LIVING MELBOURNE

Our metropolitan urban forest

April 2019

The following organisations have endorsed *Living Melbourne: our metropolitan urban forest.* Endorsement means organisations support *Living Melbourne*'s Vision, Goals and Actions and commit to work in partnership with the other endorsing organisations towards its implementation.

[Logos]

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Vision

Our thriving communities are resilient, connected through nature.

Foreword

Message from 100 Resilient Cities

On behalf of the entire 100 Resilient Cities Network of cities and partners, I would like to congratulate Resilient Melbourne, The Nature Conservancy, and all of the organisations who have co-authored *Living Melbourne*, a robust metropolitan response to multiple urban resilience challenges. *Living Melbourne* is a truly collaborative and strategic approach to connect existing greening and urban forest approaches across metropolitan Melbourne.

A flagship action from the Resilient Melbourne strategy*, Living Melbourne* is the cumulative result of over two years of collaboration to develop the evidence base for greening a city. In 2017, Resilient Melbourne hosted Chief Resilience Officers from New Orleans, Durban, Boulder and Semarang to discuss biodiversity and develop a set of recommendations for cities hoping to use nature to build resilience. This exchange led to a set of clear guidelines based on the principle that natural infrastructure is real infrastructure that allows cities to meet goals and service targets while also providing co-benefits to the community.

Living Melbourne was built on these lessons and provides a framework not only for Melbourne but for global peers like Milan and Paris that are now seeking to better incorporate nature into the fabric of their cities, the lives of their citizens and the foundations of their policies. *Living Melbourne* represents a first for Australia as well as global best practice as Melbourne's nature-based approach emerges at a metropolitan scale to deliver benefits to the city's most vulnerable residents. This is a fine example of how cities in the 100 Resilient Cities network are convening technical experts, city practitioners, private sector partners and communities to bridge the gap between city challenges and practical solutions.

Living Melbourne builds on this city's legacy of liveability and seeks to plant roots for the continued high quality of life for which Melbourne is known. I commend this work and encourage you and your organisations support it by incorporating its actions into your operational plans and budgets. I wish you well in your ongoing ambition to make your great city, Melbourne, truly liveable, both now and in the future.

Michael Berkowitz
Global President
100 Resilient Cities

Message from The Nature Conservancy

The Nature Conservancy is proud to work with 100 Resilient Cities and Resilient Melbourne as partners to present *Living Melbourne* – Melbourne's first metropolitan urban forest strategy.

As a global organisation that conserves the lands and waters on which all life depends, The Nature Conservancy focuses its work on four key priorities, one of which is the building of healthy cities.

Cities are growing – fast. By 2050, two thirds of the world's population will live in urban areas. Cities' footprints are expanding at an alarming rate, putting habitat, human health, and access to food and water at risk. But with smart planning, science-based solutions and strong partnerships, we believe that cities can become resilient, healthy and equitable. Melbourne is a perfect place to start to combat problems caused by this super-rapid growth.

As nature comes under increasing threat from climate change, the destruction of natural habitats, and unsustainable urbanisation, it is more important than ever to understand that people are an essential part of the solution. And to harness the power of people in the conservation of nature, they need to have a connection to it. That's why The Nature Conservancy sees *Living Melbourne* as an important opportunity to transform Melbourne's approach to urban greening. I hope it will encourage Melburnians to value their urban nature for its biodiversity values and for the benefits it offers them – from cooler neighbourhoods to better physical and mental health.

I'm confident that *Living Melbourne* will inspire the city's residents, and allow them and others around the world to aspire to a future where cities value the contribution that nature makes to our urban environment.

Pascal Mittermaier
Managing Director, Global Cities
The Nature Conservancy

Aboriginal acknowledgement

Living Melbourne, and its many contributors and owners, respectfully acknowledges Aboriginal people as Australia's First Peoples and the local Traditional Owners as the original custodians of the land and water on which we rely and operate. We specifically acknowledge the Traditional Owners and we pay our respects to Elders past, present and future. We acknowledge the continued cultural, social and spiritual connections that Aboriginal people have with the lands and waters, and recognise and value that the Traditional Owner groups have cared for and protected for thousands of generations. We recognise and value the essential and continuing contribution of Aboriginal people to the region.

Executive summary

Living Melbourne: our metropolitan urban forest is a bold new strategy for a greener, more liveable Melbourne. It presents a vision of international significance in its massive scale, its outstanding collaboration, and its use of new and innovative mapping technology.

In developing the strategy, we have brought together 32 metropolitan councils, state government agencies, non-government and community organisations, and other partners united around a common vision for an urban forest – **thriving and resilient communities, connected through nature**. *Living Melbourne* establishes tangible next steps for action to turn that vision into reality.

Made up of all the trees, shrubs, grasses, soil and water on public and private land across metropolitan Melbourne, our urban forest protects human health, nurtures abundant nature and strengthens natural infrastructure.

Living Melbourne aims to create a profound shift in the way we think about, build, grow and value Melbourne. Until recently, cities have existed in conflict with nature. Increasingly, around the world, people understand that the success and long-term viability of cities depend on them being able to live alongside nature. This is neatly expressed in Melbourne through the concept of our urban forest.

The urban forest cleans our air and water, reduces damaging heat in our neighbourhoods, and provides valuable habitat for flora and fauna. Exposure to nature reduces stress and the incidence of mental illness, and it provides opportunities to strengthen community bonds by providing spaces where people can congregate and recreate.

The 21st century will be remembered as the urban century, the century with the most significant urban growth ever witnessed. This is not news for Melbourne. With a population of eight million people projected for 2051, we will soon be the largest city in one of the most urbanised nations on the planet.[1] Given the difficulties that we will face in the urban century, it is crucial that we create and nurture our urban forest.

Melburnians value and are proud of their parks and gardens. Admirable efforts are already under way to add to the natural features that make our city a safe, healthy and pleasant place to live. But Melbourne's urban forest is under pressure. Changes in urban form, a growing population and climate change – including increasing urban heat – leave it vulnerable. At the moment we lack a metropolitan-wide approach to assess and reduce the harm that these trends inflict upon the city and existing urban forest. This strategy, *Living Melbourne: our metropolitan urban forest*, is a timely and invaluable opportunity to rise to these challenges.

In pursuit of the vision – thriving and resilient communities, connected through nature – and the three goals that support this vision – healthy people, abundant nature and natural infrastructure – this strategy proposes a series of actions to help our rapidly changing city better protect, connect and enhance our urban forest. The strategy, if implemented, will help transform the city for the benefit of all Melburnians.

The strategy's six recommended actions are:

Action 1: Protect and restore species habitat, and improve connectivity.

Action 2: Set targets and track progress.

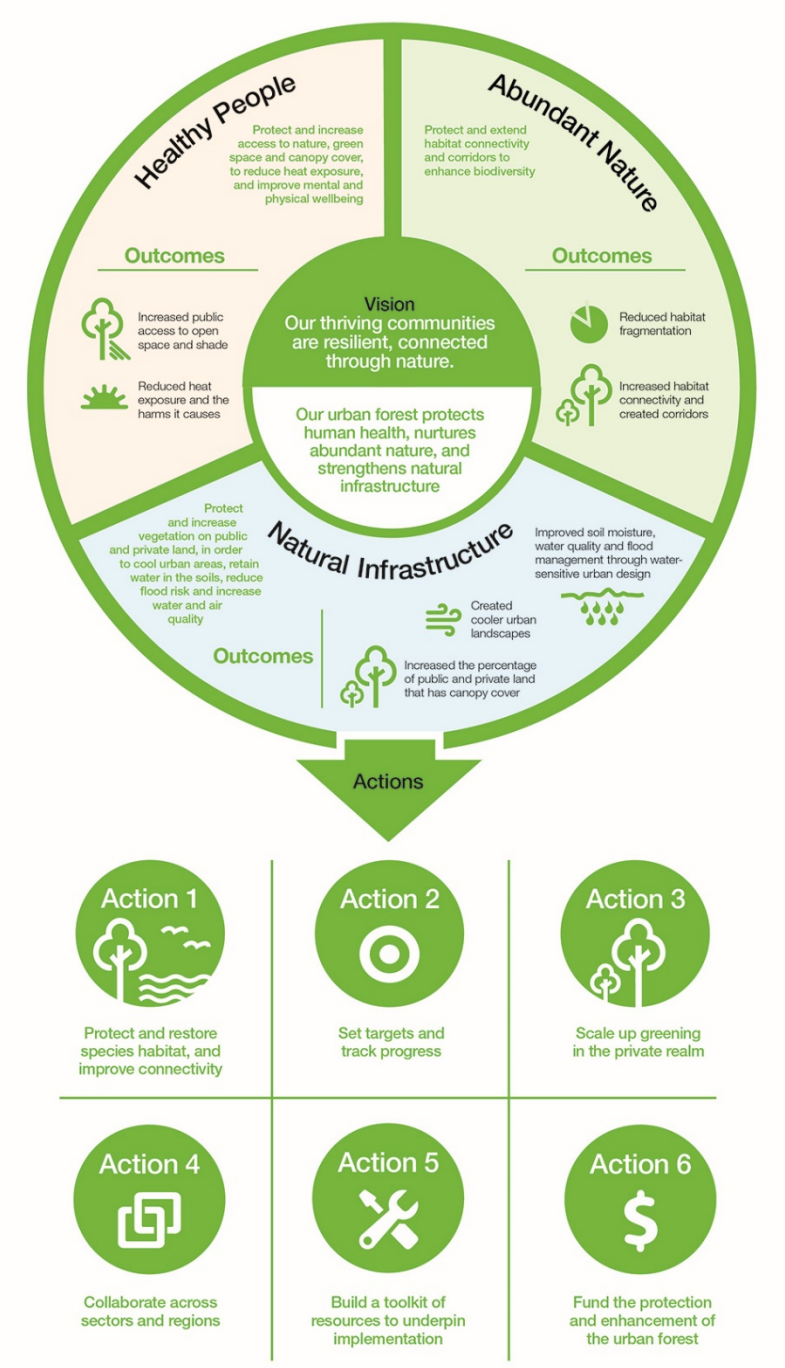
Action 3: Scale up greening in the private realm.

Action 4: Collaborate across sectors and regions.

Action 5: Build a toolkit of resources to underpin implementation.

Action 6: Fund the protection and enhancement of the urban forest.

Living Melbourne's vision extends to 2050. However, we expect that the strategy will be reviewed regularly as our urban forest science, implementation expertise and achievements grow.



Introduction

Why do we need this strategy?

More than ever before, we need nature in our cities. Melbourne is predicted to be a city of eight million people by 2051, which would make it the largest city in one of the world's most urbanised nations.[2] Although growth brings tremendous opportunities for innovation and economic development, it also threatens the natural environment and the many ecosystem services it provides to Melburnians.

These 'ecosystem services' include clean drinking water, respite from rising summer temperatures through heat mitigation, and protection from flooding – to name just a few. There are also many broader benefits, such as improving social connection and cohesion, reducing energy costs, encouraging outdoor activity, providing shade and cooling our city, helping to build a stronger individual and collective identity and improving habitats for native species.

Protecting and enhancing natural areas and habitat for flora and fauna in cities is essential for strengthening our resilience to acute shocks and chronic stresses, many of which will be exacerbated by climate change and rapid urbanisation. The time to act is now.

Melbourne's liveability is under threat

Melburnians are proud of their leafy streets, public gardens, parkways along rivers and creeks, grassy basalt plains in the west, and the Dandenong Ranges that climb above the eastern suburbs. Our natural environment contributes to Melbourne's status as one of the world's most liveable cities. Our city's liveability requires a healthy natural environment, accessible to all.

Our economy also relies upon the greenness of our city. Destination Melbourne's 2017 report shows that visitors to Melbourne, who contribute approximately $8 billion to our annual economy, rank parks and gardens as Melbourne's number-one unique attribute, and as the city's top 'must do' attraction.[3]

However, as metropolitan Melbourne expands outwards and also becomes more densely populated, green space is shrinking, putting many of our natural values at risk. Despite the perception of extensive green areas, some of Melbourne's local government areas have among the lowest urban tree canopy cover in Australia.[4] With Melbourne's population growing and its area expanding, we must act now if we are to maintain and improve our city's liveability and appeal for generations to come.

Our urban forest protects human health, nurtures abundant nature, and strengthens natural infrastructure

The urban forest is made up of native and exotic trees, shrubs, grasslands and other vegetation, growing on public and private land across metropolitan Melbourne, and the soil and water that support them. This includes vegetation in parks, reserves and private gardens, along railways, waterways, main roads and local streets, and on other green infrastructure such as green walls and roofs. The urban forest encompasses all types of vegetation and ecosystems, but among the most iconic elements are its trees and shrubs.

Fauna is an important component too, with complex interrelations between animals and plants helping to maintain the urban forest.

The urban forest plays a significant role in making our city a place where we can all thrive. But Melbourne's urban forest is also under pressure. A denser urban form will increasingly crowd out opportunities for trees, while a changing climate and higher urban temperatures put physical stress on the forest. Urban expansion beyond its current footprint threatens existing vegetation and natural values. This is already happening across the city.

Our current fragmented approach to managing the urban forest increases its vulnerability. Investing in the protection, strengthening and expansion of the urban forest will bring many opportunities, including better management of our water resources, higher quality and better-connected natural habitat, and easier access to green space for all Melburnians. The benefits of, challenges to, and opportunities presented by the urban forest are discussed later in this document.

Taking action for a *Living Melbourne*

Living Melbourne: our metropolitan urban forest is bringing together councils, state government agencies, non-government and community organisations, residents, and other partners, to work towards a shared vision for the urban forest: thriving and resilient communities, connected through nature. This strategy focuses on improving the quality and quantity of trees and vegetation in the urban forest – whether on public or private land. While acknowledging that canopy cover is a particularly important measure of the urban forest's ability to benefit the community and the environment[5], this document does not advocate intervention in situations where it is not ecologically appropriate to do so. Urban forests should be managed to reduce risks such as fire and ecological vulnerability in the system.

This strategy sets out six actions to enable and inspire our rapidly growing city to better protect and strengthen its natural assets. It is supported by solid evidence presented in the accompanying *Living Melbourne: Our Metropolitan Urban Forest Technical Report* (the *Technical Report*).[6] Collaboration is a central element of this strategy. Only by working collaboratively between organisations, land tenures, and regions can we understand the needs, agree on priorities for protection and improvement, set targets, and track progress. Together, we can build on the strong foundation of urban forest initiatives already started or under way in Melbourne. In this way we can bring city-wide benefits that could not be achieved by individual neighbourhoods, infrastructure operators, businesses or governments acting alone.

Protecting and enhancing Melbourne's urban forest is a vital part of planning for shocks and stresses. Box 1 illustrates the link between urban resilience and nature.

Box 1: Urban resilience and the urban forest

Urbanisation, globalisation and climate change are causing more people to move to cities. This presents a series of additional challenges, reducing and threatening the liveability of those cities.

In response, the urban resilience movement pioneered by 100 Resilient Cities (100RC) seeks to build the capacity of a city's individuals, communities, institutions, businesses and systems to adapt, survive and thrive – no matter what kinds of chronic stresses and acute shocks they experience. By equipping themselves to cope not only with acute shocks (such as fires and floods), but also with the chronic stresses that weaken the fabric of a city on a day-to-day or cyclical basis (such as social inequity, overburdened public transport and chronic water shortages), cities are better able to deal with disruptions, while also enjoying a higher quality of life every day.

To build resilience we must look at our city in its entirety, to understand its many assets and systems and how they interact with each other. Nature is increasingly recognised as one of our most valuable resilience assets: the urban forest and the biodiversity that it supports can take pressure off our increasingly strained built infrastructure. The urban forest helps reduce the damage caused by several types of shocks and stresses. Failure to protect and improve our urban forest is a missed opportunity to unlock the economic, health and social dividends that strengthen Melbourne's ability to thrive, no matter what the future holds.

Shocks and stresses on cities

Benefits, challenges and opportunities

Benefits of nature and the urban forest

The urban forest brings a multitude of benefits to a city. But many of the ecosystem services that nature provides to the urban realm are currently served by grey infrastructure (such as reticulated water supply and stormwater drainage systems). The costs of maintaining this grey infrastructure generally increase over time, while its level of service declines. In the City of Melbourne alone (which makes up approximately 0.4 per cent of metropolitan Melbourne's land mass) amenity valuations estimated that the 70,000 trees in streets and parks had an approximate worth of $700 million.[7]

A 2005 study of five US cities estimated that every $1 spent on planting and maintaining trees generated annual benefits ranging from $1.37 to $3.09 – a strong return on investment.[8] Similarly, a more recent study by the US Forest Service and the University of California found that every $1 spent on tree planting and maintenance in Californian cities brought $5.82 in benefits.[9]

Trees and other vegetation are essential components of urban infrastructure, providing a range of benefits, as described further below, with more detailed information and analysis provided in Chapter 3 of the *Technical Report*.

Figure 1: Benefits of nature and the urban forest

Social connection and cohesion

Urban green spaces – such as parks – foster social cohesion, inclusion and interaction. They give residents a stronger sense of place and local identity, and reduce fear and crime levels in the community. Urban forests and urban green space provide places to hold major events, festivals and celebrations throughout the city. Events and spaces can bring together diverse groups of people by providing a public realm that is available for everyone to enjoy. Green spaces play an especially important role in integrating minority groups into the wider society, and can help new immigrants adapt to their host country.[10]

'We live opposite a beautiful park … it's right at our doorstep. We feel very, very lucky to live opposite this beautiful park, it's very well maintained by the local council and it's highly utilised. So even just out there walking, I've got to know people in my neighbourhood. – female resident of Wyndham'.[11]

Connection to Country

The flourishing of, and interactions between, our diverse plants, animals, soils and waterways are important to the identity of current and future generations. Aboriginal Victorians, the Traditional Owners of the land, attach great value to biodiversity, which is core to many cultural practices and obligations. Connection to Country is fundamentally important for Victorian Aboriginal communities.[12]

This connection builds stronger individual and collective identity, a sense of self-esteem, resilience, and helps to improve people's health, education, economic stability and community safety.[13] Increasingly, we understand that *all* parts of society benefit from being closely connected to nature. Box 2 provides a summary of one project that has involved Traditional Owners in not only the long-term vision for the Yarra River, but its policy framework, strategic planning and future actions.

Box 2: The Yarra Strategic Plan – a whole of government project, led by Melbourne Water

In 2017, the landmark *Yarra River Protection (Wilip-gin Birrarung murron) Act* (the Act) passed through the Victorian Parliament, enshrining in law the protection of the Yarra River.

The Act identifies the Yarra River and its corridor as 'one living, integrated natural entity for protection and improvement' and recognises Traditional Owners' custodianship and intrinsic connection to the river.

