Maribyrnong
CITY COUNCIL

Urban Forest Strategy

December 2018

Contents

Introduction

Our cities are dynamic and complex urban environments.

A critical component of cities that can signify social and ecological health, equity, resilience and liveability, are the living elements of these cities, particularly the vegetation, trees and plants. Urban vegetation is for cities like food is for humans.

Maribyrnong's trees and vegetation, its urban forest, plays such an important role in the overall health and liveability of the western Melbourne region that there is now a recognised need to plan for and manage it effectively to maximise social, environmental and economic benefits. Trees are one of the top four reasons why Maribyrnong residents visit the City's parks and gardens.

Maribyrnong has a past history and attributed character of industrialisation that is becoming less relevant as the Municipality transitions into a thriving, multicultural and economically diverse inner city locale. This transition towards people away from industry, is an opportunity to reflect the same within the urban fabric of Maribyrnong. Creating streets for people, accessible and high quality open space, tree-lined boulevards, inviting and safe commercial and retail precincts are some such ideals for the municipality.

This Strategy fits within the **context** of the Council Plan 2017-2021 which incorporates the Municipal Health and Wellbeing Plan, and a suite of existing policy and planning documents. The Strategy is also supported by a range of broader regional programs and collaborations including *Greening the West* and *Resilient Melbourne*.

Our vision

We want to live in a sustainable city that maximises the many benefits of urban trees.

We want our City to be leafy, cool and inviting.

Our **vision** is for *'A Greener Maribyrnong'*.

As part of this we want to see:

- More trees planted in streets and parks
- More large canopy trees across the city
- More tree planting in major infrastructure projects
- Better protection of significant trees
- Better awareness of the value and benefits of trees
- Improved amenity and neighbourhood character
- Cooler, healthier neighbourhoods.

Our objectives

The objectives of the Strategy are to:

- Increase tree canopy on public land
- Adapt to climate change and maximise environmental outcomes
- Raise awareness and improve advocacy
- Improve outcomes for trees on private land
- Maximise community health and wellbeing outcomes
- Support and enhance our local biodiversity
- Streamline Council's processes and monitor progress.

Targets

These objectives will be measured by targets to:

- Increase canopy cover in the public realm to 20% by 2040
- Seek gains in canopy cover on private land and at a minimum achieve no net loss.

Strategic framework

MUNICIPAL STRATEGIC STATEMENT

COUNCIL PLAN 2017-2021 AND MUNICIPAL HEALTH & WELLBEING PLAN

MARIBYRNONG PLANNING SCHEME

URBAN FOREST STRATEGY

MARIBYRNONG OPEN SPACE STRATEGY

HERITAGE PLAN AND REVIEW

Recommends protection for important natural and cultural heritage places

STREET TREE PLANTING STRATEGY

Recommends which species to be planted in each location

OPERATIONAL AND MANAGEMENT PLANS

Technical guidelines for operational tree planting and renewal

Why an urban forest strategy?

Trees are valuable to everyone in the city. The benefits include:

Health and wellbeing

- Provision of natural shade and shelter for people: Canopy trees reduce daytime temperatures between 5 and 20 degrees Celsius (*Akbari et al., 1997; Livesley, 2010*)
- Improved desirability of a neighbourhood and encourage people to spend time outdoors and interact with their community, particularly in areas of socio-economic disadvantage*
- Improved amenity and aesthetics of public open space, encouraging people to be active*
- Encouragement of pedestrian and cycling activity which can contribute to more sustainable transport use
- Provision of uniform, avenue like plantings along streets encourages motorists to drive more slowly and creates safer streets*
- Reduced air, water and soil pollution*
- improved real and perceived community safety in public spaces
- improved mental health from exposure to natural environments including lower levels of stress and anxiety.

Environmental

- Effective reduction of the Urban Heat Island Effect (Silva 2010, Rozenzwieg 2009, Gober 2010 etc.) (Adams Smith 2014) (GHD, 2011)
- Sequestering of carbon, particulate matter and other air pollutants*
- Reducing the severity of localised flooding by intercepting stormwater*
- Connecting biodiverse locations and provide localised biodiversity habitat (including understory)*.

Economic and amenity

- Improved city image and streetscape amenity
- Improved retail activity by up to 20%. Shoppers spend longer and more money in retail areas that are well treed and landscaped (Wolf, 2005)
- Increased house prices through the provision of higher streetscape amenity (Plant, 2016, Pandit 2013)
- Improved character, amenity, and brand of the region*
- Reducing energy use in buildings: a 10% increase in deciduous tree cover can reduce heating and cooling costs in houses by 5-10% (Simpson and McPherson, 1996; Akbari et al., 2001).

*(*All referenced from Mullaney, 2014)*

Drivers for change

There are a number of drivers for why an urban Forest Strategy is needed for Maribyrnong. These include:

1. HISTORICALLY LOW CANOPY COVER

Historical land use patterns in the Maribyrnong area have resulted in a low baseline tree canopy due to large industrial areas and narrow streets with small lots not supporting a large number of trees. Further, Maribyrnong's pre-existing vegetation classes, being predominantly Plains Grassland and Woodland Mosaic did not support extensive canopy cover, as determined by temperature, rainfall and soil types.

2. CANOPY COVER CHANGE

An independent study has found that Council's proactive tree planting is increasing the growth of canopy cover in the public realm (in both streets and open space). Conversely, tree canopy cover in the private realm has decreased slightly by 0.5% between 2011 and 2017. This change has seen the City's overall canopy cover decline slightly between 2011 and 2017.

Canopy modelling suggests that street and park tree canopy will continue to grow incrementally, taking into account future growth of many juvenile trees. However, if continuing along on the same path of loss in the private realm, it is likely that this public tree canopy growth may not be able to mitigate the loss on private land.

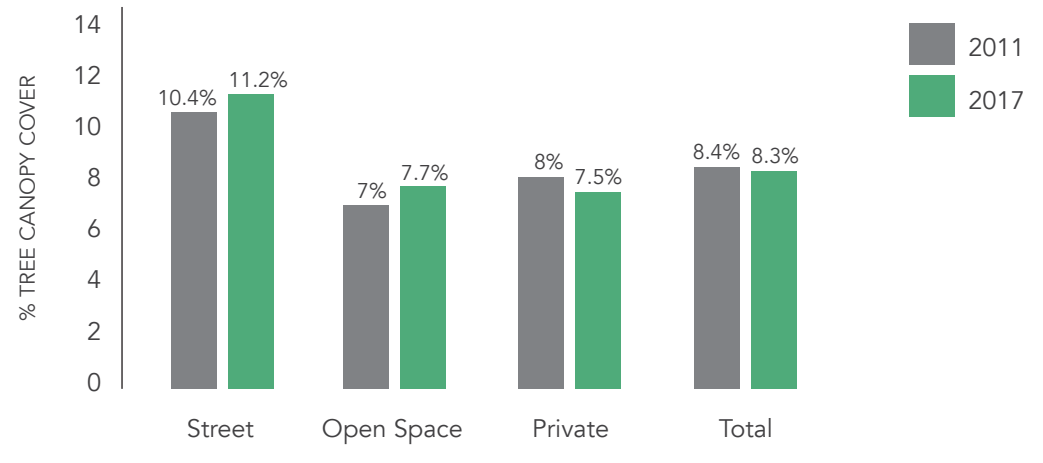

Figure 1: Percentage of canopy cover across the municipality by land tenure type

3. CLIMATE CHANGE AND URBAN HEAT ISLAND EFFECT

Climate change modelling shows that Maribyrnong's urban environment will get hotter and drier, with more extreme weather events, like flooding and heatwaves. This will be particularly felt in the western region of metropolitan Melbourne, where overall tree and green cover is lower than its eastern counterparts but where population and urban development is growing quickly. The Urban Heat Island effect, whereby heat is retained in the hard surfaces of an urban landscape and reradiated out at night is particularly problematic in the inner areas of Melbourne and exacerbates extreme heat events, which has serious human health impacts.

The image below shows thermal hotspots and cool spots across the City. Surfaces that commonly register as hotspots are large dark industrial roofing, bare earth and concrete patches, large shopping centres, at grade carparks etc. Cool spots, found in blue are waterways, irrigated open space, parkland and even industrial cool roofing. Hotspots can be ameliorated by increased vegetation and water in the landscape.

