FUTURE MELBOURNE (ECO CITY) COMMITTEE REPORT **Agenda Item 5.3**

DRAFT URBAN FOREST STRATEGY

8 November 2011

Presenter: Ian Shears, Manager Urban Landscapes

Purpose and background

1. The purpose of this report is to seek endorsement of the draft Urban Forest Strategy (UFS) and Diversity Guidelines (refer Attachments 2 and 3) for community consultation.

2. The UFS has been developed to provide a robust strategic framework for the evolution and longevity of Melbourne's urban forest. It will guide the transition of our landscape to a future forest that is diverse, resilient and responsive to the varied needs of the community and of the city.

Key issues

3. The City of Melbourne's urban forest is undergoing unprecedented change. Research shows that 27 per cent of the current tree population will be lost within 10 years and 44 per cent within 20 years.

4. Responding to this change requires a new approach in how the municipal urban forest is managed, so that future risk can be minimised.

5. Both climate change science and international urban forestry research indicate that the range of threats facing the urban forest will increase in the future, particularly vulnerability to pests and disease and extreme weather.

6. A key action within this strategy is the implementation of a tree species diversity target for the tree population. Increasing tree species diversity is sound contemporary practice in urban forestry internationally.

7. The strategy recommends that tree precinct plans and master plans be undertaken in collaboration with the community to guide City of Melbourne's approach to implementing diversity and maximising the benefits of the urban forest. (Refer Attachment 4 for more detail.)

8. It is proposed that City of Melbourne undertakes an extensive engagement process from November 2011 until February 2012 to involve the community in the further development of this strategy.

9. Feedback from the community will be documented and incorporated into the final report which is planned to be presented to Council in April 2012. (Refer Attachment 5 for more detail.)

Recommendation from management

10. That the Future Melbourne Committee endorses the draft Urban Forest Strategy for community consultation for the period from 9 November 2011 to 27 February 2012.

Attachments:

1. Supporting Attachment
2. Draft Urban Forest Strategy
3. Diversity Guidelines
4. Tree Precinct Plans & Master Plans
5. Community Consultation

SUPPORTING ATTACHMENT

Legal

1. No direct legal issues arise from the recommendation from management.

Finance

2. There is an operational budget allocated to the Urban Forest Strategy which covers costs incurred through the running of community engagement events and the consultation online forum.

Conflict of interest

3. No member of Council staff, or other person engaged under a contract, involved in advising on or preparing this report has declared a direct or indirect interest in relation to the matter of the report.

Stakeholder consultation

4. It is proposed that an extensive engagement process is undertaken from November 2011 until February 2012 to involve the community and all interested stakeholders in the further development of this strategy. The UFS consultation period is planned to coincide with the consultation period for the Open Space Strategy.

5. Communications activities will encompass messages that align both strategies, however the community engagement meetings and events for both strategies will be undertaken independently in order to focus on separate issues in an efficient and effective manner.

6. A range of methods will be employed during the engagement process to ensure that consultation and communications are as wide-reaching as possible; this will include a series of community meetings, an Eco-City Forum and online forums. Feedback provided will be documented and reported back to Council with the final report expected in April 2012.

Relation to Council policy

7. The Urban Forest Strategy relates to and is consistent with the following policies and strategies:

   7.1. Future Melbourne – Eco City

   7.2. Draft Open Space Strategy (2011)

   7.3. Draft Arden MacAulay Structure Plan & North Melbourne Structure Plan (2011)

   7.4. Southbank Structure Plan (2010)

   7.5. Climate Change Adaptation Strategy (2009)

   7.6. Total Watermark; City as a Catchment (2008)

Environmental sustainability

8. Environmental sustainability issues have been a priority in the development of this document. The implementation of the recommended actions and targets within the strategy will bring about multiple environmental benefits, including increasing the longevity of tree life, increasing canopy coverage and

vegetation throughout the municipality, lowering air pollution, increasing carbon storage and sequestration, capture and reuse of stormwater, removing pollutants from water, reducing energy expenditure during summer months and periods of extreme heat, mitigating the urban heat island and adapting the municipality to climate change.

Urban Forest Strategy

Making a great city greener

2012-2032

melbourne.vic.gov.au/**urbanforest**

CITY OF MELBOURNE


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A message from the City of Melbourne

The City of Melbourne is renowned for its heritage-listed iconic parks, gardens, reserves and boulevards. They have formed an essential part of Melbourne's identity for more than a century.

Recently our 'urban forests' became valued for providing more than aesthetic and recreational values, they provide proven economic and environmental benefits to our city.

Melbourne's urban forests are facing two very real challenges, climate change and population growth. Our trees are becoming more important to the city's landscape than before. Increasing evidence and research points to the fact that urban forests and green space are vital to supporting a healthy community.

Melbourne's urban forests are changing. We expect to lose 44% of our trees within the next 20 years. The past decade of drought has triggered severe irreversible decline for many of our trees.

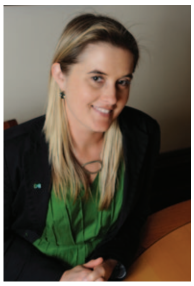
The Draft Urban Forest Strategy 2012 – 2032 sets out how the City of Melbourne's urban forest will become diverse, resilient and responsive to the needs of the community and the city.

We will work closely with and listen to the local community so we can enhance our urban forests in line with Melbourne's existing character. With a new set of principles, this strategy will help us build Melbourne's ecosystem for future communities, attracting more people to live, work and visit our city.

The Draft Urban Forest Strategy 2012 – 2032 aims to make a great city even better and we invite you to read the draft strategy and to forward feedback to the City of Melbourne, from November 2011 – February 2012.

Robert Doyle

Lord Mayor



Cr Cathy Oke

Future Melbourne
(Eco-city) Committee Chair

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Vision

The City of Melbourne's urban forest will be resilient, healthy and diverse and will contribute to the health and wellbeing of our community and to the creation of a liveable city.

A future 'greener' Melbourne - artist's impression

1 Introduction

The City of Melbourne is a unique, highly liveable city that is renowned for its parks, gardens and boulevards. The ring of parks and gardens around the eastern and southern edges of the Central City and the spacious boulevards of St Kilda Road, Flemington Road, Royal Parade and Victoria Parade leading into the Hoddle Grid are distinguished for the formality of their design and the consistency of their treed avenues.

These iconic elements contribute greatly to the city's character, they are integral to its social and cultural life, and an important part of the city's 'urban forest', which is broadly defined as: the sum of all trees and vegetation, soil and water that provides valuable ecosystem services which are essential for a healthy liveable city (See further 3.1). Our trees in particular are the most recognisable and important element within the urban forest.

The City of Melbourne is facing two significant challenges: climate change and urban growth. These challenges will place significant pressure on the existing built fabric and services of the city. A healthy urban forest will play a critical role in maintaining the health and liveability of Melbourne.

Through the development of an Urban Forest Strategy the City of Melbourne recognises the importance of a holistic, whole-of-forest approach to understanding and managing this invaluable resource. Many of the venerated landscapes of Melbourne were created well over 100 years ago in a different climatic and social environment. A significant number of our trees are nearing the end of their lives and landscapes are struggling to adapt to a changing climate. Now is the time to design and plant the forest of the future in a way that respects Melbourne's unique character, responds to climate change and growth, and underpins the health, liveability and wellbeing of the city and its inhabitants.

The goal of this strategy is to provide a robust strategic framework for the evolution and longevity of Melbourne's urban forest. It will guide the transition of our landscape to a future forest that is diverse, resilient and responsive to the varied needs of the community and of the city. Its intended outcomes are supported by three primary purposes – to create resilient landscapes, community health and wellbeing and a liveable, sustainable city. Central to this is the vision to 'make a great city greener' – to become a city within a forest rather than a forest within a city.

Over the next 20 years and beyond, Melbourne will experience a changing climate, becoming increasingly warmer and drier, and likely to more frequently experience extreme heat and inundation. This strategy foresees that Melbourne will continue to be one of the world's most liveable cities and that the urban forest will play a critical role in creating and maintaining the integrity of its urban landscapes.

One of the important attributes of the urban forest is to compensate for the predicted increases in temperature by providing shade and cooling. Increased canopy coverage throughout the city will minimise the urban heat island effect and improve thermal comfort at street level for pedestrians. Increased water sensitive urban design incorporated into the landscape will play an important role in managing frequent inundation and providing essential soil moisture for healthy vegetation growth.

Urban growth will see significant residential, employment and visitor populations within the city (see further 4.5) and densification of built form. An associated growth in the urban forest, 'green infrastructure' and 'ecosystem services' of the city will respond to these increases, reduce the cost of grey infrastructure and improve the quality of the urban environment. Urban forests and associated ecosystem services will also yield further benefits for future communities, attracting more people to live, work and visit our city.

To achieve this vision the principles outlined in this strategy will guide decision-making to create our future forest. The strategy highlights proactive and adaptive management, and transforms an asset that has a current amenity value estimated at $650 million and a future value that is potentially priceless.

Our urban forest is undergoing unprecedented change. The recent period of drought combined with water restrictions has triggered irreversible decline for many of our trees. This has coincided with the decline of Melbourne's significant and 'symbolic' Elms and other ageing trees. Modelling shows that within the next ten years, 27 per cent of the current tree population will be at the end of their useful lives and within twenty years this figure will have reached 44 per cent.

The City of Melbourne is addressing these changes head on by looking at retention of existing trees and planning the urban forest of the future.

To guide future planting a series of tools and programs have been, and continue to be, developed. Building the urban forest as a living ecosystem will rely on smart species selection to deal with goals such as improving biodiversity, improving soil moisture retention, reducing stormwater flows, increasing shade and canopy cover, reducing infrastructure conflicts and ensuring our urban forest provides the maximum benefits for our communities.

Ultimately, urban forestry is now entering a new era in Australia and this strategy highlights how critically important urban forestry is for urban planning and design particularly in context of enhancing liveability and adapting to predicted climate change. An urban forest provides a multitude of benefits for the ecosystem, the economy and community health and wellbeing. It is essential that we acknowledge and build upon those benefits now to ensure the best future for our city – an urban forest loved and enjoyed by our children and their children.

We often think of the trees as the lungs of our city, but they are also, in some ways, our heart and soul. The whole community owns our trees and our future trees… There are few political, budget or policy decisions that must deliver for people in 100 years. In politics, so much is driven by the artificial three- or four-year election cycle. Not this plan. Our trees are too important.

Robert Doyle Herald Sun 9 January 2011

2 Executive summary

The City of Melbourne's Urban Forest is undergoing unprecedented change. Research shows that 27 per cent of the current tree population will reach the end of their useful life within in 10 years and 44 per cent within 20 years.

We now have an opportunity to create a healthy, resilient forest for the future that maximises the economic, social and ecological benefits that can be conferred by the urban forest.

Responding to change requires a new approach in how the municipal urban forest is managed, so that future vulnerability can be minimised.

Both climate change science and international urban forestry research indicate that the range of threats facing the urban forest will increase in the future, particularly vulnerability to pests and disease and extremes of weather.

As we anticipate increases in urban temperatures and density we can expect that Melbourne's Urban Heat Island (UHI) effect will intensify. An increased canopy cover throughout the municipality will minimise the impact of the UHI effect.

This strategy provides the framework to build a resilient, healthy urban forest that can thrive in the future. Our key principles are to;

- mitigate and adapt to climate change
- reduce the urban heat island effect
- design for Liveability and Cultural Integrity
- design for health and wellbeing
- create healthier ecosystems
- become a Water Sensitive City
- position Melbourne as a leader in urban forestry

To achieve our vision of a healthy and resilient urban forest that contributes to the health and wellbeing of our communities and to a liveable city, we need to create better urban environments for everyone. Our guiding principles defined above highlight the importance of a well-designed city, and the following strategies list how we go about creating these 'living spaces'.

Strategy 1: Increase canopy cover

Target: Increase public realm canopy cover from 22 per cent to 40 per cent by 2040.

Strategy 2: Increase urban forest diversity

Target: The urban forest will be composed of no more than 5 per cent of any tree species, no more than 10 per cent of any genus and no more than 20 per cent of any one family.

Strategy 3: Improve vegetation health

Target: 90 per cent of the City of Melbourne's tree population will be healthy by 2040.

Strategy 4: Improve soil moisture and water quality

Target: Soil moisture levels will be maintained at levels to provide healthy growth of vegetation.

Strategy 5: Improve biodiversity

Target: Melbourne's green spaces will protect and enhance a level of biodiversity which contributes to the delivery of ecosystem services.

Strategy 6: Inform and consult the community

Target: The community will have a broader understanding of the importance of our urban forest, increase their connection to it and engage with its process of evolution.

The delivery of these strategies and targets will provide multiple benefits for Melbourne's urban forest. Most importantly they will ensure that we prepare and adapt adequately for predicted climate change, manage the health of the urban forest and provide the community with world class open spaces, parks and streetscapes that provide multiple benefits for public health and wellbeing.

This strategy provides the City of Melbourne and its communities a unique opportunity to work collaboratively to develop our new urban forest.

The City of Melbourne has a leading role to play in urban forest advocacy. The principles and actions developed through this strategy have the capacity to be used and adapted across Melbourne, thereby reinforcing Greater Melbourne's urban forest.

The renowned boulevard of Plane trees along St Kilda Road

Equally renowned avenue of Lemon Scented Gums along Fraser Avenue, Kings Park, Perth

A city literally within a forest, Berlin.

3 Background & Context

3.1 What is an Urban forest?

The urban forest, in the context of the Melbourne municipality, comprises all of the trees and vegetation – including the soil, air and water that supports it – within an urban environment. It incorporates trees and vegetation in streets, parks, gardens, plazas, campuses, river and creek embankments, railway corridors, community gardens, green walls, balconies and green roofs. Urban forests provide critical ecosystem services such as air and water filtration, shade, habitat, oxygen, carbon sequestration and nutrient cycling. The urban forest also provides the 'connection to nature' that is often perceived to be missing in urban areas.

Urban forestry, as opposed to arboriculture and horticulture, allows us to consider the cumulative benefits of an entire areas tree population, such as a town or city. Looking holistically then at the urban forest and its associated ecosystem services, we can begin to consider the broader issues of climate change, urban heat island effects and population growth that can be influenced by the presence of an urban forest, but also how they will impact on our future urban forest.

Urban forestry can be described as the science and art of managing trees, forests and natural ecosystems in and around urban communities to maximise the physiological, sociological, economic and aesthetic benefits that trees provide society.[1] Often this responsibility for management, including 'green governance', is considered a local government responsibility; however its sphere of influence frequently extends well beyond that. Local communities, schools, community groups, developers, industry and State and Federal Government all have a key role to play in ensuring we manage and care for Australia's urban forests.

The discipline of 'urban forestry' originally stemmed from research conducted by Erik Jorgensen at the University of Toronto, Canada in 1965. This was the first recognition that urban trees provide environmental benefits in addition to providing recreational and amenity value.[2] With support from the International Society of Arboriculture and the US Department of Agriculture's Forestry Department, the practice of urban forestry gradually pervaded US urban policy, and its outreach met UK shores in the early 1980s – sparking the Forest of London project aimed at social, ecological and economic regeneration of UK cities, and flowed into the Netherlands in the mid 1980s. From there, Scandinavian, European and Asian cities have embraced the concept, broadening the depth of knowledge and research globally.

Urban forestry has yet to be well researched, implemented and evaluated in an Australian context. There is a reliance on research from the United States, Europe, Scandinavia and Asia to supplement thinking and programs domestically. Whilst Australia is some way behind in providing robust urban forest research and literature, Australian cities are by no means behind in current management and planning of urban trees. We have been practicing the art and science of urban forestry for years through tree and parks planning, arboriculture and urban design.

Defining what urban forestry means for Melbourne and Australia is important in determining visions for our future cities and how we will go about realising them. Essentially, urban forestry is the meeting of arboricultural and forestry practices with other disciplines such as urban planning, landscape architecture, sustainability, architecture, engineering and economics. Ensuring these groups work collaboratively will be integral to creating a genuinely Australian concept of urban forestry.

'Local scale' urban greening - waterfront promenade at Victoria Harbour, Docklands (at left), and front facade of Triptych, Southbank (above)

3.2 Benefits of the Urban forest

Urban forests have been around for as long as people have lived in cities but only recently have they become valued for providing more than aesthetic and recreational values.

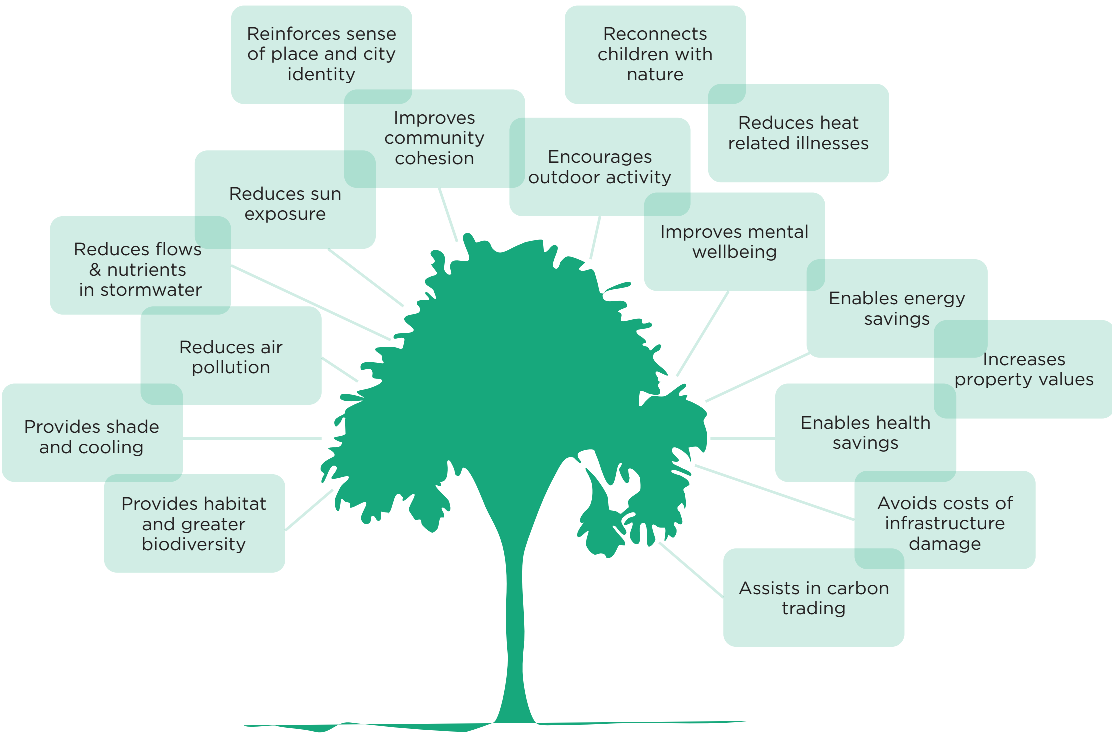
Cities around the world now regard trees and other vegetation as critical urban infrastructure – as important to how a city functions as roads or public transport and particularly vital to the health and wellbeing of communities.

The benefits of urban forests span environmental, economic, social and political domains. These benefits are interrelated, with each cumulatively feeding into the creation of resilient and sustainable urban landscapes.

Given the pressure on governments to plan for greater populations, increased urban density and climate change adaptation, there is a clear opportunity to communicate the importance and benefits of urban forests in creating resilient, sustainable cities that provide healthy and enjoyable places for people to live and work.

Some of the major benefits of urban forests in supporting, provisioning, regulating and providing essential services are explored in this section.

Foresting the suburbs provides cumulative benefits for ensuring a healthy city - in particular they offer the opportunity to be the 'green lungs' of the city



Summary of the broad array of benefits offered by urban trees (adapted from the Woodland Trust, UK)

3.2.1 Environmental benefits

The urban forest is essentially the 'engine room' for urban ecosystems. The urban forest takes in water, nutrients and carbon dioxide and processes them through photosynthesis and transpiration, transforming them into the valuable environmental outputs of clean air, oxygen, shade and habitat. Broad calculations suggest that larger mature trees provide 75 per cent more environmental benefits than smaller trees.

The environmental benefits of the urban forest are as follows:

- **Provide shade and cool our cities**

  Established research and ongoing studies by the City of Melbourne confirm that the addition of trees and vegetation in the built environment provides the greatest benefit in terms of mitigating the Urban Heat Island effect. Through the natural process of transpiration trees help reduce day and night-time temperatures in cities, especially during summer. Trees provide shade for streets and footpaths and their leaves reflect and absorb sunlight, minimising the heat absorbed by the built environment during the day.

- **Reduce stormwater flows and nutrient loads**

  Tree canopies and root systems reduce stormwater flows and nutrient loads that end up in our waterways. Broad tree canopies intercept and mitigate the impact of heavy rainfalls and healthy tree roots help reduce the nitrogen, phosphorus and heavy metal content in stormwater.

- **Reduce air pollution and air-borne particulates**

  The role of urban vegetation is equally vital in ameliorating air pollution and greenhouse gases. Through the process of photosynthesis trees take up carbon dioxide, nitrous oxides, sulphur dioxide, carbon monoxide and ozone from the atmosphere. Studies show a typical mature tree can store as much as 10 tonnes of carbon.

Research has shown that a 20 per cent increase in a city's urban forest canopy can reduce ambient temperatures by 3-4 degrees Celsius.[3]

A study in New York found that its urban forest removed 1,821 metric tonnes of air pollution at an estimated value to society of $9.3 million annually.[4]

- **Provide habitat and enhancing levels of biodiversity**

Although few cities have preserved large areas of natural habitat, a healthy urban forest contributes to biodiversity and provides habitat for a variety of wildlife. Urban forests round the world have been shown to harbour a wide range of species, even endangered animals and other biological species of high conservation value. By planting and managing different age strata, biodiversity and a wider range of animal habitats can be enhanced.

Through the research and documentation of these benefits, the capacity of healthy and well-designed urban forests to mitigate and to adapt to climate change is broad and well-documented.

A well-placed tree with suitable below ground growing conditions (in this case above a disused WC in Russell Street) maximises the benefits of trees in a city street

The biodiverse habitat of the wetlands at Trin Warren Tam-boore in Royal Park also provides a valuable public open space

3.2.2 Community benefits

Urban forests have a large range of positive impacts on the community by forming shared points of orientation within the urban environment and allowing daily interaction with nature. Specific benefits are as follows:

- **Providing a sense of place and creation of local identity**

  A city's landscape helps define its character in much the same way as architecture or urban design because trees physically define a place. Landscapes are the setting for many everyday recreational opportunities such as organised sport, walking the dog or having a picnic and therefore help forge a sense of connection to place.

- **Improving community cohesion**

  Urban forests and green open space provide the place for major events, festivals and celebrations throughout the city. Events and spaces can bring diverse groups of people together through the provision of a public realm which is available for everyone to enjoy. Green spaces especially play an important role in the integration of minority groups and can assist in the adaptation process of immigrants into their host country.[5]

- **Encouraging outdoor activity**

  Well-treed parks, gardens and streets encourage the use of open spaces, which have multiple flow-on health benefits such as reduction in obesity and improvement in general physical and mental wellbeing. In an era where lifestyle-related illnesses are prevalent and 61 per cent of Australian adults are overweight or obese, (obesity costs Australia's health care industry $58 billion in 2008) prevention methods are usually more effective than cures.

- **Reconnecting children with nature**

  With technological innovations enticing children into 'make believe worlds' of computer games, electronic technology is prevalent in contributing to childhood obesity and inactivity. Studies have shown that green spaces provide therapy to children, allow creativity of mind, encourage exploration and adventure, promote physical activity, build resilience and enhance experiential learnings.[6]

- **Reducing sun exposure to people**

  Sun exposure illnesses such as skin cancer, have long associated the importance of protection from sunlight's UV rays is paramount. Shade alone can reduce overall exposure to UV radiation by up to 75 per cent (Parsons et al, 1998). Our urban forest provides the best form of natural shade, with broad canopied street and park trees the most effective.

- **Reducing heat related illnesses**

  From a public health perspective, the shade provided by large canopied trees during hot summer days helps reduce localised day time temperatures by up to 2 degrees Celsius. In Melbourne, on days over 30 degrees Celsius the risk of heat related morbidity and mortality for people over 64 years of age increases significantly.[7] Evidence suggests that buildings with little or no surrounding vegetation are at higher risk of heat related morbidity.[8]

- **Improving mental wellbeing**

  The availability of, access to and even the ability to view green spaces and trees has positive effects on people's wellbeing. Many studies have explored the relationships between the amount of green in the landscape and associated levels of depression and wellbeing. In the Netherlands, disease rates, including mental disease were shown to be of a lower prevalence in areas with higher percentage of green spaces within a 1km radius than those with lower percentages.[9]

Melbourne's tan track is one of its premier green spaces for active recreation for all ages and abilities

3.2.3 Economic benefits

The breadth of urban forest benefits that can be quantified in dollar terms span a range of industries and disciplines. Most infrastructure and design decisions are based on economic cost benefit analysis and understanding the financial impacts of urban forests is critical in helping understand their functionalities. The economic benefits of an urban forest are as follows:

- **Reducing energy costs**

  A major economic benefit of an urban forest is the ability of healthy trees to shade buildings in summer, reducing the need for air conditioning, in turn cutting energy costs. Increasing tree cover by 10 per cent – or planting about three trees per building lot – saves annual heating and cooling costs by an estimated $50 to $90 per dwelling unit because of increased shade.[10]

- **Increasing property values**

  Tree planting in streets directly enhances and improves the neighbourhood aesthetics and consequently is proven to increase property values. It is estimated that properties in tree-lined streets are valued around 30 per cent higher than those in streets without trees.[11]

- **Avoiding costs of infrastructure damage**

  Urban forests that provide significant canopy coverage over a city improve the lifespan of certain assets, such as asphalt by shading them from harmful UV rays. Tree canopies and root systems also play a key role in mitigating flood levels during extreme events and have the ability to lower stormwater flows into our existing drainage infrastructure. Urban forests can increase the lifespan of asphalt by 30 per cent.[12]

In the Chicago Trees Initiative, economic calculations indicated that a 17.2% canopy cover:

> Stores $14.8M carbon

> Sequesters carbon at a value of $521,000 per year

> Filters air pollution at $6M per year

> Has a structural value of $2.3 billion

- **Decreasing health costs**

  Knowing the extensive health benefits of urban forests and green spaces, it is likely that the provision of these in urban areas reduces health costs associated with sedentary behaviour, obesity and mental illness. Whilst it is difficult to create a direct link and quantify exact dollar savings, research suggests that a healthy green city helps alleviate the burden on national health systems. Access to a view of green space, including trees can encourage hospital patient recoveries, reducing the amount of time spent in hospital.

- **Marketing the City**

  Many cities now aim to have their green spaces recognised internationally. Tourism and city marketing can be boosted by green infrastructure. Urban forests and parks can be marketed as city attractions, provide attractive settings for various events and activities which boost the local economy.

- **Storing and sequestering carbon**

  During photosynthesis, trees convert carbon dioxide (CO2) and water into sugar and oxygen and store carbon within their biomass as they grow older. Urban trees therefore make an impact in absorbing carbon from the atmosphere. Chicago's urban forest annually sequesters 318,800 tonnes of carbon from the atmosphere, equivalent to the annual greenhouse gas emissions from over 50,000 passenger vehicles.[14]

The diversity of benefits which can be quantified in dollar terms span health, engineering, planning, sustainability, geology and real estate industries. Bringing these altogether to form a solid economic business case for urban forests is a very powerful tool for decision makers.

Evolution of Melbourne's Urban forest

3.3.1 Historical development

Melbourne's original forest evolved in a completely different landscape than the one we have come to know now. The section of the Yarra River that runs through our city was once a lush riverbank and wetlands brimming with vegetation that supported the indigenous communities that made the river their home. The area surrounding the Yarra River and modern day Melbourne was inhabited by various clans of the Kulin nation.

In the in 1850s and 1860s, public gardens and boulevards were developed with the notion of human beings and their society being central to any evaluation of the environment. Aesthetics and functionality of green spaces were key objectives in planning green spaces in early Australian cities. Whilst there is still great consideration given to the needs of society in planning for urban green infrastructure, a separate set of environmental needs and solutions has entered the planning discussions.

European settlement saw the taming of the bush to make way for a burgeoning township where trees were an abundant resource available for exploitation. The late 1800s and early 1900s saw a refinement of the landscape through the building of contrived, highly designed English garden spaces for recreation of the elite classes. The City of Melbourne now displays a culturally and heritage rich palette of open green spaces that are highly valued by all members of the community such as the Royal Botanic Gardens, Royal Park, St Kilda Road, the Yarra River banks and green roofs and walls across the city.

Significant numbers of Melbourne's trees, including our Elm tree population now need to be renewed as many are approaching the end of their useful natural life and many have been affected by the prolonged drought. Urban tree renewal is now not simply about when to replace old and dying trees, but also why, where, how and what. Our original urban forest was planted in a wholly different landscape that has evolved into the dynamic and culturally rich city that Melbourne has become.