The Wurundjeri have a unique knowledge and connection to the Birrarung. In early 2018, the Wurundjeri developed their vision for the Birrarung in a policy titled *Nhanbu narrun ba ngargunin twarn Birrarung* (Ancient Spirit and Lore of the Yarra). This policy defines the Wurundjeri's aspirations for planning, policy and decision-making to enhance the integrity of the Yarra Strategic Plan.

In line with community feedback, the Act calls for modern governance which recognises the importance of the Yarra River and its parklands to the economic prosperity and vitality of Melbourne. Once complete, the Yarra Strategic Plan will give effect to the Yarra River 50 Year Community Vision and *Nhanbu narrun ba ngargunin twarn Birrarung*, to enable agencies and Traditional Owners to plan, protect and manage the river corridor as one living, integrated natural entity.

Socio-economic benefits

Green spaces provide important socio-economic benefits, such as reducing energy costs by shading against heat, reducing maintenance costs, and boosting business activity. By shading buildings in summer, trees reduce the need for air-conditioning, and can reduce annual cooling costs by between $30 and $400 per year, depending on the height of the tree. Blacktown Council in Sydney, in partnership with the Cool Streets initiative, found that changes to street design could reduce carbon dioxide emissions, cool neighbourhoods and reduce power bills for residents. Cool Streets found that annual average household savings from tree shading were $249.[14]

Trees can also protect asphalt pavements from heat, reducing the need for regular maintenance.[15] Figure 2 is a thermal image of an urban street. It shows an urban street with large trees. The surface temperature is indicated on the right of the image in the scale bar. It illustrates that shaded surfaces (the darker colours) are significantly cooler than unshaded surfaces (lighter colours) such as the roads and footpath.

Figure 2: **Thermal image of an urban street with large trees (courtesy Banyule City Council, image © ENSPEC)**

Green infrastructure on commercial sites has been found to encourage economic activity by attracting customers who stay longer and return more frequently.[16]

Although there is currently no total valuation of the benefits and savings attributable to Melbourne's metropolitan trees, one study used iTree Eco software, a common and well-accepted method, to value as many local government tree assets as possible across metropolitan Melbourne.[17] Thirteen tree asset databases were suitable for analysis. In total, the economic savings in the form of pollution removal, carbon storage, carbon sequestration, and avoided water run-off were calculated at $6 million per year. More importantly, the cost of replacing these assets with similar trees – based on size, species, health and location – was calculated at $2.5 billion. These two figures, which could be extrapolated across the metropolitan area for all 32 councils, are for only a relatively small proportion of the total tree canopy of Melbourne.

Physical and mental health

Urban forests improve people's physical and mental health by reducing heat stress, encouraging physical activity, and offering recreational opportunities. The urban forest provides space that encourages the types of physical activity that reduce people's risk of developing chronic heart disease, diabetes, dementia and some cancers. Easily accessible green spaces and trees have positive effects on people's wellbeing, improving their mental health.[18] Scientific research highlights the wellbeing benefits of contact with nature, and disconnection from nature impacting detrimentally on human happiness and ecology.[19] Purely being in the outdoors can be effective in strengthening wellbeing for vulnerable populations.[20] Research that looked at environments which promote people's health and wellbeing identified green open spaces as playing a key role in this process.[21]

A study of more than 200,000 Australians aged 45 years and over found that those who had more than 20 per cent green space within a one-kilometre radius of their home were significantly more likely to walk and participate in physical activities rated as 'moderate to vigorous'. Greener neighbourhoods lead not only to weekly participation, but also to more frequent sessions of walking and moderate to vigorous activity, such as jogging and team

sports. These findings suggest that the amount of green space available to middle-aged and older adults in their neighbourhood environments influences their level of physical activity.[22]

Urban forests also cool surrounding environments. Built-up areas of cities can be as much as 7°C warmer than surrounding areas.[23] This 'urban heat island effect' is caused by the heat-absorptive thermal mass of concrete, bitumen and bricks. The urban heat island disproportionately affects vulnerable people, including young children, the elderly, people who are unwell or socially isolated, and those who are financially disadvantaged.[24]

The *Living Melbourne* strategy takes a further step towards determining where the urban forest will be most beneficial, particularly for vulnerable communities, by using heat-mapping and socio-economic indicators. Some of our metropolitan councils have been leading the way in their urban forest strategies. For example, Yarra City Council considers three criteria to help identify areas of greatest need for improving and protecting the urban forest, including new plantings:

- hotspots – where more heat is currently being retained in the urban landscape, locally exacerbating the urban heat island effect
- social vulnerability – areas with significant populations of people deemed to be especially vulnerable to extreme heat and heatwaves
- pedestrian activity zones – areas of high pedestrian thoroughfare or congregation, or active transport activity, including school zones.[25]

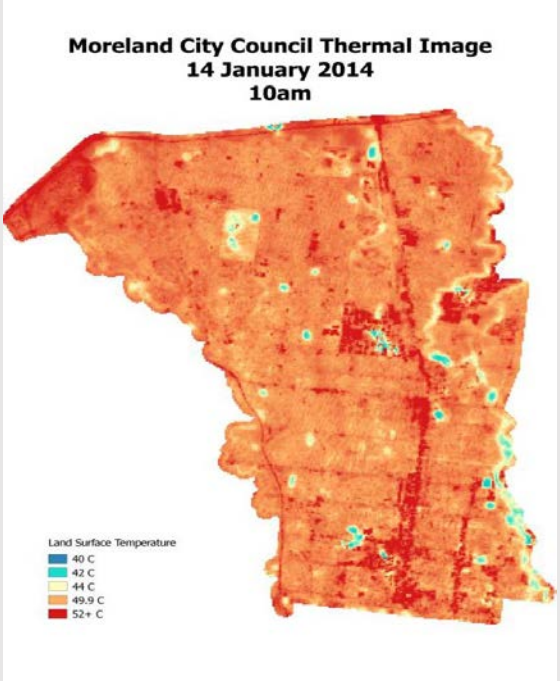
Moreland City Council has developed an urban heat island action plan – see Box 3.

Box 3: Heat planning case study

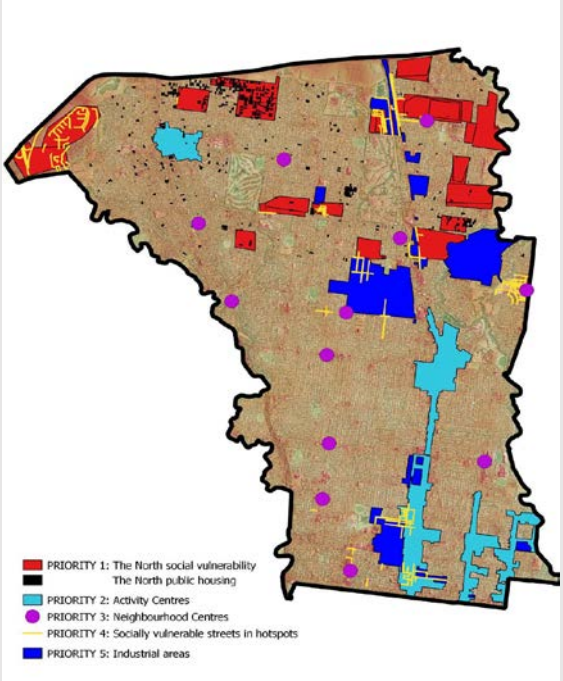
The Moreland City Council's *Urban Heat Island Effect Action Plan* prioritises heat-reduction initiatives by considering the intersection between human vulnerability and urban hot spots.

Satellite thermal imaging (below, left) was used to identify Moreland's hot spots – areas of concentrated heat retention – such as major roads, commercial and industrial centres, and new residential subdivisions. This information was then used to prioritise schools, childcare centres, kindergartens, activity centres, neighbourhood shopping strips and industrial areas for cooling strategies (below, right). In this way, Moreland's *Action Plan* ensures that heat-reduction measures are being taken where they are most needed.

City of Moreland: thermal image[26]



City of Moreland: priorities for heat mitigation[27]



This case study suggests ways to reduce heat across our city generally, and to respond to heatwaves, which are discussed in Box 4. The Department of Environment, Land, Water and Planning has worked in partnership with RMIT University, the University of Western Australia, CSIRO, and the Clean Air and Urban Landscapes Hub of the National Environmental Science Program to develop a heat vulnerability mapping dataset for 2014. This data assists with heat-action planning and is available via the Victorian Government Spatial DataMart.

Box 4: Heatwaves in Victoria

Heatwaves have taken more human lives than any other natural hazard in Australia since European settlement[28], and are projected to increase in frequency, duration and intensity over coming decades.

In Melbourne, deaths begin to rise when the mean daily temperature reaches 28°C, with hospital admissions for heart attack increasing by 10.8 per cent when the mean daily temperature reaches 30°C.[29] When the average temperature is higher than 27°C for three consecutive days, hospital admissions increase by 37.7 per cent. This suggests that even a small reduction in temperature during a heatwave will reduce the numbers of deaths. One of the most effective ways to reduce temperatures is to provide shade trees.

Ecosystem services

In addition to shading and cooling our cities, urban forests:

- improve stormwater quality by reducing run-off
- improve air quality by capturing and filtering pollutants, including ozone, sulphur dioxide, nitrogen oxides, and particulates
- mitigate climate change by capturing and storing carbon dioxide
- reduce emissions from powering air-conditioning equipment, by cooling the environment.

Melbourne's metropolitan parks are estimated to release, on average, more than 31 tonnes of nitrogen per annum into the waters of Port Phillip Bay and Westernport Bay. However, it has been estimated that a similar-sized residential area would release 213 tonnes (an additional 182 tonnes) of nitrogen per annum into these two bays. This would also incur additional stormwater treatment costs in order to protect and maintain the water quality of the bays.[30]

Retaining stormwater in the urban environment not only helps protect natural areas from polluted stormwater run-off, but also reduces flooding and the use of potable (drinkable) water for non-potable needs (such as irrigation), improves soil moisture and soil health, decreases the urban heat island effect, and supports healthy green infrastructure with its associated amenity value.[31] The importance of water-sensitive urban design and integrated water management is further explored later in this strategy.

Ecosystem health

Melbourne's urban forest is rich in biodiversity. The metropolitan region is positioned at the confluence of seven bioregions, resulting in a rich mosaic of different plant communities. Bioregions are broad geographical regions composed of clusters of interacting ecosystems that share common physical and biological features, such as climate, geology, landforms, soils and vegetation. Most of Melbourne sits in the bioregion of the Gippsland Plain (in the east and south-east), Highlands Southern Fall (in the outer east) and Victorian Volcanic Plain (in the north and west). A total of 93 recognised ecological vegetation classes occur across almost 28 per cent of this land, many of which are endangered or vulnerable. Rivers, creeks, wetlands and swamps add to the complexity and richness of habitats.

Metropolitan Melbourne supports a diverse array of native plant and animal species. More than 2,000 native plant species grow in the Melbourne region. The backyards and

streetscapes of our city and suburbs are also home to many plant species that are not native to the region or to Australia. Reflecting the significant changes that have occurred in the region since European settlement in 1788, there are 34 species of plants and 52 species of animals that are listed as threatened under the national *Environment Protection and Biodiversity Conservation Act 1999*, plus 64 species of plants and 95 species of wildlife listed under Victoria's *Flora and Fauna Guarantee Act 1988.*[32] Please see Chapter 2 of the *Technical Report* for further information about biodiversity and conservation across metropolitan Melbourne, including a map of Melbourne's bioregions.

In Melbourne, streetscapes with native trees support significantly more diverse and abundant populations of native birds than streets with mostly exotic trees.[33] Although many local government authorities maintain good inventories of their street trees, there is no comprehensive picture of street trees across the entire metropolitan area. There is limited data about the trees in our parks and open spaces, and almost no information about the species of trees and other vegetation on privately owned land such as backyards (see 'Opportunities for the urban forest'). At the neighbourhood level, the highest number of native bird species per hectare is found in native vegetation in parks and reserves[34]. The size of urban remnant vegetation in Melbourne is a major determinant of bird diversity (the larger the area, the greater the diversity).[35] Large old trees are disproportionate providers of the structural elements (such as hollows, and coarse woody debris) that are crucial habitat resources for many fauna species. But in urban areas these large old trees are particularly susceptible to loss.[36]

Most of those natural areas that are in urban landscapes are fragmented. In order to survive, many species' populations must be able to disperse, as this facilitates gene flow. A common conservation approach is to create or improve connectivity by restoring habitat using corridors, stepping stones and buffer zones.[37] Effective connectivity comprises structural connectivity (physical linkages and proximity of landscape components) and functional connectivity (species movement needs and behavioural responses to the structural connectivity).[38] Some species may need to move very little, while others may require greater freedom but are constrained by hard barriers such as fences or roads.

Depending on the movement needs of different species, functional connectivity may or may not require physical habitat connectivity. Therefore the same landscape will have different levels of functional connectivity for different species. We need to consider connectivity at various scales: local, regional, metropolitan-wide and beyond. Understanding and designing ways to maintain and restore structural and functional connectivity in cities is complex and still in its infancy, although some local government authorities have been working on this concept (Box 5).[39]

Box 5: Hume City Council and Brimbank City Council: connectivity priorities

Hume City Council and Brimbank City Council used the 'guild approach' to determine the connectivity priorities for their ecological connectivity plans. An important part of this work was a series of expert workshops to decide on parameters such as:

- broad habitat types across the council districts and bounding areas (for instance, woodlands, riparian, grasslands)
- the appropriate guilds (groups of species with common attributes) and structural connectivity needs (for instance, species-specific movement capabilities, thresholds, needs, and minimum habitat patch size)
- selection of the focal species for each guild, (shown in bold text in the table below).

The result of the analysis was a matrix, comprising four main habitats, two dispersal capabilities (longer and shorter relative distances) and 10 focal species. A fifth general habitat for a long disperser was included, to represent species less affected by fragmentation and capable of greater dispersal.

Habitat	Disperser capability	
	Longer disperser	**Shorter disperser**
Grassland	Brown Songlark **Fat-tailed Dunnart** Plains-wanderer Red-chested Button-quail Stubble Quail	Australasian Pipit **Golden Sun Moth** Grassland Earless Dragon Little Whip Snake **Striped Legless Lizard** Tussock Skink
Woodlands and forest	**Brown Treecreeper** Agile Antechinus Grey-crowned Babbler	Cunningham's Skink Diamond Firetail Fuscous Honeyeater **Grey Shrike-thrush** **Speckled Warbler** White-throated Treecreeper Yellow-faced Honeyeater
Riparian	Azure Kingfisher Common Ringtail Possum Common Wombat Nankeen Night-Heron **Southern (Large-footed) Myotis** Swamp Wallaby Common Wombat	Eastern Yellow Robin Southern Water Skink **Sugar Glider** Swamp Rat White-browed Scrubwren
Wet habitat	Baillon's Crake Buff-banded Rail Eastern Long-neck Turtle Lowland Copperhead **Rakali**	Brown Toadlet **Growling Grass Frog** Lesueur's Tree Frog
Generalist	Eastern Grey Kangaroo **Short-beaked Echidna**	

Encouragingly, there are many good examples across Melbourne where the creation of corridors and the restoration of quality habitat have resulted in the return of animal species that are otherwise susceptible to urban development. Box 6 describes the case study of Westgate Park in inner Melbourne, which has achieved remarkable results.

Box 6: Westgate Park case study

Many parks in the Melbourne area have a friends' group of volunteers to assist the public land manager with restoration and stewardship. The Friends of Westgate Park, in partnership with Parks Victoria, have welcomed people of all ages and backgrounds to volunteer their time and effort over the last 19 years. Together, they have transformed the 64-hectare park by planting 300,000 plants in nine ecological zones.

This major landscaping project has seen the return of a range of small bird species not present in the surrounding suburbs, including White-browed Scrubwrens and Superb Fairy-wrens. In recognition of their work, the Friends of Westgate Park won the 2010 Urban Landcare Award.

Challenges for Melbourne's urban forest

Melbourne and its urban forest are facing some key challenges, including:

- a growing, densifying, and sprawling urban form
- climate change
- threats to nature
- fragmented governance
- diverse community attitudes to trees and vegetation

A growing and densifying urban form

Australia is one of the most highly urbanised nations in the world, with 84 per cent of the population living in cities, towns and suburbs.

From 2012 to 2017, Melbourne accommodated 87 per cent of Victoria's total population growth.[40] A combination of natural increase and net immigration will make Melbourne Australia's largest city, with a population of 8 million people by 2051, accounting for 80 per cent of Victoria's population. To house this growing population, more than 1.6 million new dwellings will be needed, resulting in further density in existing areas and the addition of new suburbs on the urban fringe.

The characteristics of recent and projected urban growth present remarkably different prospects and challenges for the urban forest in Melbourne. On the one hand urban development reduces total green cover (trees, shrubs and grasses). On the other hand, in outer growth areas, tree canopy and vegetation structure is being created through urban development where it may not have previously existed.

Until about 1990, much of Melbourne's residential development consisted of detached houses that took up about one-third of the lot, with a large backyard.[41] However, since that time there has been a trend towards building larger houses on smaller greenfield plots in new suburbs, and urban infill in established urban areas. The latter includes larger new

houses replacing smaller, older houses, extensions to existing houses, and medium-density to high-density development of townhouses and apartments (Figure 3). These processes combine to reduce lawn and garden size and increase impervious surfaces.

One study compared plot ratios in older established suburbs to those in newer suburbs.[42] The difference was considerable: in the older, established Melbourne suburb about 30 per cent of the plot was covered by buildings and hard surfaces, whereas in a newer Melbourne suburb this increased to about 65 per cent.

Figure 3: Historic vs recent growth patterns in established urban areas in Melbourne's Eastern Region

(a) 1996

(b) 2018

Images (a) and (b) show a redevelopment of three single dwellings that maximises construction over the allotment area, resulting in less private open space, overall vegetation and canopy cover (source: Explore Whitehorse).

(c) 2009

(d) 2018

Images (c) and (d) illustrate that higher residential density and single-dwelling renovation (or construction of new dwellings) can reduce backyard space, vegetation and canopy.

This results in larger areas covered by impervious surfaces, and less potential habitat for flora and fauna (source: Nearmap).

(e) 2010

(f) 2018

Images (e) and (f) show a redevelopment of four allotments with four detached dwellings to yield 12 dwellings – a gain of eight dwellings.

However, there is a corresponding loss of significant vegetation cover, an almost complete loss of canopy and potential habitat, and a gain in impervious surfaces (source: Nearmap).

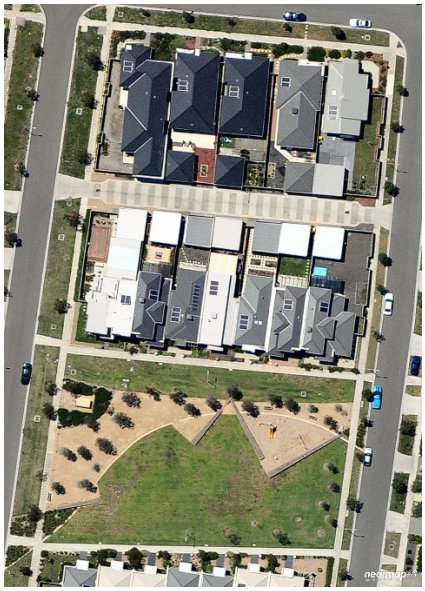
Conversely, in our western and northern growth areas, canopy trees are being planted in new streetscapes. These improve amenity and provide shade on previously rural land that consisted of cleared or largely treeless plains supporting a mixture of exotic and native grasslands (Figure 4).