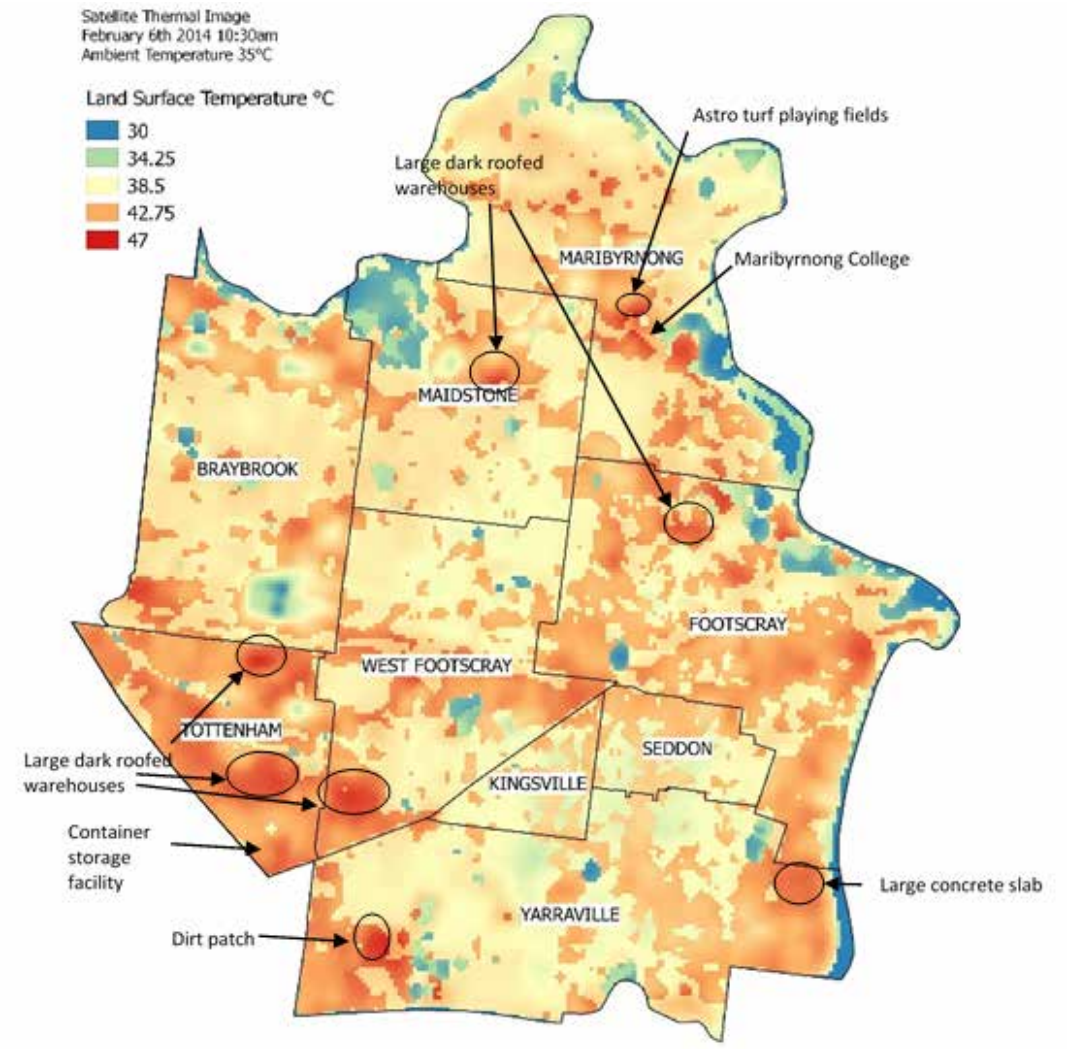

Figure 2: Thermal Satellite Image over Maribyrnong City Council showing hot spots in orange and red and cool spots in blue.

4. POPULATION GROWTH

Maribyrnong's resident population is forecast to increase by over 65% by 2041, reaching a total of 157,000 people. The current population (2018) is 94,124.

This growth means that additional housing, public infrastructure and services will be required, including quality open space to meet the health and wellbeing needs of this growth.

The character and amenity of our neighbourhoods and activity centres must also keep pace with the needs and expectations of this growing community.

5. INCREASED DENSITY OF DEVELOPMENT

Hard surfaces across Maribyrnong's land area increased by 1.5% from 2011 to 2017. This was predominantly at the expense of grass or bare earth which decreased from 26.2% to 24.3%. Population growth will require further densification and urban consolidation to meet the housing and service requirements of future communities. This will place pressure on Maribyrnongs' urban forest and open spaces as the economic return on property development competes with the intangible benefits provided by green public space.

The full amenity and environmental values of trees should be considered in planning for the growth of the City to ensure a balanced consideration of appropriate land uses and development types.

The Maribyrnong Open Space Strategy frames requirements for additional open space and enhancement of the Maribyrnong River corridor. The urban forest plays an important role in improving the quality of open space through shade provision, biodiversity value and also amenity and character.

6. CONFLICTS WITH INFRASTRUCTURE

Previous tree planting regimes, particularly those in the 1970's and 1980's did not always comply with the common sense approach of planting the right tree in the right place. Added to this, some trees were planted well before urban development encroached on their growing space. As a result, planners are now left with a legacy of inappropriately planted trees in locations that cause conflict with both hard infrastructure and service provision such as stormwater, sewerage and electricity. Council has been undertaking a program of works to remove inappropriate trees and replace them with more appropriate species for the location. However, some damage has occurred and rectification required. Council are ever mindful of mitigating ongoing risk through all of their asset programming.

7. INTEGRATED WATER MANAGEMENT

For trees and urban vegetation to thrive and mitigate urban heat, retaining and using stormwater in the landscape is a high priority. Integrated water management involves a holistic approach that considers alternative water uses and sources, such as passive irrigation of street and park trees, and stormwater treatment and harvesting.

Council is participating in the State-led forum for the Maribyrnong catchment of the Integrated Water Management (IWM) Framework for Victoria. There is also the opportunity for Council to improve tree health and growth through a Council IWM Plan.

Figure 3: The many constraints a tree must contend with to grow in inner Melbourne.

Current state of our urban forest

Council manages 46,000 trees in streets and open space. The amenity value of these is estimated to be $32,000,000. Based on the current tree planting program this value will double by 2025 to $64,000,000.

An independent analysis of Maribyrnong's street and park trees found that overall the public urban forest has good levels of diversity of species, age and useful life expectancy within the population suggesting a well managed and thriving urban forest. Further analysis is contained in Appendix A.

The implementation of the Maribyrnong Street Tree Planting Strategy 2013 has resulted in considerable additional investment in new tree planting. Council's Urban Tree Renewal Plan has also resulted in improved tree management and practices.

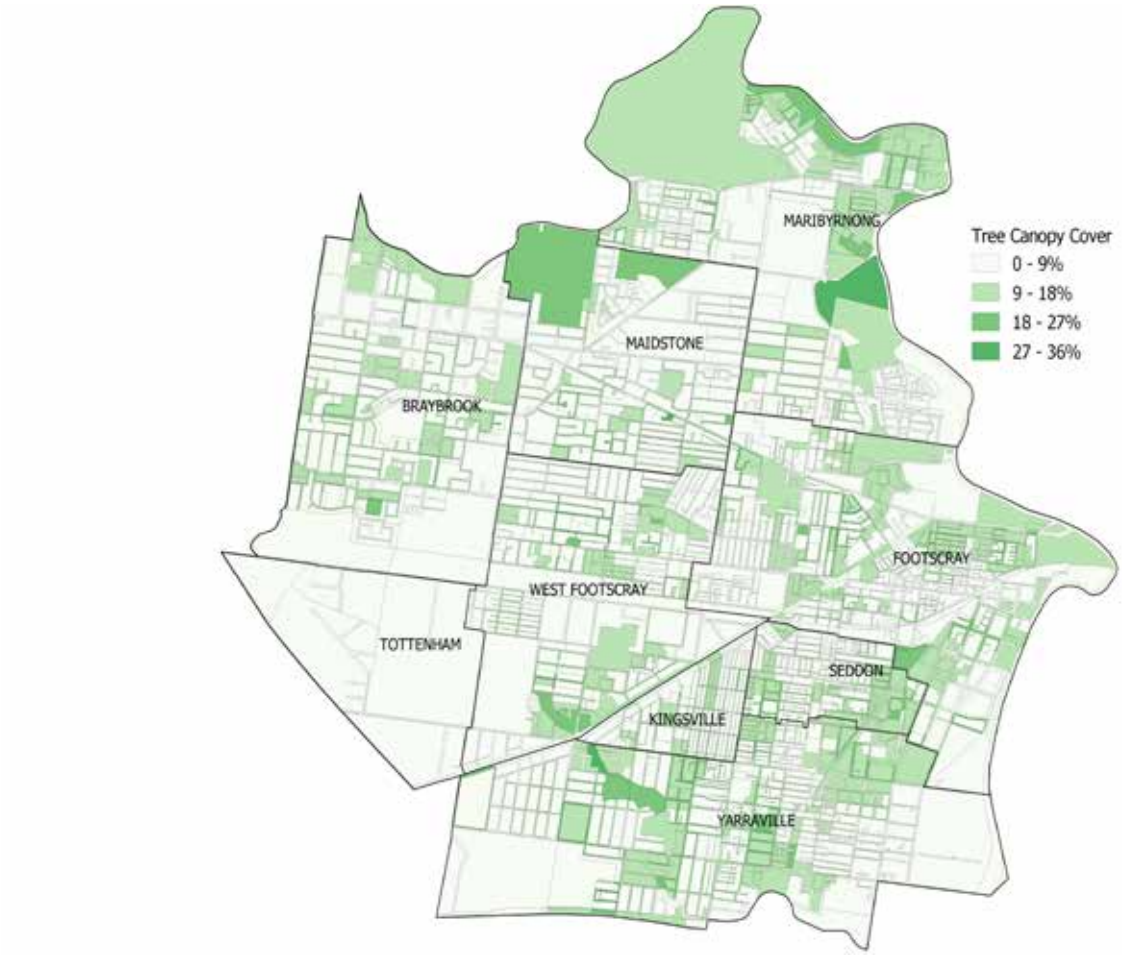

Figure 4: Distribution of Tree Canopy Cover in Maribyrnong

Clean Air and Urban Landscapes Hub (2018) Metropolitan Melbourne Vegetation 2014, Department of Environment, Land, Water & Planning, Melbourne