Alexandra Avenue and Queen Victoria Gardens in the 1800s, showing a variety of acclimatisation era species, and the original four lanes for walking, cycling, carriages and horses

Alexandra Avenue by the 1940s (Photo: Mark Strizic)

St Kilda Road in the early 1900s, showing the original median plantations and avenues.

3.3.2 The urban forest today

The City of Melbourne's urban forest comprises around 60,000 trees in streets and parks as well as approximately 20,000 trees located in the private realm. The trees managed by the City of Melbourne in the public realm contribute significantly to the individual character and identity of Melbourne. Carlton Gardens, Fitzroy Gardens, Royal Parade, St Kilda Road and the Yarra River banks are landscapes that are highly valued by our residents, workers, visitors and tourists.

There are over 250 different species of trees in our municipality ranging from the iconic Elms and Planes to River Red Gums, Melaleucas, Lemon Scented Gums, Spotted Gums and significant stands of conifers in our gardens. Over 35 per cent of the tree population is composed of just three species: Elms, Planes and River Red Gums, however this dominance is part of what creates the respected and unique character of Melbourne's urban forest. Plane trees alone make up 75 per cent of the trees within our CBD.

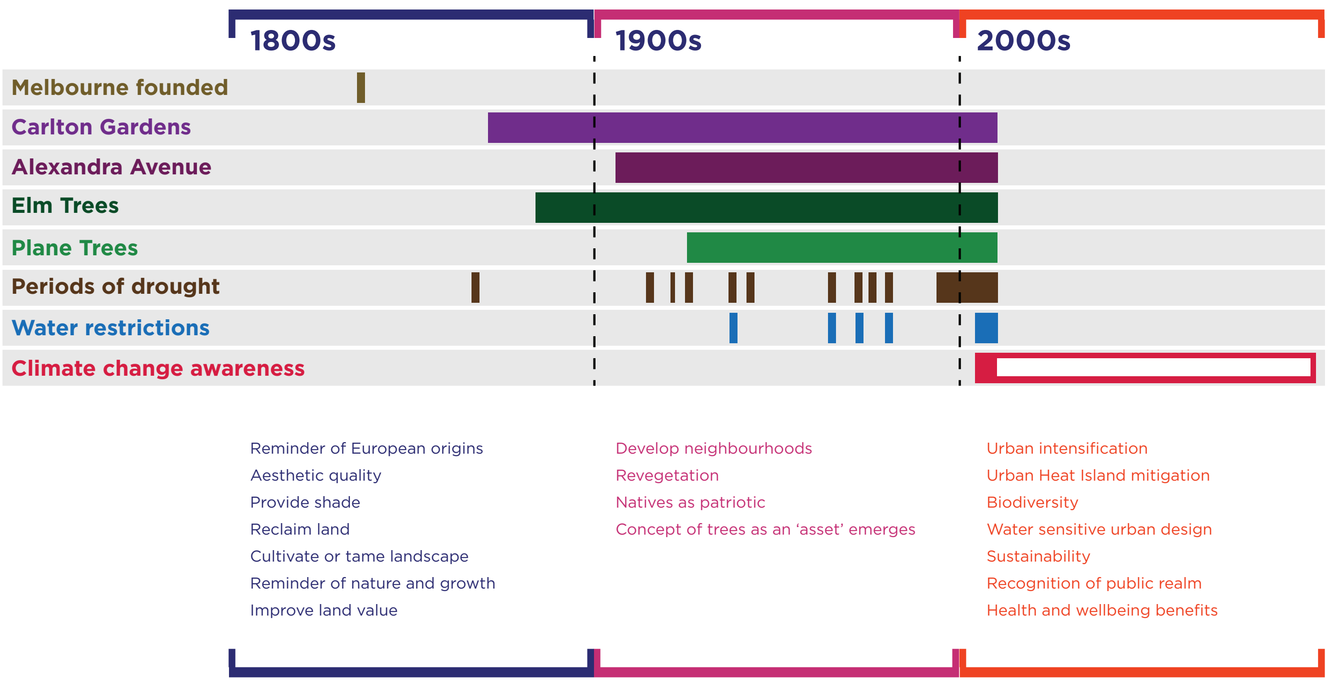
The majestic but ageing Elms of our grand boulevards and park avenues are the largest stand of urban Elms remaining in the world after Dutch Elm Disease decimated Elm forests in Europe and North America.

Our urban forest is home to a rich diversity of animal species including the Powerful Owl, Tawny Frogmouths, Kookaburras, Kingfishers, Possums, White's Skink, Grey-headed Flying Foxes, Striped Legless Lizard and Blue-tongued Lizard, the Eltham Copper butterfly, and a variety of frogs and micro bats. Various waterways across the municipality are used by migratory birds for nesting and habitat.

Unfortunately, however, the urban forest is undergoing unprecedented change and is highly vulnerable from a range of perspectives. The dominance of a few tree species and the ageing of many of our Elms, in particular, combine to render it susceptible to significant loss due to potential pest and disease attack, heat waves and ageing.

Key urban forest indicators

We can regard and examine our public urban forest in a number of different ways. In order to best manage our existing vegetation and to guide the development of the forest of the future, we have undertaken extensive mapping of tree health, species composition, canopy cover and expected useful life in the landscape of trees currently managed by the City of Melbourne. This mapping provides us with key indicators with which to benchmark the forest, set future targets and measure change over time. The private realm requires a more collaborative approach with the community to gain a better understanding of its health, diversity and distribution. As such we have very little information on the private realm component of our urban forest.



Tree canopy cover

Canopy cover is a measure of the physical coverage of the tree canopy over the land. It represents a way of expressing as a percentage the spatial extent or density of tree crown coverage in an area. Canopy cover provides an important way of measuring and expressing the character of any urban forest. It is a repeatable benchmark that can be measured at any time and will guide and evaluate future tree planting programs. The measure of canopy cover for our urban forest is more valuable than focussing on the total number of trees in the municipality. This is because we are looking at increasing shade and biomass in the municipality to combat urban heat Island effects, adapt to climate change and enhance our streetscapes for the comfort of people, of which canopy cover is paramount.

Location	Percentage
Whole of Municipality	22.23%
Road Network	10.23%
All Parks and Gardens	28.02%

Canopy cover – City precincts (public realm)

City Precinct	Percentage
South Yarra	33.44%
Carlton	29.11%
CBD	21.20%
East Melbourne & Jolimont	20.66%
North & West Melbourne	19.87%
Kensington	19.68%
Parkville	19.42%
Southbank	14.20%
Fishermans Bend	6.40%
Docklands	4.72%

Tree canopy cumulatively covers 22 per cent of public streets and park areas. This means 78 per cent of our public municipality is without natural shade.

Canopy cover – Parks and gardens (public realm)

Major Parks and Gardens	Percentage
Carlton Gardens North	62.32%
Carlton Gardens South	58.00%
Kensington Reserves	56.10%
Fitzroy Gardens	53.10%
Kings Domain	50.32%
Treasury Gardens	50.08%
Alexandra Gardens	48.04%
Flagstaff Gardens	44.97%
Shrine Reserve	42.49%
Fawkner Park	38.38%
Birrarung Marr	25.51%
Princes Park	21.87%
Royal Park	21.64%
JJ Holland Park	20.19%
Docklands Park	5.95%

Environmental dollar values

The City of Melbourne has prepared a scientifically based amenity formula for calculating the amenity value of our trees. The formula is based on factors such as tree condition, species type and its growth rates, aesthetics value and locality values. A rough estimate of the City of Melbourne's urban forest amenity value is around $650 million.

We also have the ability to value the environmental benefits of our urban forest through a US based tool called i-tree Eco. Air pollution amelioration, carbon storage and sequestration, energy savings benefits of trees and structural values of the urban forest can be calculated using i-tree.

Our first initial results using i-tree on trees in Royal Parade, Collins Street, Swanston Street, Lonsdale Street and Victoria Parade show that the 982 trees within the municipality:

- remove 0.5 metric tonnes of air pollution per year at a dollar benefit of $3,820
- store 838 metric tonnes of carbon at a dollar value of $19,100
- sequester 24 metric tonnes of carbon each year at a value of $548 per year
- save $6,370 in energy costs each year through shading buildings in summer and providing solar access in winter
- avoid carbon emissions by reducing energy use by $114 per year
- are structurally worth $10.4 million.

If we broadly extrapolate these figures across the entire population of 60,000 trees, there is a clear indication that our urban forest is a very valuable environmental asset.

Tree species

Species diversity plays an important role in the long-term stability of an ecosystem and is a representation of vulnerability within the forest. Low tree species and age diversity is likely to create an unstable ecosystem that is vulnerable to pest and disease attack or loss from extreme events such as heat or drought. A skewed age profile amongst the urban forest also contributes to vulnerability as trees will decline and senesce at the same time. We should therefore aim for greater species and age diversity.

Top ten species within the City of Melbourne tree population

SPECIES	Common name	Total	%
Platanus x acerifolia + P. orientalis	London Plane + Oriental Plane	6064	12%
Ulmus procera + U. hollandica	English Elm + Dutch Elm	5822	12%
Eucalyptus camaldulensis	River Red Gum	5407	11%
Corymbia maculata	Spotted Gum	3038	6%
Eucalyptus melliodora	Yellow Box	1623	3%
Eucalyptus leucoxylon	Yellow Gum	1518	3%
Corymbia citriodora	Lemon-Scented Gum	1297	3%
Allocasuarina verticillata	Drooping She-Oak	1267	3%
Angophora costata	Smooth-barked Apple Gum	1024	2%
Lophostemon confertus	Brush Box	930	2%

Top ten genera within the City of Melbourne tree population

There is a noted high percentage of the genus Eucalyptus within our tree population. This is due in part to the fact that many different Eucalyptus species make up this genus, that these trees are native to Australia and also prove hardy as urban trees. This is also due to the fact that Royal Park, a large native landscape, houses many of these Eucalypts, including our entire population of 5,400 River Red Gums (*Eucalyptus camaldulensis).*

GENUS	Common name	Total	%
Eucalyptus	Eucalypt	12371	24%
Ulmus	Elm	6579	13%
Platanus	Plane	6308	12%
Corymbia	Corymbia	4355	9%
Acacia	Wattle	2048	4%
Quercus	Oak	1611	3%
Allocasuarina	She-Oak	1562	3%
Melaleuca	Ti-tree	1207	2%
Ficus	Fig	1126	2%
Angophora	Apple Gum	1044	2%

Top ten botanical families within the City of Melbourne tree population

43 per cent of our tree base is from one family, the Myrtaceae family. In fact, many Australian native trees that function well as urban trees in Melbourne belong to this family, which includes Eucalypts, Corymbia, Callistemon, Angophora and Melaleuca. It should be noted that of the 13,000 trees in Royal Park, 9,800 are from the Myrtaceae family. This creates a high level of vulnerability in terms of pest and diseases such as Myrtle Rust.

FAMILY	Common name	Total	%
Myrtaceae	Myrtle	21821	43%
Ulmaceae	Elm	7212	14%
Platanaceae	Plane	6308	12%
Mimosaceae	N/A	2048	4%
Casuarinaceae	N/A	2022	4%
Fagaceae	Beech	1617	3%
Moraceae	Fig	1129	2%
Rosaceae	Rose	869	2%
Pinaceae	Pine	659	1%
Salicaceae	N/A	605	1%

Vulnerability

City of Melbourne's urban forest, whilst significant and valuable in its current state, is essentially vulnerable. There is a dominance of certain species with the tree population such as Elms and Planes, there are a significant number of trees reaching their end of their lives, the drought has left the forest and the urban ecosystem less than robust and whilst the existing City of Melbourne Tree Policy references the issue of low species diversity within the municipality, there are no formal guidelines in place for ensuring a diversity of tree species and ages.

Useful Life Expectancy (ULE) of City of Melbourne's trees

Useful life expectancy (ULE) is an estimated measure of how long a tree is likely to remain in the landscape based on health, amenity, environmental services contribution and risk to the community. It is not a measure of the biological life of the tree.

The latest ULE assessment on our urban forest has been undertaken since March 2011. At present, 30,000 trees have been assessed, and on the basis of this assessment, 27 per cent of our entire tree population will be at the end of its useful life in the landscape within the next ten years and 44 per cent in the next twenty years.

ULE (years)	Total	Percentage
1-10 years	7,268	27%
11-20 years	4,513	17%
21-30 years	4,468	17%
31-60 years	6,788	26%
61+ years	3,514	13%

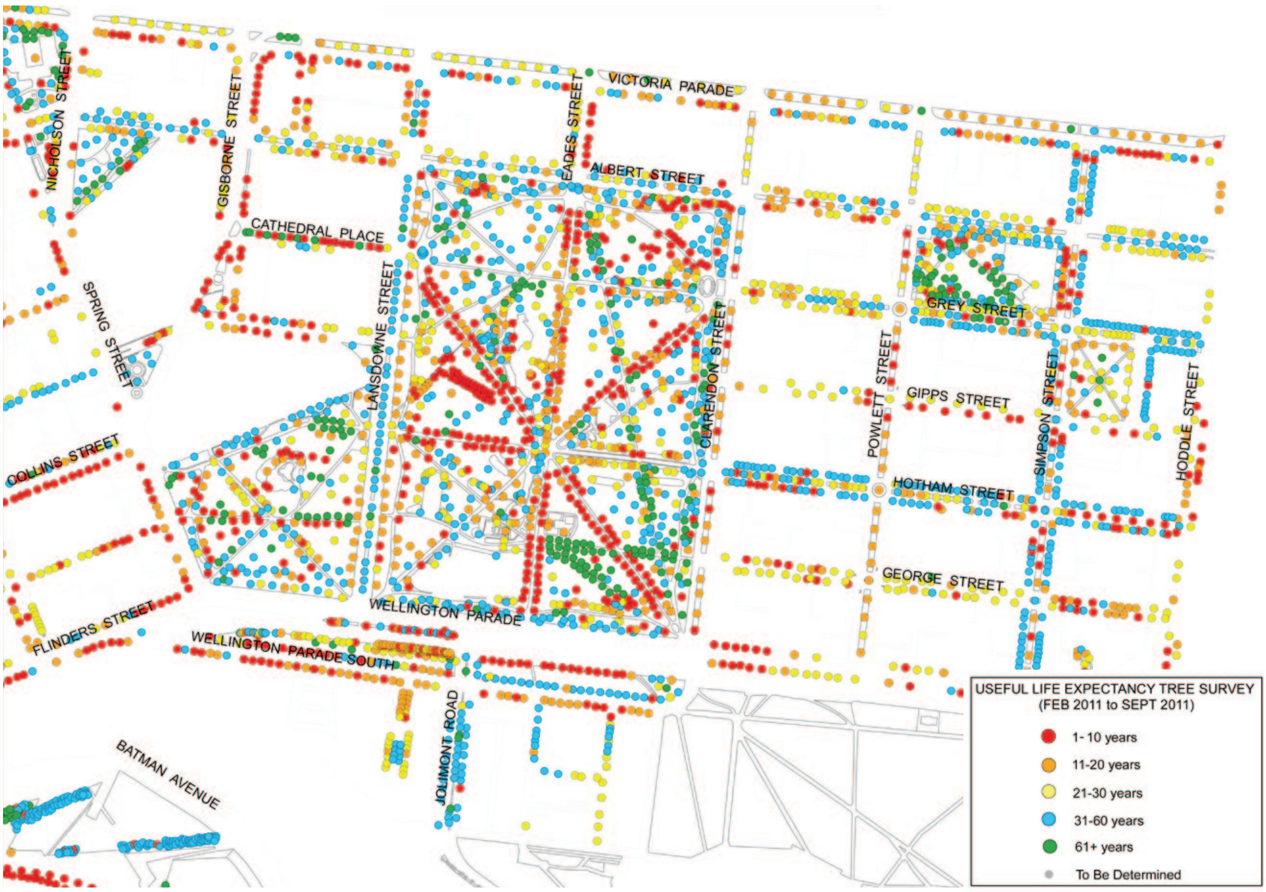
Useful Life Expectancy (ULE) of City of Melbourne's Elms

55 per cent of Melbourne's Elms will need to be removed from the landscape within the next ten years.

ULE (years)	Percentage
1-10 years	55%
11-20 years	21%
21-30 years	11%
31-60 years	9%
61+ years	4%

Mapping ULE for the city's tree population is one of the most effective tools for strategic planning of its replacement

This page and overleaf: ULE mapping of 30,000 trees to date has focused on some of the city's premier landscapes in parks, gardens, avenues and boulevards



Soil moisture levels

Adequate available soil moisture levels are critical for healthy vegetation growth. The extended period of low rainfall over 13 years has left soil moisture levels in the city morbidly low. The low levels have impacted severely on tree health throughout the municipality. In particular, trees in traditionally irrigated landscapes have been impacted by lower rainfall and decreased irrigation due to restrictions.

While 2010/2011 summer rains have been valuable, soil moisture levels remain depleted and this poses an ongoing threat to tree and vegetation health. A number of active and passive approaches are currently undertaken to recharge and replenish soil moisture and ensure they are maintained at levels to provide healthy growth.

The capture and reuse of stormwater is an important key to decreasing reliance on potable water and its lack of availability and increasing costs. The city that has traditionally shed water needs to capture, store and reuse. Impervious surfaces need to allow natural rainfall to enter the soil, a huge reservoir that is ready made to provide for a healthy forest.

Changes to irrigation practices, mulching, soil injection, water barrier and tanker watering have preserved the health of many trees. Tree health monitoring programs and measurement of soil moisture provide strategic guidance to direct resources and will be vital in ensuring the health of the future forest.

Pests and diseases

The city has suffered attacks from Elm Leaf Beetle and has countered this with a trunk injection of Confidor in every Elm across the municipality. Fusarium Wilt, Phytopthera cinnamomi, Fig Psyillid and Leaf Skeletoniser have been identified within our urban forest, however each episode has been contained and treated where needed. To date there has been no large scale tree mortality as a result of pest and disese, due to the resilience of our trees and the responding action taken by the City of Melbourne.

City of Melbourne is currently monitoring the urban forest for Myrtle Rust and Sycamore Lace Bug and has an interactive relationship with the Committee for Amenity Tree Health and the State Government Department of Primary Industries.

3.3.3 Policy context

The following is a list of the City of Melbourne's policy documents that underpin and inform this Strategy:

Future Melbourne, City of Melbourne, 2008

Municipal Strategic Statement, Melbourne Planning Scheme Amendment C162, 2010

Climate Change Adaptation Strategy, City of Melbourne, 2009

Total Watermark: City as a Catchment, City of Melbourne, 2008

Open Space Strategy, City of Melbourne, draft in progress 2011

Biodiversity Action Plan, City of Melbourne, draft in progress 2011

Urban Heat Island effect study and consequential policies, draft in progress 2011

City North and Arden Macauley Structure Plans, City of Melbourne, 2011

Endnotes

1 Schwab, 2008
2 Randrup et al, 2005
3 McPherson, 1993
4 Nowak, 2002
5 Jey et al, 20090
6 Louv, 2005
7 Department of Health, 2010
8 Loughnan, 2010
9 Maas et al, 2009
10 McPherson, Nowak, 1997
11 Sander et al, 2010
12 Stringer et al
14 Ulrich, 1984
15 McPherson et al, 1997

Fawkner Park, South Yarra

4 Issues & Challenges

We know that our current urban forest is vulnerable on a range of levels as has been identified in Section 3.3.2. Its health has been impacted by lack of rainfall, water restrictions, extreme heat, and development expansion and consolidation. We also have a tree population that is ageing at the same point in time.

Three species dominate our total population: Elms, Plane Trees and River Red Gums. We have also noted (3.3.2) that this exposes the population to a higher risk of ill health and mortality through pests, diseases, heat waves and low rainfall futures.

There is pressure on all levels of government to plan for greater population, economic growth, expanded urban boundaries and densification, ensuring that our cities remain not only resilient to this future change but also also become even greater places to live. Urban forests play a quiet yet critical role in helping urban areas to meet these future challenges. Sound adaptation solutions will be those actions which can be considered to have multiple benefits. Effective adaptation in the built environment will need to take account of the fact that green infrastructure solutions can be highly cost effective, and in many cases may have to take precedence over 'grey infrastructure' solutions.

Green infrastructure, including open space, green environmental corridors, canopy cover and ecosystem services are the most efficient tools that cities can utilise to remain healthy, robust and liveable.

Here we identify the key challenges that Melbourne faces in terms of the vulnerability of its urban forest are:

- ageing tree population
- diminishing availability of water
- climate change
- urban heat island effect
- population increase and urban intensification

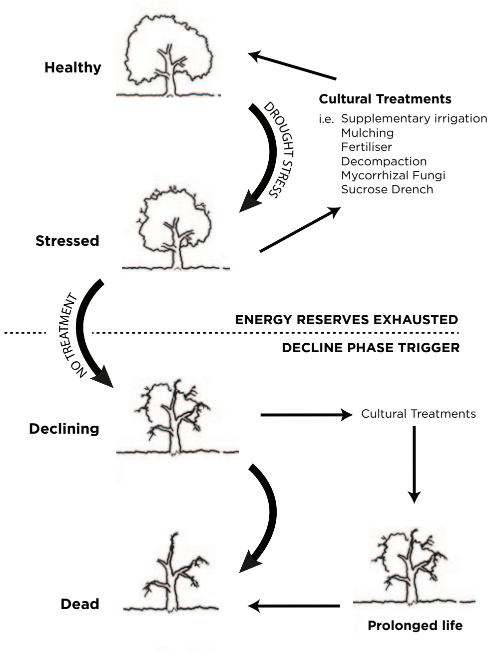
Examples of life stages of tree decline, highlighting degree of vulnerability, in various locations in the city

4.1 Ageing tree population

Many of Melbourne's trees, including those in our iconic boulevards and parks, are now well over 100 years old and approaching the end of their useful life. Elms planted in the late 1800s such as those in Fitzroy Gardens, Royal Parade, Flemington Road, Fawkner Park, Alexandra Avenue and St Kilda Road were planted in socially, culturally and environmentally different times, and have performed remarkably well thus far in faring against droughts, urbanisation and changing cultural trends. However the older a tree becomes, the less tolerant it is to change.

The City of Melbourne currently manages the population of ageing trees, particularly our Elms, through regular assessments to determine which trees need to be removed, and in turn planning when, and how and with what trees they will be replaced. Managing ageing trees requires careful consideration of some key challenges. Urban tree renewal is now not simply about when to replace old and dying trees, but also why, where, how and what.

- An ageing tree population requires increased resources to manage and sustain. Over time, the environmental value of urban trees diminishes, they become hazardous and dangerous, their environmental values diminish and they become far less cost effective in the landscape. Having a high proportion of over-mature trees in the landscape also carries an element of public risk (and cost) as they become hazardous and therefore must be managed accordingly.

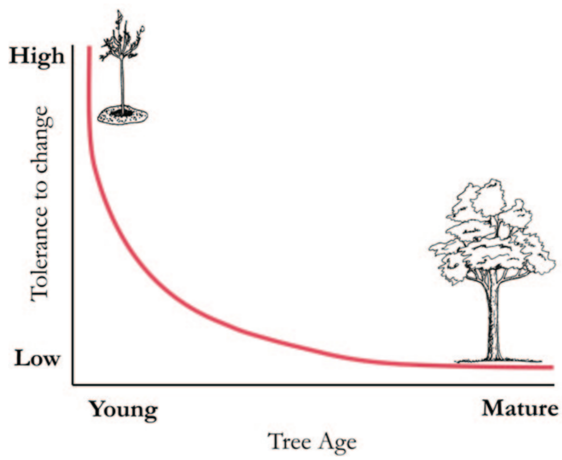


Tree mortality spiral: once a tree is in a declining state of health it has passed the point of return back to good health

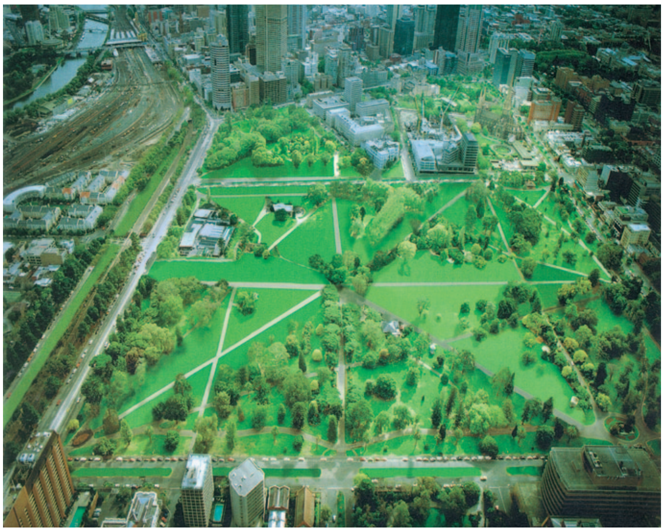
- Boulevards and avenues create wonderful vistas through our main streets and in Melbourne they are largely synonymous with broad-canopied deciduous trees such as Elms and Planes. This raises a critical issue that needs to be carefully managed in consultation with the community. It is essential to recognise that to achieve these wonderful assets, the growth habit of identically aged trees is necessary to maintain the aesthetic consistency of the avenues and boulevards. This poses significant challenges to the community when confronted by trees that will all die – or preferably will be replaced – at the same time.

- St Kilda Road and Royal Parade are examples of this problem in Melbourne. They both require special care and extensive, thoughtful planning for their futures. The Elms are ageing and that the Planes are declining due to water restrictions and increases in extreme heat days. Supported by scientific research, the role of stakeholder/community engagement will be crucial in determining how we manage the loss of these trees and their subsequent replacement.

While the ageing population in some cases suggests subsequent landscape change, opportunities arise for us to now 'retrofit' these landscapes to ensure better conditions for our future trees. Such conditions that require improvement include those below ground (soil structure, ground water, and conflict with underground services) and above ground (access to stormwater, conflict with infrastructure, mulching and potential compaction).



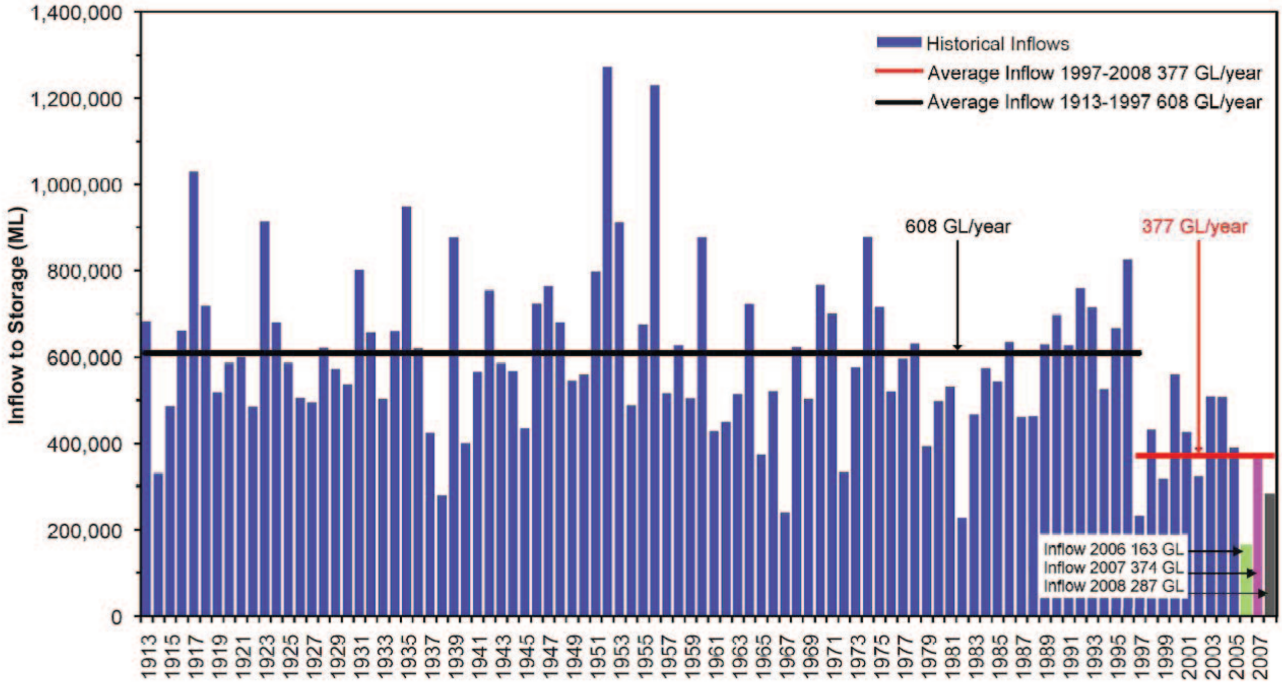
With increasing age, a tree's tolerance to change is greatly reduced

Fitzroy Gardens potential loss of avenues modelling from aerial perspective, showing existing conditions (above left) and potential devastating effect if Elm avenues were lost (above right)


Fitzroy Gardens potential loss of avenues modelling at ground plane, showing existing conditions (above left) and effect if Elm avenues were lost (above right)


Royal Parade potential loss of avenues modelling at ground plane, showing existing conditions (above left) and effect if Elm avenues were lost (above right)



Source: Modified after Augmentation of the Melbourne Water Supply System*, DSE 2008*

4.2 Water

Water is the primary element needed for an urban vegetation growth. The recent extended drought and water restrictions have impacted severely on the health of Melbourne's urban forest. There has been a steep increase in tree mortality due to stress and dieback from lack of water. The useful life expectancy mapping in Section 3.3.2 shows that about 27 per cent of our trees reach the end of their useful lives within a ten year period. Much of this is premature and is due to the longer term effects of low water availability on stressed trees that have been unable to return to a healthy state.