Figure 4: Historic vs current growth patterns in urban growth areas

(a) 2010 Northern Region, Melbourne

(b) 2018 Northern Region, Melbourne

Images (a) and (b) show the substantial growth of canopy trees in and around a new recreation reserve in Melbourne's Northern Region (Source: Nearmap).



(c) 2010 Northern Region, Melbourne

(d) 2018 Northern Region, Melbourne

Images (c) and (d) show the growth of street trees over an eight-year period in Melbourne's Northern Region.

Note that due to the relatively small size of the privately owned spaces, street trees and park trees provide most of the canopy cover (source: Nearmap).

The retention and expansion of the urban street tree canopy continues to be challenged by regulations governing powerline clearance, which mandate minimum clearance distances between vegetation and overhead powerlines, depending on the type of infrastructure in place. Solutions need to be developed to encourage electricity distribution systems that minimise vegetation loss, such as underground cables, aerial bundles and insulation. Solutions are also needed for similar threats posed to the urban forest by other utility services.

In greenfield developments, the pavements and nature strips have been narrowed. This has the effect of reducing space available for planting large canopy trees, with room for root growth constrained by underground utility services.

Another challenge is to increase the tree canopy on our road reserves (particularly on boulevards and major roads) without increasing risks to property and human life. The introduction of flexible wire-rope safety barriers provides an opportunity, in collaboration with Department of Transport, to achieve this balance on high speed roads. Research indicates that while roadside trees are one of the most common structures involved in single-vehicle crashes, they can also help calm traffic, reduce drivers' stress and have been correlated with reduced driving speeds[43].

As we face a larger population and a denser urban environment, the benefits of the urban forest have never been more important, yet these growth trends present a significant threat to the health of the urban forest. Denser urban forms generally have greater areas covered by impervious surfaces, reducing the soil moisture that trees need in order to grow and to survive during dry periods. Also, water flows more quickly off these surfaces, leading to increased soil erosion. Taller buildings cast shade over environments that would otherwise be suitable for vegetation, and soil is compacted, making it more difficult for plants to thrive.

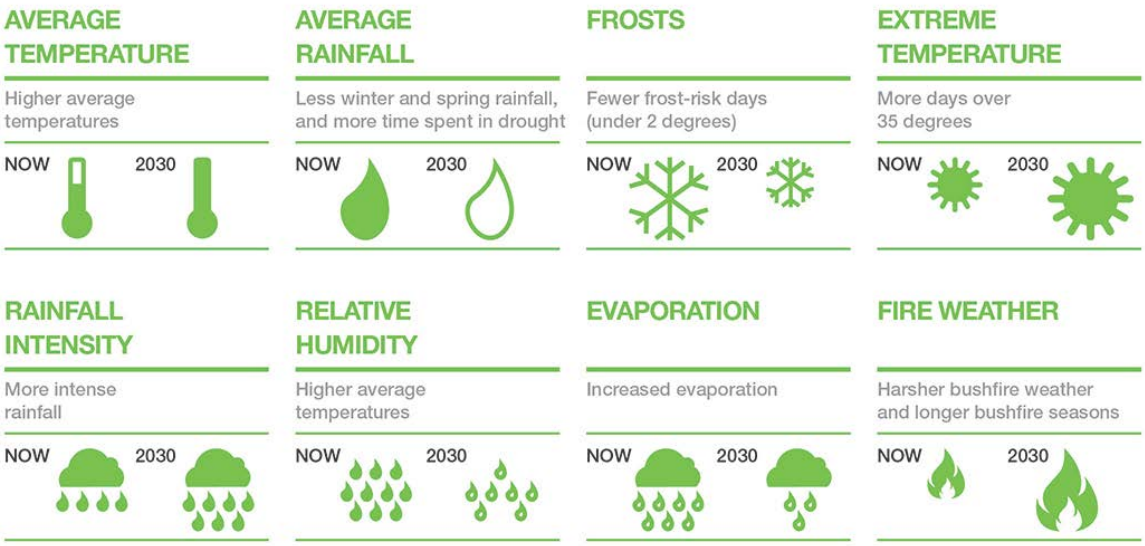
Climate change

Climate research continues to show that maximum and minimum temperatures are rising in Australia. Such changes will expose Melburnians to more frequent and intense droughts,

fires, heatwaves, extreme rainfall, and coastal inundation (see Figure 5). Climate change makes the urban forest more susceptible to pests and diseases, thus increasing the frequency of tree death, further reducing canopy cover.

Australia's climate has warmed by an average of approximately 1°C since 1910.[44] With this has come an increase in the duration, frequency and intensity of heatwaves, increase in extreme fire weather, a decline in April–October rainfall, and rising sea levels, which amplify the effects of high tides and storm surges. These trends are expected to continue.

Figure 5: Projections for temperature changes in Melbourne[45]



Even if there are considerable reductions in global greenhouse gas emissions in the near future, the lag in the climatic system means that much harm is already unavoidable, requiring communities and organisations to change their behaviour and practices in response. Urban form changes slowly – the long lives of trees and vegetation require planning decisions to account for long-term climate changes and the uncertainties these changes will bring.

Rising temperatures and extreme heat

As average temperatures rise, many trees are becoming increasingly vulnerable, including exotic species from colder climates and indigenous species that thrive only in relatively narrow climatic bands.[46] When extreme heat is combined with low soil moisture, some trees' foliage and bark can scorch, which can lead to declines in tree and ecosystem health. Warmer temperatures also change the geographical extent of pests and diseases, by affecting life cycles, habitat suitability and reproduction rates. The urban forest will face new risks and challenges as pest and disease ranges change.

Rainfall, droughts and floods

Droughts have become more frequent and intense due to climate change, with confident predictions that this trend will continue. Between 1997 and 2009, Victoria experienced a period now known as the Millennium Drought. In some communities, long periods under severe water restrictions caused the death of significant trees in parks, led to the closure of

sports fields and compromised the survival of some businesses such as nurseries.[47] In 2015 the total rainfall across Melbourne's water catchments was more than 15 per cent below the 30-year average, and the total catchment inflow was more than 40 per cent below the long-term average.[48] Increasing evaporation due to higher temperatures and declining rainfall will exacerbate reductions in soil moisture caused by impervious surfaces. This reduces urban vegetation's resilience to droughts and hot days.

Despite an overall trend of declining rainfall, more of the rain that does fall will be in increasingly heavy downpours. This is likely to lead to more frequent flooding, particularly in urbanised and small catchments. Flooding and inundation can contribute to soil erosion, tree instability and tree death.

Threats to nature

Victoria has experienced biodiversity loss over the past two centuries due to land development, land clearing, water pollution, fire, pest plants and animals and, more recently, reduced resilience under climate change.[49] Historically, urban growth and densification have been major causes of natural habitat loss around the world. Melbourne is no exception.[50]

Melbourne's fauna is dynamic, and changes in species presence and abundance are largely the result of changes to the extent, structure and composition of habitat over time, as well as adaptation by some species to the urban environment.

Despite Melbourne's relatively high proportion of public open space and overall native vegetation cover, many species of native flora and fauna have declined.[51] Further losses can be expected due to species extinction, unless we put additional effort into sustaining plant populations.[52] Higher urban density not only reduces backyard size and opportunities for conservation, it also reduces opportunities for people to connect with nature at home.

Despite these known broad-scale trends in urban growth, there is still much to learn about the consequences of urbanisation for biodiversity, and how best to design cities and towns to conserve biodiversity and maintain healthy ecosystems.[53] Best practice guidelines are lacking on how to halt biodiversity loss and increase biodiversity.[54]

Fragmented governance

Federal, state and local governments, utility providers, property developers and residents all have roles – formal and informal – to play in the governance and management of our urban forest. Relationships between the tiers of government are complex and sometimes effective cooperation is easier said than done. However, the urban forest does not recognise or adhere to administrative boundaries. This situation of fragmented governance hampers our ability to plan for and adequately protect our metropolitan urban forest across different jurisdictions and land tenures.

Despite the many benefits that we know they provide, most trees are not protected by planning or environmental controls. Individual trees are sometimes protected through controls such as local laws or planning overlays. Many municipalities have their own local laws, which require permits to remove or carry out works to trees on both public and private property. Significant tree registers recognise and protect individual trees that are of high value to the community and some councils have their significant tree registers linked to a relevant planning overlay.

Thirteen of Melbourne's councils are leading the way in protecting and improving the urban forest in their municipal areas through urban forest strategies, in which the active involvement of private landholders is essential. Many other local government authorities have urban landscape, open space or street tree strategies that also benefit the urban forest.

Managing and developing our urban forest requires us to bring together many different organisations to work collaboratively towards both a long-term vision and short-term priorities. Significant progress has already been made in this regard, providing a strong foundation for further integrated efforts between sectors and regions. Landcare is one example of an inclusive, community approach to natural habitat protection and development across Australia (Box 7).

Box 7: Landcare – an Australian model fostering social connection

Landcare groups are communities of volunteers who take action to improve their local environment. A Landcare group usually starts when community members with common objectives notice a local environmental problem that needs to be remedied, and come together to make it happen. Landcare builds social capital in rural communities and helps communities promote sustainable land and water management and tackle common problems across farm boundaries. These groups have proven that community-based, decentralised, sustainable land and water management can be extremely successful.

Landcare became an Australian national program in July 1989, when the Australian Government, with bipartisan support, announced its *Decade of Landcare* plan and provided $320 million to the National Landcare Program. Since then, Landcare groups have formed across Australia, and in more than 20 countries around the world. Because Landcare's cornerstones are to be community-owned and community-led, bipartisan in nature, and encouraging integrated management of environmental assets, it has a number of positive attributes that are relevant to the *Living Melbourne* strategy.

Diverse community attitudes to trees and vegetation

Councils, and other public land management agencies, apply significant resources to managing, maintaining and expanding the urban forest on behalf of their local community. The majority of community members appreciate and respect the multitude of benefits that the urban forest provides and are actively involved in its stewardship. However, some do not share this view.[55]

Residents have diverse attitudes to trees and vegetation. Trees are planted for many reasons including for their beauty, to improve the appearance of gardens, to enhance privacy, to attract native wildlife and improve the appearance and value of private houses. However, councils must also manage community feedback and requests that arise from both real and perceived risks. Reasons often cited for removing trees include advanced age, root damage to foundations or utility infrastructure, limbs or trees at risk of falling and the risk of fire.[56]

Understanding community perceptions of the urban forest is required as a critical step to help frame positive messages, and develop new – and support existing — behaviour-change programs that empower the community to promote the urban forest. It will also be critical to assist the development of community information that will inform private decision-making. Taking a strategic and informed approach will improve the way we select appropriate

species for planting in different places, and improve the relationship community members have with their urban forest.

Opportunities for the urban forest

Mapping the urban forest

To better inform the strategic approach of connecting and enhancing our metropolitan urban forest, *Living Melbourne* has developed new mapping resources including imagery and mapping derivatives. These can be used by partners to set priorities for their investment, and regional opportunities to scale up existing efforts.

We used eCognition Essentials software provided by global software developer Trimble, to map metropolitan Melbourne's urban forest. The two main sources of data were:

- two-metre resolution multispectral satellite imagery provided by DigitalGlobe
- Victorian Government Light Detection and Ranging (LiDAR) datasets

These data sets were prepared and formatted before being processed by the eCognition Essentials software. The output provides a map of the distribution and height of vegetation across metropolitan Melbourne (Figure 6). For further information and maps please refer to Chapter 6 of the *Technical Report*.

Mapping the urban forest is essential for its development, protection, maintenance and growth. Comprehensive and accurate maps give government authorities and other land managers the information they need to make informed decisions about improving, re-establishing and connecting Melbourne's natural environments. Canopy cover is an important measure of the urban forest's ability to benefit the community and the environment.[57] Developing a consistent, metropolitan-wide vegetation and canopy map for this *Living Melbourne* strategy is a critical step in assessing the current status of Melbourne's urban forest, and for setting future targets and actions.

Figure 6: Melbourne's urban forest

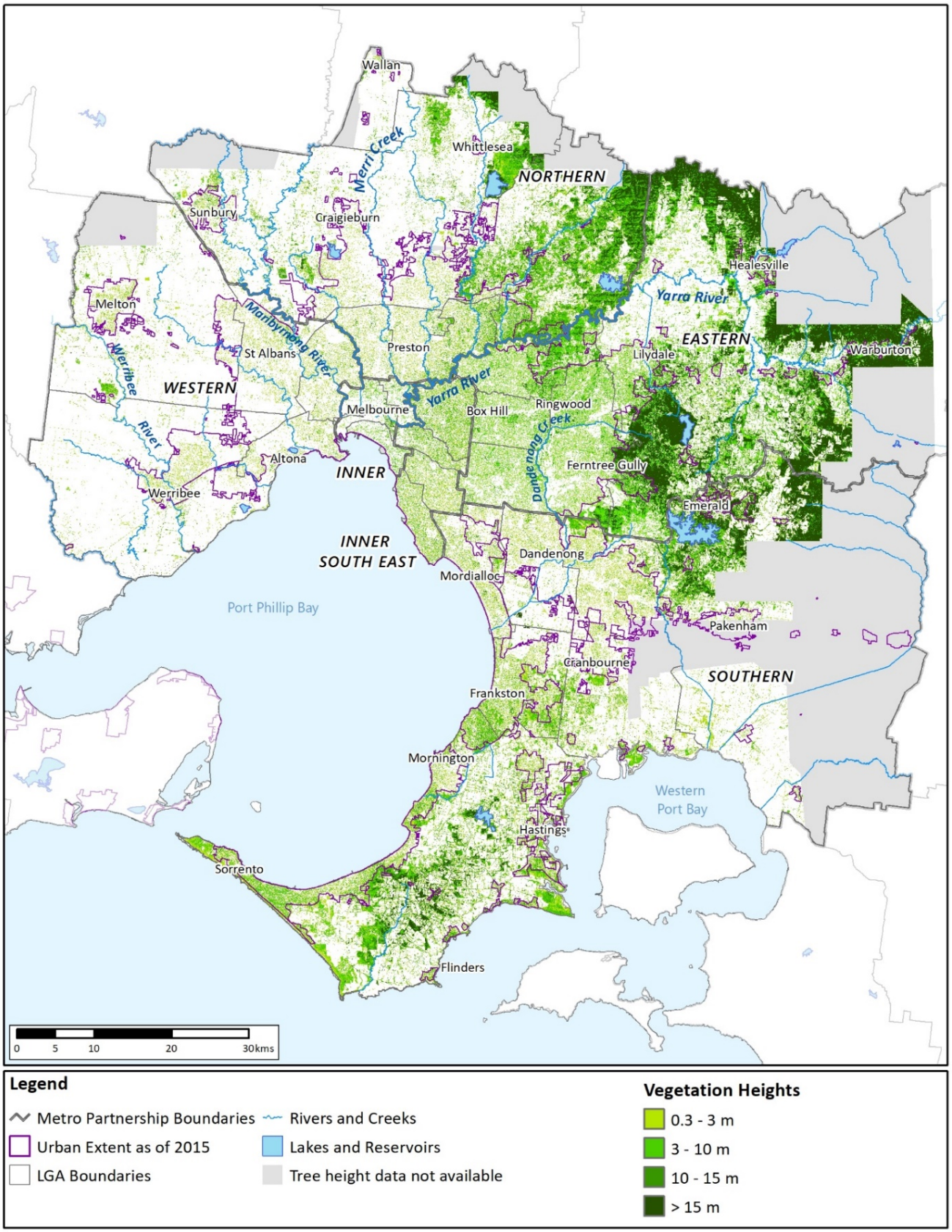


Table 1 provides a regional breakdown of the distribution of canopy cover across metropolitan Melbourne. 'Canopy' is defined as vegetation above three metres in height.

The metropolitan urban area has a total canopy cover of 15 per cent. Canopy cover is highest in the Eastern (25%) and Inner South-East (22%) regions. The Southern (16%), Inner (13%) and Northern (12%) regions have less canopy cover. Canopy cover is lowest in the Western Region (4%).

Table 1: Canopy cover in urban Melbourne*

Metropolitan region	Percentage of land with canopy cover (of trees 3 metres high or taller)
Eastern	25
Inner South-East	22
Southern	16
Inner	13
Northern	12
Western	4
Total metropolitan tree canopy	**15**

*Figures rounded to nearest whole number

The different regions vary widely in canopy cover. This is a result of their natural attributes – which influence vegetation patterns – combined with the historical development and growth of Melbourne.

One important factor is Melbourne's location at the confluence of multiple bioregions. For example, the vegetation types that existed in Melbourne before European settlement included grasslands and grassy woodlands in the west, heaths and heathy woodlands in the south-east, and dry forests in the east.

In addition to these natural differences, Melbourne's development and growth since the 1830s has had an important influence on the shape and form of today's urban forest. Settlers' preferences for elevation, views, water and mature trees meant that Melbourne's early development moved outwards from the original European settlement on the banks of the Yarra River to the north-east, east and south-east, and tended to be on the hillier, treed terrain.[58] The flatter northern and western areas – largely grassland plains – were considered less hospitable and desirable.

These underlying differences are critical – any work on the urban forest across Melbourne must respond to these characteristics. Both the natural systems and built urban form, including infrastructure, should be considered in all efforts to protect and enhance our urban forest.