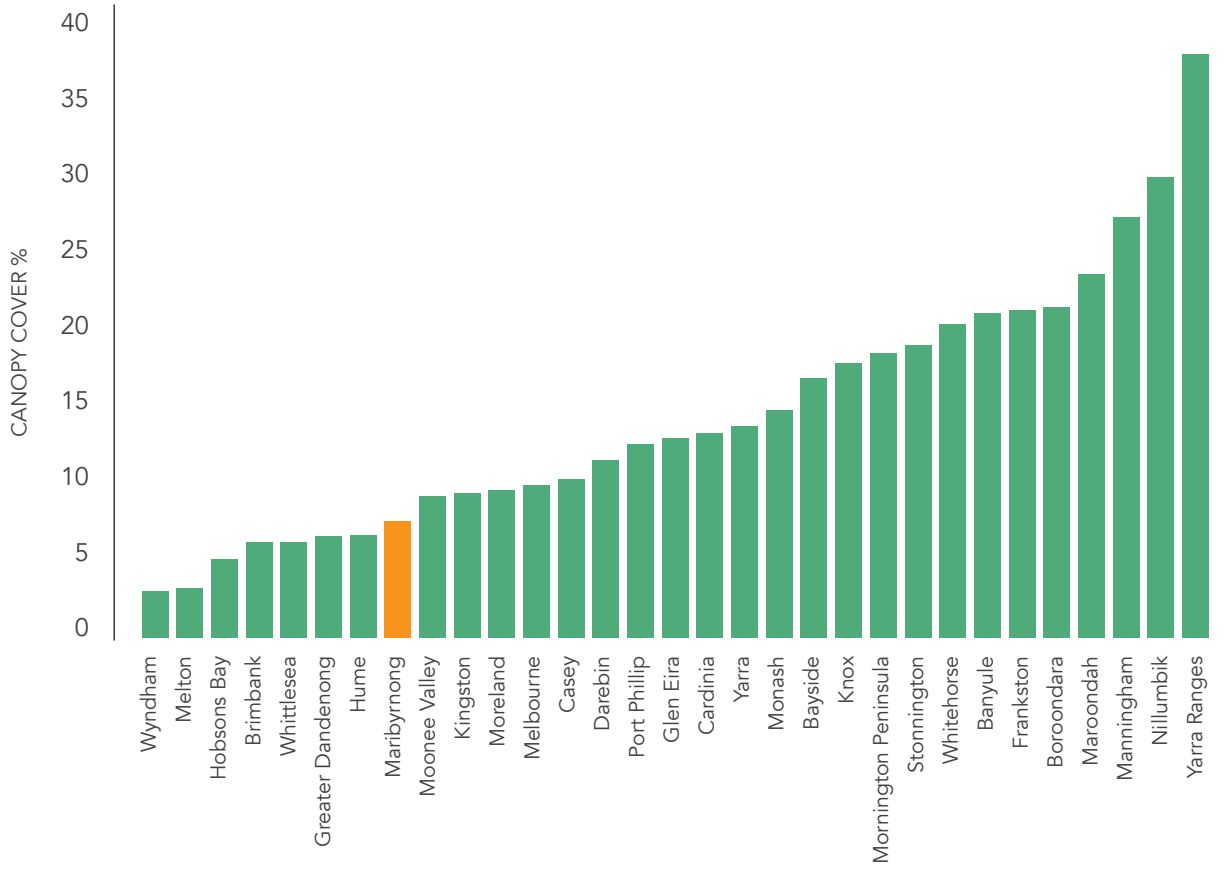

Figure 5: Tree canopy cover

Clean Air and Urban Landscapes Hub (2018) Metropolitan Melbourne Vegetation 2014, Department of Environment, Land, Water & Planning, Melbourne

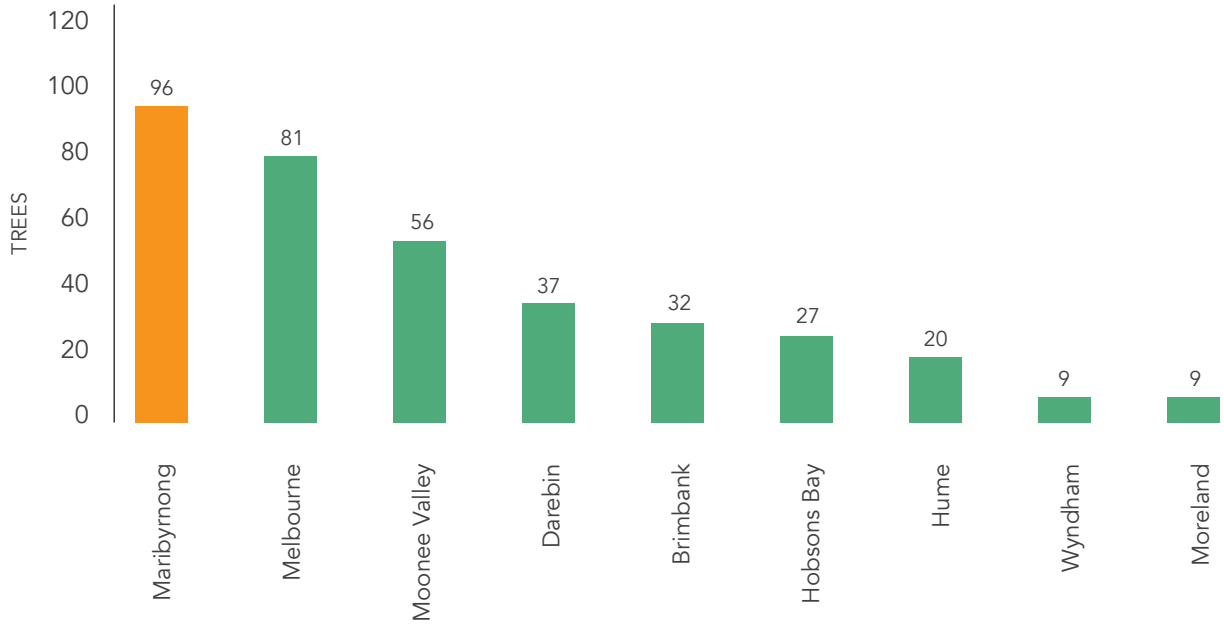

Figure 6: Number of trees established per square kilometre in various inner city municipalities

Since 2014 we have achieved the following:

- 12,000 new trees planted and established
- a 95% success rate achieved in establishment
- more trees planted per km2 than any other Melbourne Council
- increased species diversity
- major boulevards planted along Ballarat Road and Geelong Road through partnerships with VicRoads.

CANOPY COVER

Much of Maribyrnong is characterised by areas of industrial land, small parcels of parkland and narrow streets which currently do not support adequate levels of canopy cover.

Hence Maribyrnong has a low canopy cover compared to most Victorian municipal areas despite intensive tree planting efforts in the public realm. Total canopy cover in 2018 is measured at 8.3%.

It is important to note that Maribyrnong's pre-existing ecological vegetation classes are Plains Grasslands and Plains Grasslands/Woodland Mosaic benchmarks which again did not support high levels of tree canopy cover unlike the eastern suburbs of Nillumbik, Maroondah and Banyule.

However, given Maribyrnong's highly urbanised landscape and its future as an inner city residential municipality, the level of canopy should and can be increased to provide much needed benefits, particularly as canopy has been decreasing since 2011.

TREES ON PRIVATE LAND

Around 70% of Maribyrnong's land area is owned privately or by other institutions. There is a large amount of urban forest not actively managed or controlled by Council. Trees on private land are influenced heavily by two things: people's preferences towards urban vegetation and urban densification and the Victorian Planning System.

There is the opportunity for Maribyrnong to increase regulation and protection of trees on private land in order to address the current slight decline in canopy cover in the private realm. Incentives and innovative design could also be encouraged to realise to a greater extent the benefits of trees in quality development.

DOMINANCE OF SMALLER TREES

Given the space constraints and infrastructure layers within Maribyrnong's public realm, smaller tree species dominate the public urban forest. This has been due to the need to mitigate risk and conflict with existing infrastructure.

However, this has limited the number of larger canopy trees. Research definitively reveals that large canopy trees can provide up to 60-70 times the benefits of smaller trees e.g. shade, cooling and air pollution mitigation. Locations for larger canopied trees should be prioritised as part of an ongoing tree planting program. Existing large canopied trees in both the public and private realm should also be protected from removal where possible.

LOCAL COMMUNITY AND ORGANISATIONAL AWARENESS

There is a growing awareness in the community of the value of urban vegetation. Council has an important role in promoting the benefits that urban trees and vegetation provide neighbourhoods and the importance of retaining trees within the private realm. Urban forest leadership, education and awareness will need sufficient skills, resourcing and appropriate policy settings to effect change.