Fundamentally the city has low levels of water permeability. Hard surfaces such as roads, footpaths and roofs expedite stormwater through an extensive drainage system to prevent flooding and direct it into Port Phillip Bay or the Yarra River. While this traditional approach is an innovative way to ensuring the functionality of the city to some extent, it has meant that natural rainfall has limited the opportunity to infiltrate the soil.

With expected long-term low water futures and a desired move away from unreliable and increasingly costly potable water, alternative water sources are needed to ensure healthy vegetation growth. Increased access to soil moisture also enables trees to actively transpire and assist in atmospheric cooling.

Clearly, the amount of stormwater flowing into the rivers and bay provides large potential for capturing, storing and re-using this run-off to meet the water requirements of our healthy future urban forest. This presents us with an array of challenges as well as opportunities:

- Storage of captured stormwater for reuse during periods of demand is challenging in built urban environments, but can be supported by wetlands, below-ground tanks and water sensitive urban design (see further 5.3.4). By using soil as a reservoir to store captured water has multiple benefits in addition to vegetation health, including improvement in stream health, reduced damage to infrastructure from soil movement and decreased flood damage.
- Ensuring thorough wetting of the entire soil profile is critical. Surface irrigation exacerbates the vulnerability of trees in particular by encouraging shallow root systems. Deep wetting of the soil profile encourages deeper root systems better able to access soil moisture throughout low rainfall periods.
- Ensuring our trees are not reliant on potable water – which runs the risk of being restricted when running at low levels – and yet still have access to adequate soil moisture, particularly during periods of low rainfall, is also crucial. We can learn from past practices in irrigation, particularly in parks, where supplemental irrigation via surface watering resulted in the development of shallow rooted, unstable trees wholly reliant on continued superficial irrigation.

Alexandra Avenue and riverfront with healthy tree canopy in Feb 2004

Alexandra Avenue and riverfront with tree canopy in severe state of decline in Feb 2010

4.3 Climate change

The Australian Government's most recent report on climate change, the Critical Decade, states unequivocally that it is now '"beyond doubt"' that climate change is occurring. Whilst the rate of climate change is just becoming discernible now, it will be increasingly prominent in the coming decades. The risks to cities of more severe weather conditions will continue to increase, bringing with them high economic, social and environmental costs. This makes immediate climate change adaptation planning by governments an absolute priority.

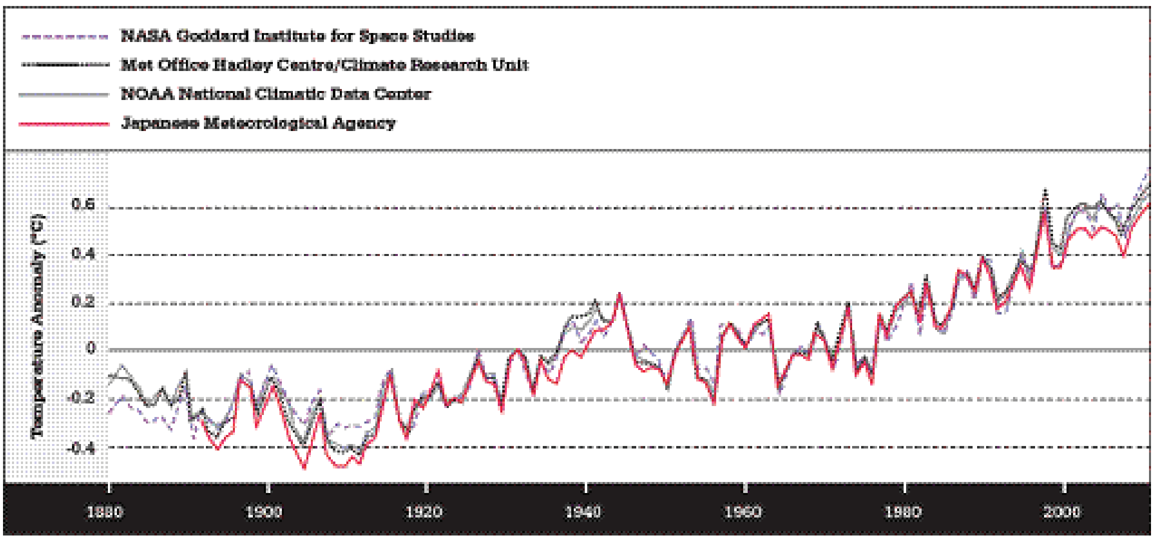
The most widely used indicator of climate change is the global mean, annual average, near-surface air temperature – commonly referred to as the global average temperature. We know that the global average temperature has risen by about 0.17°C over the last three decades. More notably, the global average temperature from 2001-2010 was 0.46°C above the 1961 - 1990 average, making it the warmest decade on record.

The effects of climate change over coming decades will include warmer average temperatures, heatwaves, extreme storm events and lower average annual rainfall. We have already observed the damage and devastation caused by extreme heat and floods in Australia in recent years, and it is likely that these events will become more prevalent.

The Bureau of Meteorology and CSIRO climate change modelling predicts that Melbourne is likely to experience an increase inmore days of extreme heat. The city already experiences on average nine days per annum over 35°C but by 2030 it is predicted this will increase to 11 days, and then increase again to 20 days by 2070.

Projections for future changes in rainfall patterns are uncertain. It is likely that Melbourne will experience increasing extremes of lower average annual rainfall (drought) as well as extreme rainfall events. Rainfall patterns are likely to be more unpredictable, increasing risks of low for water availability during certain periods.

The CSIRO (2010) predicts that current sea levels will increase by 1.1 metres at the end of the century.[2] Inundation modelling shows that while few areas of the city will be vulnerable to permanent inundation at this level of increase, many areas in the municipality will be prone to inundation with the combination of extreme high tides and a 1.1 metre rise in current sea levels.



Source: NASA GISS Surface Temperature Analysis.

Surface air temperature trend from the 1800s to the present. The baseline for the analysis is the 1951-1980 average.

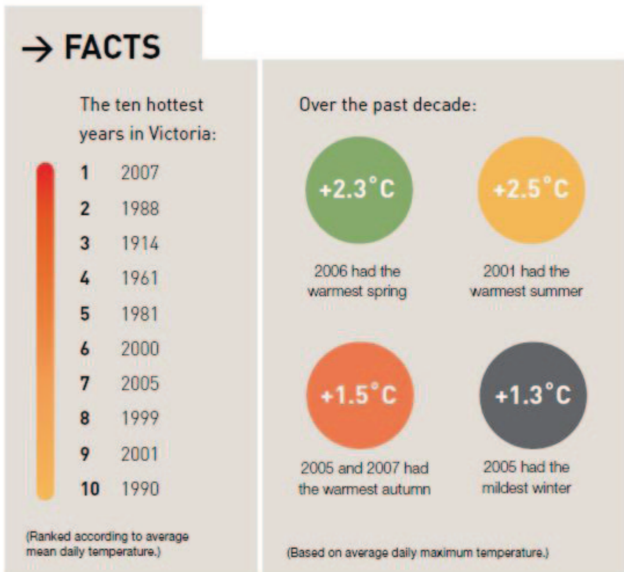
Impacts of climate change on the urban forest will occur in a number of ways:

- The realisation of predicted change will inflict many stresses on our trees. The susceptibility of vegetation to increasing pests and diseases will also challenge its ability to withstand these outbreaks and recover. Changes in climate can affect the life cycles of pest populations. Hotter summer temperatures can increase the development rate and reproductive potential of insect pests, while warmer winters will increase over-winter survival. Many pests and diseases will have extended geographical range as increases in temperature affect flight behaviour and vector spread. This also impacts the geographic distribution of pests and pathogens, which means forests not previously at risk can become vulnerable.[1] Many pests will be able to extend their current geographical range as increases in temperature tend to affect flight behaviour and increase feeding. Recent observations in NSW pine plantations have found that drought-stressed trees are now suffering increased incidence of attack from insect stem borers, bark beetles and fungi.[2]
- Extreme weather events directly impact on vegetation health, generally leading to reduction in canopy cover and overall decline. Heat extremes lead to foliage and trunk scorch and canopy desiccation. Storm events have the ability to shred foliage and uproot trees.
- Lower rainfall will result in increasing frequency of tree death and decline in response to frequent and severe drought.
- Inundation can lead to soil erosion, salinity, tree instability and damage to infrastructure. In southern Australia, increased frequency of extreme wet and dry periods may increase incidence of the root rot pathogen *Phytophthora cinnamomi*. Trees weakened by this disease have a reduced capacity to survive periods of drought.

'The evidence that the Earth's surface is warming rapidly is now exceptionally strong, and beyond doubt. Evidence for changes in other aspects of the climate system is also strengthening. The primary cause of the observed warming and associated changes since the mid-20th century – human emissions of greenhouse gases – is also known with a high level of confidence.'

Climate Variable		Now	Predicted by 2070
IPPCC (2007) Predictions for Melb			Estimate of Change
Temperature	Annual average temperature	Max 18.7°C Min 8.3°C	+2.6°C (1.8 to 3.7°C)
Extreme Temperature	Annual av. no. of hot days (over 35°C)	9 days	20 days (15 to 26 days)
Rainfall	Annual average rainfall	864 mm	-11% (-24% to no change)
	Summer	166 mm	-7% (-31 to +21%)
	Autumn	213 mm	-5% (-24 to +16%)
	Winter	245 mm	-11% (-26 to +4%)
	Spring	152 mm	-21% (-41 to -1%)
Extreme Rainfall	Heavy rainfall intensity (99th percentile)	Not avail.	+5.9% (-24.9 to +48.9%)
Sea Level Rise	Average sea level rise	3.2mm per year	+110cm (CSIRO)

Climate changes predicted in Australia by 2070



The ten hottest years recorded in Victoria

4.4 The urban heat island effect

The urban heat island effect (UHI) is a common phenomenon in cities worldwide that occurs when densely built urban areas become warmer than nearby suburban and regional areas, particularly after dark. After a hot day parts of the city can be four to seven degrees hotter than the surrounding areas. The urban heat island effect is present all year round, but it becomes a problem during the hotter months.

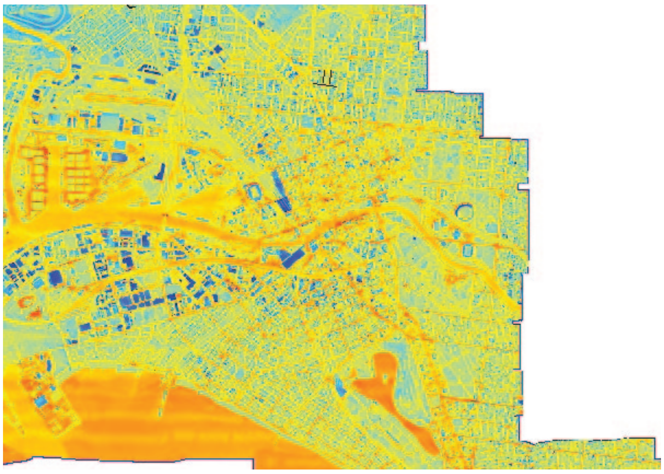
In periods of prolonged heat, the urban heat island effect increases pressure on the city. It also exacerbates the effects of heat stress particularly for vulnerable people, such as the elderly, the very young, and those with pre-existing medical conditions.

Victoria's Chief Health Officer found that the heatwave preceding the Black Saturday fires in 2009 contributed to an increase above normal of 374 people's deaths in inner Melbourne[4] – more than double the number who perished in the fires. Currently heat related deaths in Victoria are greater than the average annual road toll.

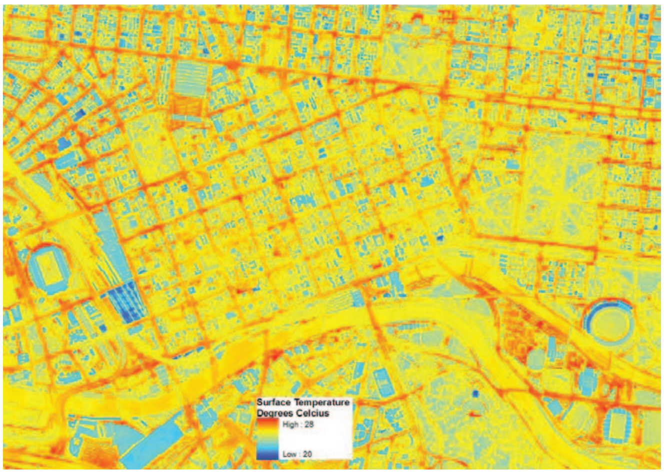
This heat also contributes to the decline of certain tree species. Extreme heat, particularly if combined with low soil moisture, causes the foliage of some trees to scorch, which can lead to decline.

The urban heat island effect has three main causes:

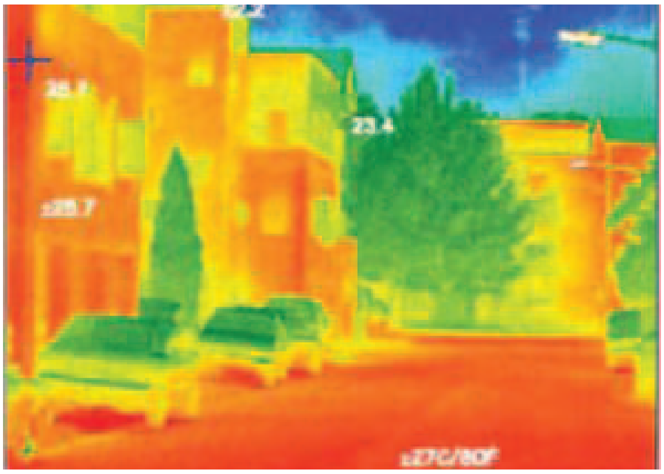
1. **Impervious surfaces:** Most urban development involves removal of vegetation and increase of hard, impervious surfaces such as buildings, roads and footpaths with high heat absorption capabilities. Asphalt and concrete trap and store heat from the sun, while solar radiation is reflected multiple times off building surfaces along street canyons, causing greater absorption of solar energy and a reduction in the reflective power of these surfaces.
2. **Human activity:** The phenomenal increase in motorised transport (people and freight) is a major contributor to increased greenhouse gas emissions. In hot weather, the use of air conditioners also increases, generating more waste heat and putting pressure on the grid which can also lead to blackouts.
3. **Low vegetation coverage:** With less vegetation, cities receive less natural cooling from shade and evapotranspiration through foliage.



Thermal imaging - Melbourne municipality (including section of Port Phillip)



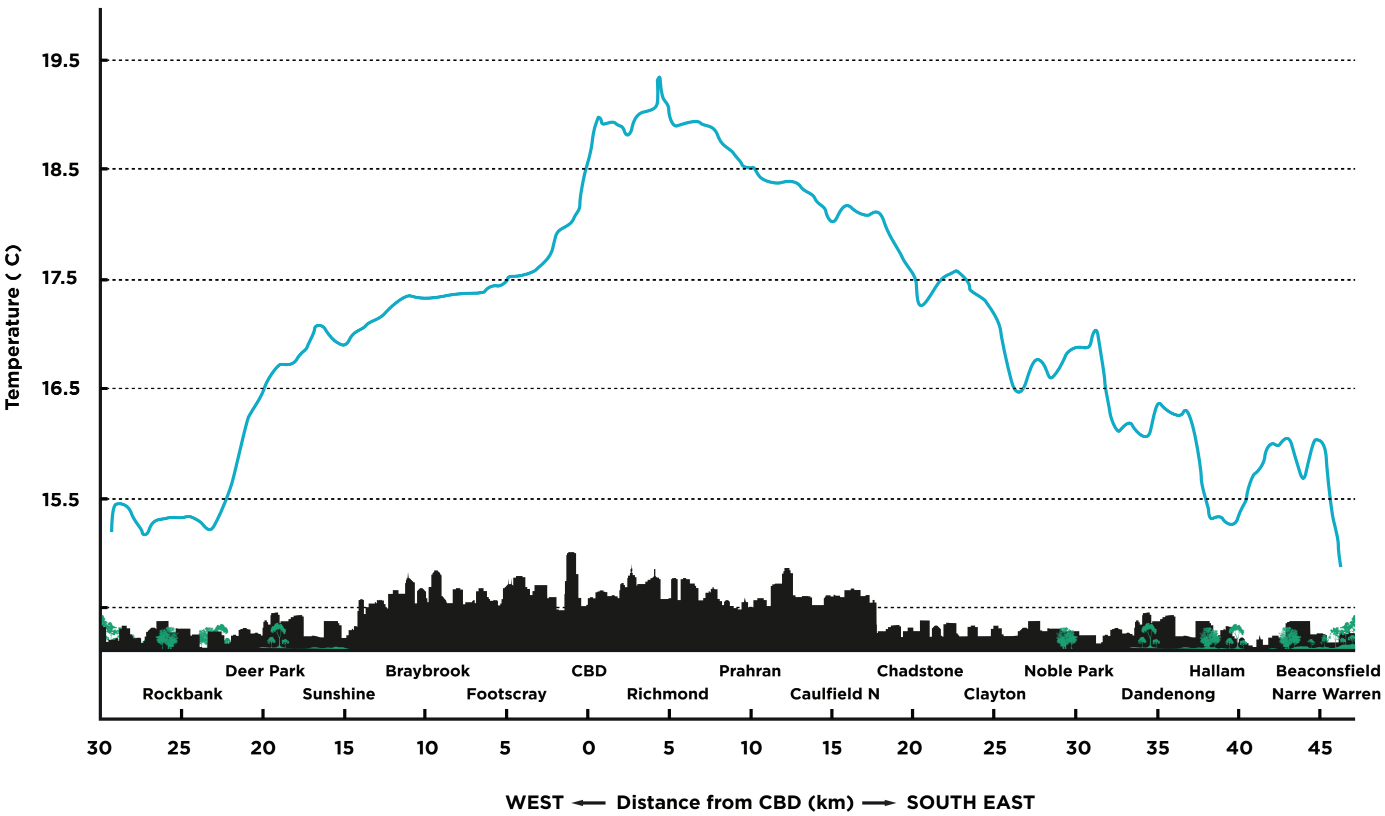
Thermal imaging - Melbourne central city



Example of thermal imaging at streetscape level

Urban forests have proven to be one of the most effective methods for mitigating heat retention in dense urban areas, particularly central business districts, through shading and evapotranspiration. However, there are several challenges we face in tackling the urban heat island. Those challenges are:

- The current urban heat island effect will be exacerbated by the predicted changes in future climate.
- Our existing tree canopy cumulatively covers 22 per cent of public streets and park areas. This means 78 per cent of our public streets and parks are without natural shade.
- It can take up to 20 years for a tree to mature and provide full canopy that will assist effectively in mitigating the urban heat island effect.
- Vegetation cover must be primarily composed of species that are able to withstand and succeed over the hotter conditions.
- Mitigating the urban heat island effect may mean increased water usage during periods of low rainfall to maintain the health of urban forests.



Mapping of the UHI for Melbourne taken in 2009

4.5 Population increase and urban intensification

In 2011, The City of Melbourne's residential population is 93,000. By 2030, it is projected that the population could reach 150,000 people, or potentially as many as 208,000 with the extra capacity available in underutilised parts of the City.

The city's daily population is also growing. There are about 790,000 daily workers and visitors to the Central City with daily visitation expected to exceed one million by 2030. In 2006 there were approximately 74,000 daily tourist visitors to the municipality. By 2020 national and international visitors are expected to increase to around 250,000 visitors daily.[5]

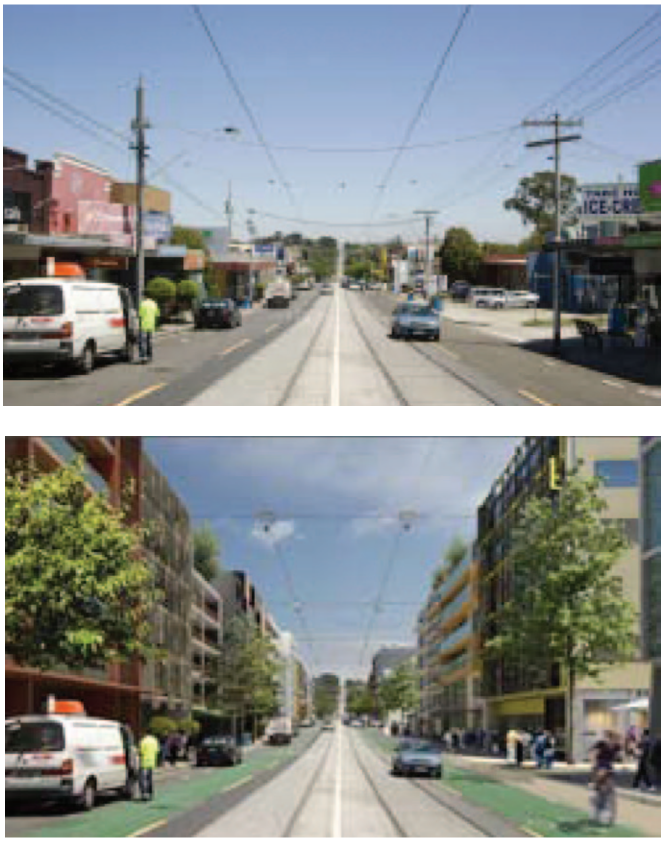
While metropolitan Melbourne has one of the largest per capita ecological footprints in the world – reflecting increasingly unsustainable trends of resources consumption, waste generation and greenhouse gas emissions – the City of Melbourne is one of the most compact, dense and mixed use parts of the metropolitan area, with the richest network of public transport services and generous reservations of public open space. These characteristics have efficiencies that can offer significant potential to drive down per capita energy use for building and transport services, to ultimately make the city more robust against the predicted impacts of climate change, particularly water scarcity and heatwaves.[6]

In meeting the challenge of population increase and urban intensification, we need to acknowledge the following:

- Transforming the urban area will not only involve rebuilding roads, transport networks and services, but will also require rationalisation and better utilisation of existing infrastructure with a strong focus on expanding green infrastructure.
- This will need to be integrated with the application of good urban design principles, such as high quality public realm, clear definition between public and private space, active street frontages, sun and weather protection and, above all, incorporation of green infrastructure.
- Trees and other green infrastructure provide an important *integrative* element, not just acting as a buffer between the established and the developing areas. The urban forest will be central to delivering amenity and ecosystem services, and ensuring that the new growth and development of the city is functionally and visually integrated with the existing neighbouring urban fabric.

The City of Melbourne's Municipal Strategic Statement has established a framework for urban consolidation that will cater for the projected population increase as well as enable the city to transform toward a low carbon future. Large areas of the city that are currently redundant, underutilised or undervalued will be the Urban Renewal Areas subject to greatest intensity of development; areas of Ongoing Change where additional activity and vitality are required will enable ongoing growth on a site by site basis; while the character and identity of the remaining established neighbourhoods or Stable Areas – will be maintained.[7]

Importantly, the stable areas will be protected from high density development and encouraged to become the 'green lungs' of the city through increased street tree plantings, water collection and purification, generating renewable energy and productive gardens.



Sample visualisation showing the integrative role of landscape and the built enviroment in denser urban corridors - existing & future (Source: Transforming Australian Cities: 19)

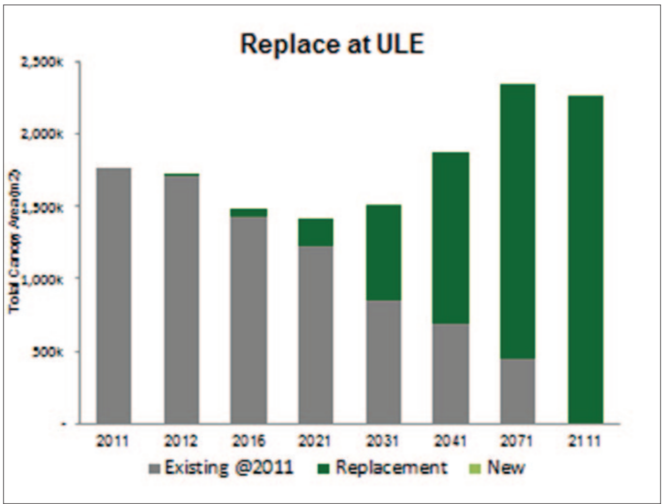
4.6 Towards our Future Forest

How do we then set out to achieve our vision of a healthy, diverse and resilient, urban forest that contributes to the health and wellbeing of our community and to the creation of a liveability of the city?

This strategy sets out the priorities in our strategic thinking to guide all future decisions whilst responding to the three overarching themes of resilient landscapes, community health and wellbeing, values and liveability and sustainability. We have outlined the issues and challenges facing Melbourne that directly affect the Urban Forest allowing space to offer pragmatic solutions.

This strategy is not a short term strategic perspective. To achieve the forest of the future, we must work in tree life cycles, not electoral cycles. The forest of the future requires expert input from multiple disciplines: planning, engineering, urban design, landscape architecture, economics, sustainability and most importantly from the general community. To secure its place in future Melbourne, Melburnians must recognise the importance of and nurture our urban forest.

The community's sense of place and their capacity for change needs to be captured and nurtured to ensure a dynamic approach in managing Melbourne's urban forest.



Temporal mapping of loss and replacement of canopy cover

What tools will we use to measure our future urban forest to ensure we are reaching our vision?

Taking the current composition of Melbourne's urban forest as a baseline, we have established a series of processes and tools for measurement and modelling the future potential of our urban forest:

- On ground field data collections have provided us with a rich source of data relating to our trees and their environment.
- Spatial and temporal mapping using ArcGIS allows us to determine which trees we will lose, where, when and how much tree canopy will diminish.
- Thermal imaging of our city highlights the hot and cool areas of our city which guides our tree planting decision making.
- A detailed urban heat island study has recommended canopy cover levels to mitigate heat retention in the City of Melbourne.
- US based valuation model, i-tree Eco has given us the ability to attribute dollar values to the environmental benefits of our trees.
- Weather stations installed around the city allow us to determine the effects of tree canopy on streetscape thermal comfort levels.
- Tabling of our ULE results and canopy cover has provided the opportunity to determine when and where we can start to plant trees to overcome the inevitable tree loss of canopy cover.

Using this knowledge we are able to benchmark key certain urban forest attributes to make sure we are on track for achieving our great vision.

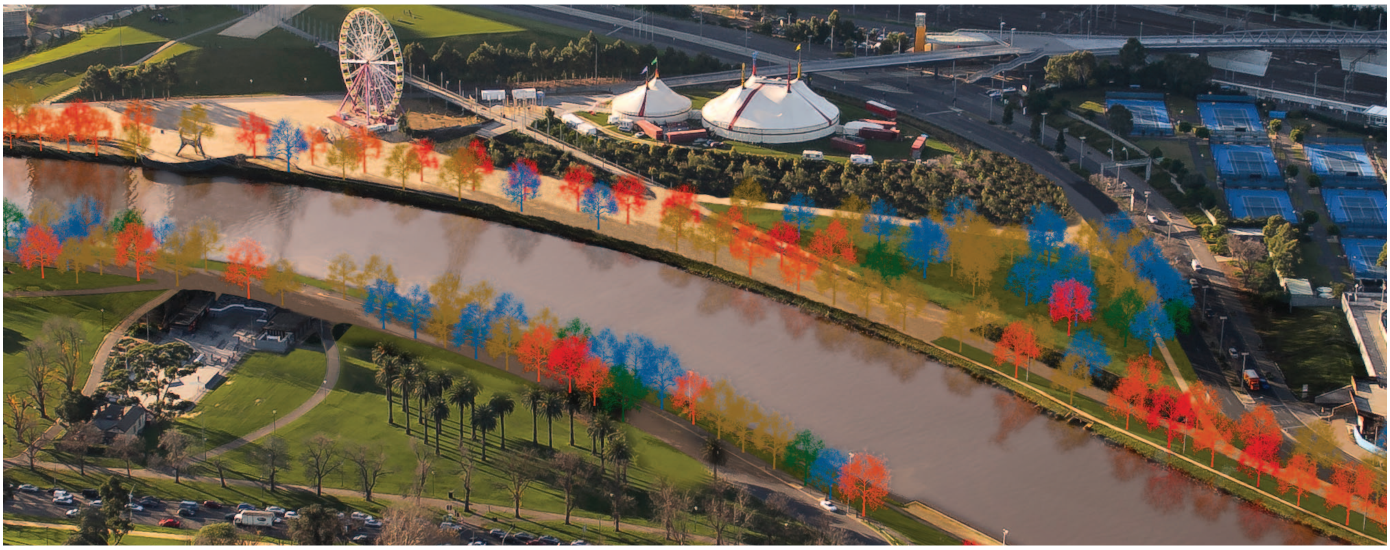
(Endnotes)

3 Old and Stone, 2005

5 Existing and projected figures from MSS:2-3

6 MSS:4

7 MSS:6; TAC:13



Existing conditions at Birrarung Marr and Yarra River southern bank showing existing ULE through colour coding (Colour representation shows: Red 0-5 years ULE; Orange 5-10 years ULE; Blue 10-20 years ULE; Green 20+ years ULE)

Modelling of Birrarung Marr and river bank in next 11-20+ years without replacement planting

Modelling of Birrarung Marr where successional planting has been undertaking over the next 11-20+ years

The above series of images clearly illustrate the importance of successional planing to compensate for the future loss of trees

5 Principles & Strategies

The City of Melbourne's urban forest will be resilient, healthy and diverse. It will contribute to the health and wellbeing of our community and to the creation of a liveable city.

