.

Overall, the trees measured are estimated to intercept 442m^3 of rainfall each year, valued at $1,004.56[13]. **Significant and regulated trees** comprise 85.9% of this overall value ($859.31).

The **greatest species contribution to rainfall interception** was by the river red gums which together intercept 265.9m^3 of rainfall each year, valued at $604.09; followed by SA blue gums (71.5m^3, $162.93), and the sugar gums (49.1m^3, $110.91).

The **greatest average rainfall intercepted per tree** was 1.95m^3 by the Moreton Bay fig trees and valued at $4.40, followed by the bunya pines (1.85m^3; $4.16 each), and the hoop pine (1.8m^3; $4.00). Comparatively, the river red gums intercept and average of 1.03m^3 of rainfall per tree per year, valued at $2.35 per tree.

The **greatest amount of rainfall intercepted by an individual tree** was 4.7 m3 valued at $10.63 for a significant SA blue gum (Project ID #36798) and a significant river red gum (4.6m^3, $10.35; Asset ID #35199) (Plate 5). These trees had the highest leaf surface area (3,564.3m^2 and 3,469.7m^2, respectively) and largest canopy cover area (759.6m^2 and 711.6m^2, respectively) of all the trees measured.

The 10 trees estimated to intercept the most amount of rainfall each year were significant eucalypts and a significant Port Jackson fig; together these 10 trees intercept 37.8m^3 of rainfall each year, valued at $85.37 (Figure 7).

Plate 5. Significant river red gum (left) and SA blue gum (right) that provide the highest amount of rainfall interception per year of the trees measured in Hazelwood Park (4.7 m3 valued at $10.63 and 4.6 m3 valued at $10.35, respectively).