THE URBAN FOREST MOVEMENT ACROSS AUSTRALIA

There is now a large and growing evidence base supporting the importance of urban forests across Australia. As a result, local and state governments are endorsing urban forest commitments for their own jurisdictions, aiming to increase tree canopy cover, incorporate more water sensitive design, enhance biodiversity and raise awareness for the urban forest.

More detailed information and data on Maribyrnong's existing urban forest can be found in Appendix A.

BIODIVERSITY

Providing native habitat and improving biodiversity is key to achieving a 'Clean and Green City', per the Council Plan. Council's Rangers and committed community groups run a range of educational, conservation and revegetation programs, but there is still the need for an overall Biodiversity Plan. Quality data is needed to inform improved connectivity, revegetation efforts and to identify the key role that Maribyrnong residents play in improving biodiversity.

The Biodiversity Plan will focus on the bushland areas along the waterways, in the open spaces along the Maribyrnong River valley and Stony Creek. Council's street tree planting program will also continue to build in appropriate species selection to ensure biodiversity outcomes are prioritised in relevant locations.

Action Plan

Objectives

The actions in the implementation plan below have been identified to deliver the following objectives:

- Increase tree canopy on public land
- Adapt to climate change and maximise environmental outcomes
- Raise awareness and improve advocacy
- Improve planning processes for trees
- Maximise community health and wellbeing outcomes
- Streamline Council's processes and monitor progress.

Target

These objectives will be measured by targets to:

- Increase canopy cover in the public realm to 20% by 2040
- Seek gains in canopy cover on private land and at a minimum achieve no net loss.

Actions

URBAN FOREST IMPLEMENTATION PLAN

Objective	Action	Timing
1. Increase tree canopy on public land	**1.1** Review and continue to implement the Street Tree Planting Strategy	Short
	1.2 Identify innovative opportunities for increased tree planting and green space in streets including such as kerb outstands, median, roundabout and nature strips	Short
	1.3 Continue to work and negotiate closely with VicRoads and other authorities to explore tree planting opportunities in non Council infrastructure projects	Short
	1.4 Develop tree planting plans for all major open spaces, that complements active recreation including locations suitable for large canopy trees	Medium
	1.5 Implement boulevard planting plans as outlined in the Street Tree Planting Strategy in collaboration with VicRoads	Medium
	1.6 Review and update preferred and adaptive species list considering viability and availability of stock	Ongoing
2. Adapt to climate change and maximise environmental outcomes	**2.1** Develop an integrated water management plan to encourage the use of water sensitive urban design as appropriate incorporate use of stormwater for passive irrigation in streets and open spaces wherever possible	Medium
	2.2 Reduce paved/hard surface areas in streets and Council carparks and explore innovative materials paving to reduce heat island effect. E.g. narrower road lanes, larger vegetated areas, new medians or permeable paving where possible	Ongoing
	2.3 Maintain a diversity of tree species throughout Maribyrnong's streets, parks and reserves including both native and exotic species in alignment with other Council strategic priorities	Ongoing
	2.4 Investigate and trial tree species tolerant of predicted change in local climate and innovative planting typologies in alignment with other Council strategic priorities	Ongoing
3. Raise awareness and improve advocacy	**3.1** Coordinate promotional activities including free trees for residents at seasonal events	Short
	3.2 Undertake community engagement on street reconstruction projects to maximise greening opportunities in local streets	Short
	3.3 Increase communications and media coverage about Maribyrnong's urban forest	Short
	3.4 Develop Precinct Planting Plans through consultation, to inform the Street Tree Planting Strategy	Medium
	3.5 Lead conversations around desired neighbourhood amenity and character and the benefits of trees	Ongoing
	3.6 Participate in the Greening the West program with neighbouring Council's , VicRoads and City West Water	Ongoing

4. Improve outcomes for trees on private land	**4.1** Update landscape guidelines for planning applications to guide tree planting in private development for best practice outcomes	Short
	4.2 Progress a Significant Tree Register to protect existing canopy trees in the private realm from removal or damage and explore appropriate planning or local law mechanism for ongoing protection	Medium
	4.3 Prepare an Urban Forest Strategy Technical Report to analyse and support the preparation of appropriate planning scheme changes or suitable guidelines or other mechanisms to implement the design and tree protection measures of the Urban Forest Strategy.	Medium
	4.4 Continue to monitor and enforce conditions on planning permits to ensure landscape plans are implemented	Ongoing
	4.5 Continue to enforce the protection of identified public and private trees during construction works using tree management plans, tree protection zones and regular inspections	Ongoing
	4.6 Explore non-regulatory mechanisms to encourage planting of canopy trees in new developments e.g. incentives, educations, supporting innovative developers	Ongoing
5. Maximise community health and wellbeing outcomes	**5.1** Prioritise canopy tree planting in activity centres, along pedestrian routes and known heat spots	Short
	5.2 Work with schools and community groups to encourage shade tree planting programs	Medium
6. Support and enhance our local biodiversity	**6.1** Develop a biodiversity / habitat connectivity plan to guide revegetation efforts in areas along the Maribyrnong River and Stony Creek corridors	Medium
	6.2 Provide plant species selection guidelines for residents e.g. 'What to plant in your backyard'	Medium
	6.3 Continue to engage with and support local tree planting community groups such as 'Friends' groups	Ongoing
	6.4 Collaborate with surrounding municipalities, waterway managers and community groups to enhance biodiversity links within and outside of Maribyrnong	Ongoing
7. Streamline Council's processes and monitor progress	**7.1** Measure canopy cover every two years to understand change	Medium
	7.2 Measure public street and park tree species diversity every five years	Medium
	7.3 Integrate Urban Forest objectives into Council's infrastructure and capital work programs	Ongoing
	7.4 Continue to use dollar bonds to protect public trees during development works and explore further the use of bonds to protect vegetation in open space adjoining development works	Ongoing
	7.5 Investigate the inclusion of public trees within the Street Protection Bond process	Ongoing
	7.6 Align annual street tree planting program with future development sites to minimise loss of newly planted trees	Ongoing

Glossary of terms

Biodiversity: The variety of all life forms on earth: the different plants, animals and micro-organisms and the ecosystems in which they are a part

Canopy cover: the measure of the area of tree canopy when viewed from above, and is recorded as a percentage of total land area

Capital Works Program: A program of works conducted by Council which renews, upgrades or creates new infrastructure to support the delivery of services to the Yarra community.

Carbon sequestration: The process of capturing and storing atmospheric carbon dioxide.

Deciduous: trees that shed or lose all of their leaves for part of the year, usually over winter

Ecosystem: A community of organisms interacting with each other in their environment

Evapotranspiration: the movement of water from the landscape to the atmosphere through vegetative matter by the process of evaporation and transpiration

Greening the West: A partnership between City West Water and western Councils advocating for and working towards more green space in the West of Melbourne.

I-Tree Eco: A model built by the United States Forestry Service that analyses certain tree parameters in conjunction with air quality measures to determine an environmental value of a tree. The value includes air pollution, carbon sequestration and storage, energy saving benefits, stormwater flow reductions and a structural value, allocating an overall figure of worth on a population of urban trees.

Integrated water management: a holistic approach to water that promotes the sustainable use of all available water resources in ways that best deliver multiple community objectives

Liveability: As assessment of what a place is like to live in, taking into account environmental quality, crime and safety, education and health provision, access to shops and services, recreational facilities and cultural activities.

Particulates: microscopic solid or liquid matter that are suspended in the air. PM10 and PM 2.5 are found in urban air and are known to be harmful to human health.

Resilience (urban): the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.

Resilient Melbourne: The Resilient Melbourne project is auspiced by the City of Melbourne in collaboration with the councils that make up Greater Melbourne, and many associated partners. It offers a new way to address the chronic stresses and acute shocks we are likely to experience, and to achieve our vision of a city that is viable, sustainable, liveable and prosperous, today and long into the future.

SEIFA Disadvantage: Socio-Economic Index for Areas which categorises census parcels based on socio-economic advantage or disadvantage.

Social vulnerability: members of the population who are more vulnerable to urban heat and heatwaves due to social factors such as economic status, age, health or background.

Stormwater interception: the halt or reduced flow of stormwater into the drainage system for re-use

Sustainable transport: transport that prioritises those modes that have limited or no environmental impact

Urban densification: the increasing density of people living in urban areas

Urban Forest: the sum of all urban trees including those on public and private land

Urban Heat Island Effect: when urban areas are warmer than surrounding rural areas due to heat retention in hard surfaces. This build-up of heat is re-radiated at night time, increasing air temperatures which can have serious human health consequences particularly during heatwaves. The UHI effect can be mitigated by a range of factors. The most cost effective and efficient mitigation tool is an increase in tree canopy cover.

Useful Life Expectancy: the amount of time a tree is estimated to remain in the landscape before it needs to be removed and replaced.

Vacant sites: sites within streets that could house a street tree but are currently vacant due to tree removal, vandalism or because a tree had never been planted.

Water sensitive urban design: is the integration of the water cycle into urban planning and design by recognising all water streams in the urban environment as a potential resource e.g. rainwater, stormwater, grey water and blackwater. WSUD is often used to describe the infrastructure built to capture and reuse stormwater

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Appendix A

Maribyrnong's Urban Forest

Maribyrnong's urban forest is comprised of trees and vegetation on both public and private land. Council has a complete set of data for all street and park trees which includes species, age and health of individual trees. This data provides an understanding of the diversity and health of the whole public tree population. Very little is known however about trees or vegetation on private property or land owned by other organisations e.g. Crown land, state government land, developments, industrial land, commercial/retail land or private residences.