5.1 Our priorities

The challenges facing Melbourne's urban forest provide the City of Melbourne and its many diverse communities with a unique opportunity to genuinely connect with our urban forest.

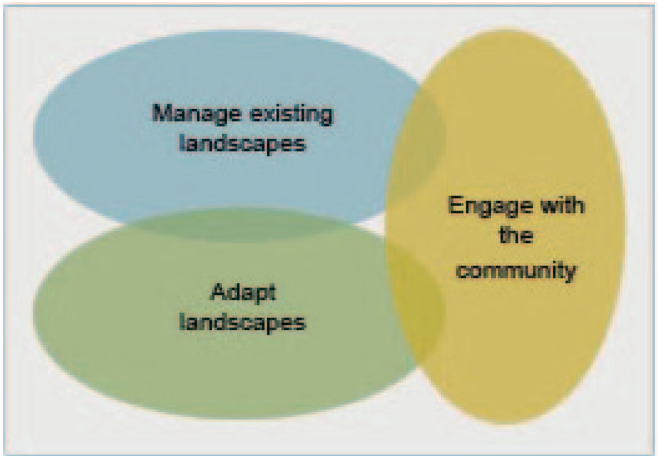
The City of Melbourne has a leading role to play in encouraging other councils, development agencies and landholders to enhance the city's urban forest. The principles and actions developed through this strategy have the capacity to be used and adapted across Melbourne, thereby reinforcing Greater Melbourne's urban forest.

Our community also has an important role to play in building a more resilient urban landscape through their actions and decisions at home, in their own gardens. Private green spaces across Melbourne are an important component of our urban ecology that contribute to neighbourhood wellbeing, connectedness to nature and biodiversity, and help our city adapt to changing climates. These private urban forests also need nurturing and growth.

Given the impact of the diminishing water supply for Melbourne's urban forest and the fact that many of the city's mature trees are ageing or in decline, the next ten years will be critical for how we adapt the landscape to make it more suited to Melbourne's future needs, and more resilient to the anticipated impacts of climate change and population and urban growth generally.

Vegetation is one of the key components of urban ecosystems. Various indicators highlight the relative health of cities such as biodiversity levels, vegetation species diversity, soil moisture levels, and air and water pollution levels. Setting achievable benchmarks for these components will ensure we stay on track to achieving our vision.

Before we quantify these benchmarks, we need to establish principles which will guide our decision making. These principles respond directly to the challenges and opportunities that face our urban forest when we consider to the need to manage our existing landscapes, adapt new landscapes and involve and engage with the community.



Three interrelated themes define our main priorities for the planning and management of our urban forest

5.2 Principles

The City of Melbourne will ensure that the planning, design and ongoing management of the urban forest will reflect the following principles:

To mitigate and adapt to climate change

Build a resilient urban forest that can tolerate and continue to thrive in future climatic extremes

Ensure a diversity of tree species and ages to maximise resilience against pests and diseases

Increase overall vegetation biomass to assist in storage and sequestration of carbon

To reduce the urban heat island effect

Build a functioning healthy urban forest canopy to provide shade and cooling to reduce heat absorption and emission by the built environment

Develop public spaces to improve human thermal comfort and maximise health benefits

Capture more stormwater to increase filtration into the soil and enable maximum evapotranspiration

To become a Water Sensitive City

Promote use of innovative techniques for Water Sensitive Urban Design, such as rain gardens, bioswales, underground storage reservoirs and biofilters

Use alternative water sources for irrigation to reduce potable water use

Ease stormwater flows and peaks by replacing impervious surfaces with porous materials to reduce heat absorption and encourage soil moisture retention

To design for health and wellbeing

Provide cool shaded spaces in summer; sunlight access in winter

Plan and manage the urban forest to ensure longevity of green spaces for future generations

Create well-designed public spaces to encourage outdoor activity, social connectedness, respite, exercise and general sense of wellbeing

Design for Liveability and Cultural Integrity

Design landscapes to reflect the cultural integrity, identity and character of Melbourne

Lead by example in the creation of world class spaces, parks and streetscapes

Design spaces for people to reconnect with nature

Design spaces that create a sense of place and enable reflection and tranquility

To create healthier ecosystems

Support healthy ecosystems in order to provide maximum benefits in terms of clean air, water and soils

Expand and improve biological and structural diversity

To position Melbourne as a leader in urban forestry

Create world class open spaces, parks and streetscapes

Increase Australian-based urban forestry research

Inform and involve the community in decision-making for landscape adaptation and change

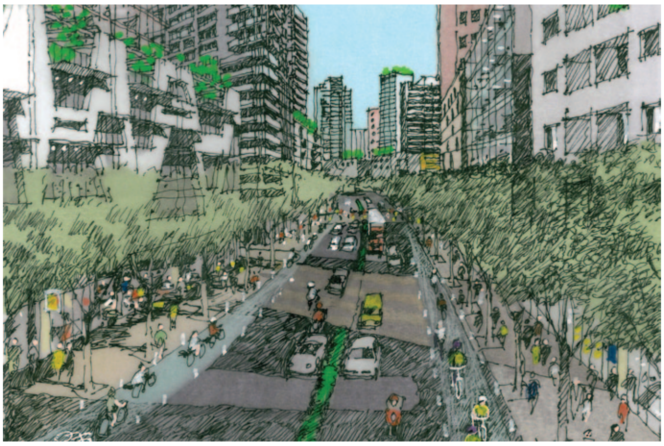
Increase the public profile and understanding of the attributes, role and benefits of the urban forest

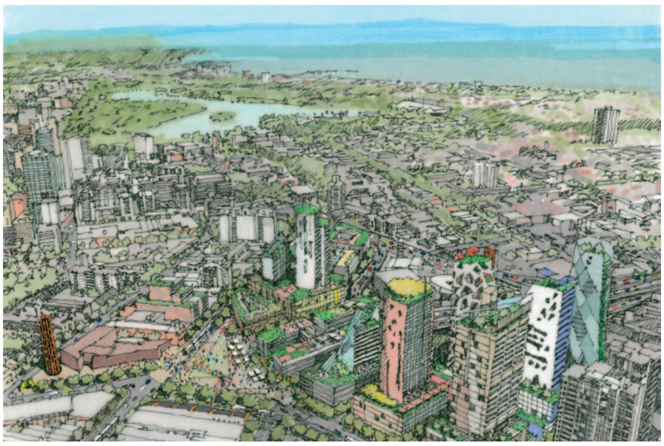
5.3 Strategies

To achieve our vision by 2032 and beyond of a healthy and resilient urban forest that contributes to the health and wellbeing of our communities and to a liveable city, we need to create better urban environments for everyone. Our guiding principles defined above highlight the importance of a well-designed city, and the following strategies list how we go about creating these 'living spaces'.

Each of these strategies have action plans to demonstrate how we will implement specific targets:

- increase canopy cover
- increase urban forest diversity
- improve vegetation health
- improve soil moisture and water quality
- improve biodiversity
- inform and consult the community.





Visualisations showing the potential impact of increasing tree canopy cover and structural diversity of the urban forest in Southbank - City Road and Southbank generally - existing & future (Source: Southbank Structure Plan)

5.3.1 Increase canopy cover

Canopy cover is the key criteria from which we measure the urban forest's ability to produce benefits for the community and the environment. Large canopied trees provide greater environmental and health benefits than smaller canopies and, depending on the scale, a large tree can provide up to 75 per cent greater benefits.

Increasing the number of trees within our municipality is important, however we must plan properly to achieve the greatest environmental and health benefits. It is more important to monitor and improve the extent of canopy cover across the municipality instead of simply benchmarking the total number of trees. Analysis of aerial imagery combined with canopy cover modelling suggests that the municipality can accommodate a significant increase in canopy cover. 80 per cent of the City of Melbourne's public space is in streetscapes providing the best opportunities for increasing canopy cover.

An independent study conducted by consultants GHD on the Urban Heat Island effect in Melbourne, recommended that one of the most cost efficient and yet effective mitigation strategies is to ensure a minimum canopy cover of 30 per cent with a leaf area index (a measure of shade density) of 5.3 within the municipality.

Thermal images taken of the city (refer Section 4.4) identify particular areas of the City that absorb more heat than others and highlight the cooling effect that canopy cover and green spaces has. This mapping also locates areas, coloured red, that are a high priority for increasing canopy cover.

The City of Melbourne along with Monash University is monitoring the microclimatic conditions at streetscape level underneath different tree canopy configurations. Weather stations have been installed in Bourke Street in the CBD, and Gipps and George Streets, East Melbourne. Data from these stations highlights the temperature differentials between canopy shaded and open streetscapes. When this data is used in conjunction with the thermal image, it provides the opportunity for increasing canopy cover to provide thermal comfort to people during periods of heat. This data also provides guidance around spatial patterns of canopy distribution.

The private realm occupies 68 per cent of the area of the municipality and therefore has the capacity to contribute significantly to the canopy of the urban forest. Accurate data for percentage canopy cover in the private realm is currently not available, however a study conducted by three Melbourne councils suggests that private realm trees have reduced in number

Map showing the municipality's current canopy cover

Diagram showing how placement of three large trees with appropriate growing conditions can increase canopy cover in a streetscape while minimising conflicts with infrastructure, buildings and pedestrian spaces

A newly planted Agathis robusta (Queensland Kauri) avenue in Fitzroy Gardens considerably since the 1970s. This reduction is due largely to infill development, competing land uses and increases in prices of land.Protection and enhancement of the private realm vegetation is therefore an important component of the Urban Forest Strategy.

Modelling for the development of linear transport corridors into medium-rise high density routes demonstrates that development pressure can be alleviated on the surrounding suburbs. These areas may in turn act as the green wedges for intensified greening, both in streetscapes and in private gardens. Above all, increasing canopy in these areas will have the greatest benefit in planning a healthy city (see further Section 4.5).

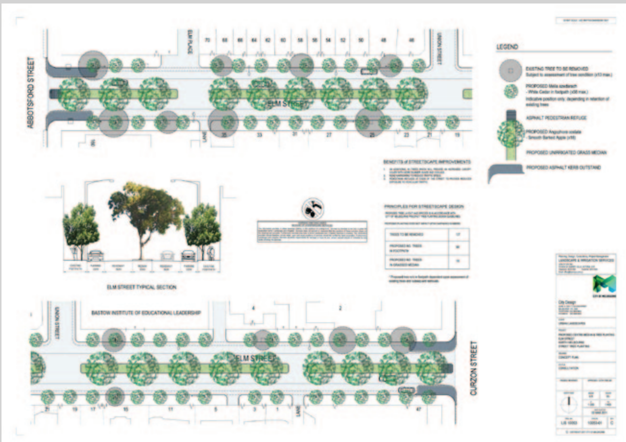
Target: City of Melbourne's Canopy Cover will be 40 per cent by 2040.

Actions:

- Conduct a thorough spatial analysis to identify areas of low canopy and include the selected areas in planting schedules for the next twenty years.
- Provide best planting conditions possible for newly planted trees to ensure maximum canopy potential, including below ground spaces and water.
- Select the most appropriate vegetation type and species for each location given spatial and climatic constraints and neighbourhood character.
- Ensure that the overall urban design for places ensures that spaces and streets are best designed for our urban forest and for people.
- Review and update Council's Tree Precinct Plans which detail the locations for increasing canopy cover.
- Increase canopy cover where possible in the private realm.
- Ensure that management regimes over the urban forest are adaptive to reflect its dynamic nature.

Increasing Canopy Cover in residential streets – Elm Street, North Melbourne

Identification of new opportunities for tree plantings is central to increasing canopy cover throughout the municipality. In precincts such as North and West Melbourne with a 20 per cent canopy cover, streets are a priority for strategic tree planting.



A project in Elm Street, North Melbourne, completed in 2011, will increase canopy cover from 18 to 65 per cent. This has been achieved through the creation of a new central median, providing an opportunity for 13 large canopy trees to be planted. This, combined with 26 smaller trees in the footpath, will within 20 years decrease summer temperatures in the streetscape by 3-4 degrees Celsius, compared to a non-treed street.

Extensive community consultation with residents and residents' association contributed to a successful outcome, and notably there was majority support for this project by demonstrating that increased tree planting would not impair the integrity or functionality of the street.

5.3.2 Increase urban forest diversity

Much of the vulnerability of our urban forest can be attributable to a lack in diversity of plant species and ages (see Section 4.0). Accordingly, a greater range of species with varied life expectancy provides greater resilience to pests and diseases, reduces the risk of trees ageing at the same time, and supports biodiversity and healthy habitats.

When managing financial assets, diversification within asset classes is a well cited rule for reducing vulnerability and risk. The same principle applies within our Urban Forest. A diverse urban forest constitutes many plant species with varying life expectancies, growth rates and growing conditions. In the natural landscape, a diverse ecosystem inclusive of water, soil, groundcovers, shrubs, tree roots, trunks, branches and canopies is fully functional and provides the best possible array of benefits. Structural diversity in the urban landscape includes these different vegetation strata, as well as avenues in parks, street trees, green walls, and green roofs and balconies.

Every plant has its own benefits: large deciduous trees provide summer shade and allow the winter sunlight to penetrate buildings and streets; native trees (including deadwood) promote biodiversity and habitat; smaller trees can be planted in areas that are not able to accommodate larger trees; climbers can cover walls for shading and protection; and green roofs reduce stormwater flows and improve insulation. The interactions between these various layers of the urban forest provide an opportunity for everyone to connect to nature, and for the different forms of green infrastructure to integrate and thereby increase the impact of their ecosystem services.

What we choose to plant now must have a proven ability to remain resilient in hotter, drier conditions, and potentially also cope with major storm events. Diversifying the urban forest lowers the risk of incurring significant loss in any one particular individual or range of species.

Target: The City of Melbourne urban forest population will be composed of no more than 5 per cent of one tree species, no more than 10 per cent of one genus and no more than 20 per cent of any one family.

Actions:

- Follow planting targets set out in the Urban Forest Diversity Guidelines.
- Undertake regular plantings across the municipality until 2040 to reduce the risk of similar aged trees dying at the same time.
- Map out planting schedules for each precinct to ensure spread of tree age and species as part of the Tree Precinct Plan reviews.
- Monitor, treat and evaluate pest and disease attacks as part of the maintenance program.
- Utilise a scientifically-based tree selection matrix when planting in different street and park typologies.

New plantings of Eucalypts, Cycads and a range of shrubs and groundcovers in Birrarung Marr - middle terrace

Five rows of newly established Lemon Scented Gums to replace the unsuccessful Poplars along Birdwood Avenue

- Conduct a full review of Melbourne's Elm population determining best locations throughout the city in which to house no more than 5 per cent of the total population.
- Enhance structural diversity in our urban forest through green walls, green roofs and green laneways and encourage design, funding and implementation where possible.

Vulnerability and species in New York's urban forest

New York's Urban Forest consists of 5.2 million trees, including 592,000 street trees. The street trees alone have an asset value of $2.3 billion and an average replacement value of $3,938 per tree.

In 1995 New York recognised that limited species diversity exposed the urban forest to catastrophic loss from extreme weather events, pests and diseases. London Plane, Norway Maple and Callery Pear comprised nearly 39 per cent of the street tree population with, for example, 44 per cent of all trees vulnerable to the Asian Long-Horned Beetle.

Active diversification over the past 16 years through the Million Trees NYC program has seen an increased range of species planted in place of the dominant species. This has been successful in decreasing Norway Maples comprising 23 per cent of street trees to 13 per cent.

Mountain Pine Beetle decimates Canadian forests

The Mountain Pine Beetle (Dendroctonus ponderosae) is a tiny insect that bores into pine trees such as Scots Pine, Ponderosa Pine, Lodgepole Pine and Limber Pine. An infestation of these beetles generally kills a tree within a two week period.

In British Colombia, where Pines constitute 80 per cent of Canada's native forest, these beetles pose a severe threat. In the past, their threat has been eliminated through the freezing winters. The beetles cannot survive night time temperatures below -40 degrees Celsius or average day time temperature of -32 degrees Celsius.

However recent summers in Canada have been longer than usual, which has facilitated an outburst of the beetle population. Whilst the winters of 2008 and 2009 were colder than years before, these winters still didn't reach the critical temperature thresholds needed to eradicate the beetle. Consequently, the destruction of Canada's native forests has been brutal, with 60 per cent wiped out. The effects have been modelled by ecologists and scientists and the predictions are poor. Whilst this case study showcases native forests, it is also a lesson for urban forests: diversify the structure and species, and monitor all pest and disease invasions.

5.3.3 Improve vegetation health

To maximise the ecosystem services and community health and financial benefits that our urban forest provides, it is imperative to ensure our trees are healthy. Safeguarding our urban forest against extreme weather events such as drought, heat or flooding is vital for long-term forest health, particularly for our ageing significant trees (see Section 4.3). Integral to tree planning is to ensure that the most appropriate species is selected for each specific location, stock quality assurance checks are made, and best practice planting procedures are in place.

Tree planting in the City of Melbourne is followed by a two year maintenance program for newly planted trees. During this period it is vital to monitor stress and/or pest and disease attacks. Throughout the lifecycle of each of our trees, annual analyses are carried out to ensure that data collection supports their ongoing health and longevity. Maintenance of our tree database regarding tree health, dieback, symptoms of stress, and pest and disease movements will highlight vulnerabilities and ensure refinement of management programs.

Given the current vulnerability of our urban forest and relatively poor tree health affecting a substantial number of our trees, replacement of the impending loss while simultaneously increasing canopy presents many challenges. The urban environment is highly modified which means conditions for plant growth are harsher than those conditions found in a natural landscapes. It is therefore necessary that species selected for planting throughout the municipality are adaptable to current urban conditions as well as future urban conditions which are likely to be even harsher in a changed climate. As a matter of urgency, we have already implemented improved irrigation regimes, more frequent health assessments, removal of dying and dead trees, and continuous replacement with healthy stock.

Target: 90 per cent of the City of Melbourne's tree population will be healthy by 2040.

Actions:

- Undertake annual health checks for every tree within the municipality.
- Reduce the number of stressed trees through regular watering, mulching and other cultural treatments, particularly over the summer periods.
- Choose species that are robust and likely to cope with future climate changes and urbanisation.
- Implement best practice soil preparation before each planting.
- Ensure the water needs of all vegetation are met, particularly during summer.
- Minimise infrastructure conflicts.
- Create median strips in residential streets where possible to allow for space for larger healthier trees to grow.
- Remove asphalt and concrete where possible and replace with pervious surfaces to encourage healthy root growth for larger trees.

Healthy Golden Elms in King's Domain

Figs providing a healthy canopy cover for wind protection and shading at Yarra's Edge

Case study:

Street Tree Evaluation Project, Ohio.

In 1971, the Ohio Department of Natural Resources initiated a project that assessed the long term performance of 53 tree species in five Ohio cities. The comprehensive study, entitled 'Street Tree Evaluation Project' or STEP, was developed as a tool to assist in the planning and management of appropriate tree species in the variety of urban environmental conditions found across the state. At its onset, the trees were assessed for health and growth characteristics and the locations and photographs of each tree were documented.

In 1997, the potential values of the STEP project, established more than two decades before, were realised. Now, every ten years, survival data, tree measurements, and specific information on tree height, girth, and spread, along with a current photograph are collected. The information gathered has been able to inform urban forest planning and management by identifying optimal species to achieve various goals in various locations. Additionally, the four decades of documented change illustrates how different species have, over time, greatly affected the character of the individual streets.

The knowledge gained by such long term studies, and the ongoing attention and care given to the established and mature trees in these cities mean that the appearance, resilience and other important ecosystem services of the urban forest can be optimised.

5.3.4 Improve soil moisture and water quality

Cities have become experts in expediting stormwater away to prevent flooding. In Melbourne, we have paved over creeks and streams, diverted rivers, and installed millions of kilometres of pipelines to ensure that stormwater is diverted directly into Port Phillip Bay. This increase in impervious surfaces across the city has consequences for depleting soil moisture, irrespective of the amount of current rainfall (or drought as the case may be), simply due to the inability of water to reach and permeate the soil. Trees will seek out water wherever possible, penetrating deep into the groundwater if they need to, thereby also slowly also reducing groundwater levels.

Ironically, while the traditional engineering solutions for water capture and discharge are efficient, extreme weather events have still proven that certain areas throughout the city, including the central city, are still prone to heavy inundation during major storm events.

Introducing measures to capture and retain stormwater in the soil, and to increase water availability for tree roots, will allow water to filtrate back naturally into the soil in readiness for periods of low rainfall. The higher the level of moisture in the soil, the more trees are able to transpire at maximum efficiency, allowing for cooling of the urban environment and combating the urban heat island effect.

Trees have the added benefit of collecting phosphorus, nitrogen and heavy metals from our stormwater through their root systems, lowering the levels of stormwater pollution.

Traditionally, surface irrigation has been employed throughout most of our parks and gardens and has been regarded as a temporary response to minimise tree mortality during summer. However this merely has encouraged trees to develop superficial root systems close to the soil surface and does little to recharge groundwater resources.

A range of innovative tools is required to aid in increasing permeability of our urban soil structure: to recharge groundwater; to reduce the amount of stormwater flowing into waterways; and to improve water quality. This will directly contribute to tree health, ensuring that they provide the maximum benefits to support healthy landscapes and communities.

There are a range of Water Sensitive Urban Design (WSUD) measures that are being implemented throughout Australian cities and towns. These techniques include: roadside tree pits and bioswales, stormwater capture and storage systems beneath parks and streets, rain gardens and permeable paving. Implementation of these measures is generally adaptable to different locations and budgets. However it is fair to say that most landscape typologies, whether streets, laneways, parks, median strips, boulevards or individual trees, provide an opportunity for water sensitive design.

Examples of WSUD tree pits in the central city and South Yarra allowing stormwater to increase soil moisture levgels in tree root zones

Open water storage and purification at Trin Warren Tam-boore in Royal Park, with enhanced ecological and habitat value

Target: Soil moisture levels will be maintained at levels to provide healthy growth of vegetation.

Actions:

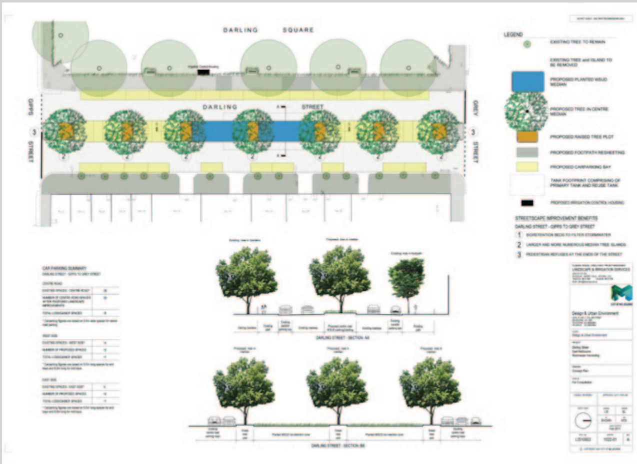
- Action the works detailed in Total Watermark, encouraging Melbourne to become a water sensitive city.
- Incorporate and expand water sensitive urban design (WSUD) measures, wherever possible.
- Alter irrigation regimes to ensure available water content of soils in irrigated landscapes does not fall below 50 per cent during vegetation growing seasons.
- Improve soil structures to allow for oxygenation and water movement for the benefit of tree roots.
- Replace asphalt and concrete with porous surfaces such as porous asphalt, turf, garden beds and rain gardens to reduce heat retention and encourage soil moisture retention.
- Seek alternative water sources for all major parks and gardens and treed boulevards, avenues, roads and streets.

Darling Street, East Melbourne

The stormwater harvesting project in Darling Street East Melbourne is a prototype for in-road stormwater capture and re-use. Completed in 2011 this system has been designed to capture and treat stormwater from surrounding streets to irrigate Darling Square, Powlett Reserve and median strips with trees in Grey, Simpson, Powlett and Albert Streets.

This system has the potential to harvest an estimated 24 million litres of stormwater each year, which is the equivalent of saving more than 18 Olympic swimming pools worth of water annually.

As well as capturing water for irrigation, this system prevents gross pollutants such as soil, silt. clay and litter, and can aid in reduction of local flooding. With funding from the Victorian Government and Melbourne Water, the system is being monitored to measure its ongoing success.

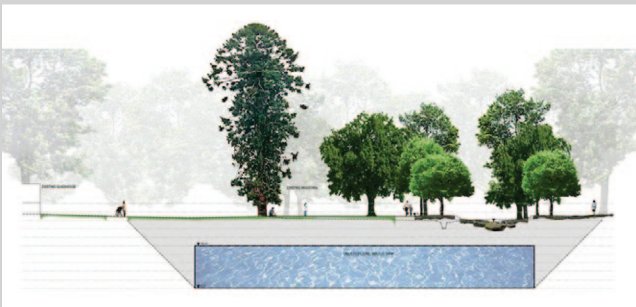


Fitzroy Gardens

The Fitzroy Gardens stormwater harvesting project will divert 69 mega litres per annum of stormwater.

The treated stormwater will be stored in a 5 mega litre tank beneath the gardens and will supply fit-for-purpose water through the existing irrigation system to the Victorian Heritage listed Fitzroy Gardens and nearby Treasury Gardens. Drawing on a 67 hectare urban stormwater catchment, the project will remove gross pollutants and high nutrient levels from stormwater through a bio-retention basin. This will have significant positive outcomes on the health of the Yarra River.

Scheduled for completion in 2013 the project is funded under the Federal Government's Water for the Future initiative. It will be one of the largest water projects ever undertaken by the City of Melbourne and is part of a suite of initiatives being undertaken across the city.



5.3.5 Improve biodiversity

Over 40 per cent of nationally listed threatened ecological communities in Australia occur in urban areas. Loss of natural habitat, urbanisation, and air and water pollution have all impacted upon the survival of plant and animal species. A 2009 VEAC study showcased ten major threats to biodiversity in Melbourne including: fragmented landscapes, connectivity loss due to major roads, urban pollution, human impacts (e.g. rubbish and trampling), predation from cats and dogs, and competition from other introduced species.[3] With the potential expansion of urban growth into brown and green field sites, the potential loss of biodiversity from these threats becomes even greater, highlighting the need to seriously regard biodiversity in our city.

In terms of biodiversity in the urban landscape, we recognise that cities and biodiversity have often been mutually exclusive however research continues to demonstrate that urban areas can provide large opportunities for protecting and enhancing vulnerable species. Public parks and gardens, golf courses, remnant vegetation and private property gardens are capable of providing habitat for certain species.

This is not to underestimate the impact that urbanisation has had on biodiversity. Our imperative is to ensure protection and enhancement of vulnerable species. Whilst certain species (e.g. Eastern Quoll) face severe loss or even extinction due to loss of habitat, others (e.g. Brush Tail Possum) have adapted all too well to urbanisation, to the extent of becoming overpopulated in many inner area parks.

As identified previously in Section 3.3.2 biodiversity in the City of Melbourne includes a wide range of wildlife species. The urban forest plays a crucial role in providing habitat, food and protection to wildlife as equally as it provides a diversity of plant species throughout the municipality.

In summary, healthy trees supported by adequate soil moisture and structural and biological diversity collectively contribute to healthy ecosystems. Taking all these factors into consideration is essential for setting and achieving our benchmarks and goals.

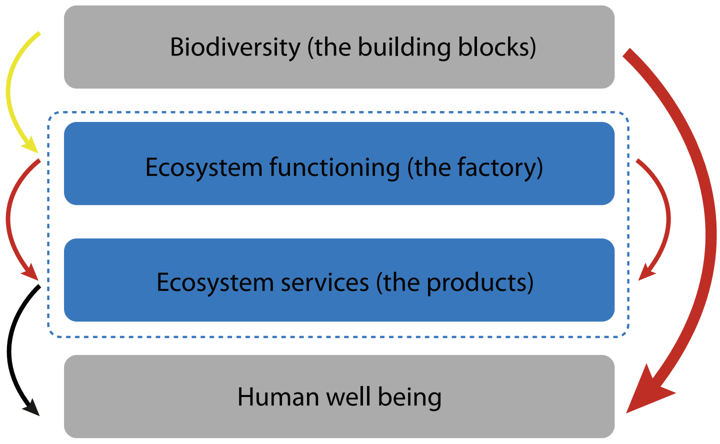
Target: Melbourne's green spaces will protect and enhance a level of biodiversity which contributes to the delivery of ecosystem services.