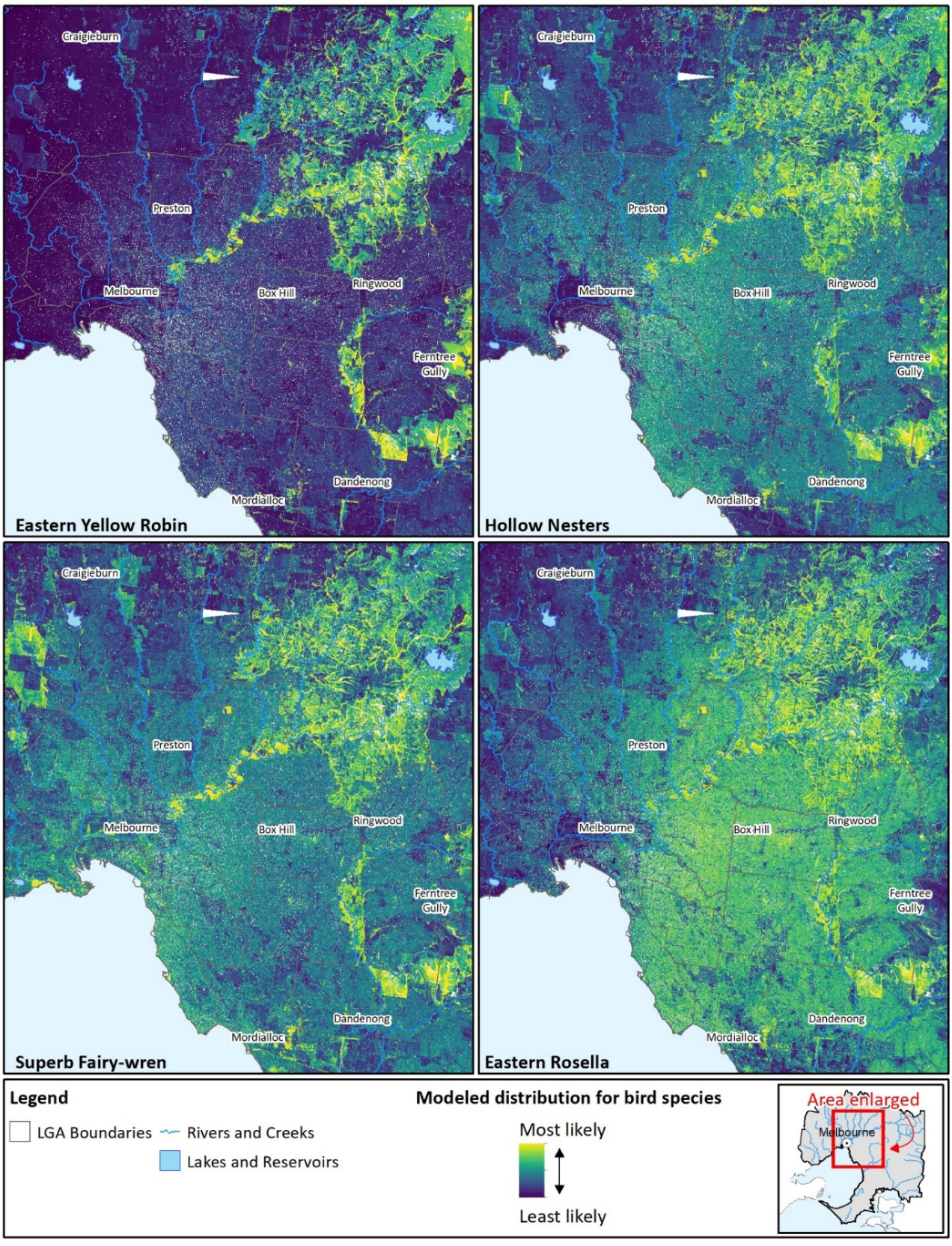
Habitat connectivity

Connectivity and the ability of animals to move, and plants to disperse, within or between patches of habitat is critical for conservation. Many individual patches are too small and widely dispersed to support viable populations. It is therefore important that green spaces, such as gardens and public open space, are not viewed at the individual scale, but instead considered collectively as interconnected networks of green spaces across the urban

landscape. By extending the urban forest, we can link and create an interconnected matrix of green spaces across our diverse urban landscape.

Using the urban forest canopy cover mapping layer with bird atlas data (supplied by BirdLife Australia) and other important datasets (such as ecological vegetation classes), enables the modelling of different levels of connectivity and landscape permeability for different bird species and bird groups (see Figure 7 and the *Technical Report* for more details).

Figure 7: **Modelled distribution for various bird species or bird groups in Melbourne's urban landscape, with suitability ranging from most likely (yellow) to least likely (dark blue)**



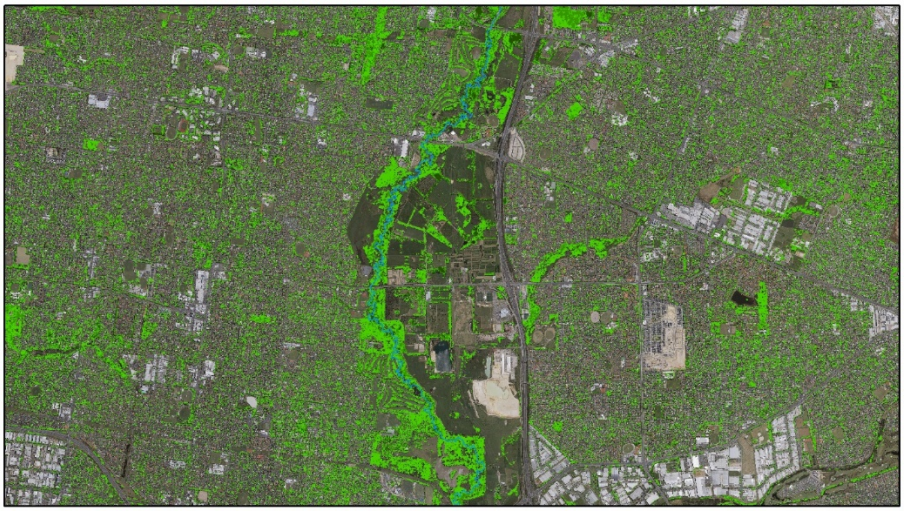
The high suitability of particular riparian corridors (such as along the Yarra River and Dandenong Creek) for many of these species highlights the importance of these features for the persistence of some species in the urban landscape, and the importance of connectivity. However, for species that are better able to exist in the urban environment, suitable habitat and connectivity are also provided by streetscapes and backyards.

Identifying a network of existing and potentially new habitat corridors at different scales for a range of species (and protecting and improving these corridors) will be an important step in creating an enhanced urban forest for Melbourne. For example, combining habitat models based on species records and known habitat preferences with canopy mapping can reveal areas for future corridor improvement, as illustrated in Figure 8.

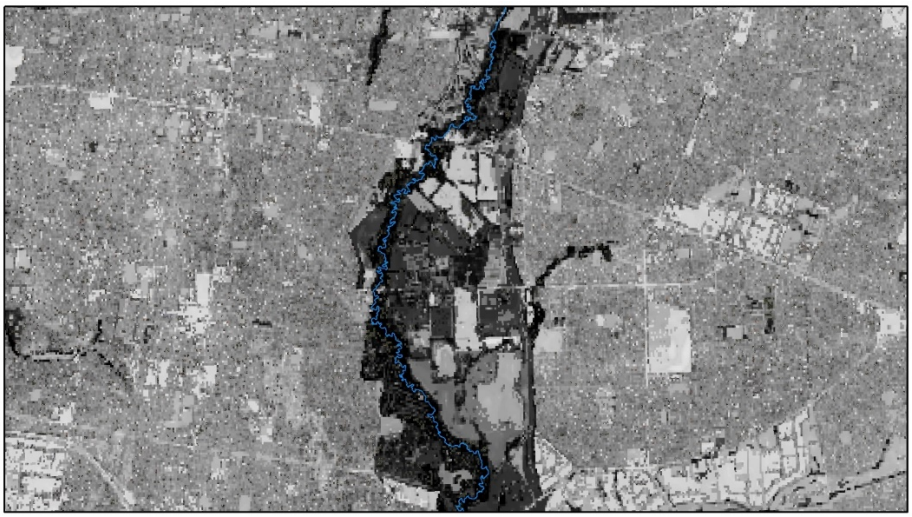
Figure 8: Canopy mapping and bird species habitat modelling used together, to reveal areas suitable for corridor improvement by expanding the urban forest: Dandenong Creek Valley Parklands in eastern Melbourne

a) Current aerial photography of part of the Dandenong Creek Valley Parklands in eastern Melbourne.

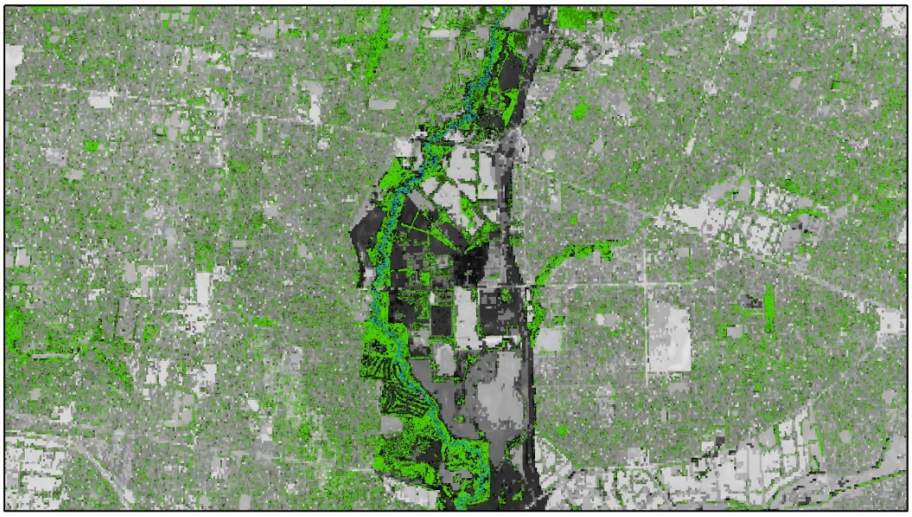
b) Mapped canopy cover over the Dandenong Creek Valley and surrounding suburbs over aerial photography.



c) **Likelihood of occurrence for a suite of hollow-nesting bird species in the Dandenong Creek Valley (black and dark grey areas are most likely) (see also Figure 7 and the *Living Melbourne Technical Report* for more details).**



d) **Canopy cover (green) overlayed on hollow-nesting bird species suitability. The visible areas of darkest shading (black and dark grey) indicate areas without existing canopy that could be suitable for restoration and connectivity improvement for hollow-nesting bird species.**



Correlations between the urban forest and heat vulnerability

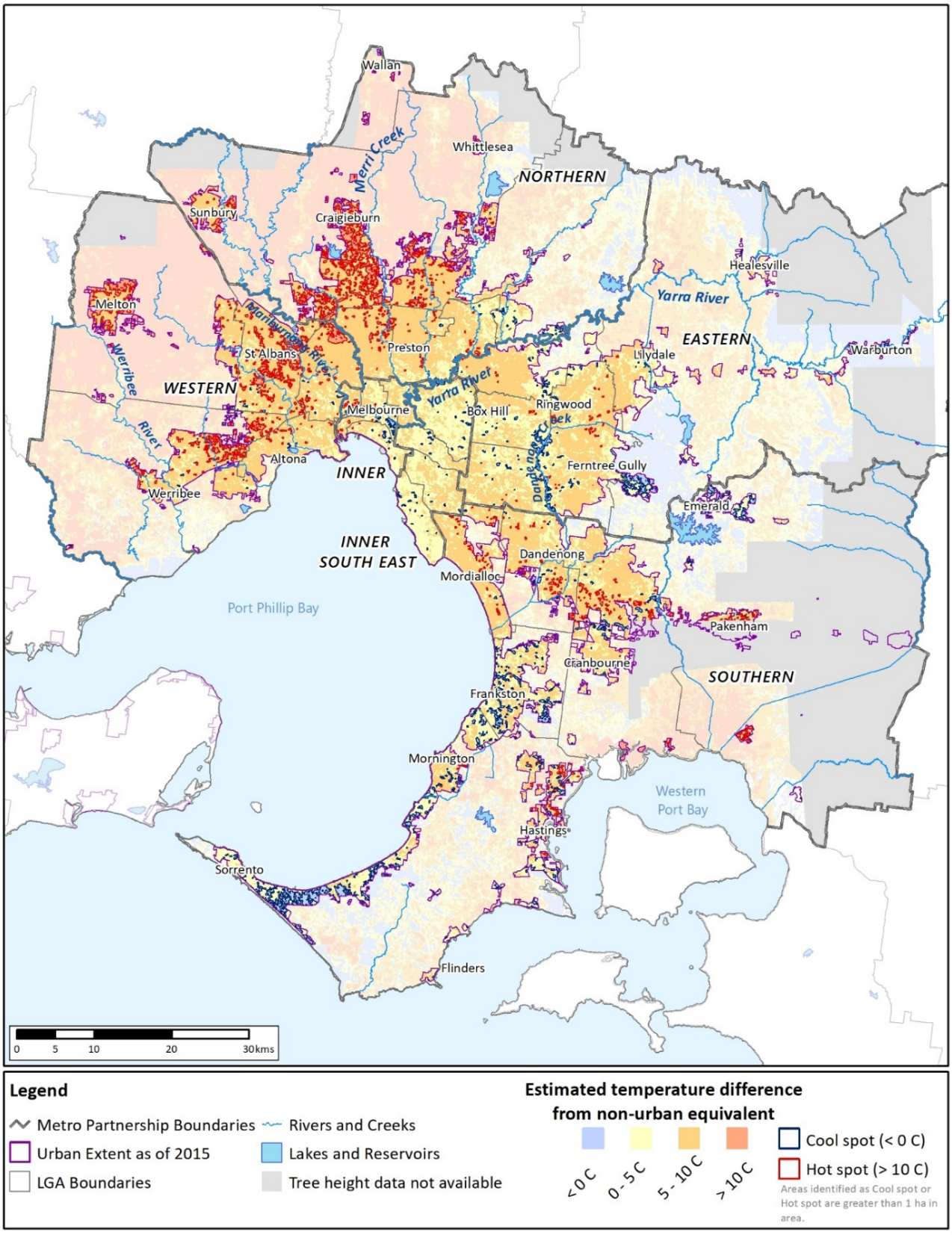
In developing the *Living Melbourne* strategy, we analysed land surface temperature (Figure 9) using a variety of Australian Bureau of Statistics indices, such as the Socio-Economic Indexes for Areas, which ranks areas in Australia according to relative socio-economic advantage and disadvantage. This found a close correlation between hot spots in the landscape and vulnerable populations. We also found, in most cases, a greater number of hot spots where the percentage of residential rental properties is higher and where weekly household income is lower.

The land surface temperature analysis was also undertaken to explore the effect of total vegetation cover and vegetation height. About half of metropolitan Melbourne is 5°C above the city's estimated non-urban baseline temperature. This applies to about 80 per cent of the Northern and Western regions. It also shows that, overall, in cool spots (areas that are equal to or below their estimated non-urban baseline temperature) there is more vegetation and far more canopy (vegetation greater than three metres in height). On average, hot spots have less than three per cent canopy and no tall trees (trees greater than 15 metres high). Vegetation between three and 10 metres high is predominant across Melbourne, and provides for more cool spots.

The highest numbers of hot spots occur in the north, west and south of Melbourne. The north and west also have far more hot spots than cool spots. The size of hot spots and cool spots varies: hot spots in the east are on average three hectares in area, compared to hot spots in the west averaging nearly 10 hectares in area. The opposite is true for the cool spots: these are larger in southern and eastern Melbourne (which is more heavily vegetated) and smaller in the north and west.

A full analysis is provided in Chapter 7 of the *Technical Report*.

Figure 9: **Urban heat islands across metropolitan Melbourne. Hot spots (> 10°C warmer than non-urban conditions) bordered in bright red. Cool spots (areas that are equal to or *below* their estimated non-urban baseline temperature = <0°C) bordered in dark blue.**

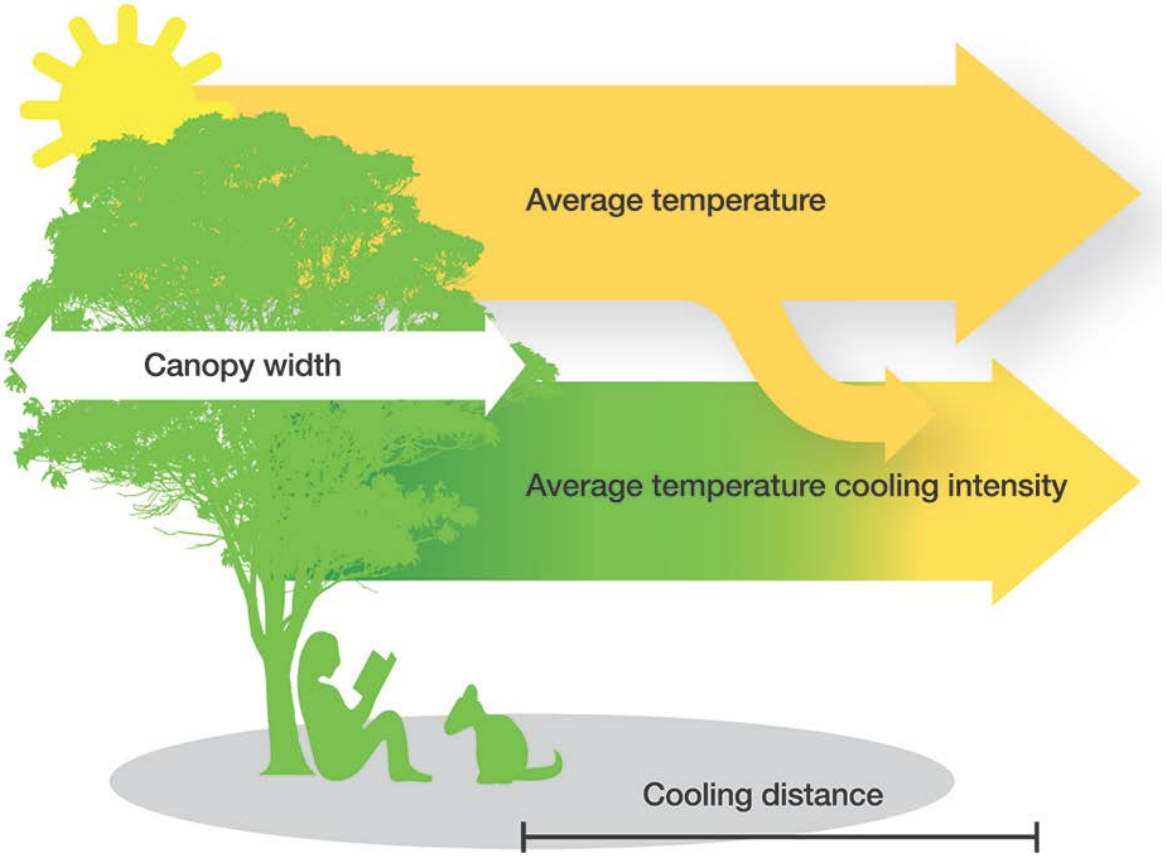


Trees and temperature reduction

In urban areas, individual trees can substantially lower maximum summer daytime air temperatures at the street and pedestrian level. They do this in two ways: by transpirative cooling and by shading.[59] However, the shading of sealed surfaces under a tree canopy is particularly important in improving pedestrian thermal comfort, because it dramatically lowers surface temperatures, and the mean radiant temperature to which pedestrians are exposed.[60]

A tree canopy produces a 'cooling intensity' (the reduction in average air temperature under a tree canopy compared to the temperature outside the patch covered by the canopy, expressed in degrees Celsius). The cooling intensity of urban trees can vary substantially between tree species but generally, the larger the canopy, the greater the cooling intensity. The cooler air from beneath the canopy then disperses away from the patch and slowly mixes with the adjacent hot air. The further the air moves from the canopy, the closer it gets to the average temperature in the city, as illustrated in Figure 10. Further discussion about tree species can be found in Chapter 3 of the *Technical Report*.