STREET AND PARK TREES

Public street and park trees in Maribyrnong today are a healthy mix of natives and exotics comprising a total of 54,787 trees. Around 70% of these trees are in streets and 30% in parks. There are over 620 different tree species and cultivars growing on Council managed land.

SPECIES DIVERSITY

Species	Common Name	No	% of Population
Ulmus parvifolia	Chinese Elms	3152	5.76%
Melia azedarach	White cedar	2972	5.43%
Eucalyptus leucoxylon	Yellow gum	2730	4.99%
Lophostemon confertus	Queensland brushbox	2547	4.65%
Pyrus calleryana	Ornamental Pear	2453	4.48%
Angophora costata	Smooth-bark Apple	1922	3.51%
Corymbia maculata	Spotted Gum	1455	2.66%
Lagerstroemia indica	Crepe myrtle	1445	2.64%
Corymbia citriodora	Lemon-scented Gum	1428	2.61%
Eucalyptus melliodora	Yellow Box	1391	2.54%
Eucalyptus camaldulensis	River Red Gum	1291	2.36%
Tristaniopsis laurina	Watergum	1282	2.34%
Melaleuca styphelioides	Prickly leaved paperbark	1207	2.21%
Olea europaea	Olive	1120	2.05%
Callistemon viminalis	Bottlebrush	1091	1.99%
Agonis flexuosa	Willow Myrtle	1066	1.95%
Eucalyptus sideroxylon	Red Ironbark	961	1.76%
Corymbia ficifolia	Red flowering gum	881	1.61%
Fraxinus angustifolia sbsp. Angustifolia	Narrow Leafed Ash	792	1.45%
Pyrus ussuriensis	Manchurian Pear	715	1.31%

Individual tree values

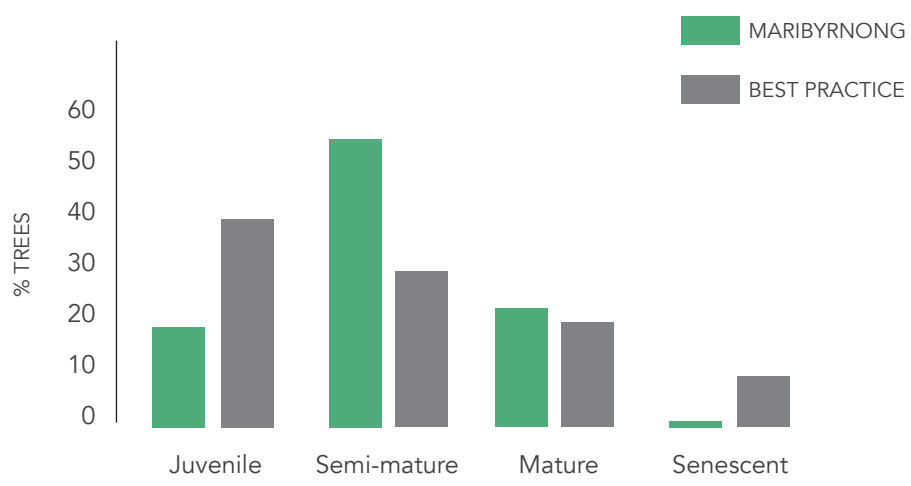
Using a tool developed in the United States, individual trees can be valued for the environmental benefits they provide. I-Tree Eco attributes a dollar value to the structure of the tree, the amount of air pollution it absorbs, the amount of stormwater it intercepts and the amount of carbon it sequesters and stores.

The street trees in Maribyrnong listed below have been measured for their environmental benefits.

A large mature Melaleuca is worth $32,000 and returns $44 annually in quantifiable benefits. On the other hand, a small ornamental pear is worth $57.09 and returns $0.17 annually.

EXAMPLES OF INDIVIDUAL TREE VALUES

Tree Species, Address	Structural Value	Carbon Storage		Avoided Runoff		Air Pollution Removal		Total Annual Benefits
	(A$)	(kg)	(A$)	(m^3/yr)	(A$/yr)	(g/yr)	(A$/yr)	(A$/yr)
Melaleuca linariifolia 1 Kerr Street Kingsville	32,649.08	5037.60	114.86	3.70	8.32	2777.60	34.91	44.19
Eucalyptus camaldulensis 119 Coronation Street, Kingsville	17,368.30	1516.90	34.59	1.20	2.76	920.40	11.57	15.07
Platanus xacerifolia 62 O'Farrell Street, Yarraville	15,460.24	1476.80	33.67	1.50	3.46	1155.40	14.52	18.73
Fraxinus angustifolia sbsp. Angustifolia 16 Parker Street, Footscray	11,690.20	1021.40	23.29	0.70	1.52	508.80	6.39	8.44
Melia azedarach 68 Station Road, Seddon	9,966.14	1023.50	23.33	0.60	1.34	448.20	5.63	7.58
Lophostemon confertus 178 Williamstown Rd, Kingsville	12,757.68	1022.70	23.32	0.80	1.86	622.40	7.82	10.29
Pyrus calleryana Gamon Street, Harris Reserve	5,621.52	486.00	11.08	0.40	0.85	282.30	3.55	4.78
Gleditsia triacanthos 'Sunburst' 24 Wales Street, Kingsville	6,358.30	495.40	11.29	0.20	0.55	184.10	2.31	3.26
Olea europaea 161 Charles Street, Seddon	6,272.05	394.70	9.00	0.50	1.19	396.20	4.98	6.51
Ulmus parvifolia 280 Ballarat Rd, Braybrook	2,206.46	100.20	2.28	0.40	0.80	266.70	3.35	4.29
Lagerstroemia indica 35 Chirnside Street, Kingsville	1,267.06	67.20	1.53	0.10	0.23	75.20	0.95	1.29
Platanus xacerifolia 3 Hamilton Street, Seddon	327.95	13.40	0.30	0.10	0.23	75.70	0.95	1.23
Ulmus parvifolia 16/18 Butler Street, Braybrook	109.23	3.30	0.07	0.00	0.09	31.50	0.40	0.51
Pyrus calleryana 24 Gamon Street, Seddon	57.09	1.40	0.03	0.00	0.03	10.20	0.13	0.17



Tree age diversity

Age diversity

The majority of Maribyrnong's trees are either young or semi mature. These figures demonstrate a dynamic and well-managed tree population.

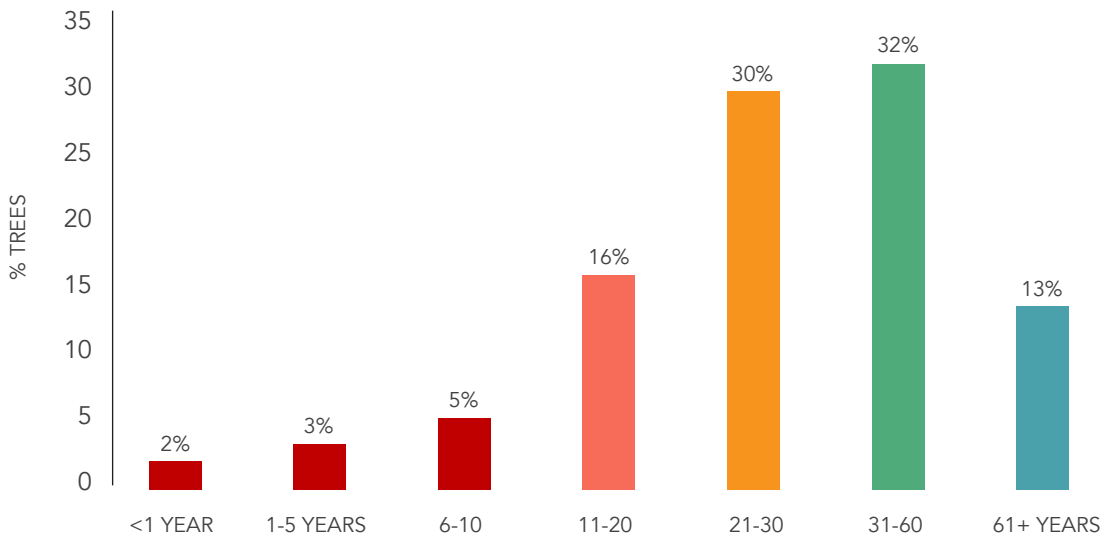
In terms of matching best practice, the intensive tree renewal program currently being delivered will see the number of juvenile trees increase considerably, closer to 40% within the next five years.

Furthermore, it is expected that more trees will move into the senescent category as more mature trees will enter into old age and require more active management and ultimately removal.

Useful life expectancy (ULE)

ULE is an estimate of how long a tree is likely to be viable in the landscape based on health, amenity, environmental services contribution and risk to the community. 45,000 trees have had their ULE assessed. The remaining 9,700 trees have all been newly planted since 2013 and are therefore likely to have ULE's greater than 20 years depending on their species.