Actions:

- Review City of Melbourne's Biodiversity Action Plan and conduct an opportunity assessment.
- Integrate biodiversity values into the planning of parks, green spaces, precinct and waterways through Master Plans, Structure Plans, Precinct Plans and the Total Watermark–City as a Catchment Review.
- Increase the diversity of tree species amongst the tree population to provide diversity of food sources, protection and habitat
- Utilise water sensitive urban design to encourage biodiversity in our soils through the improvement of groundwater levels.

Providing a diverse range of species and combining all vegetation strata (trees, shrubs & groundovers) in the landscape improves habitat value for plants and wildlife

- Provide habitat through dead trees where possible, ensuring health and safety for everyone.
- Maintain ongoing relationships with key research institutes such as ARCUE (University of Melbourne)[4] and CSIRO Ecosystem Sciences.
- Develop programs to encourage the interaction between people and nature and to raise awareness.
- Enhance ecological connectivity through the provision of urban forest corridors along streetscapes between our green spaces.
- Develop productive urban landscapes – where possible in the public realm, but primarily through encouragement and incentives for private realm gardens.



Improving urban biodiversity – Adelaide

Adelaide's Urban Forest Biodiversity Program attempts to redress the loss of biodiversity across Adelaide. It has been delivered alongside two other programs: the Million Trees program and Backyards 4 Wildlife. Each program is aimed at improving the amount and type of vegetation across the city in both the public and private realms to provide more habitat, food and protection for Adelaide's native wildlife.

A study of Adelaide's biodiversity has found that only 12 per cent of the area's original vegetation remains which is recognised in being a contributor to the severe decline in native fauna and flora. The Government of South Australia has responded along with the Federal Government to improve the biological diversity of the city, recognising that biodiversity conservation is crucial in ensuring a healthy and sustainable local environment for future generations.

Four key actions were taken by the SA Government to kick start this initiative:

- A spatial analysis identified areas of high conservation significance.
- Implementation of on ground restoration projects.
- Provision of education, training and resources for everyone to improve biodiversity.
- Raising awareness about the importance of biodiversity.

There are currently around 14 projects taking place throughout Adelaide enhancing parks, waterways and corridors for biodiversity.

5.3.6 Inform and consult with the wider community

The urban forest influences everyone in the community. Engaging people throughout the City of Melbourne and wider community involves not only informing them about the importance and multiple benefits of green infrastructure, but also highlighting the role it plays in ensuring Melbourne's liveability, sustainability and support of cultural identity.

The success of an urban forestry program does not hinge only on the contributions of the Council or a small group of professionals trained in this field. It requires the commitment of the citizens and local businesses who represent the community to be involved at different levels, all of whom bring something vital to the process.

Community support for the urban forest in the public realm can include: tree-related advocacy groups and trusts; other organisations or associations that lobby for more street trees and greenery in their neighbourhoods; and still others who demand open space and tree protection through better planning, new regulations, and public acquisition. They often provide the 'glue' to link open space networks within larger metropolitan areas, and can provide the political backbone behind municipal efforts to sustain public investment in green infrastructure and the urban forest.[5]

On a larger scale, business-driven civic leadership can incorporate urban forestry visibly into much broader planning initiatives and thus build its legitimacy as a public policy issue. Similarly, educational institutions at all levels should be involved in any long-term communications strategy for urban forestry.[6]

What we aim to achieve is for our urban landscape to be considered through conversations about the urban forest to inform 'narratives' about how Melbourne's cultural identity can be enhanced through revisioning, redesign and ultimately replanting. For example: Can we link Melbourne's increasing diversification of its landscapes to its multicultural plurality?[7] The narratives should open the space for the community to connect with our urban forest, to find their sense of place whether reflective or spiritual, to allow the community to nurture and love our urban forest.

The City of Melbourne will be a strong advocate for the benefits of a healthy urban forest and continue through various media to seek the views of the wider community about how to protect, manage and enhance our urban forest asset for future generations. We will continue to build ongoing research and measurement into management innovations, and above all allow the local community to have their say in the way our landscapes are planned, designed and managed into the future.

Target: The community will have a broader understanding of the importance of our urban forest, increase their connection to it and engage with its process of evolution.

Actions:

- Enable the community to have a say in the design of landscapes of the future.
- Use innovative tools to engage and involve with this strategy.
- Encourage diverse conversations about the urban forest.
- Direct the emergence of urban forestry as an essential planning discipline.
- Align with other local municipalities to enhance the whole Melbourne urban forest.
- Encourage and support further research into Australian urban forestry.
- Create opportunities and co-benefits of producing this strategy: align with other strategies to ensure greater impact, increase field of research, and develop relationships with private landholders.
- Work with the traditional owner groups within the City of Melbourne to develop community programs that increase community knowledge of the cultural significance of treed landscapes in our environment.
- Develop health and wellbeing indicators to benchmark the role of our urban forests in contributing to human health.

Planting days, such as this at Royal Park, provide an opportunity for our community to be directly involved in the establishment and ongoing management of the urban forest

Melbourne Urban Forest Accord Group (MUFAG) aims to help people understand the values of the urban forest

Designs from the Urban Forest Project in New York

The socio-cultural dimension of place has to do with the 'inscription' of sense of place through cultural processes, social networks within place, as well as political and environmental involvement …. The cultural dimension refers to the exploration and recognition of symbols that social groups use to produce and reproduce narratives about their places, such as [urban] forests.
C Konijnendijk, The Forest and the City, 2008

(Endnotes)

1. G Moore 2009
2. VEAC 2009
3. Australian Research Centre for Urban Ecology is the prime body in Melbourne that collects data on plant and wildlife species
4. Schwab: 17
5. Schwab: 28-29
6. C Konijnendijk, pers. comm, 2011

Case study:

In 2006, Times Square in New York City was brought to life by banners inspired by the form or metaphor of the tree, compiled by one hundred and eighty-five acclaimed artists from around the globe. The project, entitled 'The Urban Forest Project', was received and paraded as a visually stimulating, powerful community engagement event that both celebrated the urban forest, and stimulated discussions around sustainability and the environment.

Since its New York germination, 'The Urban Forest Project' has spread to other U.S cities of Albuquerque, Baltimore, Denver, Portland, Toledo, San Francisco, Tacoma and Washington, DC. In each city, local artists, designers and students have contributed their personal reflections on the tree to the outdoor exhibitions. The banners, inspired by and displayed in a unique local context of each city have proved a positive way to promote eco-city events and programs that exist in the local area, while opening up the community's imagination and motivation to stimulate new ones.

'The Urban Forest Project' and similar initiatives sprouting up alongside innovative approaches to the management of urban forests provide a platform from which to engage the public in urban forest planning and management strategies, to share narratives, and to celebrate art, community, and the environment.

Raingardens outside the Dame Elisabeth Murdoch Building at the Victorian College of the Arts on St Kilda Rd

The aspirational end of the spectrum: fully integrated architecture, art, urban design and green infrastructure - Hundertwasser's Waldspirale housing in Darmstadt, Germany

6. Implementation Framework

This strategy puts forward the principles which will guide the long-term planning, development and management of our urban forest. It also outlines a set of benchmark targets to evaluate the success of implementation.

Evolution of our urban forest will need to occur from the basis of solid research, well-informed options and best practice implementation tools and processes. With these foundations, the City of Melbourne will lead the practice of urban forestry in Australia.

Creating a resilient and robust urban forest requires forward planning in a similar manner to municipal strategic planning. The management and development of our urban forest needs to undertaken with a long-term vision. Planning, development and implementation of urban tree policy takes place at two levels: long-term (strategic and spatial) planning and shorter-term (project-focused). The success of the Urban Forest Strategy will rely on effective ‘green governance’ by the City of Melbourne, clear communications, and a widely understood implementation strategy that comprises programs that meet both short- and long-term goals.

6.1 Integrated planning

Integrated planning and management is at the heart of this in the effort to direct actions towards common goals, and as the setting, context and application of generally agreed to principles and objectives. It needs to occur on a range of levels, and includes governance by, with and without government – and where it is with government, in many cases the boundaries between and within public and private sectors have become blurred.

- **Intra-Council** integration involves ensuring internal stakeholder and interdepartmental cooperation. At city scale, planners work directly with urban foresters to integrate policy, practices and analytical tools, coordinating input from many other departments related to managing growth.
- In **community and inter-professional** integration the role of non-public proponents becomes more influential by raising public and bi-partisan political awareness. We recognise the impact that changes in the urban forest have on the values of communities and individual, and must therefore maintain and enhance interaction with the community to ensure these values are considered during urban forest planning and decision making.
- **Inter-municipal** integration involves the need for policy makers to link together with other cities and local municipalities. At this scale, this calls for more systematic assessments of the urban forest across a larger bio-geographical area, beyond arbitrary political boundaries.
- Locally-led action on the urban forest potentially influences **national** action. The learning acquired from small scale autonomous urban forest projects can aid in steering policy-making and the quality and quantity of research across the country. The importance of comparable data would allow urban forests to be managed and have collective benchmarks established to ensure that national climate adaptation targets can be met.

6.2 Implementation tools

With a full picture in place of the integrated benefits and processes for managing our urban forest, we can now determine the technical and supportive documents, tools and processes for integrating green infrastructure into the built environment.

The tools comprise the following:

Online access – the City of Melbourne website will incorporate this Strategy, current projects, events and scientific research.

Documents

Three principal documents will support implementation of the Urban Forest Strategy:

1. **City of Melbourne’s Tree Precinct Plans**
   Tree Precinct Plans will be developed in collaboration with the community. The plans will guide future street tree planting programs and tree species selections. Through an extensive community engagement program, the plans will ensure tree population diversity and reinforce precinct character.
2. **Urban Forest Diversity Guidelines**
   These guidelines provide the basis for selecting the right trees and other vegetation for our future urban forest. A scientifically-based matrix has been created allowing City of Melbourne to select a range of appropriate trees for each street typology within the municipality. The guidelines also stipulate diversity targets to be set across the total urban forest in terms of vegetation form, species, age and health.

3. **Urban Forest Community Engagement Plan**
   The Community Engagement Plan will aim to include the broadest possible cross-section of the community, including federal, state and local governments, leaseholders, champions and environmental sector leaders, research and educational institutions, artists, industry forums, schools and developers. The plan also includes innovative ways to engage and consult with the community, such as through the website, design competitions, art projects, school programs, etc.

The other main supportive documents include:

- Biodiversity Action Plan
- Community Health and Wellbeing Indicators
- Pest and Disease Risk Management Strategies
- Significant Trees Register (Heritage Trees, Significant Private)
- Open Space Strategy
- Green Infrastructure Implementation Guide
- Parks and Gardens Master Plan Reviews
- Draft Urban Agriculture Policy

Capital Works program

Streetscape improvements provide opportunities for additional tree planting and WSUD measures, particularly through identification of areas of redundant asphalt paving which can be removed.

Formal and informal consultation between City of Melbourne branches is required to develop a common understanding of, and agreement on, the scope of project proposals. A concept is developed with Landscape Architects including a calculation of resulting increase in canopy cover. The project then undergoes internal and external consultation to seek feedback.

Following this process, proposals can be costed and funding bids submitted to Council for consideration to be included in annual works programs. There may be opportunities for external funding to be obtained from Federal or State Governments for stormwater harvesting and re-use projects to support existing and future tree population. A significant proportion of the road network in the municipality is managed by VicRoads which can add a complexity to the approval process for additional tree planting.

Technical tools

I-tree

i-tree Eco is a valuation model that allows us to value the environmental benefits of the Urban Forest. These value have typically been used by communities, local governments and NGOs in the United States to inventory, evaluate, and assess the environmental benefits of urban and community forests. This assists in determining existing tree cover, calculating its ecosystem benefits and economic value whilst quantifying the effect urban forests have on stormwater, air and water quality, and carbon storage and sequestration. This, in turn, gives them the means to establish levels of priority and importance for both preservation and acquisition of various elements of tree cover within the spatial planning process.

City of Melbourne will utilise the data from i-tree Eco along with tree amenity values against cost of installation and maintenance. It will provide us with a more holistic dollar value of our urban forest. For example, New York has used i-tree to evaluate that for every dollar they spend on trees, they receive a return of $5.60. New York’s 600,000 trees are valued at $122 million using i-tree.

Other tools

The other main technical tools include:

- ULE/Tree health assessments
- Thermal imaging
- Weather stations

6.3 Measurement, monitoring and review

A key element of success for any long-term process is to monitor and evaluate progress over time. A vital aspect of the sustainable development approach is to ensure that connections between the various pieces of work and feedback loops are encouraged and understood. Because the learning process is ongoing, new tools for scientific measurement of results from the urban forest continue to emerge and advance our understanding in this area. It is the role of good planning to make effective use of this new knowledge.

Design and management of public places is an iterative process. It extends well beyond the initial development of an asset to its ongoing maintenance and review of its continued operation through 'adaptive management', wherein applying the new knowledge from lessons learnt as an urban forestry program moves forward (for instance the ways in which trees respond to new stresses as well as new treatments for those stresses) helps improve the accuracy in predicting how an ecosystem will respond to new managerial approaches.

Monitoring and reviewing progress for the Urban Forest Strategy will involve assessing how well the actions of the strategy are realising its principles, goals and objectives, and whether projects at an individual or collective level are meeting the strategy's performance criteria and targets to ensure that its directions are still valid. Evaluating this progress over time may allow, if necessary, to introduce remedial measures and actions, to refine or adjust key directions, and to maintain the momentum of its actions and outcomes into the future. In each of the above cases, the information gained will become part of a collective knowledge affecting the direction of future urban forest (or green infrastructure) proposals or processes.

6.4 Funding resources

Ultimately, true success in maintaining our urban forest depends on the continuing support of the public sector, developers, corporations and the wider community. The City of Melbourne recognises that effective implementation of green infrastructure throughout our urban environment depends ultimately on the coherent public policy supporting it – financially, administratively and legally – and that a long-term funding commitment is required over the next two decades.

Development of our urban forest is also an area of public planning where government does not need to tackle the job alone.

Developers have always looked for a marketing edge for their properties. The best developers understand that building green means not just structural design, but the entire development site and its relationship to its surrounding context. Developer open space contributions are also an important means of supporting and advancing tree programs and other green infrastructure initiatives in newly developing areas.

Business partners can be powerful contributors to the expansion and success of urban forestry through financial support, planting and maintenance of trees on commercial property, and active support of civic organizations involved in forestry. 'Some businesses clearly have a direct stake in urban forestry as a function of their own enterprises. Others may be interested in offsetting environmental impacts, an area that is likely to grow as carbon credits become commoditised as a result of climate change policy.'

Achieving funding stability is ultimately a matter of continuing to have the support of the public for City of Melbourne to remain committed to allocating sufficient funding for programs in perpetuity. Much of this hinges on communicating and disseminating information about the increasing benefits of Melbourne's urban forest in terms of stormwater pollution impact, electricity saved, carbon and water savings from lower energy use in buildings and lower air-conditioner and power plant use, biodiversity benefits and temperature reductions in city as a whole – not to mention the aesthetic enhancement of the city and wide-ranging social and economic advantages. Project costs can be more easily justified when they can be linked to benefits derived from specific green infrastructure implementation strategies, and the provision of a robust cost benefit analysis for the urban forest will help ensure that it remains competitive as a high value land use amongst hard infrastructure and transport. In other words, stable support of the community is generated by a long-term track record of documenting and disseminating those benefits.

Glossary

Adaptive management generally refers to the application of new knowledge in updates and changes to a program. In this approach, 'the best science, albeit incomplete, is brought to bear on an ecosystem, management is implemented under rigorously monitored conditions, and adaptations in management are made as the feedback from monitoring teaches us ore about the way the ecosystem behaves.' (Rowntree, 1995)

Ecosystem resilience is a measure of how much disturbance (like storms, fire or pollutants) an ecosystem can handle without shifting into a qualitatively different state. It is the capacity of a system to both withstand shocks and surprises and to rebuild itself if damaged. [add from AILA policy]

Ecosystem Services are the benefits people obtain from ecosystem processes. These include water and air purification, flood control, erosion control, generation of fertile soils, detoxification of wastes, resistance to climate and other environmental changes, pollination, and aesthetic and cultural benefits that derive from nature.

Green infrastructure refers to 'an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clear air and water, and provides a wide array of benefits to people and wildlife'. (Benedict & McMahon, 2006)

Natural Capital is an extension of the traditional economic notion of capital. The term was coined to represent the natural assets that economists, governments, and corporations tend to leave off the balance sheets. Natural capital can be non-renewable resources (e.g. fossil fuels and mineral deposits)' renewable resources (e.g. fish or timber) or ecosystem services (e.g. the generation of fertile soils, pollination, or purification of air and water).

Resilience is the capacity to deal with change and continue to develop.

Social Capital is a concept used in various fields, from economics and political science to sociology and natural resources management. Broadly, it refers to social relations and among individuals and the norms and social trust which they generate and which facilitate coordination and cooperation for mutual benefit.

Social resilience is the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval. Resilience in societies and their life-supporting ecosystems is crucial in maintaining options for future human development.

Social-ecological systems are linked systems of people and nature. The term emphasises that humans must be seen as a part of, not apart from, nature — that the delineation between social and ecological systems is artificial and arbitrary. Scholars have also used concepts like 'coupled human-environment systems', 'ecosocial systems' and 'socio-ecological systems' to illustrate the interplay between social and ecological systems. The term was coined by Fikret Berkes and Carl Folke in 1998.

Sustainable urban development provides a framework focused on creating urban communities where both the current and future needs of residents are met. There are two important principles - resilience and connectivity - that underpin sustainable urban development.

Urban forest Helms, 1998 from Schwab: 'the art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic and aesthetic benefits trees provide society'. Or US Forest Service, from Schwab: 'the art, science and technology of managing trees, forests and natural systems in and around cities, suburbs and towns for the health and wellbeing of all people'.

Urban Heat Island Effect (UHI) As urban areas generally contain less permeable surfaces and vegetation than surrounding rural areas, urban regions tend to become warmer than their rural surroundings forming an "island" of higher temperatures in the landscape. Heat islands occur on the surface and in the atmosphere. Surface urban heat islands are typically present day and night, but tend to be strongest during the day when the sun is shining. In contrast, atmospheric urban heat islands are often weak during the late morning and throughout the day and become more pronounced after sunset due to the slow release of heat from urban infrastructure.

Urban sprawl is a phenomenon that plagues cities in both developing and industrial countries. It is an uncontrolled or unplanned extension of urban areas into the countryside that tends to result in an inefficient and wasteful use of land and its associated natural resources.

Vulnerability refers to the propensity of social and ecological system to suffer harm from exposure to external stresses and shocks. Research on vulnerability can, for example, assess how large the risk is that people and ecosystems will be affected by climate changes and how sensitive they will be to such changes. Vulnerability is generally regarded as the antithesis of resilience.

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2 Schwab:35

3 Schwab:17

4 Schwab: 28-9

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CITY OF MELBOURNE

Urban Forest
Diversity Guidelines

2011 Tree Species Selection Strategy for the City of Melbourne
















Prepared on behalf of City of Melbourne by ASPECT Studios and Tree Logic.

Contents

Executive Summary

The Urban Forest Diversity Guidelines is a subsidiary document to the City of Melbourne Urban Forest Strategy. The guidelines are intended to inform the Tree Precinct Plans that in turn will determine locations for street tree plantings. Park trees will be planted using existing Masterplans and site specific plans.

The urban forest is a significant asset for the City of Melbourne and to protect that asset it is necessary to diversify its content. Urban forest diversity will make a more resilient and robust forest, help protect the forest as a whole from pests and pathogens, streamline maintenance programs, and even out annual budgetary requirements.

Without diversity, the urban forest is at greater risk from extreme events such as drought and climate change, and from the urban heat island effect.

The urban Forest Diversity Guidelines recommend that by 2040 no more than 5 percent of the forest is to be of any single species, no more than 10 percent is to be of any one genus, and no more than 20 percent is to be of any one Family.

The current profile of the urban forest contains an overproportion of the Family *Myrtaceae*, as well as the genus *Eucalyptus*. Regular annual tree planting to 2040 is proposed to reduce this predominance, and to create a forest with greater age spread.

This document also recommends a full review of the City's Elm and Plane Tree populations, to determine best locations to grow these species.

The Urban Forest Diversity Guidelines provide a non-subjective, scientifically based set of criteria for establishing what tree species are suitable for the urban conditions found in the City of Melbourne.

The Master List of Street and Park Trees provides a broad selection of trees that can meet all of the needs of the City in terms of adaptability, heritage and character.

Trees that are suitable for one location may not be suitable to another location. In order to find the right tree for the right place, a typology of street and park tree locations has been developed, with each Location Type accompanied by minimum criteria necessary for successful tree growth in that location.

By crossreferencing The Master List of Street and Park Trees with the Location Types, a set of tree lists for the diverse locations across the City of Melbourne has been established.

These Location Type Tree Lists can be further refined according to additional criteria such as neighbourhood character, heritage, and degree of shade, and it is such site specificity that will be investigated in the Precinct Street Tree Master Plans.

The Urban Forest Diversity Guidelines are considered a live document, for regular review, and capable of being updated as new knowledge and understanding of the City's requirements develops.

How to use this document

The information in this document is structured to facilitate clear decision making for street tree selection.

Chapter 1 – Introduction

The introduction outlines the relationship between the Urban Forest Strategy and the Urban Forest Diversity Guidelines.

It also summarises some of the key issues facing the growth of trees in Melbourne both today and in the future.

Chapter 2 – Tree Species Selection Criteria

This chapter outlines the selection criteria that have been chosen to identify which tree species are most suitable for the City of Melbourne's diverse types of streets and parks.

Chapter 3 – Tree Planting in Melbourne

This chapter identifies the typical tree growing conditions across the types of street and park environment in Melbourne, with a focus on street trees and streetscapes.

Chapter 4 – Choosing the Right Tree

This chapter identifies the process for selecting the most appropriate tree species for a particular location.

1. Introduction

This chapter outlines the relationship between the Urban Forest Strategy and the Urban Forest Diversity Guidelines. It also summarises some of the key issues facing the growth of trees in Melbourne both today and in the future.

1.1 Overview

The City of Melbourne's Urban Forest Strategy sets out the blueprint for achieving our vision of a resilient, healthy and diverse urban forest that will contribute to the health and wellbeing of our community and to the creation of a liveable city. A series of challenges currently faces our urban forest, and the City of Melbourne must now manage and transform our urban forest in a holistic and multidisciplinary manner in order to achieve our vision. The challenges we face include the fact that many boulevard and specimen trees are reaching the end of their natural life. Coupled with the effects of drought, increasing intensity of heat during summer, and water restrictions, this decline has been accelerated and in many cases is irreversible. The opportunity now exists to transform our public and private urban forest into a healthy, diverse, resilient and well designed forest that will enable our City to adapt to a changing climate, mitigate urban heat island effects and provide protection and wellbeing to the community.

The work that this opportunity provides will be guided by 6 principles developed to ensure all future work contributes to achieving our vision. These are:

- Adapt to climate change.
- Mitigate urban heat island effects.
- Create a water sensitive city.
- Create healthy ecosystems.
- Design our urban landscapes for community health, wellbeing and liveability.
- Position Melbourne as a leader in urban forestry.

As part of this process, a need has been identified to produce a scientifically based suite of tree species lists that highlight suitable tree species to suit various Location Types in Melbourne. This document will form the basis for ensuring diversity within our urban forest: diversity in species, age and growth rates. The scientifically based approach will ensure that overall tree selection is fit for purpose, within the context of individual sites and also of the municipality as a whole. Building the urban forest as a living ecosystem will rely on smart species selection to deal with issues such as improving biodiversity, improving soil moisture retention, reducing stormwater flows, increasing shade and canopy cover, reducing infrastructure conflicts and ensuring our urban forest provides the maximum benefits for our communities. This work will further inform species selection within all future park masterplans, precinct plans and capital works and renewal programs.

Figure 3: Relationship of this document to the Urban Forest Strategy and Precinct Street Tree Master Plans.

Objectives of the Urban Forest Diversity Guidelines

- Ensure urban forest diversification in age, species and health across the municipality.
- Provide scientifically based criteria for selecting tree species in urban Melbourne.
- Mitigate risk of pest and disease attacks.
- Develop a typology of City of Melbourne street and park locations and allocate relevant species for each Location Type.
- Ensure that nominated species are likely to survive and succeed in the face of predicted climate change.

Values of Diversity

To mitigate the risk of economic loss, financial advisors recommend asset diversification. The same principle applies for an environmental asset such as an urban forest. The greater the diversification within a forest, the lower the risk of losing the entire forest in one event, such as a pest and disease attack or an extreme heat event. By diversification we mean a variety of:

- Tree species.
- Ages of trees.
- Growth rates of trees.

By ensuring that these types of diversity are fostered in our urban forest, we are able to reduce overall vulnerability of our tree population.

History of Species Diversity

Adapted from Carver (1989), Spencer (1986), and Yau (1982).

After the initial settlement of Melbourne, when indigenous bushland was cleared to make way for a burgeoning township, trees were given little priority. In the early days they were seen as a resource to be utilised and little emphasis was given to the beautification of the town.

By the 1850s, Blue Gums were the main planting along the Yarra and St Kilda Rd due to their quick growing nature and their ability to withstand the extremes of Melbourne's cool wet winters and hot dry summers. Avenues of Silky Oak, *Grevillea robusta*, were also planted between the Botanic Gardens and Princes Bridge. Plane trees, American Ash and *Pinus radiata* were all trialled throughout this period as avenues, proving themselves to be hardy specimens for the Melbourne landscape. Conifers also played a large role in forming the larger Victorian landscape around this time, with over 355,000 plants being custom grown at the Botanic Gardens for distribution to Governmental public reserves, schools, cemeteries, and churches throughout the state. Peppercorns were also favoured due to their lush foliage and heritage values.

Interestingly, by the 1870s, through Baron Von Mueller's influence, the gentleman of society – including Municipal Mayors – fully recognised the benefits of street tree plantings in the city and in principal towns. Many of Melbourne's reserves and parks were laid out at this time and many still reflect the preference for Conifers. By the 1880s however, Pines and Blue Gums had lost their popularity and replacement with other species had begun. Blue Gums in Victoria Parade were ringbarked by a local gardener, and many considered both Pines and Blue Gums too gloomy and dense. The Peppercorns also fell out of favour due, their large weeping habit considered inappropriate for successful street trees. The nature of deciduous trees' shading during summer and allowing sunlight in winter was a new way of thinking in urban streetscape design to allow for the comfort of people. This was the beginning of the planting of Elms as shade trees.

By the early twentieth century, Planes, Elms, Oaks, Poplars, *Lagunarias*, Chestnuts and *Phoenix canariensis* were prescribed for the boulevards, streets and parks of Melbourne. For the drier areas north of Melbourne, Kurrajongs, Silky Oaks, Moreton Bay Figs, She-oaks and Golden Wattles were recommended. This period shows a much more diverse range of trees used in the more cultivated areas and highlights the thought that was given to trees environmental benefits and their abilities to withstand the Melbourne climate.

The rapid expansion of Melbourne's suburbs after the First and Second World Wars saw bushland retreat and small scale trees being planted along the streets. Trees such as the Red Flowering Gum, *Pittosporum*, *Lophostemon confertus* and *Prunus* were popular, gracing newer suburbs. Particularly after the Second World War, natives had a resurgence in popularity with more *Eucalypts*, *Melaleucas* and *Callistemons* being introduced into Melbourne as street trees. Plane trees were particularly favoured for the ability to withstand harsh urban conditions such as air pollution and poor soil conditions. Planes replaced the St Kilda Poplars during the 1960s. During the 1980s, there was another wave of indigenous tree species selection and they were encouraged as plantings to promote native ecosystems and attract wildlife. Such trees included *Eucalyptus maculata*, *E. nicholii*, *E. leucoxylon*, *E. sideroxylon* and *E. citriodora*.

Melbourne's climate, hydrology patterns and soil types provide the opportunity for many species of trees, both native and exotic, to grow well. The many types of space within our urban fabric further provide opportunity for various species such as park specimens, smaller fastigiates for narrow laneways and streets, large shade trees for medians, specimens for boulevards and natives for our indigenous landscapes. Compared to the northern hemisphere our history of species diversity amongst our urban forest appears to be relatively short, however various articles certainly highlight the changes in cultural trends, succession of tree species trials, and the recognition of the importance of diversity.

Given the immense value of Melbourne's existing tree population, and the potential vulnerability to the future challenges such as climate change and the urban heat island effect, working towards greater species diversity is a high priority.

Measures of Diversity

In Melbourne's existing stock of trees, Elms and Planes each represent 10% of our total tree population. Frequently cited, though not scientifically based, rules of thumb in the United States suggest:

- Plant no more than 30% of a family.
- Plant no more than 20% of a genus.
- Plant no more than 10% of a species.