Figure 10: Temperature mitigation by trees (© Mackinzie Jones, Apertures)



One of the most effective ways to reduce temperatures is to provide shade trees in combination with increased permeable surfaces that will retain more moisture in the landscape.

Compared with moist and shaded environments, a built-up city with one million or more people can have average air temperature increases of 1°C to 3°C during the day, and up to 12°C during the night.[61] Inner Melbourne temperatures have shown peaks up to 7°C higher than those of surrounding rural areas.[62]

The cover provided by trees and other vegetation can affect cooling intensity in two ways. First, vegetative cover shades impervious surfaces, preventing the sun's rays from hitting them. This inhibits the storage and subsequent release of heat, which would contribute to the urban heat island effect. Trees that are tall enough to create a large shaded area under their canopy are more useful than short vegetation. Trees also transpire water as they grow and photosynthesise. This water absorbs surrounding warmth and is converted from liquid into water vapour, which in turn prevents an increase in air temperature.[63]

Like vulnerability overall, the harm caused to human health by excessive heat is concentrated in particular parts of the population, particularly the elderly, young children, socially isolated persons, people with chronic disease, and those in built-up urban areas. Around the world, people are living longer and Australia is no exception. The percentage of our population aged 65 or older is projected to increase from 14 per cent in 2012 to 25 per cent in 2051. In Victoria, 2.2 million people, or 21.5 per cent of the state's population, will be 65 years or older by 2051. Higher urban temperatures disproportionately affect elderly people.[64]

Water-sensitive urban design

We need access to enough water to meet basic human needs and to support a healthy environment and economy. The Millennium Drought from 1997 to 2009 highlighted that water from any source is a valuable resource, which we need to use efficiently. Without enough water, efforts to maintain and extend the urban forest will be unsuccessful. Rainwater, stormwater and recycled water are valuable resources which can potentially be used to reduce demand on the water supply system and help sustain our urban forest. It will be important to continue to explore and invest in the right mix of sustainable water supply options to ensure urban forests establish and thrive. As more surfaces become impermeable – and as climate change reduces rainfall and increases heat, evaporation and the variability of what rain there is – we must make the most of advances in urban water management.

Water-sensitive urban design (WSUD) is one such solution that uses better urban planning and design to clean, re-use and absorb stormwater, stopping it from reaching our waterways by mimicking the natural water cycle. The urban forest is a vital part of this process. WSUD integrates 'urban planning with the management, protection, and conservation of the urban water cycle' and 'ensures water management is sensitive to natural hydrological and ecological processes'.[65] By making decisions that recognise water as a valuable, vulnerable and finite resource, we can provide water to our cities and maintain a healthy urban forest.

WSUD supports the urban forest by harvesting, using and re-using stormwater, and establishing wetlands and water infiltration systems. Conversely, the urban forest plays an important role in WSUD, by reducing evaporation, slowing and absorbing water run-off, and trapping pollutants.

Improving urban air quality

The *Victorian State of the Environment Report 2018* identifies opportunities to consider air quality when making urban planning decisions, particularly in relation to urban green space and opportunities to reduce reliance on motor vehicles and other sources of air pollution.[66]

The project Green for Good: Assessing the Health Returns of Green Investment assessed the effects of green infrastructure on the health of children in the city of Louisville, Kentucky, USA. A screen of mature trees and shrubs was planted along the busy road in front of a school; urine and blood tests were taken from the children and staff three weeks before and three weeks after the screen was installed. The results showed that, under certain conditions, the green wall bio-filter reduced particulate pollution by 60 per cent. A large body of literature suggests that trees can provide localised but meaningful reductions in airborne particulate matter. But tree planting should complement – not replace – other efforts to reduce particulates in the air.[67]

Developing the *Living Melbourne* strategy

Global and local momentum

The rapid urban growth being experienced by Melbourne is part of a worldwide trend. A recent assessment of global urbanisation patterns and biodiversity loss confirms that we are now witnessing the most significant urban growth in human history.[68]

The United Nations Department of Economic and Social Affairs estimates that, by 2050, roughly 68 per cent of the world's population will be urban.[69] This means that the next 30 years will see the largest human settlement transformation in human history. It forecasts that, by 2050, 2.4 billion more people will be living in cities, a rate of urban growth that is equivalent to building a city with the population of London every seven weeks. In the space of 30 years, humanity will urbanise an area of 1.2 million square kilometres, nearly the size of the Northern Territory.

The United Nations 2030 Agenda for Sustainable Development provides a worldwide plan for dignity, peace and prosperity for people and the planet, now and in the future. *Living Melbourne* supports the following Sustainable Development Goals[70] (Figure 11):

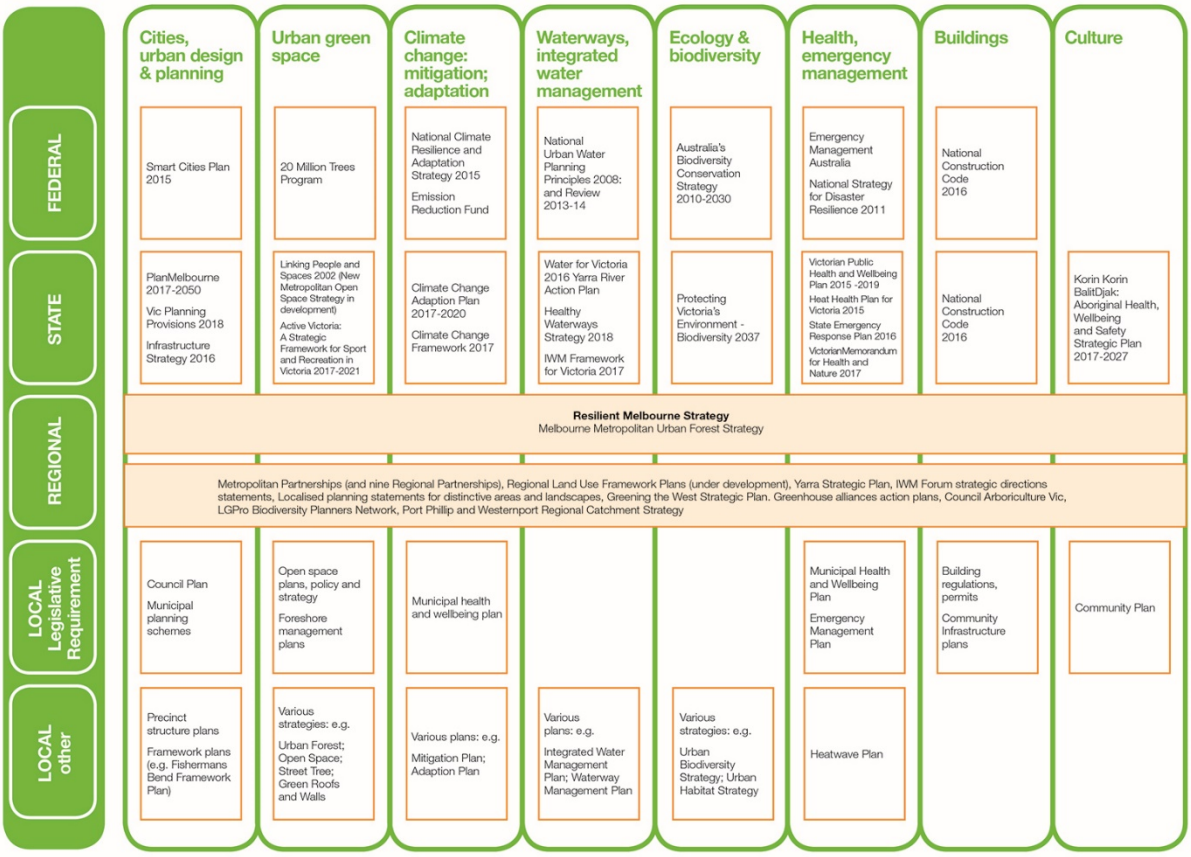
- Goal 3: Good health and wellbeing
- Goal 6: Clean water and sanitation
- Goal 11: Sustainable cities and communities
- Goal 13: Climate action
- Goal 14: Life below water
- Goal 15: Life on land
- Goal 17: Partnerships for the goals

Figure 11: The United Nations Global Goals for Sustainable Development

Policies relevant to metropolitan Melbourne's urban forest

Many local, Victorian and Australian government policies and strategies have implications for Melbourne's urban forest (Figure 12). This section summarises important documents (with further details provided in Chapter 5 of the *Technical Report*).

Figure 12: Major government policies and actions relevant to Melbourne's urban forest



Local government urban forest strategies

All councils in metropolitan Melbourne recognise, in their strategies and policies on public open space, the value of green space and tree canopy cover. This is why, when the *Resilient Melbourne* strategy was created, the metropolitan urban forest was the most strongly supported action.

At the time of writing the *Living Melbourne* strategy, 13 local government authorities have an urban forest strategy and are making efforts to maintain or increase tree canopy cover. Although some strategies focus narrowly on street trees and canopy on public land, others also consider vegetation on private land, have performance measures, are long term, and use a broad definition of an urban forest. Many more councils have urban landscape, open space, or street tree strategies which also contribute to the urban forest.

Currently, eight municipalities have specific tree requirements in the schedules to their residential zones for development proposals for two or more dwellings. Requirements include elements such as a minimum number of trees per specified area, and specific

characteristics of trees such as size, maturity, canopy tree and species. Additional responsibilities are assigned to local governments through the Victoria Planning Provisions garden area requirement, introduced in March 2017, which applies to two residential zones: General Residential and Neighbourhood Residential. Councils must now assess the garden areas in residential development proposals that require a planning permit on lots over 400 square metres in those two zones; stipulated minimum standards must be met.

Victorian Government policies and strategies

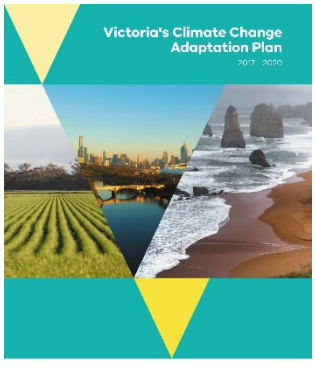
A range of Victorian Government documents provide support and guidance relating to Melbourne's urban forest. These include *Plan Melbourne 2017–2050*, the *Victorian Climate Change Adaptation Plan 2017–2020*, *Protecting Victoria's Environment – Biodiversity 2037*, and the *Victorian Public Health and Wellbeing Plan*, among others.

Plan Melbourne 2017–2050

Victoria has set a strong policy direction towards cooling and greening, to help create a city that is more sustainable, resilient and better adapted to the changing climate. *Plan Melbourne 2017–2050*, the state's long-term plan to accommodate Melbourne's future growth in population and employment, supports the need to maintain and enhance its urban forest.

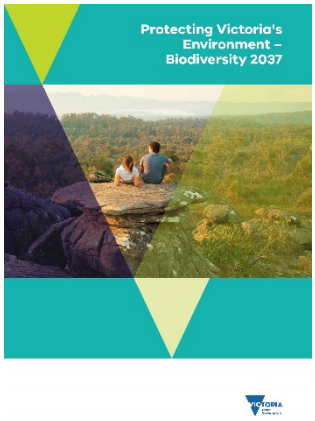
Direction 6.3 'Integrate urban development and water cycle management to support a resilient and liveable city' understands that by considering the whole water cycle when planning for urban areas, we can improve wastewater management and recycling, support urban greening and cooling, protect waterways, minimise the impact of flooding and improve water security.

Direction 6.4 'Make Melbourne cooler and greener' and Direction 6.5 'Protect and restore natural habitats', explicitly encourage 'maintaining and enhancing … [the] urban forest of trees and vegetation' and support 'the development of the metropolitan urban forest strategy'.[71]



Victoria's Climate Change Adaptation Plan 2017–2020

Victoria's Climate Change Adaptation Plan 2017–2020 sets out the Victorian Government's priorities for leading and supporting the community to adapt to climate change from 2017 to 2020.[72] It explains how the government will support adaptation and coordinate action on different scales (local, regional, and sectoral). Important elements of this plan include improving how we consider climate change when making decisions about the built environment, and taking immediate steps to minimise the urban heat island effect and manage risks to the transport system.



Protecting Victoria's Environment – Biodiversity 2037

Protecting Victoria's Environment – Biodiversity 2037 is the Victorian Government's plan to stop the decline of biodiversity and improve the state's natural environment over the next 20 years. It highlights the need to create more liveable and climate-adapted local communities, by planting trees to reduce heat and creating a network of natural and designed green spaces. Like *Plan Melbourne 2017–2050*, *Protecting Victoria's Environment: Biodiversity 2037* also refers specifically to the metropolitan-wide urban forest strategy.

Victorian Public Health and Wellbeing Plan 2015–2019

The *Victorian Public Health and Wellbeing Plan 2015–2019* sets out a long-term agenda for improving health and social wellbeing in Victoria.[73] In setting high-level goals for change and improvement, the plan recognises and seeks to complement many existing and emerging plans, strategies and policies for improving public health. A statutory link between the *Climate Change Act 2010* and the *Public Health and Wellbeing Act 2008* has been made that requires councils to regard the *Climate Change Act* when preparing a municipal public health and wellbeing plan. The Department of Health and Human Services has developed guidance about how to consider climate change in planning strategies and actions across councils.

Another important Victorian Government strategy is currently in development: the *Metropolitan Open Space Strategy*, described in Box 8.

Box 8: Metropolitan open space strategy

Plan Melbourne 2017–2050 recognises green infrastructure as essential to liveable cities and healthy communities.

Partnerships between Victorian and local government authorities will look for new ways to optimise use of and access to public land and make open space accessible and enjoyable for all Melburnians. A new investment framework, to be developed as part of the new metropolitan open space strategy under Action 93 of *Plan Melbourne 2017–2050*, will reinforce and complement the legacy and foundations of past planning to create a fairer and more equitable open space network.

The map below is from the Plan for General Development, Melbourne, commissioned by the Metropolitan Town Planning Commission in 1929, which recognised the value of Melbourne's radial waterways to the open space network. The legacy of the commission's important work still influences Melbourne's urban form today.

Healthy Waterways Strategy 2018–28 and Integrated Water Management Framework 2017

Water authorities, consistent with the strategy *Water for Victoria*, are recognising their important role in supporting a healthy urban forest. Melbourne Water's *Healthy Waterways Strategy 2018–28* is a strategy shared by Melbourne Water, state and local governments, water corporations and the community. It covers the rivers, creeks, estuaries and wetlands of the Port Phillip and Westernport Region, providing a single framework to protect and improve the waterways' environmental, social, economic and cultural values for the community.

Integrated water management is essential if we are to provide enough water to support our urban forest. The *Integrated Water Management Framework 2017* describes the benefits of

consistent and strategic collaboration in the water sector – water corporations, local governments, and catchment management authorities – and with other organisations involved in land use planning. Box 9 illustrates the importance for the urban forest of work by our water authorities.

Box 9: The importance of water authorities

Public utilities such as Melbourne Water are active in cooling and greening our city. Melbourne Water has committed to 'investing directly in improving 30 hectares of green spaces for shade and cooling across Melbourne by 2021'.[74]

Water-sensitive urban design in Melbourne is supported by several state and local government policies, including the Victorian Planning Provisions, precinct structure plans and the *Integrated Water Management Framework for Victoria*. Additionally, water authorities are applying water-sensitive urban design in their business strategies, such as Melbourne Water's *Healthy Waterways Strategy*, *Stormwater Strategy*, and *Integrated Water Future for Melbourne's North*.

Water for Victoria

Water for Victoria, the state's water plan, argues for the use of diverse water sources to protect public spaces.[75] In particular, it encourages water corporations to work with local government and other managers of public open space to identify water sources that can be used to maintain community assets such as gardens and street trees, and seek opportunities to cool the city in order to improve community health, wellbeing and liveability.

Living Melbourne: A new way forward

How was the strategy devised?

The development of the *Living Melbourne* strategy is a 'flagship action' under the *Resilient Melbourne* strategy. The Nature Conservancy and Resilient Melbourne have developed this strategy in collaboration with many other organisations and individuals. They also drew upon the advice of a Senior Reference Group and a Technical Advisory Group. This process included a series of workshops to guide development of the strategy, incorporate stakeholder perspectives and review the strategy as it progressed. The four major workshops helped us to:

- establish the baseline and set the initial vision (local government only)
- develop the strategic foundation
- identify technical evidence to guide the strategy
- frame and develop the draft strategy.

The parties involved were metropolitan Melbourne's 32 local government authorities, Victorian Government departments and statutory agencies, technical experts, land managers, policy makers, planners, developers and community representatives.

How to use this strategy

This strategy sets out a program of interrelated actions that will work together to bring metropolitan Melbourne closer to our vision of 'thriving communities that are resilient and connected through nature'. This strategy has three goals: healthy people, abundant nature and natural infrastructure. Each goal will result in specified benefits for Melbourne's people and our forest.

The goals are to be achieved by actions – the steps we need to take to get there.