10% of Maribyrnong's urban street and parks trees will likely need removal and replacement within a 10 year period due to a range of reasons including natural ageing, outgrowing tree sites, poor structure or inappropriate species selection for a site. 26% of the population will need to be removed within 20 years. Understanding this future loss helps Council to plan now for renewal and infill programs to ensure that overall, Maribyrnong's tree canopy cover and total tree numbers do not diminish. These figures also help Council to proactively manage this tree loss, reducing risk and planning for the future.

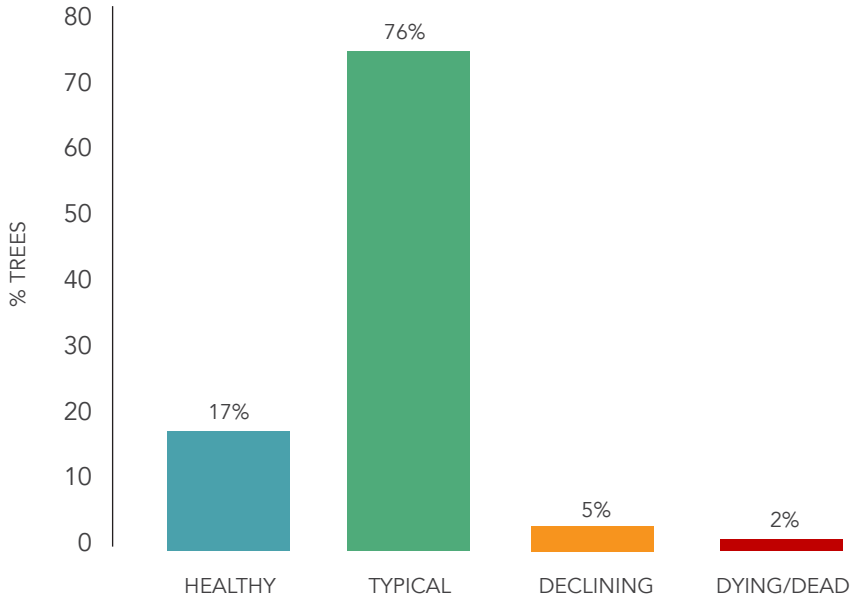


Tree useful life expectancy

Tree health

Each tree has been accorded a health rating allowing better understanding of tree species that may have short lifespans such as Wattles (*Acacia* spp.) and *Prunus* spp. that attract low ULE's but may still be healthy, therefore not requiring removal and replacement.

93% of Maribyrnong's total tree population is in typical or better health, which is a further recognition of a well-managed asset. This measure will be used by Council to determine which trees will need to be targeted in future tree removal and replacement programs.



Breakdown of health categories for all trees

Current Public Tree Planting Program

In 2012, Council committed to planting approximately 3,000 trees per year in an effort to reduce the number of vacant planting sites and improve the overall health and diversity of the tree population. Vacant sites are those along Council managed roads, whereby there once was or should have been a street tree. Through this effort, Maribyrnong has now, in 2018, successfully filled many vacant sites.

There is however, still opportunity to consider planting more trees along roads managed by VicRoads and on sites not traditionally considered a "vacant site" but have some capacity to house a tree. These sites may require additional infrastructure works to be able to incorporate a tree e.g. roundabouts, kerb outstands, hard paved areas around retail precincts, at-grade carparks.

Currently, Council is planting smaller statured trees as appropriate for the types of constrained urban streetscapes in Maribyrnong.

Chinese Elms, Crepe Myrtles, Yellowbox and Ornamental Pears are commonly planted trees. This species list needs to be monitored each year to ensure that any one species isn't being overplanted e.g. Chinese Elms (which made up 14% of recently planted trees).

In comparison to other neighbouring municipalities, Maribyrnong is planting more advanced trees per square kilometre than any other. The following graph compares trees planted annually per square kilometre between a number of Melbourne municipalities.

Appendix B

The Urban Heat Island effect, climate change and the West

Climate change modelling shows that Melbourne's urban environment will get hotter and drier, with more extreme weather events, like flooding and heatwaves. This will be particularly felt in the western region of urban Melbourne, where overall tree and green cover is lower than its Eastern counterparts but where population and urban development is growing quickly.

The Urban Heat Island effect is when urban areas become hotter than surrounding peri-urban or rural areas as heat is absorbed, stored and re-released from hard surfaces, particularly at night. The UHI effect makes the extreme hot weather events worse as urban areas fail to cool down after the sun has set. Both heatwaves and the UHI effect are proven to have significant health and wellbeing impacts on people, but also on the health of urban ecosystems, including urban vegetation.

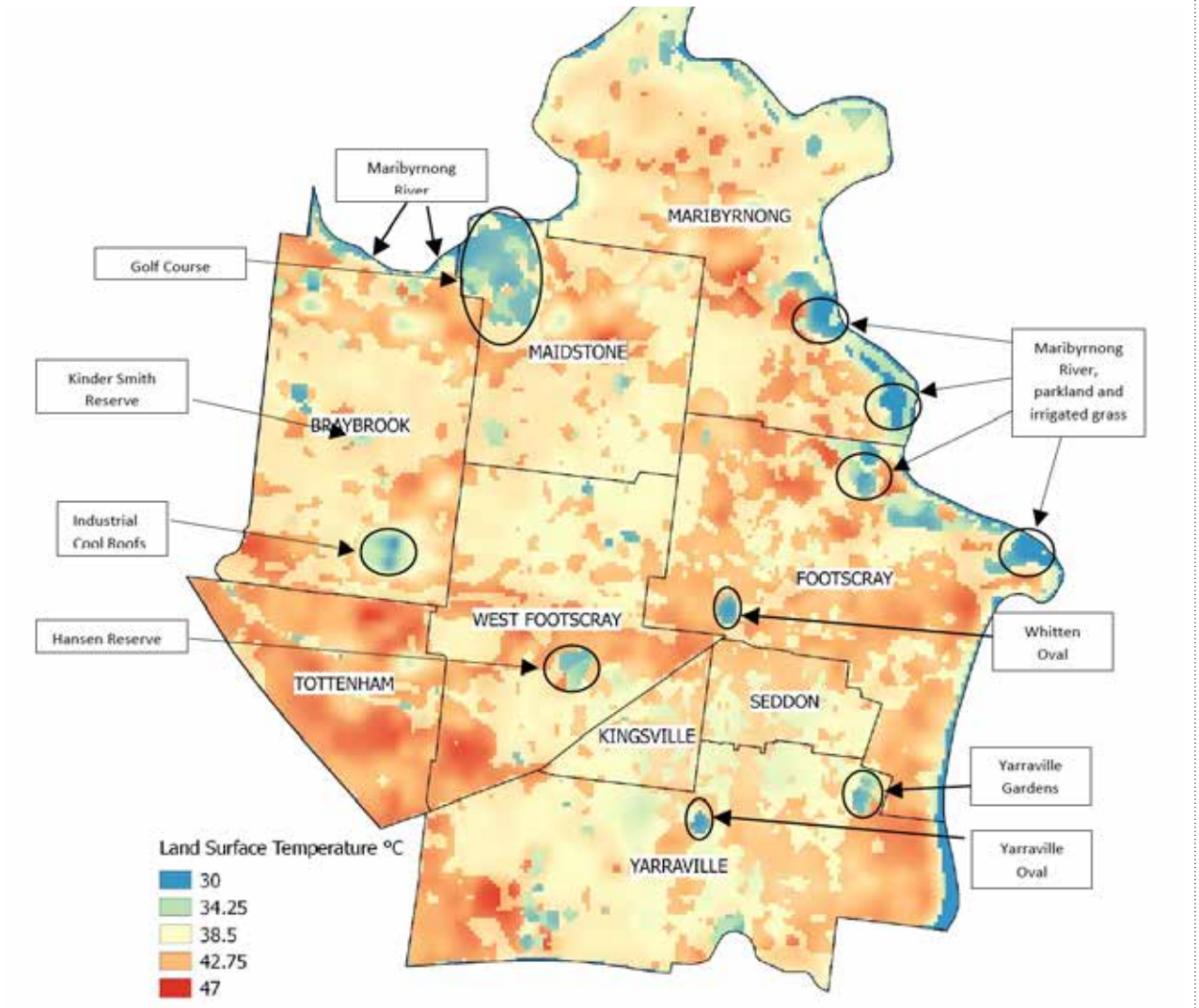
However, it is these very ecosystems, particularly the combination of water and vegetation that have been found to be some of the most cost effective and efficient mechanisms for mitigating urban heat. (Silva 2010) (Rozenzwieg 2009) (Gober 2010) (ACEEE 2014). Through the provision of natural shade and the process of evapotranspiration, urban vegetation and in particular trees, provide a natural cooling system for the urban environment. Therefore, ensuring a healthy, diverse and resilient urban forest that can not only thrive during heatwaves but also provides benefits is critical for Maribyrnong's future.

Satellite thermal imagery has been used to identify the urban areas of Maribyrnong that heat up and retain heat more quickly than other areas. Whilst there are limitations in using satellite thermal imagery to do this, research has shown that it can at least provide a basic understanding of which land use types and surfaces store and retain heat more than others. (Coutts et al, 2014).