These rules predate the rise of concern about impacts of climate change, which is likely to increase the risk of planting urban monocultures. They also omit any consideration given to the use of cultivars and clones. Clones are genetically identical to their mother stock and therefore further increase the risks associated with planting monocultures.

The rules above are therefore best seen as conservative guides only within the City of Melbourne context. The emphasis should be on a diversity greater than that suggested by these rules.

Given the immense value of Melbourne's existing tree population, and its potential vulnerability to such future challenges as climate change and the urban heat island effect, working towards greater species diversity is a high priority.

Species Diversity

If we cumulate the planes and elms:

Table 1: Top ten species within the City of Melbourne

Species	%
Platanus acerifolia and *P. orientalis*	12
Ulmus spp., *U. procera* and *U. parvifolia*	12
Eucalyptus camaldulensis	11
Corymbia maculata	6
Eucalyptus melliodora	3
Eucalyptus leucoxylon	3
Corymbia citriodora	3
Allocasuarina verticillata	3
Angophora costata	2
Lophostemon confertus	2

Genus Diversity

Table 2: Top ten genera within the City of Melbourne

Genus	%
Eucalyptus	24
Ulmus	13
Platanus	12
Corymbia	9
Acacia	4
Quercus	3
Allocasuarina	3
Melaleuca	2
Ficus	2
Angophora	2

Family Diversity

Table 3: Top ten Families within the City of Melbourne

Family	%
Myrtaceae	43
Ulmaceae	14
Platanaceae	12
Mimosaceae	4
Casuarinaceae	4
Fagaceae	3
Moraceae	2
Rosaceae	2
Pinaceae	1
Salicaceae	1

Having a large representation of any one particular family leaves Melbourne's urban forest vulnerable to pest and disease outbreaks that are family specific. The *Myrtaceae* family accounts for forty three per cent of Melbourne's tree base, a proportion which could potentially be devastated if plant pathogens targeting this family, such as Myrtle rust, take hold.

There is a noted high percentage of the genus *Eucalyptus* and the Family *Myrtaceae* within our tree population. This is due in part to the fact that many different species make up this genus and Family, many of which are native to Victoria and also to the fact that these species have proven successful as urban trees. It should be noted that Royal Park, Melbourne's largest park at 170 hectares and maintained primarily as native bushland, houses many of these *Eucalypts* and *Myrtaceae* Family, including a large proportion of our 5,400 *Eucalyptus camaldulensis*. Whilst we note the level of vulnerability amongst the tree population due to these high percentages of one genus and one Family, they form very important indigenous landscapes within our municipality that are healthy, robust and iconic for Melbourne.

Useful Life Expectancy of Melbourne's Trees

Table 4: Life expectancy of trees within the City of Melbourne Based on an assessment of 50% of the tree population	
Time Until Senescence	**%**
< 1 year	3
1-5 years	11
6-10 years	15
11-20 years	18
21-30 years	17
31-60 years	24
61+ years	12

Useful Life Expectancy is a year bracket attributed to each tree for which we expect that tree to remain as a healthy robust specimen in the landscape. During the assessment, the age of the tree, and its health, form and growth patterns, are taken into account to determine its life expectancy. From this analysis we can derive that approximately thirty percent of Melbourne's tree population will not survive in the landscape for another 10 years and forty eight percent will not last 20 years.

Useful Life Expectancy Of Melbourne's Elms

Table 5: Life expectancy of Elm trees within the City of Melbourne	
Time Until Senescence	**%**
< 1 year	6
1-5 years	22
6-10 years	26
11-20 years	21
21-30 years	11
31-60 years	10
61+ years	4

Fifty five percent of Melbourne's Elm population will not remain in the landscape after ten years due to their age.

In a cumulative analysis of our species diversity, Elms make up just over twelve percent of our tree population. Of these Elms, approximately fifty five percent are coming to the end of their natural lives and will senesce in the next 10 years. That means that 3000 elms will need to be removed from our parks and streets within the next 10 years; 700 of these will be lost within one year.

Conclusions

It is clear then that the City of Melbourne's current urban forest is vulnerable. Elms and Planes dominate our boulevards and CBD streets and we hold a high percentage of the genus *Eucalyptus* and the *Myrtaceae* Family, all of which contributes to an uneven spread of tree types within our urban forest. This makes our urban forest vulnerable to pest and disease attacks, mass senescence of certain species is likely to occur, and can magnify the deleterious effects of specific weather conditions such as heat waves: and all of which can contribute to large costs in removals and replacements.

As a result the City of Melbourne proposes to implement the following benchmarks to reduce vulnerability:

Species:

By 2040 the urban forest will be composed of:

- No more than 5% of any one Species.
- No more than 10% of any one Genus.
- No more than 20% of any one Family.

Age and growth rates:

- Diversity of tree age and growth rates will be encouraged through regular plantings each year to 2040. These regular plantings are to be much greater than the numbers of trees removed each year.

Health:

- No more than 10% of our tree population will be in poor health by 2040.

Whilst this analysis looks at the City's urban forest as a whole and sets strategic targets for managing vulnerability, the implementation of diversity actions at street and park level must reflect the larger vision.

The concept of reducing the percentage of the *Myrtaceae* Family from forty three percent to twenty percent of the entire population may seem drastic, but it is a long term benchmark that spans the life of a tree, not that of an electoral cycle. By increasing street and park tree plantings each year, the City of Melbourne intends to increase the overall population of trees incrementally over a number of years, whilst ensuring that the *Myrtaceae* Family dominate the total percentage less and less each year.

Therefore, operational plans, such as the precinct planting plans will be reviewed and developed to bridge the gap between strategic targets and day to day management of tree removal and planting. These precinct plans, along with supporting research papers and landscape implementation plans, will help us to determine how to best replace declining trees and increase street and park plantings within our targets that all align with the broader Urban Forest Strategy principles.

Key Outcomes from this Report

- A full review will be conducted of Melbourne's Elm and Plane populations, determining best locations within the city to grow each species, with each species comprising no more than 5% of the total tree population. An historical and character review of each of our prominent Boulevards should also be conducted to ensure we maintain their integrity and identity through specimen plantings.
- Over time and through increased planting regimes, the percentage of *Myrtaceae* will be required to be gradually reduced to encompass no more than twenty percent of Melbourne's total tree population.
- Regular tree planting each planting season until 2040 will ensure the number of mature trees within the overall population is reduced to a more even spread of ages.
- The review of each Council Tree Precinct Plan in conjunction with overall targets will determine the spread of species, genus and Family down to individual streets and parks. These precinct plans will also highlight opportunities for increased plantings.

1.2 Project Process

The Development of the Urban Forest Diversity Guidelines to Date

Project consultants ASPECT Studios and Tree Logic developed a tree list of potential future-proof street and park trees. The Preliminary Tree Selection List needed to provide a diverse range of species options that work alongside the principles set out in the City of Melbourne's Urban Forestry Strategy.

There was no use of subjective criteria such as personal taste, aesthetic and cultural values, perceptions, design requirements or any site based constraint, in the development of the initial tree selection list.

The Preliminary Tree Selection List was large, informed by Tree Logic's experience as one of Victoria's leading arboricultural companies.

An internal committee at the City of Melbourne contributed information including success rates of tree species growing within the existing urban forest.

The extensive Preliminary Tree Selection List was reduced to make it more workable and enable critical evaluation of suitable species.

Species that did not meet the urban forestry criteria, for instance drought tolerance, heat tolerance, wind tolerance or susceptibility to pathogens, were removed.

Project Process	Project Outcome
City of Melbourne Urban Forest Strategy	**Urban Forest Principles**
Review the Streets of Melbourne What are the current urban constraints in tree growth in Melbourne? eg. Services, roads, pavements, built form	**Fact sheet for all street and park types**
Identify all the existing and emerging tree diversity issues for Melbourne e.g. Climate change, water, pathogens	**Diversity issues noted**
Review existing street trees used by the City of Melbourne	**Street trees reviewed**
Develop a Preliminary Tree Selection List of all trees possibly suitable for inner Melbourne	**Preliminary Tree Selection List**
Determine the selection criteria for the trees of Melbourne e.g. Drought tolerance, heat tolerance, wind tolerance, longetivity, pollution tolerance, pathogen susceptibility and manageability, Community health concerns regarding allergies, shade cast, level of maintenance, and tree litter drop	**Selection criteria established**
Identify all the possible tree species suitable for Melbourne that meet the base selection criteria. Discard those that do not meet the base criteria.	**Master List of Trees Suitable for Streets and Parks**
Establish additional criteria that may be useful is determining a trees suitability within Melbourne e.g. Can be pruned to grow beneath powerlines.	**Tree Matrix**
Develop a classification system for Melbourne's boulevards, streets, lanes and parks and set minimum criteria for trees within those locations	**Location Typology and selection criteria for each Location Type**
Apply minimum criteria to Master List of Trees Suitable for Streets and Parks to produce Tree Lists for Location Types	**Tree Lists for Location Types**

Figure 4: Process and outcomes in developing the tree selection process for the Urban Forest Diversity Guidelines.

1.3 Status of document

A 'live' document

This document is envisaged as a live document with the ability to be updated as more data and information becomes available.

It is a requirement that this document be interactive and flexible for the user. Street tree management and urban forestry is a concept that is quickly developing, both from practical experience and scientific research. As a consequence the limitations of the tree selection process are carefully considered. The document will be updated as information, data and research become available.

Following are some examples:

- Potential tree pathogens may affect a particular selected species. If this is unmanageable then the tree species will be taken off the list. Similarly new cultivars and selections that are more disease resistant may be added.
- Species with reduced litter drop may be included at a later time.
- Climate change results in further extremes in weather and the status and suitability of species needs to be updated.
- Reassessment of on-site conditions such as greater incorporation of 'positive' planting innovations including structural soil beneath porous paving, infiltration, pits, and WSUD basins, may lead to species additions.

Formal review

A formal review will take place every five years. The next review should analyse the following aspects:

- Diversity Guidelines objectives: including how diversity targets are distributed amongst the Precinct Planting Design Plans and the distribution of percentage based targets.
- The Diversity Guideline's relationship to the Urban Forest Strategy and other City of Melbourne policies.
- The ten base criteria used to establish suitability to urban conditions. These criteria are not fixed.

In addition, changing community perceptions can be incorporated, including any community consultation outcomes.

1.4 Overview of Urban Forest Diversity Issues within the City of Melbourne

There are a number of issues confronting diversity of tree species in Melbourne. These issues have directly informed the selection criteria by which the preferred tree species have been identified. Species age, health and growth rates are key issues.

Species Diversity

Tree diversity within an urban forest landscape provides functional and aesthetic benefits as well as biological and ecological advantages. "A common tenet of popular ecology is that high species diversity contributes to the stability of ecosystems by reducing hazards of catastrophic loss of a particular species" (Richards, 1983). However, there is much evidence from plant ecological studies that relationships between diversity and stability cannot be as simply expressed as this premise suggests.

Whilst street tree species do not occur in monocultures to the same extent as agricultural crops or forest plantations, the presence of grand boulevards, and neighbourhood heritage and character can mean that urban areas are dominated by relatively few species. Whilst these species have proven adaptable to changing urban environs there is an inherent risk in planting few species throughout a city.

Miller and Miller (1991) recommend that "liberal use" of a species should not exceed 10% of the total tree population. Jaenson et. al. (1992) suggest that city foresters should use species percentages derived from rapid, sample surveys to "reassess their recommended species lists to achieve a 5%-10% ceiling on any one tree species". Whilst these simple numerical limits have no scientific basis they form a well used rule of thumb for essentially not putting all of your eggs in one basket.

As discussed, the 10% rule may appear to be outdated when considering the enormity of climate change issues and the increased use of clones and cultivars.

The following factors will dictate species diversity:

- Existing landscape character.
- Proven adaptability and tolerances of species.
- Availability.
- Ability to fulfil functional requirements.

In street tree populations, stability depends primarily on the longevity of individual trees and sufficient numbers of successfully planted replacements.

Age Diversity

Good age diversity is essential for future population stability. Most importantly, species that have been proven to be adapted should be stabilised through ensuring the population of that species has a good age range. When replacing older trees, this is more important than encouraging species diversity. As Richards (1983) states, to do otherwise "is a misuse of ecological concepts. Species diversity contributes to the stability of a street tree population only to the extent that individual species or cultivars prove successful".

On an economic level, diversity of age means that maintaining the urban forest becomes a more evenly paced process. Extremes – for instance those associated with sudden mass senescence – are minimised, allowing for budgets to be more easily managed and regulated.

Size Matters

A strategically located large-stature tree has a bigger impact on conserving energy and mitigating the urban heat island effect than a corresponding quantity of smaller trees. Larger trees do more to:

- Reduce stormwater run off.
- Extend the life of street surfaces.
- Improve local air, soil and water quality.
- Reduce atmospheric carbon dioxide.
- Provide wildlife habitat.
- Increase property values.
- Enhance the attractiveness of an area.
- Promote human health and well being.

The bigger the tree, the larger the benefits and, ultimately, the better the community's quality of life.

Planting Sites

Species diversity may be constrained by the range and availability of planting sites. In particular, the number and type of planting sites that allow plantings to attain larger sizes needs to be addressed.

An optimal planting site allows space for uninhibited root growth (in volume, surface area and shape of surface area), provides uncompacted soil, good solar access, sufficient space away from adjacent structures such as walls and from vehicular traffic, and is not limited by overhead conditions (e.g. power lines).

New planting sites can be developed within established avenues and landscapes to allow the planting of species different to the established species. In addition to increasing species diversity, such plantings may provide a highlight (for instance at roundabouts, medians, or in kerb outstands), or additional aesthetic value.

Above and below ground restrictions mean there will always be sites in the City of Melbourne that require the use of small stature trees.

Genetic Diversity and the Use of Cultivars

Plant breeding is the science of adapting the genetics of plants for the benefit of humankind and has been in practice since the beginning of civilisation. The overall aim of plant breeding is to improve the quality and performance of plants with the objective, in this case, of developing trees better adapted to the urban environment and ultimately for the benefit of the community.

The London Plane (*Platanus* x *acerifolia*) and Dutch Elm (*Ulmus* x *hollandica*) growing in Melbourne are cloned populations, so the concept of plant breeding it is not a new occurrence to Melbourne's streets.

Genetic diversity means a population is comprised of a broad range of individuals expressing different characteristics.

Genetic diversity is important because:

- Through artificial selection for specific characteristics, for instance quick growth, we may unintentionally select against other desirable characteristics, for example disease resistance. Wild populations provide a gene bank that can reinvigorate and strengthen domesticated populations.
- Ecosystem diversity requires species diversity.
- Adaptability can only occur in diverse populations and ecosystems. Diversity is essential for survival. Diversity is the basis for a robust and resilient population.
- Local wild populations are more likely to be adapted to local conditions than populations from elsewhere.

The maintenance of wild relatives of domesticated species is essential to plant breeding and sustainable agriculture and horticulture.

Cultivars – specially bred and domesticated varieties of wild populations – are bred because they possess desirable characteristics. While this can be good, in doing so we reduce the overall population's genetic diversity, leaving it less adaptable in the longer term.

Cultivars developed and grown in areas where the local conditions are different to those of the City of Melbourne must be regarded as unproven until they have been adequately tested under local site and cultural conditions.

Cloning is an extreme example of cultivation. Cloned populations have in the past been encouraged by some because the individuals "all look the same", hence present more neatly, are all guaranteed to have the same characteristics of disease resistance and so on. Cloned populations however, because their genetic diversity is nil, are more at risk, and minimise the adaptability and survivability of the urban forest.

A balance needs to be maintained between the use of cultivars (and clones) and stock grown from wild populations of local provenance.

Climate Change

Climate change requires consideration in the tree selection process. Climate model projections for the coming decades indicate an increasing risk of below average rainfall for southern and eastern mainland Australia, higher temperatures and evaporation, and below average runoff. In particular there is a significant projected increase in frequency of extremely hot years and extremely dry years (CSIRO, 2010). The selection of species more suited to extended dry periods and high heat will be beneficial. Other stresses caused by warming will include more pests, pathogens and fires.

In urban environments reducing the effects of climate change, for example the heat island effect, can be achieved by planting more trees. Not only do trees supply shade, reducing ground temperatures, but also trees evapotranspire – that is they release water into the air – which not only reduces urban temperatures but also improves the quality of the microclimate. Water needs to be retained in the landscape in order for evapotranspiration to occur and for the benefits of the urban forest to be maximised. Incorporating water sensitive urban design initiatives is another strategy that can be incorporated into tree planting systems.

Native and Exotic Species

Urban areas are highly contrived and very little of the original landscape – including soil and water conditions – remains. Just because a plant is indigenous to a site does not necessarily mean that the current site conditions are optimal for its growth. Urban soils and other conditions are often very different to the conditions in which both indigenous and exotic trees are found in the wild.

The focus should be on tree species adapted to a site and with acceptable characteristics relative to the desired purpose.

Non-local Australian species, and exotic species, can make positive contributions to the landscape. In some cases, these species are better adapted to the conditions of the highly modified urban environment. They may have positive attributes and are able to fulfil specific landscape functions.

The planting of the wrong choice of species, and planting in inappropriate locations, is an indication of poor planning rather than poor tree selection. In many instances the requirements set out by policy or the brief prevent the selection of suitable site-tolerant species.

Much of the character of the City of Melbourne is created by the presence of iconic exotic trees.

Remnant, indigenous and native vegetation has an important role to play in urban landscapes. It should be noted, however, that the maturity of existing vegetation is impossible to replace and the diversity of natural plant communities is difficult to replicate. Preservation of existing natural and remnant vegetation is the most efficient way to incorporate biodiversity in urban landscapes.

The use of indigenous tree species in streets will have greater impact and benefit when used adjacent to open space that has significant remnant vegetation.

Vulnerability to Pathogens and Pests

Pest and diseases are a component of the urban landscape and the City of Melbourne recognises that control measures will be required at times to maintain healthy and aesthetically pleasing landscapes.

The City of Melbourne will focus on problem prevention through appropriate tree selection, planting and tree maintenance.

When selecting tree species for Melbourne's streets all effort will be made to select species that are known to be pest and disease resistant.

We do not know, however, the extent of pest and disease resistance in many tree species, especially within the urban environment.

Moreover, there will be situations where the existing street tree species may be under threat but their ongoing use is imperative considering the strong landscape character or cultural importance they represent.

It is not possible to select a palette of tree species for urban streets that are immune from potential infestation from pathogens, particularly when some potential threats could impact on entire plant families such as *Myrtaceae* (*Eucalyptus* spp., *Corymbia* spp., *Callistemon* spp., *Melalueca* spp., *Tristaniopsis* spp., and *Lophostemon confertus*).

A number of approaches will help minimise the impact of pests and disease on the urban forest, for instance: constant monitoring of the urban forest and including the involvement of the Department of Primary Industries in that monitoring, ensuring the general health and vitality of urban forest, providing greater diversity, building a database of pest and disease, making sure of hygiene controls during maintenance, and ensuring good communication and working links with bordering councils.

Table 7: Existing pathogens and pests affecting trees within the City of Melbourne		
Pathogen	**Species Affected**	**Comment**
Armillaria luteobubalina	A soil-borne fungus that causes root rot in a wide variety of plants including many native plants and introduced ornamental plants.	At present there is no one simple method for controlling *Armillaria*. A combination of sanitation measures, good horticultural management and the addition of organic matter to soils can be expected to retard the activity of *Armillaria*.
Brushtail Possums	A range of native and exotic tree species.	Possums, flying foxes and other native animals are protected species under the *Wildlife Act 1975*. A possum management strategy will be developed to manage the possum population on the particular site.
Elm Leaf Beetle (*Pyrrhalta luteola, Xanthogaleruca luteola* (Müller, 1766))	Most species of *Ulmus*, also *Zelkova serrata*. Chinese Elm (*U. parvifolia*) is relatively resistant.	A range of management options are utilised in the control of Elm Leaf Beetle.
Elm Bark Beetle (*Scolytus multistriatus*)	*Ulmus* spp. particularly English Elm (*U. procera*) and Wych Elm (*U. glabra*).	The Elm Bark Beetle causes no serious damage to elms. However, it is the carrier of Dutch Elm Disease.
Exotic nematodes (microscopic worm like organisms, or eelworms), belonging to the *Aphelenchoididae* Family of nematodes such as *Bursaphelenchus hunanensis*	Pine trees. An infestation by a pathogenic *Aphelenchoididae* species may result in a rapid decline in tree health, with the needles turning yellow to brown and the twigs becoming dry and brittle. Symptoms first appear in late spring/early summer. Dead pines killed by the nematode tend to retain their needles for six to twelve months.	The only available control is removal of the tree and either burning the wood or deep burial well away from other trees, to kill the nematode and any potential vectors. Not known to be an ongoing threat to pines in Victoria.
Fusarium Wilt (*Fusarium oxysporum* f.sp. *canariensis*)	*Phoenix* spp., *Washingtonia filifera*.	Management is dependent upon rapid and accurate diagnosis. Once correctly diagnosed appropriate management can be implemented.
Fig Psyllid (*Mycopsylla fici*)	Periodic defoliation of Moreton Bay Fig trees (*Ficus macrophylla*).	Council will continue to support Fig Psyllid research.
Phytophthora cinnamomi	Causes root rot of a wide variety of plant species including many native plants and introduced plants.	Implement model of national best practice guidelines for management (http://www.environment.gov.au/biodiversity/invasive/publications/p-cinnamomi.html).
Psyllid (*Cardiaspina* spp.)	*Cardiaspina* cause the most damage to eucalypt foliage, especially to *Eucalyptus camaldulensis*.	Outbreaks occur periodically. Most native species of psyllids require no management; even when psyllid populations are abundant, plants can tolerate substantial feeding and psyllid populations will decline naturally. Develop integrated program for badly infested trees; monitor, cultural and chemical (imidacloprid stem or soil inject).

Table 8: Potential pathogens and pests that may affect trees within the City of Melbourne		
Pathogen	**Species Affected**	**Comment**
Dutch Elm Disease (*Ophiostoma ulmi (Buism.)* Nannf., *Ophiostoma novo-ulmi*)	*Ulmus* spp., Asian elms more resistant.	Need to constantly monitor the elm population and be aware of diseases presence. Implement Dutch Elm Disease Contingency Plan for Australia.
Eucalyptus rust or guava rust (*Puccina psidii*)	A very wide host range in the plant family *Myrtaceae*. The disease is particularly severe on susceptible eucalypt seedlings, cuttings, young trees, coppiced or damaged mature trees.	Highly susceptible trees may be grossly malformed or even killed. Growth rates of infected trees are diminished. It is currently not present in Australia.
Fire Blight (*Erwinia amylovora*)	Causes disease mostly on plants belonging to the *Maloideae* (e.g. apple, pear, cotoneaster, hawthorn, quince and loquat).	Draft Contingency Plan for Fire Blight 1996: the diagnostic protocol is considered to represent best practice for the isolation and identification of *Erwinia amylovora*. Disease present in New Zealand.
Myrtle rust (*Uredo rangelii*)	A very wide host range in the plant family *Myrtaceae*. Myrtle rust produces lesions on young, actively growing leaves and shoots as well as on fruits and sepals. Leaves may become buckled or twisted as a result of infection.	Closely related to Eucalyptus rust. Myrtle rust typically attacks young plants and new growth on established plants. Can be controlled in commercial operations with the use of fungicides.
The Sycamore lace bug, *Corythucha ciliata* (Say)	*Platanus* spp., Planes or Sycamore. The Sycamore Lace Bug feeds on the underside of leaves. This initially causes white stippling, progressing to bronzing, chlorosis and eventually, premature leaf drop. Severe infestation in late summer can cause defoliation.	Can be controlled with trunk injectable imidacloprid. Symptoms worse in drought stressed trees.

Tree Maintenance

Sustainable urban forests require human intervention in order to regenerate and maintain them in a safe and aesthetically pleasing manner. The City of Melbourne maintains trees on Council managed land to fulfil its legislative and management obligations to residents and visitors to the area. The key to maintaining and enhancing the urban forest is ensuring quality tree maintenance. Maintenance work performed on Melbourne's trees aims to manage tree health and enhance the quality of the treed landscape across the city as well as reducing the inherent risks associated with trees in an urban area.

Council undertakes routine maintenance on publicly managed trees to:

- Reduce the risk to public safety.
- Decrease potential damage to property.
- Provide adequate clearances for pedestrians, vehicles, private property and sight lines.
- Provide clearances around services and utility lines.
- Manage tree health.
- To formatively shape young trees.

Regular maintenance also includes activities such as monitoring soil moisture, mulching, decompacting soils, upgrading irrigation and making health assessments.

Maintenance work on trees will also occur in response to unexpected events or emergencies, such as tree or branch failure resulting from severe storms.

Certain trees within the municipality may require specialist maintenance work. Palms also require specific maintenance works and some trees may require specialised tree surgery works.

Australian Standards and known best practice relating to tree management will be implemented and any operation known to be detrimental to long-term tree health is not appropriate.

Tree selection will consider a tree's ability to be pruned in order to meet the above ground site constraints presented by the tree's location. Tree selection will endeavour to utilise tree size and form (shape of the canopy) in order to reduce maintenance requirements.

Tree Litter

All trees will shed litter – leaves, bark, flowers, fruit – at some time during a given growing season. Tree selection will aim to avoid the use of trees that drop excessive litter, particularly fruit, which can cause trip hazards.

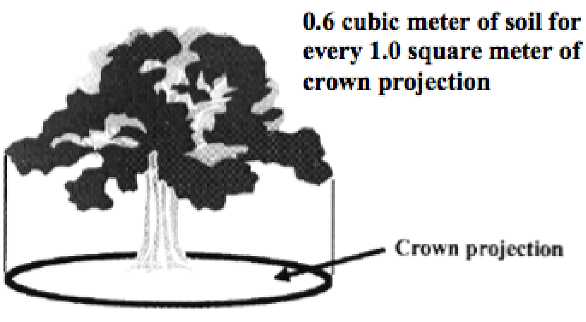


Figure 6: How much soil does a tree need? Diagram adapted from Grabosky, Bassuk & Towbridge (2002).

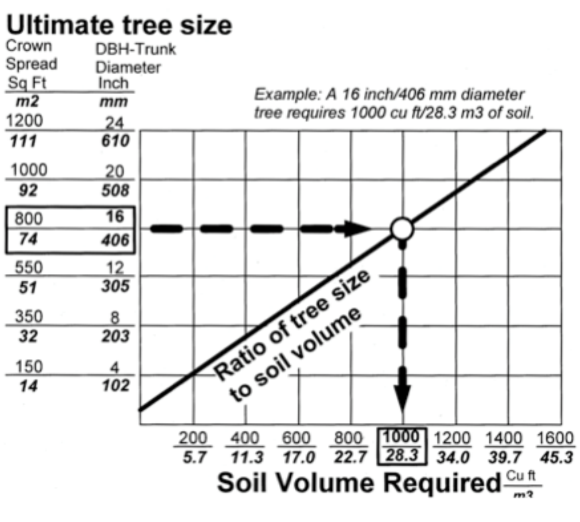


Figure 5: Soil volume and ultimate tree size relationships (Urban, 2008).

Containerisation and Tree Vaults

Containerisation is the practice of growing trees within structures that limit tree root growth to within a constrained volume of soil. It is not horticultural best practice to have street trees in containers and within vaults. This type of planting is not encouraged as it does not allow for long-term and sustainable street tree performance. The limited soil volumes will require either early replacement of trees when they have 'exhausted' their limited resources or intensive maintenance, such as root pruning and soil treatment. Trees in vaults and containers are heavily reliant on supplementary irrigation and effective drainage.

There are instances in the public domain where planting over structures is unavoidable. In these instances containerisation and vaults are unavoidable to allow street tree planting. In these instances maximizing soil volume is imperative. This soil volume needs to be provided in a 'plate' volume not as depth. This is to enable healthy root growth and adequate gaseous exchange. In these scenarios a tree's soil volume may need to be a combination of below and above grade. This can provide urban design opportunities, for example using the raised edge of a container as a strong seating edge. In such instances, it will also be necessary for City of Melbourne's arborists to advise on tree species selection, planting methodology and ongoing maintenance regimes.

Successful urban tree planting depends on the consideration of many features including species selection, site constraints, planting procedure, and post-planting maintenance. One essential site component directly affecting tree growth and performance is open soil area and soil volumes. If trees are expected to continue to maintain high levels of health and vigour (growth performance) post-planting they need to be able to access large volumes of soil as they continue to grow and their need for resources increases.

A plant grown in a container has limited root growth due to the volume of available soil. Crown growth will slow as a result, but not necessarily stop (Watson & Himelick, 1997). The same principal applies to trees planted in urban sites. Trees that have limited root space develop smaller root systems in proportion to canopy growth. This results in water stress that can subsequently predispose the tree to secondary pest and disease problems (Watson & Himelick, 1997).

Soil type, and irrigation are equally important considerations for successful containerisation.

See Appendix 6.