Much valuable work is already being led by metropolitan Melbourne's local governments, the Victorian Government, non-government and community organisations, private landowners and many others. What has been missing until now is a way for this work to be coordinated and supported at a metropolitan scale. Actions 1 to 6 set out a way to combine our efforts, enabling us to:

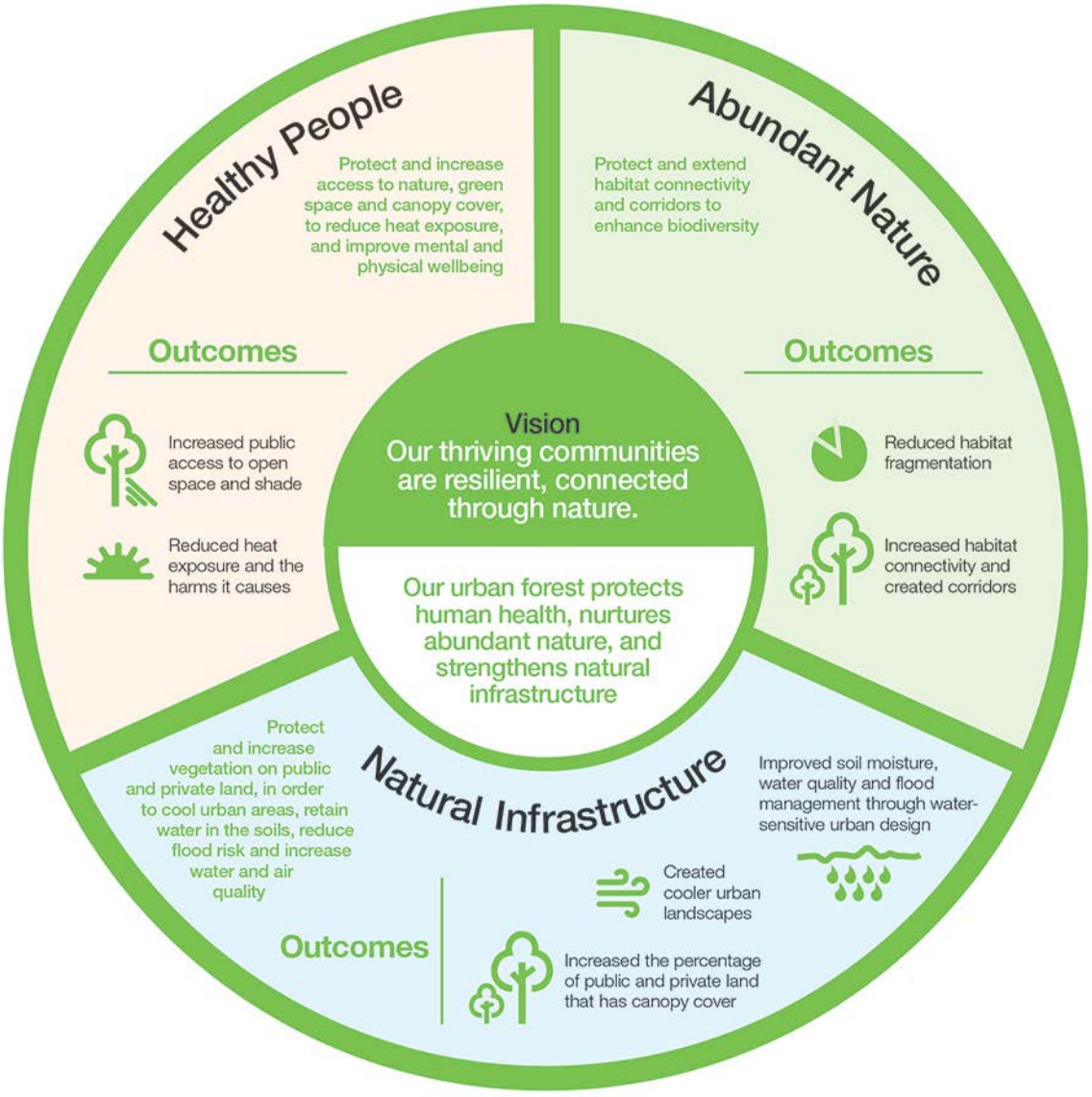
- protect and restore species habitat, and improve connectivity (Action 1)
- set targets and track progress (Action 2)
- scale up greening in the private realm (Action 3)
- collaborate across sectors and regions (Action 4)
- build a toolkit of resources to underpin implementation (Action 5)
- fund the protection, improvement and expansion of the urban forest (Action 6).

Taking action for a *Living Melbourne*

This strategy has three goals:

- **Healthy people:** Protect and increase access to nature, green space and canopy cover, to reduce heat exposure, and improve mental and physical wellbeing
- **Abundant nature:** Protect and extend habitat connectivity and corridors to enhance biodiversity
- **Natural infrastructure:** Protect and increase vegetation on public and private land, in order to cool urban areas, retain water in the soils, reduce flood risk and increase water and air quality.

Figure 13: Three goals for a *Living Melbourne*



Healthy people

Protect and increase access to nature, green space and canopy cover, to reduce heat exposure, and improve mental and physical wellbeing

Nature enriches our lives and improves our physical, mental, social and spiritual wellbeing. Traditional Owners have recognised this connection for thousands of years and their cultures reflect their profound connection to Country. Making nature accessible to more people in urban areas can instil a deeper connection with nature, and unlock the benefits of nature for people's lives and health. While this connection will remain fundamentally important to our First Peoples, there is now also wider understanding of how important such connections are.

A healthy, vibrant, biodiverse natural world enables the health of all creatures living on this earth.

We cannot achieve optimal human health without developing healthy natural environments. It is through shared responsibility and a collective effort to enable a flourishing natural world that we will position ourselves for better health into the future.

Dr Bruce Bolam
Chief Preventive Health Officer
Department of Health and Human Services

The urban forest supports cohesive and healthy communities by fostering social connections, contributing to a sense of place, and offering opportunities for relaxation and play. Exposure to nature improves our cognitive abilities, strengthens our immune systems and, by encouraging physical activity, reduces the incidence and harms of many non-communicable diseases. We must provide these benefits to all people in our city.

A healthy urban forest is also one of the most effective ways to reduce the temperature of the city and lessen the harm to mental and physical health caused by the urban heat island effect. Transpiration and shading reduce the mean temperature and greatly improve thermal comfort. Increasing our urban canopy and opening up access to nature will make our city safer during heatwaves, and people healthier in their daily lives.

We will know we have met this goal when we have:

- increased public access to open space and shade
- reduced heat exposure and the harms it causes.

Abundant nature

Protect and extend habitat connectivity and corridors to enhance biodiversity

There is widespread recognition that our natural environment is not only beautiful and provides essential ecosystem services, but also that it is fundamental to the health and wellbeing of every Victorian.[76] This understanding is reflected around the world, with an acceptance that nature in and near cities is crucial, not just for maintaining biodiversity but also for ensuring human wellbeing.[77] Although the urban forest provides many services to Melburnians, it is also important to acknowledge that native plants and animals also have

significant intrinsic value, regardless of whether they provide tangible benefits to humans. As custodians of the natural environment, it is our duty to protect the biodiversity in our city.

Our cities are not outside nature. Wherever we live, we need green, healthy places for us to survive and prosper. Without plants and nature we simply would not exist. They give us not only life, but opportunities for reflection and inspiration. Above all, we need a diverse and resilient natural landscape, around and within our cities. And we need to understand and appreciate that landscape, in particular the demands of climate change and an increasing urban population.

Professor Tim Entwisle
Director and Chief Executive,
Royal Botanic Gardens Victoria

Urbanisation, land clearing and climate change are putting our fauna and flora under stress. Our improved understanding of the urban forest and the biodiversity it supports opens the way to achieve better results for nature in our increasingly urbanised world. Flora and fauna populations are more likely to survive when their habitat is protected and when they are able to disperse across landscapes. Improving connectivity and creating corridors to reduce habitat fragmentation is essential. However, for such work to have a chance of succeeding, urban growth plans need to incorporate information on biodiversity and ecosystem values and protect and expand remnant vegetation.

We will know we have met this goal when we have:

- reduced fragmentation of existing habitat
- increased habitat connectivity and created corridors

Natural infrastructure

Protect and increase vegetation on public and private land in order to cool urban areas, retain water in the soils, reduce flood risk, and increase water and air quality

Metropolitan Melbourne's urban forest provides important ecosystem services that are vital to supporting human life, health and wellbeing in our city. The urban forest filters our air and purifies water, protects our coast from flooding and erosion, provides opportunities for social connection, and shades and cools the city and suburbs. Only recently have these benefits been recognised. Human-made 'grey infrastructure' such as roads, drainage systems and power grids, have historically taken precedence over natural infrastructure in planning decisions.

Research demonstrates that the benefits of natural infrastructure should be understood and valued in the broadest sense, inclusive of economic, environmental, health and social dividends. In urban areas natural infrastructure can act as a value multiplier across traditional infrastructure to create additional benefits for liveability and amenity that help make our cities thrive.

Appreciating the importance of prioritising natural infrastructure as an asset across our cities is vital to realising this value for all our citizens, today and for the generations that follow.

Jonathan Cartledge
Interim Chief Executive Officer
Green Building Council of Australia (GBCA)

We now know that natural infrastructure complements grey infrastructure and, in certain situations, is better at providing social, environmental and economic benefits. There are already planning policies and controls that encourage the retention of trees and a range of overlays available to councils to further protect valued trees. However, regulations and business models could be strengthened to further encourage our transport authorities, utility companies, local government authorities and developers to recognise the urban forest as essential infrastructure and afford it the protection and proper management it deserves. We must view nature and natural infrastructure as assets equally necessary for the successful operation of a society.

We will know we have met this goal when we have:

- increased the percentage of public and private land that has canopy cover
- created cooler urban landscapes
- improved soil moisture, water quality and flood management through water-sensitive urban design.

Actions for a Living Melbourne

Living Melbourne's goals are supported by six actions, summarised below in Figure 14, and described in more detail over the following pages.

Figure 14 Six actions for a Living Melbourne

Action 1: Protect and restore species habitat, and improve connectivity

Protect and restore habitats, and increase ecological connectivity of all types between streetscapes, conservation reserves, riparian and coastal areas, open spaces and other green infrastructure across metropolitan Melbourne

Why do we need to protect, restore and connect habitat?

Melbourne has one of the highest percentages of open green space of any city in the world. However, the distribution and extent of native vegetation varies, with inner-city areas retaining less original native vegetation and having a larger proportion of introduced flora species than Melbourne's outer suburbs.[78] Urban areas can play a significant role in conserving biodiversity, but without conscious efforts to protect and enhance habitat and linking corridors, our natural environment, which is 'fundamental to the health and wellbeing of every Victorian',[79] will continue to decline.

Restoring corridors and connectivity in Melbourne is required at different scales and will need different approaches. Efforts to restore corridors on public land, which often focus on riverine corridors, should give priority to indigenous plant species. In an urban setting, while indigenous plant species are usually best for fauna (especially mobile fauna such as birds, bats and insects), non-indigenous native plant species can also provide important resources (such as food and shelter). Although introduced species of trees and shrubs typically offer fewer resources to fauna, they still provide ecosystem services and, in neighbourhoods where introduced trees dominate, the habitat value of these areas can be improved by increasing structure (such as by planting shrubs and native understorey). We must manage the different elements of the urban forest collectively, building upon existing habitat and vegetation to form an interconnected matrix of green spaces across the urban landscape. Box 10 provides an example of the success of the Merri Creek revegetation works. It is an excellent example of successfully connecting natural habitats in a rapidly changing urban setting.

Box 10: Friends of Merri Creek

The Merri Creek corridor extends from rural open space to inner urban Melbourne, passing through residential and industrial landscapes including sites important to the Traditional Owners, the Wurundjeri people.

The Friends of Merri Creek is an active community group based in Melbourne. Since 1988 they have actively planned and replanted native vegetation, to restore the biodiversity of the creek and its landscape.

In addition to the greening that they have achieved over the years, the Friends foster social connection and cohesion through their activities. They hold regular creek-side activities and encourage community participation in their work, such as planting, site maintenance, surveying birdlife, testing water quality and running litter blitzes.

In addition, the Friends group is represented on the Merri Creek Management Committee, a non-profit organisation that operates the Merri Creek Environment Fund. The Friends have also played an important and successful role in opposing inappropriate development that would have harmed the creek and its surrounds.

What needs to be done?

1.1 Consolidate data, maps and other relevant information

1.2 Assess the value and quality of information, to develop a list of priority areas for immediate protection

1.3 Map existing and new areas for biodiversity connectivity at different scales, and prioritise areas for strengthening connectivity and biolinks, including responses to climate change, within each municipality and across the region

1.4 Implement priorities for conservation, to secure and build habitat connectivity

Action 1.1: Consolidate data, maps and other relevant information

To get maximum return from any investment in protecting and enhancing the urban forest, we need to improve the completeness and accuracy of available information, including data and maps. For example, understanding where remnants of native habitat are can help us to better manage, protect and connect them.

We need to build upon the mapping done for this strategy, and systematically map natural habitat connectivity opportunities at different scales, across all jurisdictions and land tenures. Initial efforts should concentrate on:

- sites of biodiversity significance
- vegetation – whether indigenous, native or introduced – that provides habitat for fauna
- areas with future potential for habitat restoration (for instance, bare earth, non-native grassland).

Many organisations are already undertaking valuable data-collecting projects. For example, BirdLife Australia's bird atlas, when used with other datasets, helped demonstrate differing levels of connectivity for different bird species and bird groups in this strategy (see Figure 8).

Action 1.2: Assess the values and quality of information, to develop a list of priority areas for immediate protection

The information gathered in Action 1.1 must be carefully assessed to develop a list of priority areas for immediate protection. This assessment will help set priorities for efforts to protect important remnant vegetation, canopy trees and other essential habitat values.

Action 1.3: Map existing and new areas for biodiversity connectivity at different scales, and prioritise areas for strengthening connectivity and biolinks, including responses to climate change, within each municipality and across the region

Connectivity allows plants to pollinate and disperse, and animals to move in or between habitat areas, enabling gene dispersal, improving adaptation to climate change, and reducing the risk of extinction. Plants and animals move in different ways. Animals move over a large range of distances – from international migrations to crossing a road to forage for food. We need to better understand Melbourne's habitat connectivity at different scales, within individual municipalities and across the region, to protect what exists and identify opportunities for increasing connectivity. In prioritising and building connectivity, we must consider the effects of climate change.

Action 1.4: Implement priorities for conservation, and secure and build habitat connectivity

Once areas for conservation have been mapped and prioritised, it is vital that action is taken to protect priority sites and create habitat corridors at various scales. This may include securing land when opportunities arise, to protect and expand corridors.

Action 2: Set targets and track progress

Set urban canopy and understorey targets for each metropolitan region, and decide on a clear and consistent method for long-term monitoring and evaluation of the quality and extent of the urban forest

Why do we need to set targets, and track progress towards meeting them?

Clear, consistent and agreed methods for monitoring and evaluating the urban forest will be essential for tracking progress and managing the urban forest in response to changes that arise. These methods are also important for transparency and accountability. Although many municipalities are already setting their own urban forest targets, there is little coordination of target-setting between local government authorities and, until now, no metropolitan-wide approach.

Monitoring and evaluation is essential to ensure that the vegetation protection, enhancement and expansion actions being taken are effectively improving mental and physical wellbeing, reducing heat exposure and increasing access to nature, green space and canopy cover.

Monitoring and evaluation are also essential for designing financial models that will attract investment (described under Action 6).

Victoria's Department of Environment, Land, Water and Planning recognises, through *Plan Melbourne 2017–2050* (Action 91) the need to create urban forests throughout metropolitan Melbourne, and to work with local government authorities to establish greening targets for each of the metropolitan regions.[80]

What needs to be done?

2.1	Establish and implement urban forest greening targets including, as a minimum, 'tree canopy' and 'tree canopy and shrub' cover for each region
2.2	Establish a measure of permeability across the regions, with the aim of implementing a permeability target for public and private land
2.3	Establish a method for monitoring, evaluating and reporting on the improvement of the urban forest, including indicators and measures for quality and extent
2.4	Develop a system for consistently collecting and analysing urban forest data, and coordinate the collection and publication of data in a publicly available, comparable database

Action 2.1: Establish and implement urban forest greening targets including, as a minimum, 'tree canopy' and 'tree canopy and shrub' cover for each region.

We need to adopt regional targets for canopy and vegetation across Melbourne that are based on a common analysis of metropolitan-scale vegetation. Targets for 'canopy cover' and 'canopy and shrub' for each region are proposed in Table 2.

As a starting point for regional agreement, *Living Melbourne* proposes targets that:

- are calculated based on vegetation in the existing urban area at 2015
- apply to all land (public and private) in each region
- recommend increases each decade

- are supported by principles, including no net loss of tree or shrub cover on public and private urban land in each metropolitan region.

Research suggests that targets should be specific to each region, and should take into account local conditions such as development density, land use, and climate.[81] After considering the literature, current local government authority urban forest strategies, and regional context, ambitious regional tree canopy cover targets of between 20 and 30 per cent are proposed. Because native understorey and tree canopy cover of at least 30 per cent benefits biodiversity,[82] both tree canopy and shrub targets of between 30 and 50 per cent by 2050 are proposed.

The 2015 baseline and targets for each of the six metropolitan regions vary, as they acknowledge the historical development of these regions and the ecological characteristics of their underlying bioregions. For example, the Eastern Region of Melbourne was developed before the Western Region, and is largely in the Gippsland Plain bioregion, which before European settlement was mostly dry forest. The result is a canopy cover of about 25 per cent in 2015, a higher 2050 target, and less action required to achieve this target. By contrast, the Western Region is a newer urban growth area and is predominantly in the Victorian Volcanic Plain bioregion, which was originally a largely plains grassland landscape. The result is a 2015 canopy cover of only 4 per cent, a lower 2050 target, and significantly more effort required to achieve this target. Further discussion on the distribution of the urban forest between public and private land, and across Melbourne, can be found in Chapter 6 of the *Technical Report*.

In providing for 'tree canopy' and 'tree canopy and shrub' cover targets, *Living Melbourne* acknowledges the increasing difficulty of getting canopy trees into some densely developed, established urban areas, and into new greenfield developments. This applies to both public and private land. It also acknowledges that shrubs are important for shading, aesthetics and habitat.

Principles to guide the implementation of urban forest targets are set out below, along with thresholds for the percentage of vegetation to be maintained or established on public and private land. This emphasis on both public and private land is important to avoid a concentration of effort on public land only, when vegetation on private urban land currently makes up 58 per cent of the tree canopy cover across metropolitan Melbourne. Although this percentage varies between the metropolitan regions (see Chapter 6 of the *Technical Report*), it is important – for both biodiversity habitat and human health and wellbeing – that this canopy is protected and expanded. Local government authorities in these regions are encouraged to follow these principles.

Principles to support the urban forest targets for Melbourne

- No net loss of tree or shrub cover on public or private land in each metropolitan region
- Regional targets for canopy cover must apply to both public and private land
- Implementation partners must strive to achieve the targets set for each category of public open space, road reserves, and private land
- No more than 70 per cent of the additional canopy and shrub cover planted to achieve targets should be on public land
- At least 30 per cent of the additional canopy and shrub cover planted to achieve targets should be on private land

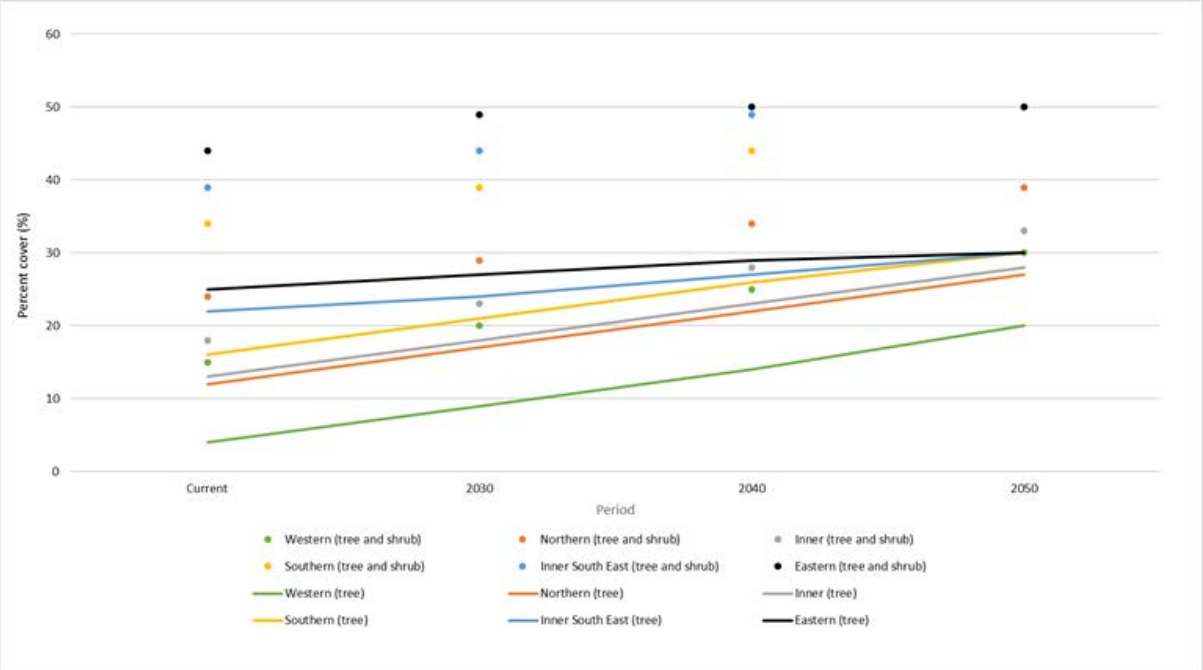
Table 2 below is organised geographically. Achieving the targets across private and public land will require government-wide action in partnership with councils, water authorities, the wider community and the land development industry. Figure 15 illustrates the relative commencement points and potential progress towards targets for each region.