Hotspots, those that display higher Land Surface Temperatures are highlighted above. Closer inspection shows that these hotspots lie over land surface types such as large scale industrial roofing, large areas of concrete, conglomerations of buildings and unirrigated grass/dirt patches.

The inset aerial photograph of Maribyrnong College demonstrates where conglomeration of buildings, an astro-turf playing field and unirrigated open space register as hotspots.

Satellite thermal imagery of Maribyrnong City Council showing cool spots in blue



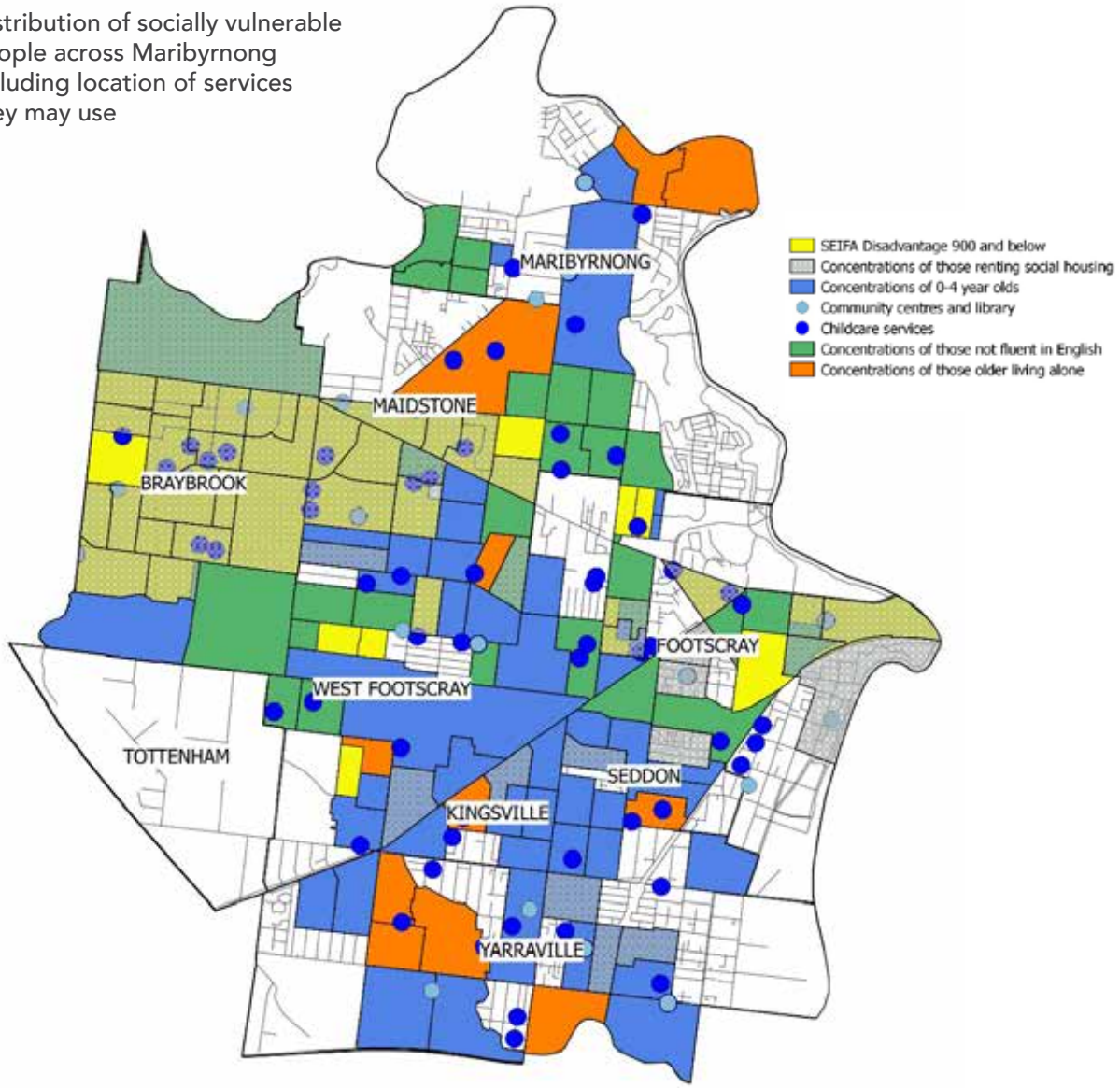
Heat, water and vegetation

The satellite mapping also pinpoints the cooler areas of the city. The majority of these cool spots, shown in blue, are watercourses, parklands or irrigated reserves. The effect of irrigated open space on land surface temperature is significant. Unirrigated open space can be up to 12 degrees hotter (land surface temperature) than irrigated open space. At night time, the difference can be even greater with irrigated vegetated spaces being up to 25 degrees cooler. These cooler spaces play a key role during heatwaves in helping the landscape to cool down after sunset. Therefore the greater area of irrigated green space, the cooler the environment.

Water can be retained in the landscape in a number of ways, not just the traditional method of irrigating grass using potable water. Melbourne is now a world leader in exploring innovative design that allows passive or active filtration of stormwater into the urban landscape for both ground water storage or for re-use as irrigation.

The CRC for Water Sensitive Cities, based at Monash University has been exploring the concept of Water Sensitive Cities and now has a raft of research and practical city-based solutions ready for trialling and adoption. Smarter use of stormwater run-off to irrigate open space and vegetation, especially street trees, is therefore a large opportunity for Maribyrnong to create cooler spaces.

Distribution of socially vulnerable people across Maribyrnong including location of services they may use



Heat and health and wellbeing

Urban heat, vegetation, open space and availability of water are all closely correlated to the health and wellbeing of people. Research shows that green open space, shady streets and landscaped retail areas are good for people. They improve mental wellbeing but also encourage active transport like walking and cycling which have positive health outcomes. However, like so many things, open space, shady streets and green shopping strips aren't necessarily distributed equitably across Cities. A growing correlation between socio-economic status and tree canopy cover shows that those people most in need from shade and quality green open space, don't necessarily have easy access to it. Heat on the other hand is directly correlated to surface types, presence or absence of vegetation and availability of water in the landscape. Heat is generally concentrated in highly urbanised areas, industrial areas and those residential areas with little vegetation cover e.g. newly developed residential estates.

Research highlights that there are certain members of the community who are more vulnerable to urban heat than others, particularly during heatwaves (Loughnan, 2013). These include:

- Young children (0-4 years old based on census data)
- Older people, especially those living alone
- Socio-economically disadvantaged people
- Those who are not fluent in English
- Those in public housing
- Those with chronic illness

SEIFA Disadvantage is most concentrated in Braybrook and Maidstone, those who aren't fluent in English are concentrated in Braybrook, Maidstone and Footscray, while young children are concentrated in West Footscray, Kingsville, Seddon and Yarraville.

State Government health data from 2011 shows that obesity rates and physical activity levels are poorest in those suburbs with higher social disadvantage, Braybrook and Maidstone.

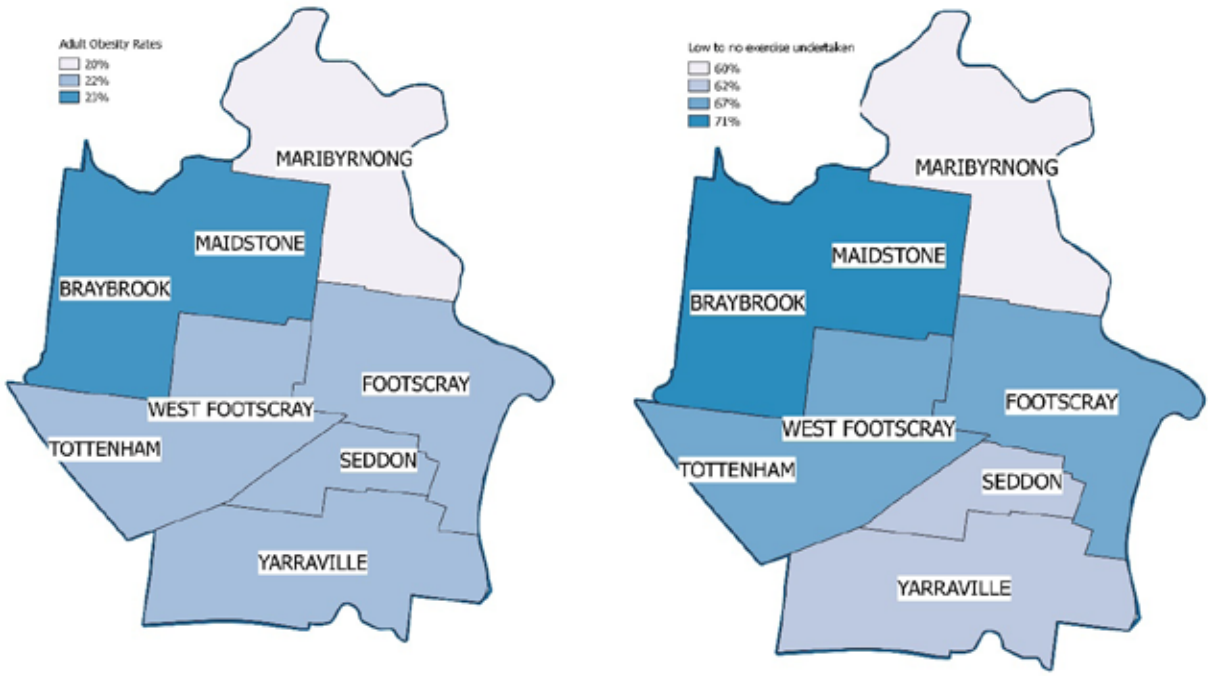
Individual attributes themselves are not necessarily an indicator of social vulnerability to heat e.g. young children living in Yarraville are not necessarily socially vulnerable. However, areas that register high concentrations of more than one attribute can be.