Water

Water stress affects most of the physiological processes involved in plant growth. As well as physical space, air and nutrient availability, a tree's moisture requirements need to be addressed in order to allow it to realise its full potential.

Strategies to maximise plant water availability include:

- Water Sensitive Urban Design (WSUD) initiatives, such as storm water harvest systems.
- Porous and permeable pavements.
- Bioretention basins (smaller areas like kerb outstands) and swales (for larger areas such as centre medians).
- Tree selection focussed on species that can tolerate extended dry periods and exposure to heat and wind.
- Supplementary irrigation systems.

In order to establish and successfully manage a tree in the urban landscape, it is important to have an appreciation of both the peak daily demand and the total amount of water required by the tree (Connellan, 2008). Any applied irrigation must be based on a planned approach with defined landscape outcomes.

Character, Community Values and Urban Design

The City of Melbourne has a long tradition of successful urban street and park characteristics that are highly valued and identifiable by the community.

This character includes the substantial avenues of Elms in Royal Parade, for example, heritage-style plantings within parks such as the Carlton Gardens, and the indigenous woodland of Royal Park.

The developed Master List of Street and Park Trees provides the substantial diversity of trees, and enough scope, to support the objectives of these valued "character streets and parks".

In developing selection criteria for street trees and the main avenue trees in parks, intelligent consideration must be given to both horticultural issues and urban character. While this report is limited to identifying the most appropriate tree species for Melbourne, the final choice of tree species is highly dependant on the existing and desired streetscape or park character and existing heritage controls.

The Precinct Street Tree Master Plans will be the primary documents through which this local character will be explored and balanced with the urban forest diversity needs of the City of Melbourne.

Strategies and Technologies for Improving Tree Growth

There are a number of strategies and technologies that are being investigated by land managers around the globe to improve the performance of urban trees. Some significant approaches are outlined in the table below.

This document has not sought to consider the effect of new tree planting technologies on the appropriate selection of the City's trees. The City of Melbourne's urban forestry principles do not rely on improvements in planting technologies as a determinant of street tree performance. It is however expected that such technologies will only improve and build upon existing street tree performance.

Table 6: Strategies and technologies for improving tree growth

Objective	Technology
Increasing useable soil root volumes to maximise tree growth.	Street kerb extensions and blisters. Use of structural soil tree pits.
Increase opportunities for gaseous exchange of water and oxygen to maximise tree growth.	Use of porous or permeable pavements over structural soil.
Reduce conflicts between tree growth and providing free pedestrian access.	Use of porous or permeable pavements over structural soil.
Enable opportunities for passive irrigation in the street from stormwater drainage.	Use of tree pit kerb inlets.

Other Tree Planting Technologies

- Genetic selection, manipulation and tissue culture.
- Cultural treatments.
- Retrofitted growing systems.
- Structural soils and the use of structural cells.
- Planting site preparation.

Formal Street Tree Trials

Formal street tree trials enable new tree species to be tested and reduce the risk of trees planted within streetscapes failing. There has been little increase in the diversity of street tree species trialing since the formative street tree planting that gained traction with Clement Hodgkinson in the 1860s and with others in the early twentieth century. With the decline in the overall urban forest population and the onset of climate induced challenges, the selection of vigorous new species from around the world is urgent. Factors to consider in such evaluations should include:

- The evaluation of 'trial' trees after growing in street conditions. Can they be upgraded or downgraded? Growing of trial trees can be carried out in conjunction with university research.
- The reason for trees either succeeding or failing can be carefully monitored and recorded to eliminate anecdotal or subjective information. While interactive web pages such as TREENET and AUSTEP can be useful, their inputs cannot be qualified easily.

Trialling will be conducted in small and industrial streets to minimise impacts of any unsuccessful trials.

A Master List of Trial Trees is provided in Appendix 7.

2. Tree Species Selection Criteria

This chapter outlines the selection criteria that have been chosen to identify which tree species are most suitable for the City of Melbourne's diverse types of streets and parks.

2.1 There is No Perfect Tree

Selection criteria was developed to provide a quantitative and qualitative basis for the Master List of Street and Park Trees for the City of Melbourne.

It should be noted that the City of Melbourne has many constraints on, and requirements of, its trees. No one tree can manage these constraints and meet all of these requirements in a perfect way.

There is no one perfect urban tree.

It is also important to understand that there is no one type of urban environment. The urban environment is a varied conglomeration of microclimates and heterogeneous soil conditions. Above ground or below ground site conditions can change dramatically within the space of a few metres.

Consequently, a site analysis of each planting site will aid appropriate tree selection.

Climate change and increases in temperatures will also require consideration when selecting tree species.

The most successful strategy is to match the planting site limitations with the right tree for that site.

Appropriate site assessment and tree selection can have the following benefits:

- Minimised conflict between tree roots and adjacent infrastructure and buildings.
- Reduced incidence of pest and disease outbreaks. This can be achieved through selecting resistant varieties of trees and increasing species diversity through the City.
- Increased plant performance.
- Improved drought survival.
- Increased tree longevity so that tree benefits exceed costs. The benefit of an urban tree is directly proportional to its crown size or volume and longevity in the landscape.
- Reduced maintenance costs, particularly pruning. Pruning requirements can be reduced by selecting smaller trees under powerlines or narrow canopy form for main roads.
- Increased attractiveness of streetscapes, reinforcing the pervading landscape and architectural character.
- Reduced environmental demand – trees that have tolerance of drought and generally do not require additional resource inputs, such as irrigation or fertiliser, in order to perform satisfactorily.

Tree selection will take into account relative plant tolerances and adaptability, and integration into surrounding planting themes.

The basic issues regarding tree selection can be summarised as follows:

- Biological requirements relate to a tree's ability to tolerate urban conditions. The species selected should have high tolerance levels that will allow establishment and sustained growth while producing desired benefits with low management inputs. Biological requirements also relate to available root space to sustain the potential tree size.
- Ecological issues include tree diversity, maintaining and enhancing existing significant areas of native and remnant indigenous vegetation, selecting plants that do not have the potential to become woody weeds that impact on natural systems.
- Functional and spatial issues include the trees' ability to be pruned to provide required clearances, the trees root system and the degree of its impact on adjacent infrastructure, and above ground and below ground restrictions.
- Aesthetic issues consider the ability for trees to enhance the visual or other sensory (for example, olfactory) amenity of a streetscape or area.
- Tree longevity: the longer a tree is allowed to grow in a site the greater the benefits to the landscape and return on initial investment.
- Availability: selected trees will need to be commercially available in the desired numbers and size for planting programs.
- Litter drop: leaves, flowers, fruit and bark can cause maintenance issues and trip hazards.
- Structural integrity: stock should be known to have received appropriate formative treatment whilst in the production nursery.

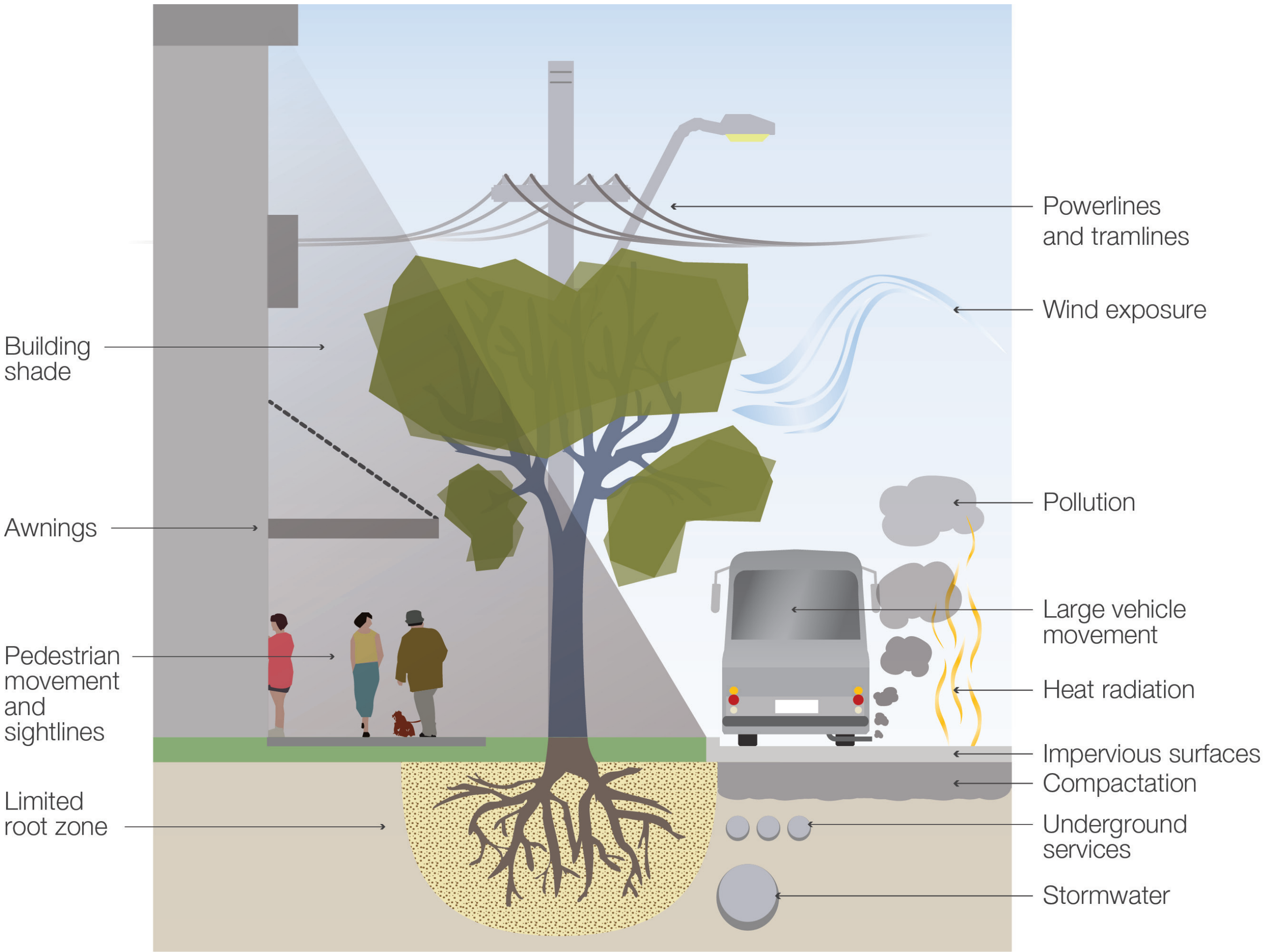


Figure 7: There is no perfect tree. The many constraints a tree must contend with to grow in inner Melbourne.

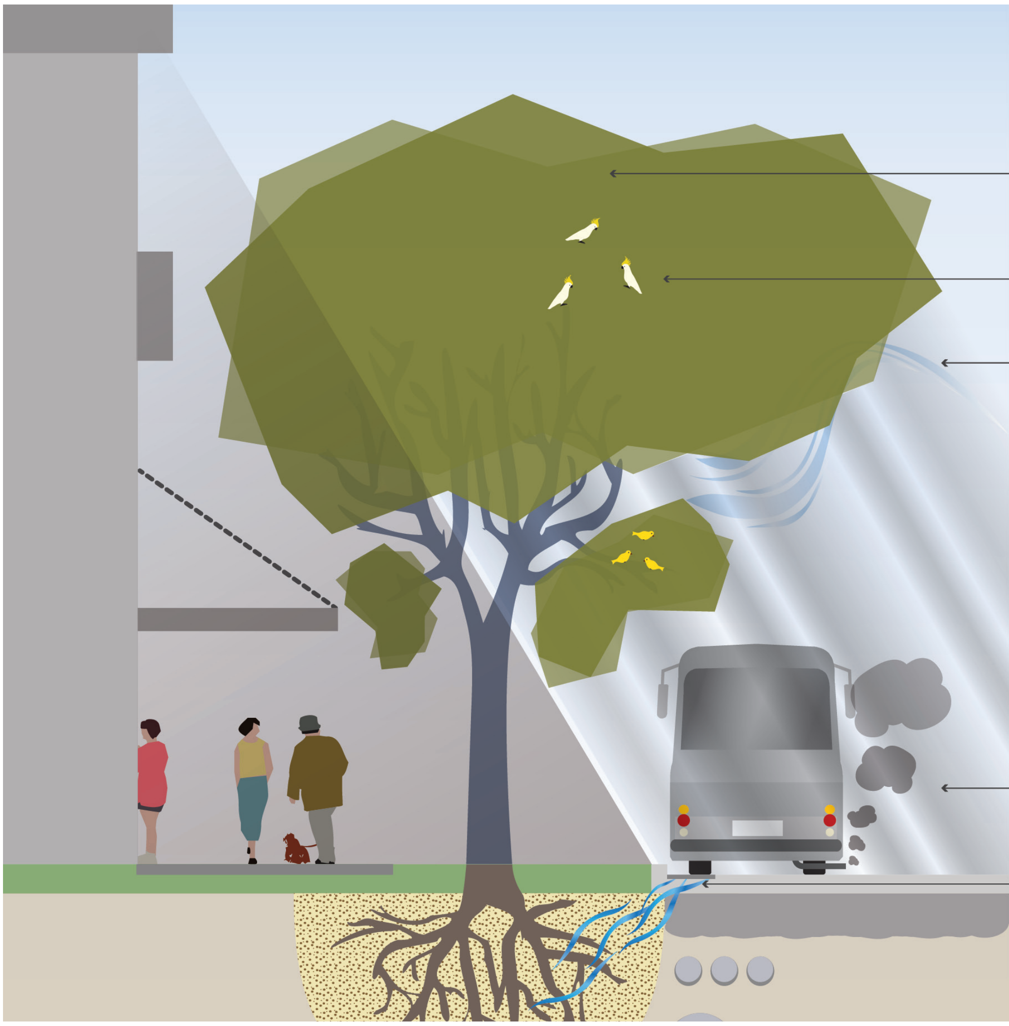


Figure 8: Tree opportunities. The preferred growing conditions and benefits of large canopy street trees.

2.2 Overview of Selection Criteria

The base selection criteria for determining the suitability of a street tree in Melbourne's urban environment and changing climatic conditions are those that affect its ability to adapt to urban conditions.

A broad range of species from varied habitats have been tested against these base selection criteria to ensure the best possible outcome given specific individual site outcomes and constraints.

Ten base selection criteria for adaptability to urban conditions

Ten base selection criteria for adaptability to urban conditions have been identified. They reflect the species' ability to respond to drought, heat, wind and pollution the species' lifespan, pathogen and pest susceptibility and manageability, affect on community health and allergies, the degree and quality of shade cast, maintenance requirements and extent of tree litter produced.

These 10 criteria that affect a species' adaptability to urban conditions are discussed more fully in the following pages.

As an aid to decision making, each species is given an overall numerical score from 1 to 50. This score is derived by assigning a value of 1 (low) to 5 (high) for each of the 10 base criteria.

While there is no such thing as the 'perfect street tree', a score of 50 points represents a highly adaptable and useful species.

The ten criteria were selected after lengthy discussion and review. The number of criteria was not selected as a neat '10'. Further review (in 5 years, or sooner if required) may conclude that the number and nature of these criteria can change. The higher the number of criteria the more accurate the scoring.

The ten identified base criteria are strictly performance or adaptability based.

Species that did not rank well against the ten base selection criteria were removed from the Master List of Street and Park Trees – the list of trees adaptable to urban conditions.

The Master List of Street and Park Trees includes all species that ranked well for being adaptable to urban conditions.

The highest scoring tree for urban adaptability is the Kurrajong (*Brachychiton populneus*).

As a street tree the Kurrajong may not be to everyone's aesthetic tastes or provide the streetscape amenity that other lesser scoring trees can provide.

Moreover, it may not be suitable for many specific locations within the City of Melbourne – for instance in a shady laneway.

Additional criteria are needed to choose a street tree.

Additional criteria

These criteria guide selection of the 'right tree for the right place'. They consider a trees suitability for being grown beneath power lines, in building shade, being pruned to allow vehicular and pedestrian movement, adaptability to waterlogged soils, and tolerance of soil compaction.

These additional criteria are discussed more fully in the following pages.

Location Types

This strategy identifies 13 street location types and 2 park location types within the City of Melbourne.

Each of the 15 Location Types is associated with a set of minimum conditions necessary for the success of a street tree in that environment. Species can be rated for their suitability against each of the 15 Location Types. Tree lists for each of the 15 Location Types can thus be generated.

These species lists for each Location Type can be used by Council in precinct plan applications in which further considerations are then overlaid on this these general and more specific species selection criteria.

The City of Melbourne Street and Park Location Types are discussed more fully in Section 3.

Non-rated Criteria

Additional considerations that may be used to further refine the selection of a street tree include, for example, heritage, biodiversity goals, microclimate goals, aesthetics and character. This strategy does not rate tree species against these criteria.

Park Trees

While most street trees can be grown in parks, the reverse is not always possible. Park trees include species that require greater root volumes than those generally achievable in the streetscape environment, and species of large size.

The list of park trees considered adaptable to urban conditions is different to the list of street trees considered adaptable to urban conditions. Not all of the ten base criteria for adaptability to urban conditions have been applied to determine an appropriate Master List of Park Trees. The criteria for selection do not include pollution tolerance, potential as allergen, and tree litter.

Park trees are generally larger tree species and cultivars suitable for planting in larger open spaces with reduced above and below ground constraints. Trees are generally able to develop natural form.

2.3 The Ten Base Selection Criteria Affecting Adaptability to Urban Conditions

Adaptability to urban conditions is a culmination of various plant tolerances that make a particular species or cultivar more or less suited to planting in urban landscapes, and here specifically the urban landscape of the City of Melbourne.

Each species' adaptability to urban conditions was given an overall numerical score from 1 to 50. This score was derived by assigning a value of 1 (low) to 5 (high) for each of the 10 base criteria.

The ten base criteria are:

- Drought tolerance
- Heat tolerance
- Wind tolerance
- Longetivity
- Pollution tolerance
- Pathogen and pest susceptibility and manageability
- Potential as allergen
- Shade cast
- Maintenance required
- Tree litter

Anthracnose infected leaf.

Possum grazing.

Drought Tolerance

Drought tolerance is defined as the ability of a species to withstand extended dry periods. Generally plants that require less water (once they are established) are drought tolerant because they are adapted to regions with frequent drought or to soils with low water-holding capacity.

Value rating:
1 = not tolerant of extended dry periods.
5 = Highly tolerant of extended dry periods

Heat Tolerance

Heat stress can be defined as the rise in temperature beyond a threshold level for a period of time sufficient to cause irreversible damage to plant growth and development. Transitory or constantly high temperatures cause an array of changes to plant growth.

Value rating:
1 = Low = not tolerant of transitory or constantly high temperatures.
5 = High = Highly tolerant of transitory or constantly high temperatures.

Wind Tolerance

Degree to which species/variety is susceptible to limb breakage.

Value rating:

1 = Low tolerance to wind loads and generally resistant to limb breakage.
3 = Moderate tolerance to wind loads and generally resistant to limb breakage.
5 = High tolerance to wind loads and generally resistant to limb breakage.

Longevity

Expected life span that a tree species can be retained in a safe and aesthetically pleasing manner in the situation (providing site conditions remain unchanged). Most urban trees have reduced life spans compared to those found in natural habitats.

Value rating:

1 = short lived (< 50 years).
2 = Moderate life span (50-100 years).
3 = Moderate to long-lived species (100-150 years).
what about 5?
4 = Long-lived species (> 150 years).

Pollution Tolerance

Air pollutants can harm trees by two means; by being absorbed as chemical contaminants through stomata, and by being absorbed as dust and particulate matter on the surface of the leaf. Virtually all of the pollutants to trees are airborne, and include fluorides, oxidants, sulfur dioxide and carbon monoxide. Sunlight reacts with oxidants to form tree pollutants, like ozone and PAN (peroxyl acetyl nitrate). The effects of pollutants on trees can cause the tree to weaken and die.

The tolerance of species to pollution is largely related to their avoidance (or not) of uptake of pollutants by the leaves or in a biochemical tolerance of pollutants. Some plants can metabolize pollutants into less toxic substances. There is enormous variability between species as to their tolerance to pollution.

Pollution ratings are primarily based on referenced literature and experience.

Value rating:
5 = High = Highly tolerant of pollution
3 = Moderate = Moderately tolerant of pollution
1 = Low = poorly tolerant of pollution).

Heat stress.

Plastic bags trapped by tree branches: visual pollution.

Pathogen and Pest Susceptibility and Manageability

This rating considers a particular species susceptibility to pests and pathogens. Major pests currently requiring management input are listed in Table 7. Potential pathogens that currently are not present but could impact on species have also been listed (see Table 8).

Value rating:
1 = High susceptibility to pathogens or pests, with control difficult.
5 = Low susceptibility to pathogens and pests, and control easy.

Potential as Allergen

Of the 50,000 different kinds of trees, less than 100 have been shown to cause allergies. Most allergies are specific to one type of tree or to the male cultivar of certain trees. The degree of allergic reaction, and the physical origin of the allergen (for instance, sap) known to cause allergic reaction, are indicated on the tree matrix.

Value rating:
1 = High potential as an allergen.
5 = Low potential as an allergen.

Shade Cast

This rating represents a qualitative estimate of the degree of shade cast projected by a tree. This rating also considers the form of the tree, for instance a broad tree will cast greater shade compared to a fastigiate tree.

Value rating:
1 = low shade cast.
2 = Moderate to low shade cast.
3 = Moderate shade cast.
4 = Moderate to high shade cast.
5 = Heavy shade cast.

Maintenance Required

This rating assumes typical pruning maintenance works such as pruning for sight clearances and clearance of powerlines. Maintenance activities are generally higher in a younger tree in order to attain the form to suit site constraints. This rating also indicates any specific maintenance requirements that may be required.

Levels:
5 = Low – Due to size or growth habit of the plant the degree of maintenance required would be less than the perceived maintenance inputs.
3 = Moderate – Typical assumes current cyclic pruning programs to meet site constraints, risk management and legislative requirements.
1 = High – Expected maintenance levels are higher than current maintenance standards, representing greater potential impacts with infrastructure or additional seasonal requirements.

Moderate to Heavy Shade: Eg. *Ulmus procera*

Moderate Shade: Eg. *Melia azaderach* and *Celtis australis*

Moderate to Light Shade: Eg. *Angophora costata*

Light Shade: Eg. *Corymbia citriodora*

Heavy Shade: Eg. *Ficus microcarpa* ‘Hillii’ and Waterhousia

Tree Litter

All trees will shed litter, leaves, bark, flowers or fruit at some time during a given growing season. As far as is possible the tree selections generally do not drop excessive litter. There are exceptions however, such as Magenta Brush Cherry, as these trees have other characteristics which make them suitable for certain planting situations.

Where excessive litter is a known for a particular species or cultivar, it has been noted on the tree matrix.

Value rating:
1 = Produces a considerable amount of troublesome litter.
5 = produces little troublesome litter.

2.4 Additional Criteria

Street type criteria are a further set of criteria that determine the tree selection for a specific type of street. Various types of street have specific affects on light availability, or restrictions such as the presence of overhead powerlines. These criteria guide selection of the 'right tree for the right place'.

Shade Tolerance

Most tree species require full sun. There are some species that will tolerate lower light levels of part shade. There are no species selected in the matrix that tolerate full shade (less than 6 hours of filtered sunlight per day).

Categories:
Full sun – More than 6 hours of direct sunlight.
Full sun to part-shade – Either more than 6 hours of direct sunlight a day or filtered light for most of the day. (These species would be more suitable for streets that have low direct sun through a day.

Power Lines

Tree species were rated as being suitable for planting under power lines without pruning, with pruning (if specifically known, for instance Smooth-barked Apple (*Angophora costata*), or not suitable.

Soil Compaction Tolerance

Tree species were rated for their ability to withstand the highly compacted soils that often occur in the urban environment.

Waterlogged Soil Tolerance

Trees that can tolerate waterlogged soils are particularly useful for WSUD applications. Soils temporarily inundated with water lead to poor aeration. Species tolerant of waterlogged soils are often also tolerant of compacted soil conditions.

Value rating:
1 = not tolerant of periodic inundation.
3 = Moderate tolerance of periodic inundation.
5 = Highly tolerant of periodic inundation (and of low oxygen in soils).

Prunability for Vehicle Clearance

Trees often need to be pruned to allow clear passage of adjacent vehicular traffic.

Trees in laneway that must withstand heavy shade

Trees pruned heavily around power lines

Small, Medium and Large Planting Sites

Small, medium and large sites relate to the size of the potential tree planting sites. Note that a smaller site could sustain a larger tree species if the site and soils (planting system) were modified to allow a larger tree size.

Table 10 provides general guidelines for planting site sizes.

Table 9: Planting site size and dimensions and maximum tree size at maturity (adapted from Gilman, 1997)

Planting site	Total planting area (lawn, island, or soil strip)	Planting strip width	Distance from trunk to pavement or wall	Maximum tree size at maturity
Small	Less than 9.5m2	1.0m to 1.3m	0.6m	Small (less than 9m tall)
Medium	9.5m2 to 18.5m2	1.3m to 2.5m	1.2m	Medium (less than 15m tall)
Large	More than 18.5m2	> 2.5m	> 1.5m	Large (taller than 15m)

3. Tree Planting in Melbourne

This chapter identifies the typical tree growing conditions across the types of street and park environment in Melbourne, with a focus on street trees and streetscapes.

3.1 Introduction

The streets of Melbourne support a robust urban forest of approximately 22,800 trees. The streets have been planned with the intention of trees being an integral component. The street geometries of Melbourne have traditionally allowed for relatively generous growing areas. During the 1860s when Melbourne rapidly expanded, boulevards, wide medians and verges within the city areas and the main thoroughfares into the city were intentionally set out to allow tree planting to contribute to the streetscape character. Surveyor Robert Hoddle, at odds with Governor King, managed to ensure that every second north-south street be 95 feet (28.96m) wide.

The north-south and east-west grid has allowed strong linear avenue planting of consistent species that gives Melbourne a particular character not achieved in other Australian capitals.

There have been a number of spikes of diversification of street and park trees in Melbourne's history. These spikes in experimentation were championed by a number of motivated directors of the Royal Botanic Gardens and landscape designers. In most of these instances a desire for botanical experimentation and trialing resulted in higher species diversity. Trees that were grown in the parks were used in the streetscapes. Curious botanists like Ferdinand von Mueller experimented with a number of conifers from around the world. With climatic change and more extreme weather events expected in Melbourne, it is interesting to note how well conifers are adapted to such extremes.

In the 1920s and 1930s there was experimentation with Australian rainforest species and myrtaceous species. Deciduous trees were also extensively planted, including many of the Elms currently part of the urban forest. This period of planting has contributed to many of the mature trees that are now in decline within the city and parks. During the 1970s the resurgence of interest in native and endemic plants contributed greater species diversity to the streetscape. Ironically, some of the earlier plantings of *Melaleucas* were also condemned in the same period, blamed for infrastructure damage. Retrospectively, the damage that these smaller *Melaleucas* have caused is in dispute. This strategy recommends that some *Melaleucas* species continue contributing to the urban forest.

Platanus x *acerifolia* is a tree species that is fast growing, deciduous, and adaptable, and has been perceived as close to being the 'perfect street tree'. As a consequence huge numbers of Plane trees were planted in Melbourne in the 1980s and 1990s in Melbourne and across the globe in temperate climate cities.

The risk of creating an urban forest monoculture is becoming apparent in Melbourne with increasingly frequent droughts. In Sydney, the combination of Sycamore Lacebug and *anthracnose* infestation results in the uban forest of Plane tress developing a distinct khaki haze in February-April. It is as characteristic a seasonal event as the November purple haze of the Jacarandas in the suburbs.

The City of Melbourne Urban Forest Strategy and Urban Forest Diversity Guidelines aim to create another spike of diversification and trialing in the history of Melbourne's park and street trees.

Central Activity District (CAD), Mixed Use, and Commercial Streets

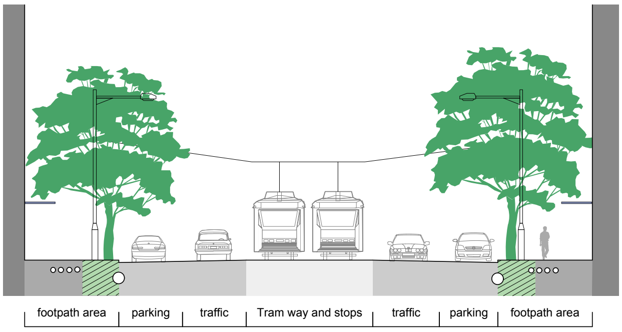
The city streets and boulevards, surveyed by Hoddle, have space for growing street trees. As development has increased post World War Two there is greater pressure for space in the street. Space for advertising, and increase in the amount of services conduits and car parking, have created greater competition with tree growing space. An increase in building height has also resulted in longer periods of overshadowing, and increased building density has produced hotter microclimates.