Table 2: Targets for tree canopy, and for canopy and shrubs, by region to 2050

Region	Local government authorities	Existing 2015		Target 2030		Target 2040		Target 2050	
		Total % tree canopy	Total % tree canopy & shrubs	Total % tree canopy	Total % tree canopy & shrubs	Total % tree canopy	Total % tree canopy & shrubs	Total % tree canopy	Total % tree canopy & shrubs
Western	Brimbank, Hobsons Bay, Maribyrnong, Melton, Moonee Valley, Wyndham	4	15	9	20	14	25	20	30
Northern	Banyule, Darebin, Hume, Mitchell, Moreland, Nillumbik, Whittlesea	12	24	17	29	22	34	27	39
Inner	Melbourne, Port Phillip, Yarra	13	18	18	23	23	28	28	33
Southern	Casey, Frankston, Greater Dandenong, Kingston, Mornington Peninsula, Cardinia	16	34	21	39	26	44	30	50
Inner South-East	Bayside, Boroondara, Glen Eira, Stonnington	22	39	24	44	27	49	30	50
Eastern	Knox, Manningham, Maroondah, Monash, Whitehorse, Yarra Ranges	25	44	27	49	29	50	30	50

Note: figures rounded to nearest whole number

Figure 15: Tree canopy and tree and shrub cover targets: 2019–2050



Setting priorities for action

In addition to the considerations set out in Action 1.1, land managers should give priority to protecting and increasing vegetation – particularly canopy cover – in the following places:

- larger consolidated cool spots – to protect areas that contribute to reducing urban heat islands
- areas with a combination of high land surface temperatures, low percentage of canopy cover, and higher proportions of vulnerable community members – young children, older persons, culturally and linguistically diverse communities, public housing tenants, and socio-economically disadvantaged people
- schools, childcare centres, kindergartens, activity centres and neighbourhood shopping strips in hot areas
- new precincts and infrastructure developments
- locations where we can build on existing opportunities, such as extending Greening the Pipeline, Chain of Ponds collaboration, Friends of Merri Creek
- road reserves and streetscapes (where safety guidelines permit, for example behind flexible wire-rope safety barriers).

Action 2.2: Establish a measure of permeability across the regions, with the aim of implementing a permeability target for public and private land

Increasing our permeable surfaces is essential for the growth of our urban forest, because water is vital for vegetation growth. Hard surfaces on roads and roofs divert polluted stormwater into our drainage system, and from there into our catchments and Port Phillip

Bay. This limits the ability of rain to infiltrate the soil and provide much-needed moisture for a healthy urban forest.

Increasing permeability allows water to be stored in the soil and used by vegetation to increase our canopy and green cover. Increasing permeable surfaces brings other benefits too, such as decreasing flood damage by limiting peak stormwater flows and floodwaters. Allowing water to infiltrate the entire soil profile is also critical. Surface irrigation exacerbates trees' vulnerability by encouraging shallow root systems, whereas deep watering encourages deep root growth, which is better able to reach soil moisture during low-rainfall periods.[83] Deep watering is easier to achieve in some soil types than others, so new ways may be needed to identify areas of lower rainfall and difficult soils.

Although a baseline analysis of permeability across metropolitan Melbourne was not available at the time of writing, the City of Melbourne has a goal for 40 per cent of the Elizabeth Street Catchment's soil surface to be unsealed by 2030, from a baseline of 17 per cent unsealed soil in 2014.[84] International examples of programs to increase permeable surfaces include cities in the United States such as Portland in Oregon,[85] Seattle in Washington[86] and Philadelphia in Pennsylvania.[87]

Methods used to increase permeability across metropolitan Melbourne might include:

- applying integrated water cycle management design principles to increase the infiltration of stormwater for new street trees
- creating more open space
- creating more permeable roadsides, introducing new road median strips and widening existing ones
- using permeable paving materials
- building green roofs and walls

There is an opportunity to standardise increased permeability as part of municipal street upgrade programs by encouraging such street upgrades and renewals to embrace green infrastructure outcomes. The outcome would result in greener streets and increased permeability.

Together with other related requirements, clauses 54 and 55 of the Victoria Planning Provisions contain site permeability standards that at least 20 per cent of the site should not be covered by impermeable surfaces. Further detail can be found in Chapter 5 of the *Technical Report*.

Further work will be required to determine how to measure progress towards the Elizabeth Street Catchment permeability target. But we should be proactive in reducing impermeable surfaces in public and private urban spaces, to benefit our urban forest.

Action 2.3: Establish a method for monitoring, evaluating and reporting on the improvement of the urban forest, including indicators and measures for quality and extent

The success of this strategy depends on collaboration between all partners and tracking our progress to ensure that our efforts and investment are achieving our goals. Measuring, monitoring and maintaining an inventory of the urban forest are not new activities. However, current efforts are varied, and comparisons between them are difficult due to incomplete

datasets, different methods and scales used, and the high costs of acquiring and analysing data. The development of a monitoring, evaluation, reporting and improvement framework will be essential for understanding the results of our actions, on the urban forest itself and more broadly on the socio-economic situation, health and wellbeing of communities. Box 11 sets out Action 91 of *Plan Melbourne 2017–2050*.

Box 11: Delivering *Plan Melbourne 2017–2050* to achieve a cooler, greener city

Plan Melbourne 2017–2050 recognises the urban heat island effect, climate change and the benefits of greening a rapidly growing city. It aims to make Melbourne cooler and greener, strengthen the metropolitan open space network, and better integrate urban development and water cycle management.

Action 91 proposes government-wide action to cool and green Melbourne through the creation of a metropolitan urban forest. This action includes working with local government and water authorities, supporting councils to develop municipal forest strategies, investigating green roof and green wall demonstration projects, and changing guidelines and regulations for subdivisions and new development. Spatial data on metropolitan Melbourne's green space network is also identified as a way to establish a detailed understanding of Melbourne's existing green cover, and how this is changing over time.

As a first step, the Department of Environment, Land, Water and Planning is working in partnership with RMIT University, the University of Western Australia, CSIRO, and the Clean Air and Urban Landscapes Hub of the National Environmental Science Program, to map and analyse vegetation, heat and land use across metropolitan Melbourne. This project is also supported by Melbourne Water. The project includes mapping 2014 and 2018 vegetation coverage, establishing an urban surface temperature baseline and mapping urban vulnerability. Some of this data is available via the Victorian Government Spatial DataMart.

Action 2.4: Develop a system for consistently collecting and analysing urban forest data, and coordinate the collection and publication of data in a publicly available, comparable database

Many different organisations and individuals help care for and monitor the urban forest, including citizens, researchers, and government bodies (such as those responsible for transport, planning, the environment, and water). They need a range of current and historical data on which to make decisions, manage resources under changing circumstances, continuously improve their work, and to provide an evidence-base for advocacy. Different types of data may be of interest to different people and groups, from data on the physical health of the urban forest, to data on ecosystem services, the health and wellbeing benefits provided by the urban forest, and the time and investment needed for its care.

Given recent technological advances in measuring and modelling, it is now possible to go beyond simply keeping inventories; we can quantify the many benefits of the urban forest. For transparency, and to allow the data to be used and contributed to by all, including residents and the community as a whole, data should be made publicly available and interactive online.

Action 3: Scale up greening in the private realm

Strengthen planning and development standards and relevant guidelines to increase the greening of the private realm

Why do we need to green the private realm?

Land zoned for residential, commercial, industrial, special or rural use contributes more than 66 per cent of the existing tree canopy, with residential land alone contributing 58 per cent. With a trend towards larger houses on smaller lots in greenfield developments, and higher-density development in urban infill areas, gardens have become smaller, and impervious surfaces have increased. The result is a rapid diminishing of the urban forest, as room for vegetation in private space shrinks. Protecting, maintaining and nurturing the trees and suitable understorey vegetation on private land is critical to maintaining and expanding the urban forest. A full regional analysis can be found in Chapter 6 of the *Technical Report*.

Further, much greater use of green roofs and green walls is required, both to increase permeability of urban environments and to provide habitat. Box 12 describes how the cities of San Francisco and Denver are attempting to achieve this.

Box 12: Regulating for green roofs in San Francisco and Denver

The City of San Francisco implemented the first green roof mandate in the United States in January 2017: San Francisco Better Roofs. The legislation is part of the Sustainable City initiative, and requires most new residential and non-residential buildings applying for building permits to designate 15 to 30 per cent of roof space for either a living roof or solar power generation, using an existing state law that requires a portion of roof space to be 'solar ready'.

A cost–benefit study conducted by engineering firm Arup demonstrated that, although the up-front cost of installing a living roof is higher, the extra expense is 'largely offset by the avoided one-time stormwater management equipment costs' and that a 'living roof provides net financial benefit to the building owner, while providing significant additional benefit to the tenants, and the broader community'.[88]

The City of Denver has implemented an even more robust green roof requirement. From 1 January 2018, all new construction with a gross floor area greater than 25,000 square feet (2,323 square metres) must cover at least 20 per cent of available roof space with greenery. And this percentage increases as the building becomes larger. The measure was approved by popular vote and used much of the data from San Francisco's program, including the study by Arup, to demonstrate the viability of green rooftops and their benefits for building owners.

What needs to be done?

3.1 Strengthen regulations to support greening in new subdivisions and developments – to benefit human health and wellbeing, and increase biodiversity

3.2 Strengthen regulations to protect canopy trees

3.3 Encourage private landholders to protect and enhance the urban forest and expand greening activities by offering incentives for planting, installing and maintaining natural infrastructure

Action 3.1: Strengthen regulations to support greening in new subdivisions and developments – to benefit human health and wellbeing, and increase biodiversity

Maintaining and enhancing the urban forest should be integral to urban planning, construction and financing. There should be more and larger green spaces in new developments in the right locations, and existing green spaces on private land should be protected through mechanisms such as amenity valuations for trees used by some councils. Strong leadership is required to strengthen planning policies, provisions and regulations, and to enforce them.

Action 3.2: Strengthen regulations to protect canopy trees

Enforcement measures, such as financial penalties, are currently insufficient to deter the unpermitted removal of canopy trees and other vegetation. Regulations to protect canopy trees should be strengthened and enforced. Financial penalties could be used for breaches of these regulations to better deter tree removal on private land.

Action 3.3: Encourage private landholders to protect and enhance the urban forest and expand greening activities by offering incentives for planting, installing and maintaining natural infrastructure

While a range of funding opportunities are available for greening work on public land, less effort has been made to increase greening on private land. Incentives for urban greening in the private realm will be important for reaching canopy targets. A range of incentives can be used to encourage private landholders to continue and increase their greening efforts.

Box 13 describes how the City of Chicago is encouraging green roofs. Incentives range from attaching benefits (such as zoning upgrades, faster processing of permits, and reduced stormwater requirements) to desired activities, to reducing fees when developers act to protect or increase planting, or install natural infrastructure. Other financial mechanisms are outlined in Action 6.

Box 13: Encouraging green roofs in Chicago

In the City of Chicago's recently updated Sustainable Development Policy, green roofs are an important component. The revisions include a new points-based system; the points required in order to be compliant are obtained in several different ways. These can include certifications or designations, such as meeting the WELL Building Standard or earning Energy Star recognition. Installing a green roof on the entire net roof area of a building earns 20 points, while adding a green roof may also earn a floor area ratio bonus under a separate program to encourage the creation of green roofs.

In 2001, the City of Chicago installed a pioneering green roof on top of its city hall, which was planted with a mix of grasses and native prairie plants. This was used as an experiment to discover whether similar roofs could be viable in Chicago. Researchers have found that the vegetation reduces rooftop temperatures by at least 70°F (about 21°C) compared to the adjacent tar roof, and increases biodiversity in the area. The roof reduces stormwater run-off, and continues to serve as a laboratory to test plant viability, new rooftop designs, and urban beekeeping.

Action 4: Collaborate across sectors and regions

Encourage collaboration between sectors and regions, to protect and expand the urban forest by strengthening existing regional partnerships, and establishing new ones, and by accelerating greening efforts on private land

Why do we need to collaborate across sectors and regions?

Although work is under way to protect and expand the urban forest across Melbourne, the fragmentation of these efforts within and between municipalities is one of the most significant barriers to reaching our urban forest goals. Achieving collective action by bringing people and projects together offers greater benefits, opportunities and efficiency. Box 14 describes three global urban sustainability networks.

Box 14: Global urban sustainability networks

The urban century offers enormous opportunity for humanity. Melbourne's participation in three international urban sustainability networks – 100 Resilient Cities, The Nature Conservancy, and ICLEI: Local Governments for Sustainability – puts it at the forefront of a global trend: creating a shared regional vision for nature and human wellbeing through urban conservation planning.

To help cities incorporate nature into their urban plans, ICLEI, in collaboration with The Nature Conservancy and the International Union for Conservation of Nature, has created CitiesWithNature, a global platform for cities and other sub-national governments that recognise and wish to increase the value of nature in and around cities.

What needs to be done?

4.1 Capitalise on existing collaborations between local and state governments and the private sector

4.2 Mobilise broad community support

4.3 Support and develop existing and new methods to obtain and apply community knowledge

4.4 Foster and promote urban forest champions, in both the public and private sectors

Action 4.1: Capitalise on existing collaborations between local and state governments and the private sector

Several successful alliances and cross-organisational governance agreements already exist in different parts of Melbourne. These should be the starting point for building further collaborations and alliances for greening across the city, including Greening the West (see Box 15). Further examples of collaborative alliances can be found in Chapter 4 of the *Technical Report*.

Box 15: Greening the West

Greening the West is a regional collaboration to help communities in Melbourne's west expand green spaces in parks, reserves, streetscapes, roofs and walls, backyards, car parks, sporting fields and waterways. A total of 23 organisations – local government authorities, Victorian Government departments and agencies, water utilities and community groups – work successfully together to protect and enhance the urban forest, sharing knowledge and promoting and scaling up practical solutions in western Melbourne. The value of this collaboration is that, to date, Greening the West has generated $30 million worth of green infrastructure projects in the Western Region of Melbourne.

For further detail of Greening the West's activities, see Chapter 4 of the *Living Melbourne Technical Report*.

Action 4.2: Mobilise broad community support

Galvanising the support of urban forest practitioners and the public will be fundamental to protecting and expanding the urban forest. To do this we must:

- understand the community's perceptions of the urban forest
- build on and support existing community education and behaviour-change programs that inform, involve and empower the community to promote the urban forest
- develop information for community use that will inform private decision-making
- devise a universal message that supports a long-term campaign to raise public awareness of, and support for, the urban forest.

Positive messaging, supported by broad-based awareness and behaviour-change programs and campaigns – such as Clean Up Australia and Gardens for Wildlife (Box 16) – are needed to communicate the benefits of the urban forest to all. Partners should collaborate to frame messages that will inform and attract all parts of the community.

Box 16: Gardens for Wildlife

Gardens for Wildlife is a network of community groups and councils involved in caring for native plants and animals in urban areas. A good example of a community/council co-designed education and behaviour-change program which leads to active stewardship on private land, Gardens for Wildlife helps individual landowners protect remnant vegetation, improve habitat, and create havens for wildlife. Launched in 2006, the Knox City Council's Gardens for Wildlife program was designed to encourage residents to provide habitat and food sources for threatened wildlife (e.g. birds, insects, and frogs), by planting indigenous plants or suitable exotic species in their gardens. The program is a partnership with the Knox Environment Society and has more than 800 contributing households. Gardens for Wildlife Programs have recently been expanded across Victoria, and there are 25 municipal areas that are part of the network.

Action 4.3: Support and develop existing and new methods to obtain and apply community knowledge

Local communities can help urban forest efforts by gathering and sharing important data, so that we target our investment in the urban forest wisely. Data is already available from aerial photography, global positioning systems, and light detection and ranging systems. These tell us much about tree cover, distribution and types. But to obtain specific tree information, such

as species and numbers, we need to involve citizen scientists and draw on Aboriginal ecological knowledge.

Action 4.4: Foster and promote urban forest champions, in both the public and private sectors

Fostering urban forest champions and leaders, as well as forging partnerships between government departments, non-government organisations and community will help to disseminate, and gain support for, our vision throughout the community.

Action 5: Build a toolkit of resources to underpin implementation

Equip practitioners to protect and enhance the urban forest by building on existing resources and creating a shared toolkit to facilitate implementation of best practices

Why do we need a toolkit of resources?

A range of information and experience exists on actions to protect and enhance our urban forest. But this information is disparate and incomplete. Building on existing materials and preparing guidelines, standards and toolkits of resources are important to help assist the many contributors to the development, management and maintenance of the urban forest.

What needs to be done?

5.1 Build the capacity of public and private sector practitioners to protect, enhance and expand the urban forest

5.2 Build on, and develop new tools for public sector land managers

5.3 Build on, and develop new guidance materials for managing the capital and operational costs of urban forest endeavours

Action 5.1: Build the capacity of public and private sector practitioners to protect, enhance and expand the urban forest

There are many parties involved in maintaining and expanding a healthy, resilient urban forest. Helping practitioners identify, agree on and adopt best practice is central to the successful protection and expansion of our urban forest. To do this, we must update existing vegetation asset-management guidelines, and provide technical training in their application, building skills and capacity across both the public and private sectors.

Box 17: National capacity building for the urban forest

The 202020 Vision has facilitated a national network aiming to make our urban areas 20% greener by 2020. To achieve this they bring together industry, business, NGOs, government, academia and individuals, providing tools, resources and networks necessary to reach this shared goal.