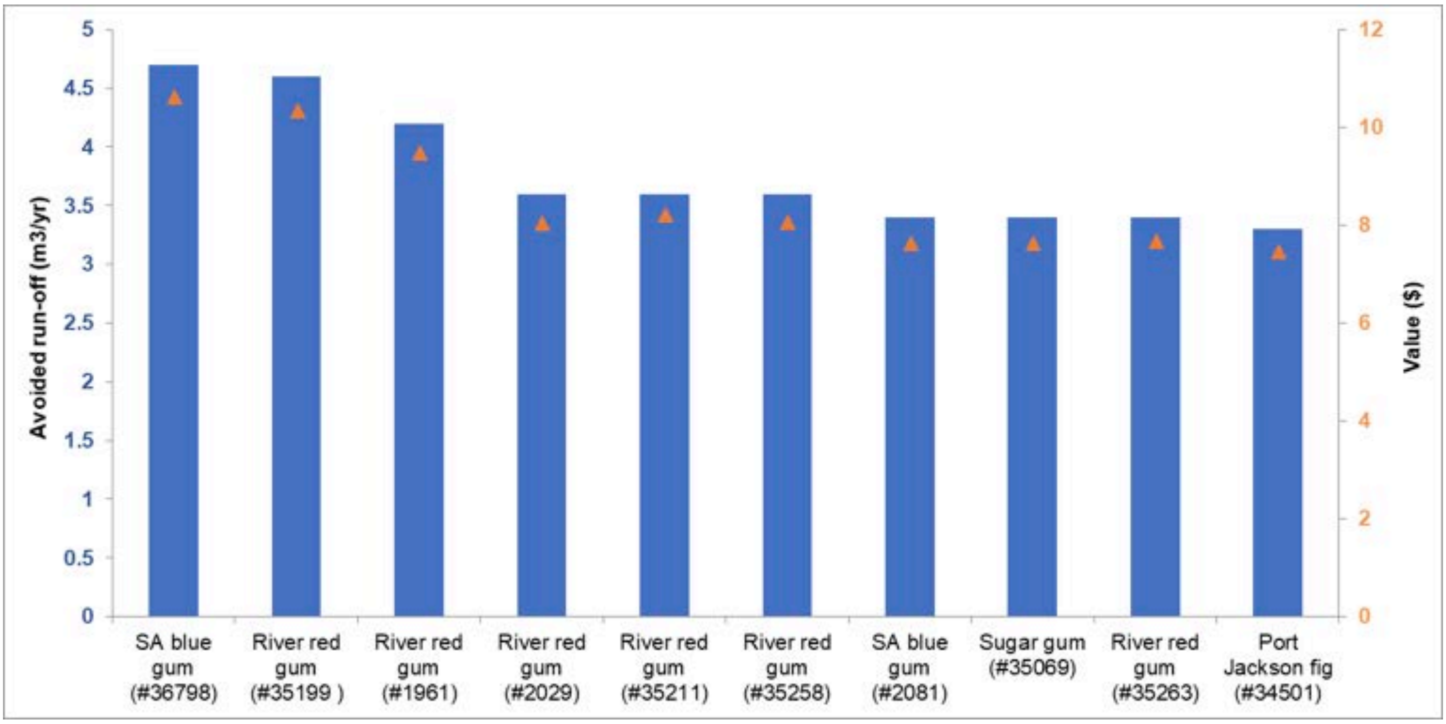


Figure 7. Estimated avoided stormwater runoff (m^3) (■) per year and associated value ($) (▲) for top 10 trees in Hazelwood Park with the greatest interception amounts. Number in parentheses is the tree Asset ID as per the Council's tree database.

ONE OF THE BEST GIFTS WE CAN GIVE FUTURE GENERATIONS ARE TREES

Anon

4. Next Steps

Urban trees offer substantial, yet often overlooked, benefit values to the liveability of cities for people and wildlife. Hazelwood Park contains some of the Council's largest and oldest trees which not only make the Park iconic in the City, but also provides a connection to the City of Burnside's history.

Through this, Hazelwood Park is much loved by the public and has a strong community stewardship interested in the well-being of the Park and the conservation of its trees.

The Park's tree population was valued using the i-Tree Eco software, which is recognised globally as the current leading tool for valuing urban trees. However, this measure was conducted on only half the population, and considers only some of those recognised benefits provided by trees, and so is highly conservative and therefore underrepresents the likely values these trees (and others) provide to the community and liveability of the City.

Although being conservative, beginning to understand an urban forest's structure, function and economic value can be useful in building the business-case for urban trees by allowing an asset value for trees to be recognised and communicated. This information can help to inform strategic planning and management decisions that will improve human health, environmental quality, and long-term urban resilience. It can be used to advocate tree protection and community awareness of the benefits these trees provide. Engaging the community is a key mechanism for helping to create positive perceptions about trees and encourage tree plantings and protection on private land, which will be essential to maintain and grow a resilient urban forest.

Based on this project's findings, the following ongoing actions are proposed as short- to long-term priorities to further help protect and grow Burnside's urban forest:

ACTION 1 COLLATE

ACTION 2 ENGAGE

ACTION 3 EXPAND

COLLATE i-Tree Eco outputs with existing Council tree databases to facilitate strategic planning and management decision-making.

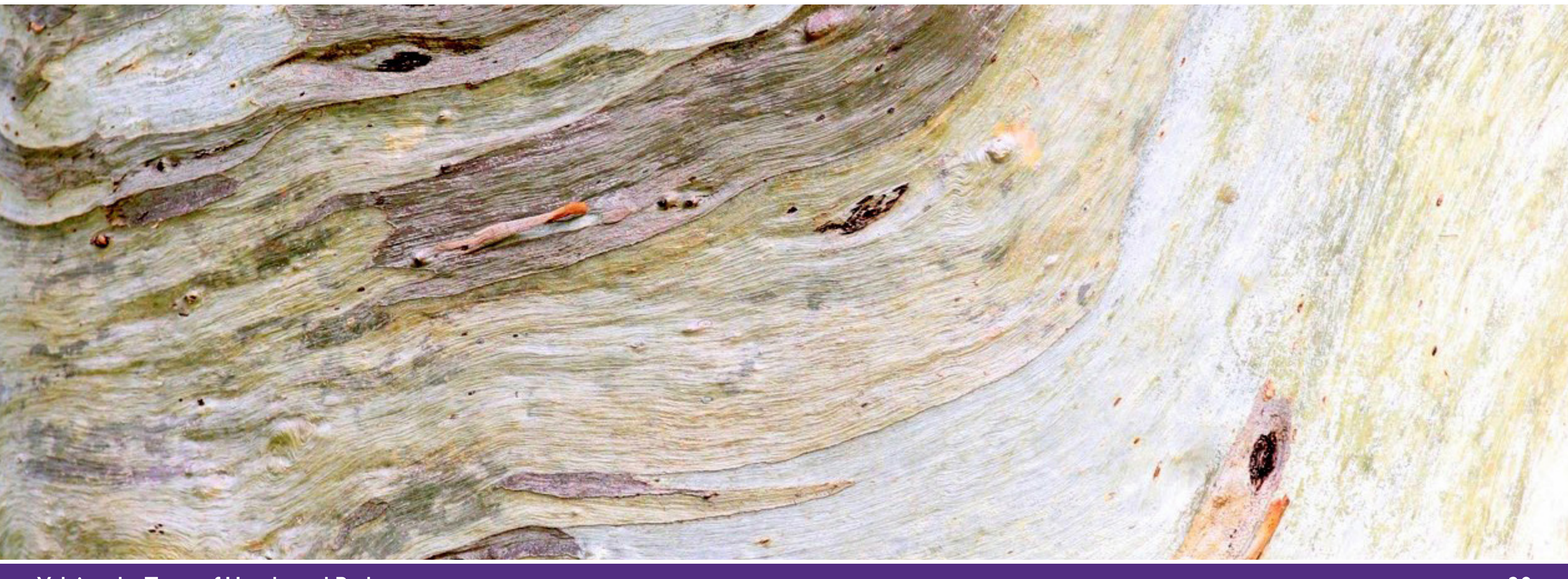
ENGAGE and educate the community about the value of trees. This could be achieved through a Tree Engagement Experience (TrEE) using the outputs from this i-Tree Eco assessment.