Areas where urban heat, social vulnerability and pedestrian activity intersect, are where heat mitigation measures such as irrigated open space, canopy trees and water sensitive urban design are highly beneficial for human health and wellbeing.

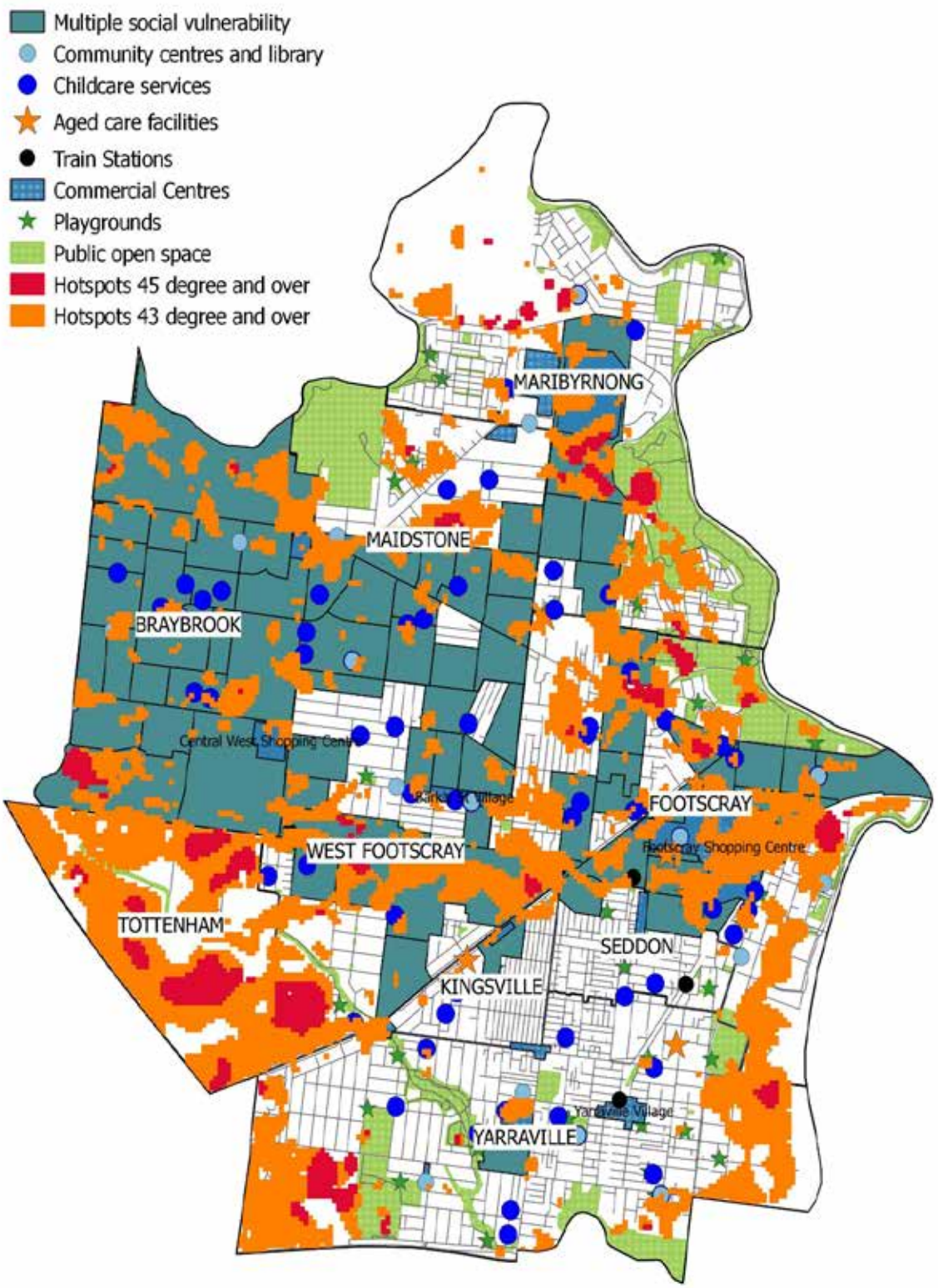
In Maribyrnong, these broad areas include Highpoint Shopping Centre and Maribyrnong College, Footscray CBD and train station, Barkly Street Village, Central West Shopping Centre, Braybrook shopping centre and the Yarraville Coles shopping centre.

It is worth noting that heat mitigation measures such as canopy trees are also valuable within residential zones, even where excessive heat is not being recorded. The limitations of satellite thermal imagery mean that areas likely to be hotspots later in the day, such as dense residential development as you find in Braybrook are not being picked up.

Council's open space Strategy confirms that there are adequate levels of open space within the suburbs recording high social vulnerability such as Braybrook or Maidstone. However the open space is generally noted as needing to be of greater quality to encourage passive recreation and better connected with the broader open space network. Shade and canopy cover, as well as passive irrigation and safety precautions are all priorities for open space within these areas (Open Space Strategy, 2013). 66% of survey respondents in Braybrook and 73% in Maidstone valued trees as the most important aspect of open space.



State government data from 2011 showing concentrations of obesity rates (left) and those who undertake low to no exercise in a 2 week period.



Areas that demonstrate concentrations of multiple social vulnerability indicators, overlayed with heat and areas of pedestrian activity e.g. community centres and libraries, child care services, commercial centres and playgrounds.

Trees and air pollution

Air pollution monitoring by the Environment Protection Authority show that air pollution in Melbourne has considerably improved since the 1970's due to greater regulation including emissions controls on vehicles and the removal of lead. Melbourne generally has very good air quality when compared to other cities in the world and this includes Maribyrnong. Monitoring of air pollution in Footscray shows that the inner west records similar air pollution levels as elsewhere in Melbourne, if not better. Of note, however is the air pollution from the neighbouring suburb of Brooklyn, which regularly records above standard levels of pollution, particularly particulate matter such as Pm2.5 and Pm10. Whilst Brooklyn is not within Maribyrnong's jurisdiction, there is a possibility that on certain wind days, pollutants can carry into Maribyrnong. Similarly, a monitoring project along Francis Street, Yarraville in 2013 showed significant exceedances in pollution levels, primarily due to heavy truck traffic. (EPA, 2016). Truck curfews have since been implemented, however reports suggest it has been negligible on the amounts of air pollution. It is likely that similar pollution levels would be registered along other streets with heavy truck traffic.

One of the greatest sources of air pollution in Melbourne is from vehicle emissions. (EPA, 2017) Those who live along busy roads are likely to be exposed to greater levels of pollutions than those in less trafficked streets.

Research has demonstrated the benefits of canopy trees in capturing certain air borne pollutants (Nowak, 1990 FIND REF). Tree canopies can even intersect particulate matter, storing it on leaves when it is washed off by rain. In certain configurations, tree lined boulevards can reduce certain pollutants by varying amounts. There are exceptions to this e.g. multi-story vegetation is more effective at capturing air pollution than simply stands of trees and the canopies need to be of a density that allows wind to carry through (Abhijith et al, 2017).

Whilst trees themselves will not have the same impact of reducing air pollution as reducing vehicular traffic and its emissions, they are able to reduce the pollution load.

An analysis of three large trees in Maribyrnong show that a Melaleuca linariifolia (Snow in Summer), River Red Gum and London Plane Tree can remove considerable amounts of pollution. The London Plane tree removes 3.6kg of pollutants each year and the Melaleuca removed 2.7kg per year. When multiplied across a 54,000 pubic tree population, the effectiveness of the urban forest to reduce air pollution loads is extremely high.

AIR POLLUTION REMOVED (G/YR)

Species Name	CO	O3	NO2	SO2	PM2.5	Total
Melaleuca linariifolia	56.60	1935.20	587.20	166.70	31.80	2777.50
Eucalyptus camaldulensis	18.80	641.30	194.60	55.20	10.50	920.40
Platanus x acerifolia	23.60	805.00	244.30	69.40	13.20	3697.90

I-Tree Eco modelling of 3 large individual street and park trees in Maribyrnong demonstrating the amount of air pollution removed each year.

Appendix C

Tools, guidelines and resources

Greening The West: *http://greeningthewest.org.au/resources/*

CRC for Water Sensitive Cities Resources by Topics: *https://watersensitivecities.org.au/topics/*

Growing Green Guide: *http://www.growinggreenguide.org/*

Planning a Green Blue City: *https://www.water.vic.gov.au/__data/assets/pdf_file/0029/89606/Green-blue-Infrastructure-Guidelines-Feb17.pdf*

Best Practice Carpark Designs: *http://www.loci.melbourne/data/documents/10BBPN-Carparks-and-Green-Infrastructure-4pp1Dec2017.pdf*

DECEMBER 2018

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