To date, the project has produced several reports to assist practitioners, including a *How to Create an Urban Forest Guide* (2015) and Where are all the Trees (2014). Such programs that bring peers together to exchange and build knowledge have been and will be important to achieve our shared aspirations for a connected and enhanced urban forest.

Action 5.2: Build on, and develop new tools for public sector land managers

Further investment is required to improve existing tools, develop new tools and provide a centralised place for such resources, creating a ‘how to’ reference point for all aspects of project planning and action. In particular, we need:

- materials that will help involve the wider community and the land development industry, such as best practice guidelines and case studies
- clear and agreed procedures to attract involvement by private and semi-public utility companies

- vegetation-management and associated technical training for staff of utility companies, to improve decision-making.

There is a growing list of open-source tools, resources and reference materials that practitioners can apply to their greening efforts.

The Clearwater program (Box 18) is an example of a centralised resource disseminating best practice across a sector.

Box 18: Clearwater

Integrated water management and water-sensitive urban design improve water quality, reduce risks to human life and property, help us use water resources more efficiently, and improve the ability of water to maintain and strengthen economic, social and cultural values. Hosted and funded by Melbourne Water, Clearwater is a capacity-building program that works with the water industry to transform the way we manage water for healthy, connected communities. Clearwater supports water professionals, organisations and the water sector by improving skills, increasing knowledge and facilitating networking across Victoria. Melbourne is recognised as a world leader in urban water management, in part due to active collaboration and dissemination of best practice.[89] A similar approach is required if we are to realise the full benefits of the urban forest.

Action 5.3 Build on, and develop new guidance materials for managing the capital and operational costs of urban forest endeavours

Managing, maintaining and expanding the urban forest require significant capital and operational expenditure. Currently, every council contributes to the urban forest. It is estimated, based on data provided by councils, that that in 2017–18 between $256 million and $384 million – approximately $8–$12 million per council – was spent on the urban forest. Guidance on current and projected future costs will help all parties forecast future funding requirements more accurately, identify any unnecessary or unreasonable expenditures, and bring efficiencies in funding the urban forest.

Action 6: Fund the protection and enhancement of the urban forest

Establish a set of funding and financing options to suit different types of urban forest action

Why do we need to fund the protection and enhancement of the urban forest?

Protecting and expanding the urban forest to connect natural habitats, create natural infrastructure and reach agreed targets requires a variety of greening actions, which inevitably need to be funded. Over the past several decades, the scientific evidence for the ecological, health and economic benefits of urban nature and natural infrastructure has become clearer. Estimates undertaken as part of developing this strategy, drawn from existing government and peer-reviewed sources, suggest that Melburnians already enjoy benefits from nature valued at close to $5 billion dollars per annum. These benefits – known as ecosystem services – include improved air quality, flood risk reduction, climate change mitigation and reduced heat. Further information about the value of the metropolitan urban forest is provided in Chapter 10 of the *Technical Report*.

Reaching the canopy and broader vegetation targets set out in Action 2 will require an estimated investment of $1 billion over the next 30 years, with the bulk of this investment to be made in the decade to 2030.

This funding is needed for:

- protecting and maintaining Melbourne's existing urban forest, including:
    - the protection of native vegetation (including grasslands), including through compliance and enforcement
    - operational management
    - replacement plantings
    - new plantings that increase the extent, diversity and quality of the urban forest on public land (such as parks, conservation reserves, other open spaces, road reserves and streetscapes) and on private land
    - the development of natural infrastructure, including as part of the Local Government Road Renewal Program and other asset replacement programs
- other complementary activities that maintain, expand and enhance the urban forest including:
    - community engagement and behaviour-change activities
    - new programs to drive good governance and collective impact
    - innovation and research, monitoring and evaluation
    - professional education and training
    - the involvement of the property industry and other industries to deliver the urban forest on private land

What needs to be done?

6.1 Identify and secure long-term financing to realise the *Living Melbourne* vision

6.2 Provide grants and funding opportunities for specific sites

Action 6.1: Identify and secure long-term financing to realise the Living Melbourne vision

Identifying financing opportunities

A range of financing tools will be required to achieve the goals of the *Living Melbourne* strategy. These sources range in scale and complexity from conventional government budget appropriations and philanthropy to public-private partnerships, ecosystem service payments, performance-based incentives and hybrid instruments that feature a range of revenue streams.

Importantly, the strategy recommends that at least 30% of the additional canopy and shrub cover planted to achieve targets should be on private land. To that end an important focus will be the design and implementation of financing tools that resolve the 'split incentives' that arise from public benefits (like wildlife habitat and improved air quality) being delivered on private property.

Collaborative work will continue with stakeholders and the private sector to identify and prioritise a suite of urban forest financing tools that can be implemented across metropolitan Melbourne. Examples of prospective financing tools that could be investigated further are outlined below.

While a significant injection of funds is required to achieve the ambitions of this strategy in the early years, land managers – both public and private – will need to consider how funds are used to support long-term maintenance. Although natural infrastructure generally becomes stronger and more valuable over time, it does require maintenance. Such work provides additional job opportunities and, particularly if tied to social procurement, can mean that the urban forest brings even greater and broader socio-economic benefits.

A Living Melbourne Sustainable Development Bond

As described earlier in the strategy, *Living Melbourne* supports seven of the United Nations' 17 Sustainable Development Goals (SDGs). Investment bonds linked to the SDGs could be a cost-effective way to obtain the funds needed to implement the actions recommended throughout this strategy.

A Living Melbourne Sustainable Development Bond would enable private sector investors, including philanthropic funds and endowments, to earn a financial return in exchange for providing financial capital for the urban forest. There is increasing global demand for these types of investments. In 2018, ANZ bank launched a €750 million SDG Bond to fund loans and expenditures that directly promote nine of the United Nations' 17 SDGs. The proceeds are intended to support projects that deliver social, economic and environmental benefits including funding for hospitals, schools, green buildings, clean water, public transport systems or clean energy.

Bonds are frequently underwritten by governments. Based on information from investors worldwide, a AAA-rated bond from an Australian government authority (whether state or federal) linked to the SDGs would be highly attractive to institutional investors.

A proportion of these funds could be made available to local government authorities, with other funds used to encourage planting, greening and water-sensitive urban design on large private landholdings. In notable cases funds could also support the acquisition of land to protect places of exceptionally high conservation value.

Carbon finance

Domestic and international carbon emissions markets – while still relatively nascent – continue to emerge as an opportunity for financing reforestation. More than 50 countries have implemented some form of carbon pricing or carbon market. According to the World Bank, in 2018 the value of global carbon emissions pricing and trade topped $110 billion, an increase of 52% in two years.

A partnership project will be initiated to explore opportunities to quantify and package local benefits that align with the ambitions of this strategy. The local benefits can be linked with voluntary carbon credits to attract new funding streams to new metropolitan greening work.

Corporations, government and other actors could purchase carbon credits to offset carbon emissions into the future, while also achieving local biodiversity benefits today. As changes occur in the regulated carbon market in Australia and globally post the 2020 review of the Paris Agreement, offset mechanisms would be able to evolve with those changes.

A number of carbon initiatives are already being explored in the Melbourne metropolitan area. In addition, some organisations already manage rural and regional carbon offset programs that could be adapted for the urban forest.

Action 6.2: Provide grants and funding opportunities for specific sites

To involve *all* of metropolitan Melbourne, it is not enough to target only larger institutions and those already able to comply with the kinds of monitoring and evaluation required for large investments. We also need a range of grants and other targeted funding mechanisms for smaller-scale and community efforts. Box 18 provides an example of a specific smaller-scale initiative — the City of Melbourne Urban Forest Fund (Box 19).

Box 19: The Urban Forest Fund – Greening Howlett Street

The City of Melbourne Urban Forest Fund provides financial support for new greening projects that otherwise would not be funded, such as green spaces, tree planting, vertical greening, or green roofs.

Approximately 75% of land in the City of Melbourne is privately owned or managed, offering huge potential for the private realm to contribute more towards greening our city. The Urban Forest Fund aims to build partnerships between government and the private sector to achieve greening above and beyond existing Council capital works investment. Established in 2017 with $1.2 million in seed funding, the Urban Forest Fund will be increased by contributions from organisations and individuals who want to create a greener city.

One of the first partnership grants went to the 45-apartment Howlett Street complex in Kensington. The site currently has very little greenery, often floods and – despite having an outdoor public common area that connects two streets – sees little interaction between residents. With the support of a $200,000 grant, residents have come together to create a project that will not only bring greening benefits, but also create rich and cohesive spaces for Howlett Street residents and the entire neighbourhood.

Implementing the strategy

The *Living Melbourne* strategy has been prepared by The Nature Conservancy and Resilient Melbourne and on behalf of many partners across metropolitan Melbourne. To achieve its vision of thriving communities that are resilient and connected through nature, all sectors and regions have a role to play. Local government authorities across the metropolitan region will continue to perform an invaluable role as managers and custodians of many of the parks, streetscapes and open spaces that form a fundamental part of our urban forest. Their involvement is also essential for working with residents and the broader community to generate local action.

The Victorian Government, including its many departments and agencies, is leading initiatives such as Action 91 of *Plan Melbourne*, and the forthcoming Metropolitan Open Space Strategy, both of which will be central to the metropolitan-wide approach set out in *Living Melbourne*. State government authorities such as VicTrack, Department of Transport, Major Transport Infrastructure Authority, Parks Victoria and Melbourne Water, all of which design and manage large tracts of public land, will play a critical role in protecting and expanding our urban forest.

Beyond the public sector, non-government and community organisations, private land owners and many others will need to disseminate information and galvanise support if we are to make the *Living Melbourne* vision a reality. The residents of Melbourne, who all benefit from, and have a vested interest in, the urban landscape, will be essential to the implementation of many actions of this strategy. 'Friends of' groups, Landcare, and communities of practice are already making significant contributions to urban greening.

It is hoped that this strategy provides the missing link for us to all work better together. The endorsing organisations named at the front of this document have committed to work in partnership towards its implementation. Together we will develop an implementation plan to start operationalising *Living Melbourne*. The following partners are already working in this space, support *Living Melbourne* and are committed to its implementation. This list is not exhaustive and we invite others to be involved.

Earthwatch Institute

Earthwatch is an international environmental research organisation that has been running citizen science projects since 1971. Their mission is to empower people to save the natural world as we understand that if society is to survive, we must live in balance with nature. Through their programs they enable scientific discovery (to solve solutions to environmental problems), increase knowledge (so people can make more informed decisions) and provide an experience (personally connecting people to the issue). It is these three things combined that empowers long term behaviour change. Earthwatch can help implement *Living Melbourne* by:

1. Assisting with raising support for the urban forest by the community and industry
2. Assisting in implementation of the green infrastructure
3. Ongoing monitoring and management of the urban forest
4. Behaviour change within the community, so they are empowered to protect and grow the urban forest

The Greater Metropolitan Cemeteries Trust (GMCT)

Established by the Victorian Government, The Greater Metropolitan Cemeteries Trust (GMCT) is a community-focused organisation operating 21 cemeteries in the north, east and west of Melbourne, contributing more than 600 hectares of open public space to local communities.

The GMCT is investing judiciously and planning carefully to provide a variety of burial, interment and memorialisation options to meet the diverse needs of Melbourne's communities now and into the future. The Trust's healthy perpetual maintenance reserve, which provides for the ongoing maintenance and preservation of sites, ensures the long-term sustainability of its cemeteries and the organisation. As an architect of these places, GMCT designs cemeteries that reflect Melbourne's rich cultural diversity and support the customs, traditions and burial practices of its people, and contributes to Melbourne's urban forests.

GMCT members play a fundamental role in caring for those who have lost a loved one and looking after those they have lost. Their services provide comfort and closure to families and individuals in times of need and cemeteries provide peaceful places for commemoration and reflection for locals and visitors alike. The Trust aspires to invest in expanding the Melbourne urban forest and contribute to the implementation of *Living Melbourne.*

Australian Institute Landscape Architects

The Australian Institute of Landscape Architects (AILA) champions quality design for public open spaces, stronger communities and greater environmental stewardship. They provide their members – in urban and rural Australia, and overseas – with training, recognition and a community of practice to share knowledge, ideas and action.

With their members, they anticipate and develop a leading position on issues of concern in landscape architecture. Alongside government and allied professions, AILA works to improve the design, planning and management of the natural and built environment.

AILA represents over 3,500 (and growing) members throughout Australia and overseas. As a not-for-profit professional association, their role is to serve the mutual interests of our members and the wider profession.

Nursery and Garden Industry Victoria

Nursery and Garden Industry Victoria (NGIV), is the peak industry body for the state's horticultural sector. NGIV represents the interests of the Victorian horticulture industry. It is a sector worth over $1.6 billion that employs more than 11 000 people and engages with over 3000 stakeholders, ranging from small family-based operations to multinational organisations. A high percentage of their members are involved in production (turf and greenlife) and retail nurseries, while others are involved in horticulture-allied trades, botanic gardens, educational institutions and other not-for-profit organisations, including government-aligned green enterprises.

NGIV maintains strong connections with its members and the wider industry, and remains committed to the continued success of Victoria's horticulture industry.

Clean Air Urban and Landscapes Hub

The Clean Air Urban and Landscapes (CAUL) Hub is one of six research hubs supported by the National Environmental Science Program, which aims to assist decision-makers to understand, manage and conserve Australia's environment by funding world-class biodiversity and climate science. The programme focuses on collaborative, practical and applied research that informs on-ground action.

The mission of the CAUL Hub is to take a holistic view on the sustainability and liveability of urban environments. They are producing the evidence base and collaborative partnerships to deliver better cities. Their approach:

- Collaboration across disciplines to tackle complex problems
- Engagement and partnerships with government, private industry and citizens
- Rigorous research with real-world impact
- Highlighting Indigenous perspectives in cities

CitiesWithNature – ICLEI Cities Biodiversity Centre

CitiesWithNature is a unique initiative by founding partners ICLEI Cities Biodiversity Center, The Nature Conservancy (TNC) and The International Union for the Conservation of Nature (IUCN) that recognises and enhances the value of nature in and around cities across the world. It provides a shared platform for cities and their partners to engage, connect and work on shared commitment towards a more sustainable world.

Each city that joins CitiesWithNature will be invited and guided along a journey to share its policies, plans, commitments, actions and results related to nature and the services of ecosystems, facilitated through a series of pathways, each dealing with a thematic focus area around urban nature. This will become a powerful resource where cities can connect, share, learn from and inspire each other to accelerate actions and raise ambitions.

202020 Vision

The 202020 Vision has facilitated a national network aiming to make our urban areas 20 per cent greener by 2020. To achieve this they bring together industry, business, NGOs, government, academia and individuals, providing tools, resources and networks necessary to reach this shared goal.

To date, the project has produced several reports to assist practitioners, including a *How to Create an Urban Forest Guide* (2015) and *Where are all the Trees* (2014). Such programs that bring peers together to exchange and build knowledge have been and will be important to achieve our shared aspirations for a connected and enhanced urban forest.

Glossary

Biodiversity	*Living Melbourne* uses the definition of biodiversity given in *Protecting Victoria's Environment: Biodiversity 2037*: 'all components of the living world: the number and variety of plants, animals and other living things (including fungi and micro-organisms) across our land, rivers, coast, and ocean. It includes the diversity of their genetic information, the habitats and ecosystems within which they live, and their connections with other life forms and the natural world'.
Connectivity	The capacity of plants, animals and other living things to move between disjunct landscape elements such as habitat patches, lakes and streams.
Cool spot	Where the land surface temperature is < 0°C cooler than non-urban conditions based on an estimation of how different the temperature is in a location relative to the temperature that would be there in the absence of urban development (areas that are equal to or below their estimated non-urban baseline temperature). This may include areas such as larger parks, waterbodies and waterways.
Cooling intensity	The reduction in average air temperature under a tree canopy compared to the temperature outside the patch covered by the canopy, expressed in degrees Celsius.
Extinction debt	The future extinction of a species due to events in the past.
Green infrastructure	The green spaces and water systems that intersperse, connect and provide life support for humans and other species in urban environments. Green infrastructure ranges in scale from residential gardens to local parks and housing estates, streetscapes and highway verges, services and communications corridors, waterways and regional recreation areas. Green infrastructure has many benefits for society and the environment.
Habitat	All the physical and biological things that collectively make up the place where a plant or animal lives.
Grey infrastructure	Human-built physical structures and systems, such as buildings, water and electrical supply, sewers, stormwater drains, dams, reservoirs, fences, paths, roads and bridges.
Hot spot	Where the land surface temperature is > 10°C warmer cooler than non-urban conditions based on an estimation of how different the temperature is in a location relative to the temperature that would be there in the absence of urban development. This may include areas of concentrated heat retention, such as major roads, commercial and industrial centres, and new residential subdivisions.
Integrated water management	Collaborative planning that brings together organisations that influence all elements of the water cycle, including waterways and bays, wastewater management, alternative and potable water supply, stormwater management and water treatment.

Metropolitan Melbourne	The geographical area that defines Melbourne as a city and the capital of the state of Victoria. Metropolitan Melbourne is made up of 32 local councils: Banyule, Bayside, Boroondara, Brimbank, Cardinia, Casey, Darebin, Frankston, Glen Eira, Greater Dandenong, Hobson's Bay, Hume, Kingston, Knox, Manningham, Maribyrnong, Maroondah, Melbourne, Melton, Mitchell, Monash, Moonee Valley, Moreland, Mornington Peninsula, Nillumbik, Port Phillip, Stonnington, Whitehorse, Whittlesea, Wyndham, Yarra, and Yarra Ranges.
Natural infrastructure	Strategically planned and managed network of natural lands, such as forests and wetlands, working landscapes, and other open spaces that conserves or enhances ecosystem values and functions and provides associated benefits to human populations.[90]
Permeability	The readiness with which a surface, whether man-made (such as a paved road) or natural (such as soil or rock) allows water, air or plant roots to penetrate or pass through.
Riparian	The interface between land and a river or stream; land alongside creeks, streams, gullies, rivers and wetlands.
Threatened species	Species of plants, animals or other life forms that are considered either vulnerable, endangered, and critically endangered.
Tree canopy	The uppermost trees or branches of trees in a forest, forming an almost continuous layer of foliage. The topmost layer of bioactivity in a forest setting.
Urban forest	All of the trees and other vegetation – and the soil and water that support them – in a municipality. Urban forest incorporates vegetation in streets, parks, gardens, plazas, campuses, river and creek embankments, wetlands, railway corridors, community gardens, green walls, balconies and roofs.
Urban green infrastructure	An interconnected network of green spaces in an urban area that conserves natural ecosystem values and functions, and provides associated benefits to human populations.
Urban heat island effect	The phenomenon of dense urban areas having significantly warmer air and land surface temperatures than surrounding rural areas.
Water-sensitive urban design	Integrated design of the water cycle, incorporating water supply, wastewater, stormwater and groundwater management, urban design and environmental protection. It sees all water as a resource to be managed to improve the environment, the economy, and liveability.

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