- **A TrEE is a highly flexible and evolving staged activities that can be designed to suit Council's and the community's needs and interests. Activities that have proved particularly popular include: Tree Tags, Tree Tags Trails, free public launch events, and vox pop filming.**

EXPAND this i-Tree assessment to cover all public trees in the City of Burnside. This can include a community volunteer element for the data collection process which will expedite the process and act as a potential TrEE activity as outline in Action 2.

Footnotes and References

1. Developed in the USA by the USDA Forest Service and other collaborators. www.itreetools.org
2. Nowak DJ et al. (2002) Compensatory value of urban trees in the United States. Journal ofArboriculture, 28: 194-199.
3. Watson G (2001) A study of CTLA formula values. Journal of Arboriculture, 27:289-297; Watson G (2002) Comparing formula methods of tree appraisal. Journal of Arboriculture, 28: 11-18.
4. Structural value in Australia is calculated using the same procedure as in the U.S. (Nowak et al. 2002). Base costs and species values for VIC and NSW are derived from Arboriculture Australia and applied to all States and territories.
5. i-Tree Eco User's Manual version 6.0. Available at: http://www.itreetools.org/resources/manuals/Ecov6_ManualsGuides/Ecov6_UsersManual.pdf
6. Further details on structural value calculations are available here: http://www.itreetools.org/eco/resources/08%20UFORE.pdf
7. State of the Environment 2011 Committee (2011) Australia State of the Environment 2011. Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities, Australia: DSEWPaC.
8. Ayres J, Maynard R, Richards R (eds) (2006) Air Pollution Reviews, Volume 3: Air Pollution and Health. UK: Imperial College Press. Brimblecombe P (ed) (2003) Air Pollution Reviews, Volume 2: The Effects of Air Pollution on the Built Environment. UK: Imperial College Press. Brimblecombe P (ed) (2016) Air Pollution Reviews, Volume 5: Urban Pollution and Changes to Materials and Building Surfaces. UK: Imperial College Press. World Health Organization Regional Office for Europe, 2013. Review of Evidence on Health Aspects of Air Pollution - REVIHAAP Project. First Results., Denmark: World Health Organization.
9. Pollution removal value was calculated based on the prices of: $0.02/kg (carbon monoxide), $7.89/kg (ozone), $1.18/kg (nitrogen dioxide), $0.43/kg (sulfur dioxide), and $274.04/kg (particulate matter less than 2.5 microns).
10. Stephenson N et al. (2014) Rate of tree carbon accumulation increases continuously with tree size. Nature, 507: 90-93.
11. Carbon storage and gross carbon sequestration values calculated based on a carbon market price of $0.0228/kg.
12. Avoided runoff values calculated at a price of $2.262/m^3 and based on a 12cm annual rainfall as per Adelaide Airport weather station recorded data for 2011.



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City of Burnside acknowledge our trees stand on Kaurna land