Generally, medians where they exist provide more space for growing trees in than the street's verges. Verge trees compete more for space than median trees, and so verge trees are more in conflict with human needs. Fortunately most of the overhead powerlines have been undergrounded, and while such undergrounding can cause restrictions to root growth area, it has eliminated canopy conflicts and so the potential for large trees is maintained.

The laneways are very narrow, and it is generally agreed that tree planting opportunities in these environments are limited due to space restrictions, low light, conflict with access requirements and commercial uses. Certain opportunities may still occur and the right tree species for the site will need close scrutiny.

Unfortunately, it is the trees in verges that are the most important for creating street tree amenity and shade. The north-south wide streets are congenial to large street tree planting, the east west streets and narrow streets have greater challenges, such as overshadowing and limited space. There are increasingly more opportunities for street tree planting as urban designers, politicians and Council planners are now prepared to change the internal geometries of streets to make them both more liveable and allow new opportunities for tree planting. Greater street tree diversity enables trees to be selected that can adapt to a variety of growing conditions, constraints and opportunities.

Refer to Chapter 4 for fact sheet on each Location Type.



Residential Streets

The residential streets of the City of Melbourne have huge potential for species diversification.

While more overhead services exist, particularly Optus cables, and in some instances the verges are narrower, the conditions for growing street trees in general provide greater opportunities than in the CAD.

Many residential streets have wide verges with no power lines, and have traffic calming 'blisters', parking lanes with lower frequency usage, little soil compaction from pedestrian traffic, and good solar access year round.

Medians are well populated with trees, but there is considerable potential for verge street tree diversification and better tree growth generally.

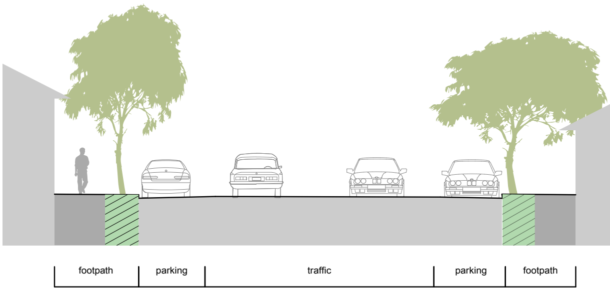
As with the city streets and boulevards, it is the street verges that are the most inhabited, so ideally this is where tree canopy cover should be located.

Residential streets provide a range of street conditions and types. The street geometry and width, overhead services or not, aspect, building awnings, access to adjacent soil volumes, parking arrangements, precinct character, water sensitive urban design opportunities, the age of the suburb, and streetscape design provide a multitude of scenarios.

Consequently, a large selection of tree species is required to reflect this broad range of planting situations.

Shorter streets and more diverse streetscape characters both enable and suit a finer grain of species implementation than is possible within the CAD.

Refer to Chapter 4 for fact sheet on each Location Type.

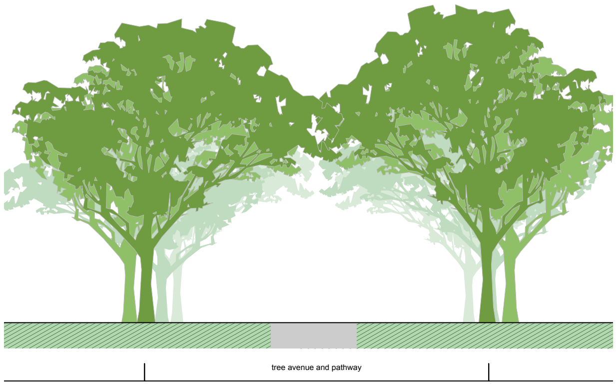


Park Types

The parks of Melbourne have a strong 'Victorian' era character that defines the city. The parks were opportunities for trialling Australian species, new species from other Botanical gardens, and recently discovered species from plant hunting expeditions. Fashions, environmental awareness, heritage, architectural styles and aesthetics have also influenced the composition of the City's tree species population.

In marked contrast to these 'Victorian' parks, parks such as Royal Park have a character with greater emphasis on ecological goals, habitat provision, preservation of the remnant vegetation, and a celebration of space.

Refer to Chapter 4 for fact sheet on each Location Type.



4. Choosing the Right Tree

This chapter identifies the process for selecting the most appropriate tree species for a particular location.

4.1 Introduction

To successfully choose a street tree it is necessary to determine the type of location in which the tree is to be grown.

The right choice of species for a street tree will depend on a number of factors. Consideration needs to be given to:

- Zoning: whether the tree is in a residential area or the CAD.
- The street's form and use: Is the street wide or narrow, does it have powerlines? What type of vehicles use the street?
- The location within the street: Is the tree on the street's edge or does the street have a median in which the tree is to be positioned.
- Desired qualities: How much maintenance can be provided? How long-lived is the desired tree? How drought tolerant should the tree be? Pollution tolerant? How much shade is to be provided by the tree?

As discussed in Section 3, this strategy identifies 13 street location types and 2 park location types within the City of Melbourne.

Each of the 15 Location Types is associated with a set of minimum conditions necessary for the success of a tree in that environment.

For instance, the criteria for a tree in the wide verge of a CAD street are: canopy > 8m, height > 10m, shade rating > 2, pollution rating > 2, no overhead powerlines.

Species have been rated for their suitability against each of the 15 Location Types.

Tree lists for each Location Type can be found in the following pages.

These species lists for each Location Type can be used by Council in precinct plan applications in which further considerations are then overlaid on this these general and more specific species selection criteria.

The choice of tree can then be refined by considering additional criteria such as heritage and neighbourhood character.

Step 1 — Use the diagram on the following page to determine which of the 13 Street and 2 Park Location Types best describes the location.

Step 2 — Look up the list of species appropriate to location

Step 3 — Consider additional criteria that might refine the species selection, for instance heritage or neighbourhood character

Step 4 — Choose from the tree/s species

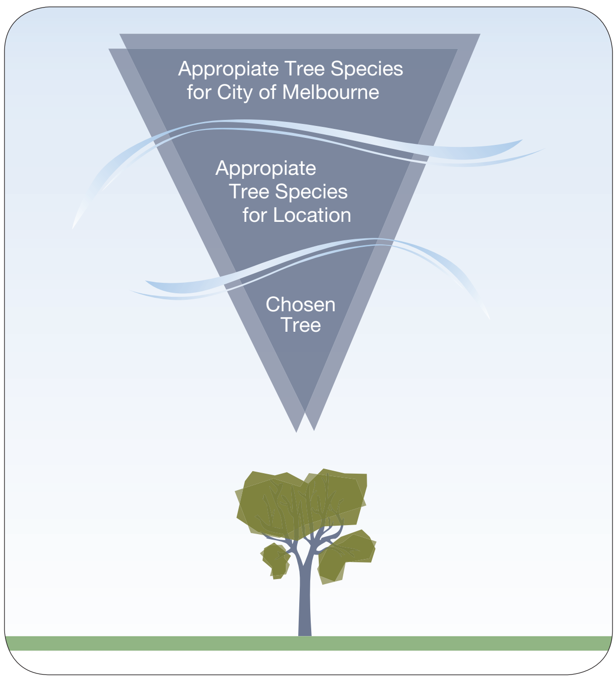
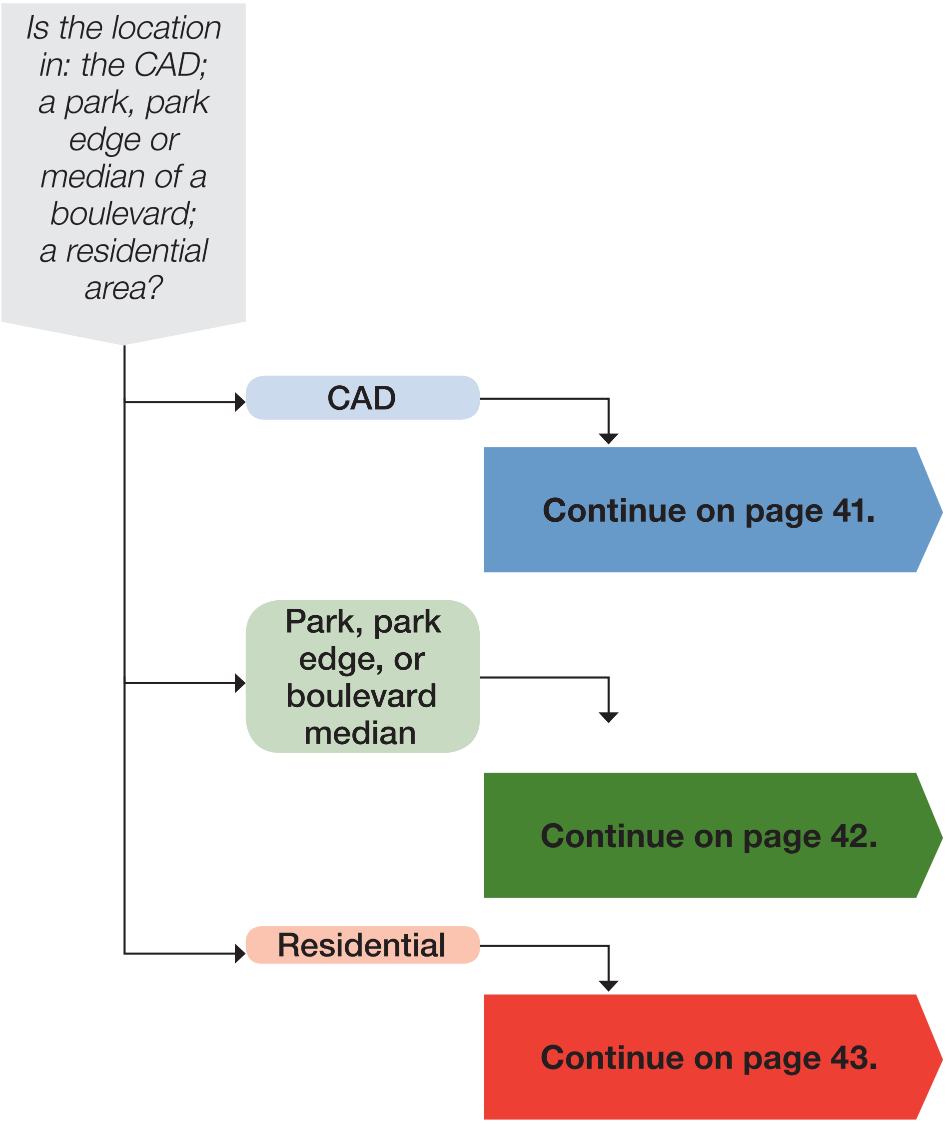


Figure 9: How to choose the right tree for the right location.

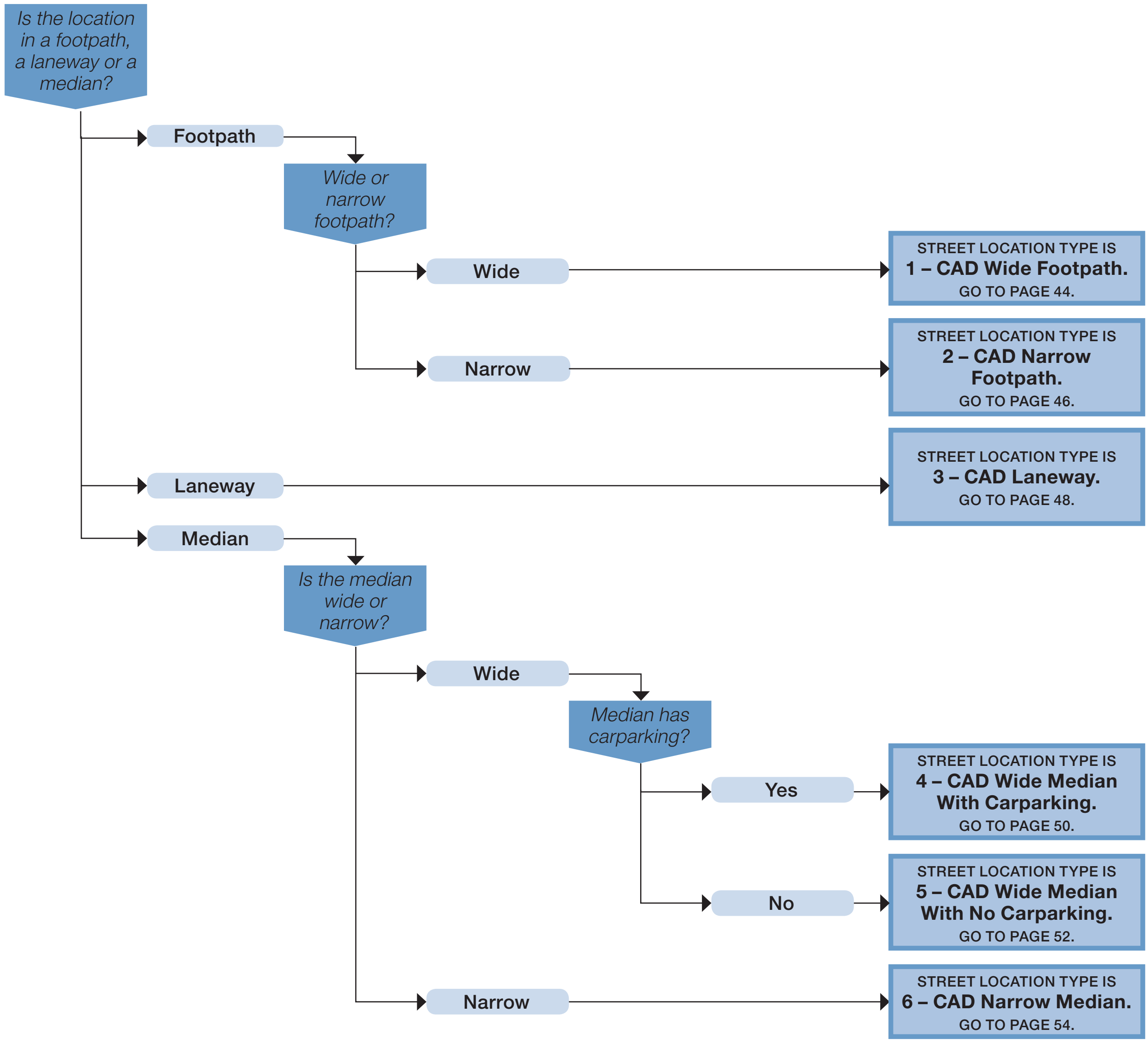
4.2 Determining Location Type

To determine the type of location in which the tree is to be grown, follow the diagram on this page and over the following 3 pages.

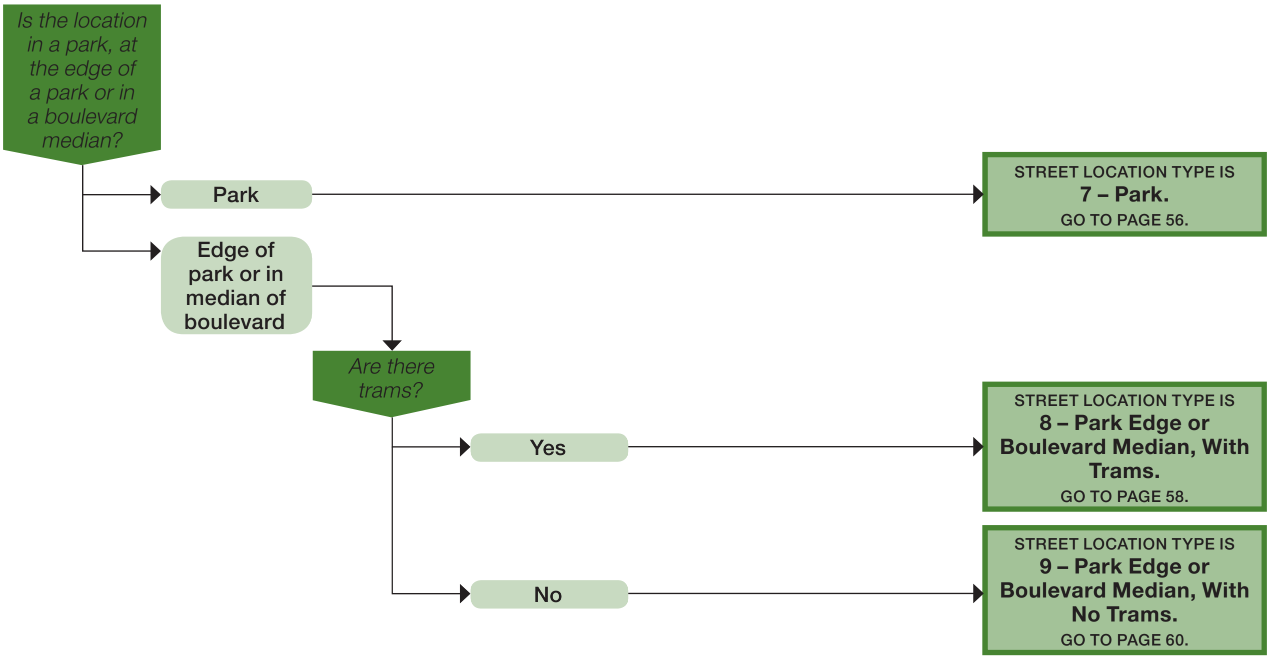
Zoning of Street or Park Location



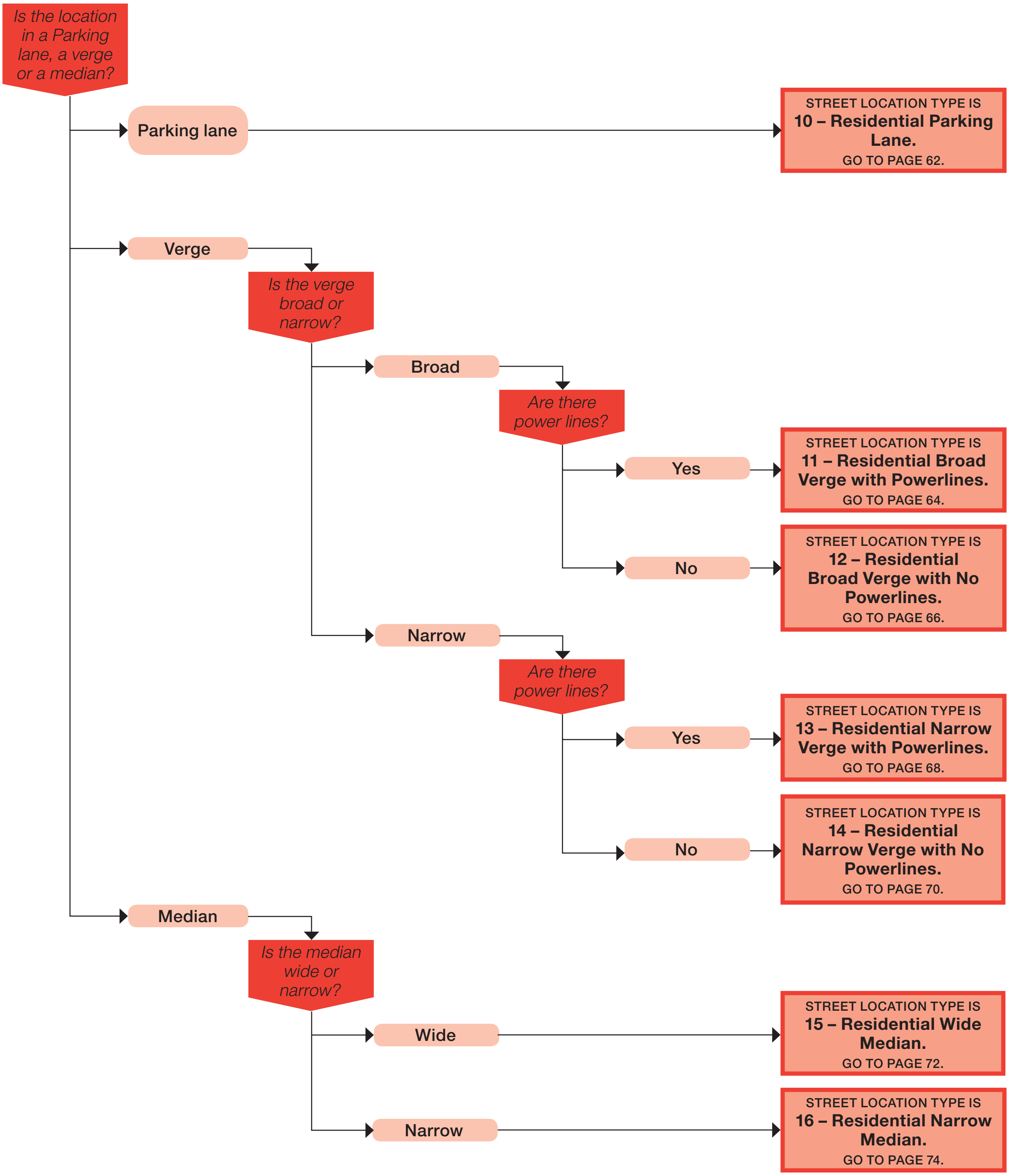
CAD Street Type Location



Park, Park Edge, or Boulevard Median Type Location



Residential Street Type Location

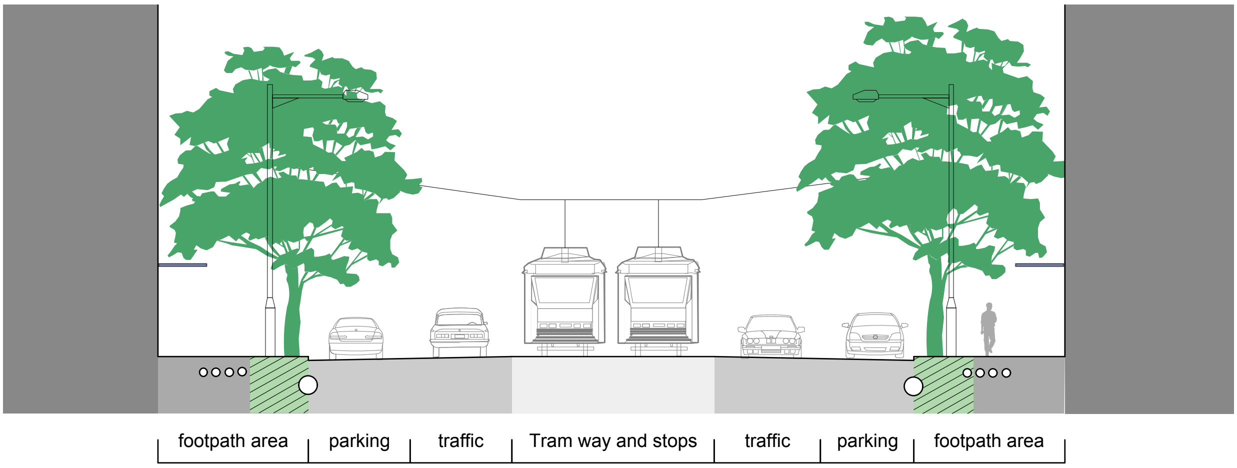


4.3 Location Types and Tree Selection Lists

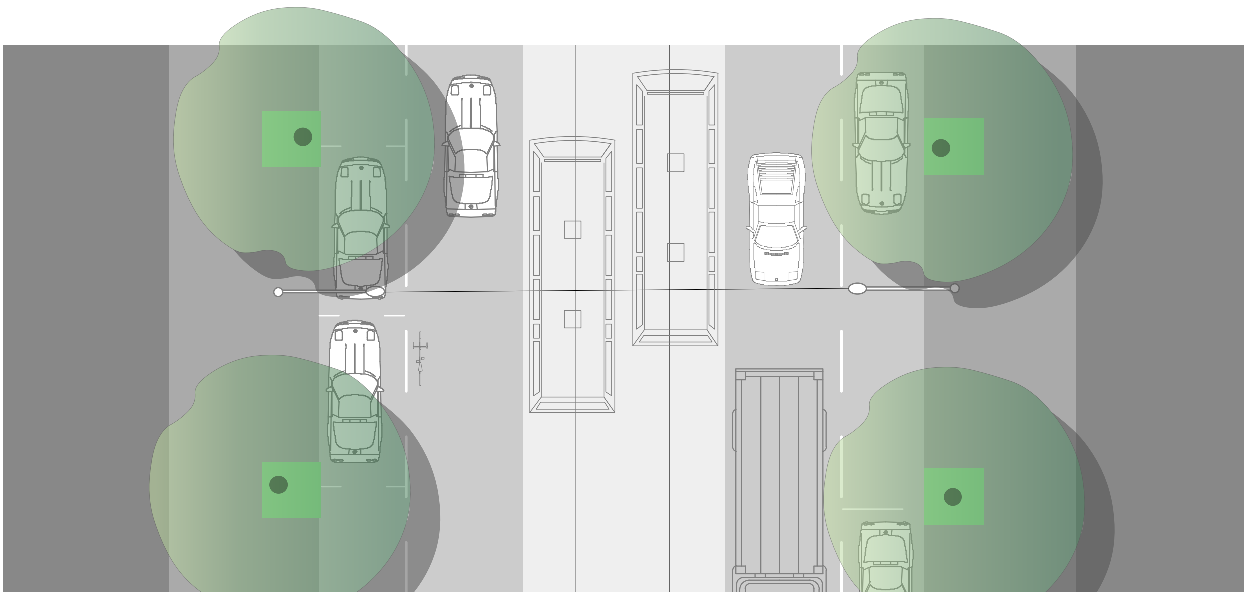
Location Type 1 – CAD Wide Footpath

Description of Key Characteristics

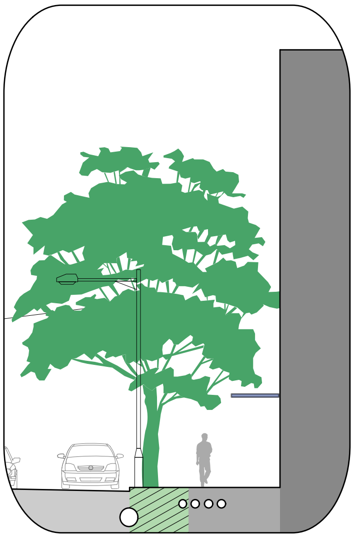
Street Width	30 metres
Traffic Lanes	2 lanes with central tramway, and bike lanes. Predominantly running east/west
Overhead	Powerlines, tram cabling
Buildings	High, awnings
Parking	Parallel kerbside
Road centre	Tramway
Pathways	5.4 metre footpath
Trees	Kerb edge avenue
Examples	Collins Street, Bourke Street



Typical Section



Typical Plan



Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m
Shade rating >2
Pollution rating >2
No powerlines

Street Tree Considerations

Requires formative pruning
Minimum height clearance of 4.6 m on road
Minimum height clearance of 2.5 m on footpath
Requires shade rating greater than 3
Requires high maintenance
Low litter drop

Successful Tree Application

Problematic Tree Application

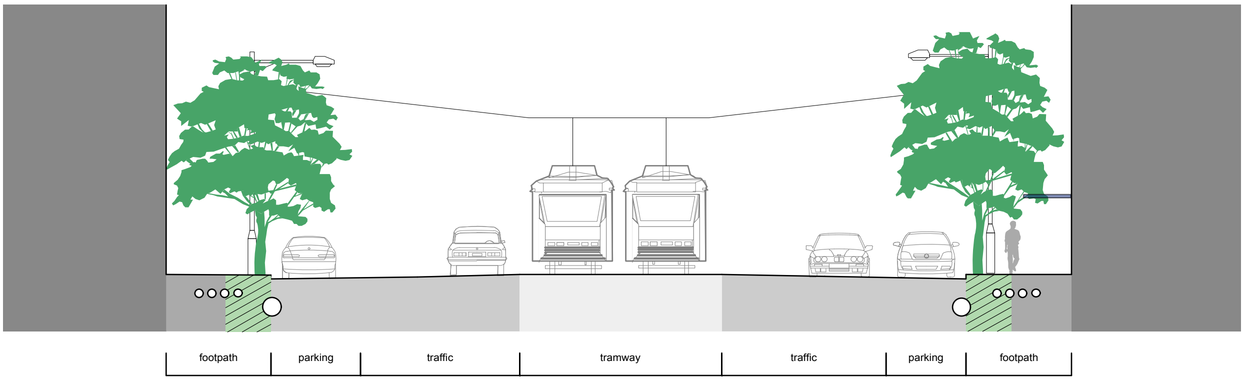
Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Allocasuarina torulosa
Angophora costata
Angophora floribunda
Araucaria cunninghamii
Araucaria heterophylla
Banksia integrifolia subsp. integrifolia
Banksia serrata
Casuarina cunninghamiana
Cedrus atlantica
Cedrus deodara
Celtis australis
Celtis occidentalis
Corymbia maculata
Cupressus glabra (syn. C. arizonica)
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus leucoxylon
Eucalyptus melliodora
Eucalyptus polyanthemos
Eucalyptus scoparia
Eucalyptus sideroxylon
Ficus macrophylla
Ficus microcarpa var. hillii
Fraxinus excelsior 'Aurea'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Ginkgo biloba
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Metasequoia glyptostroboides
Paulownia tomentosa
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Syzygium paniculatum
Taxodium distichum
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Ulmus x hollandica
Waterhousea floribunda
Zelkova serrata 'Green Vase'

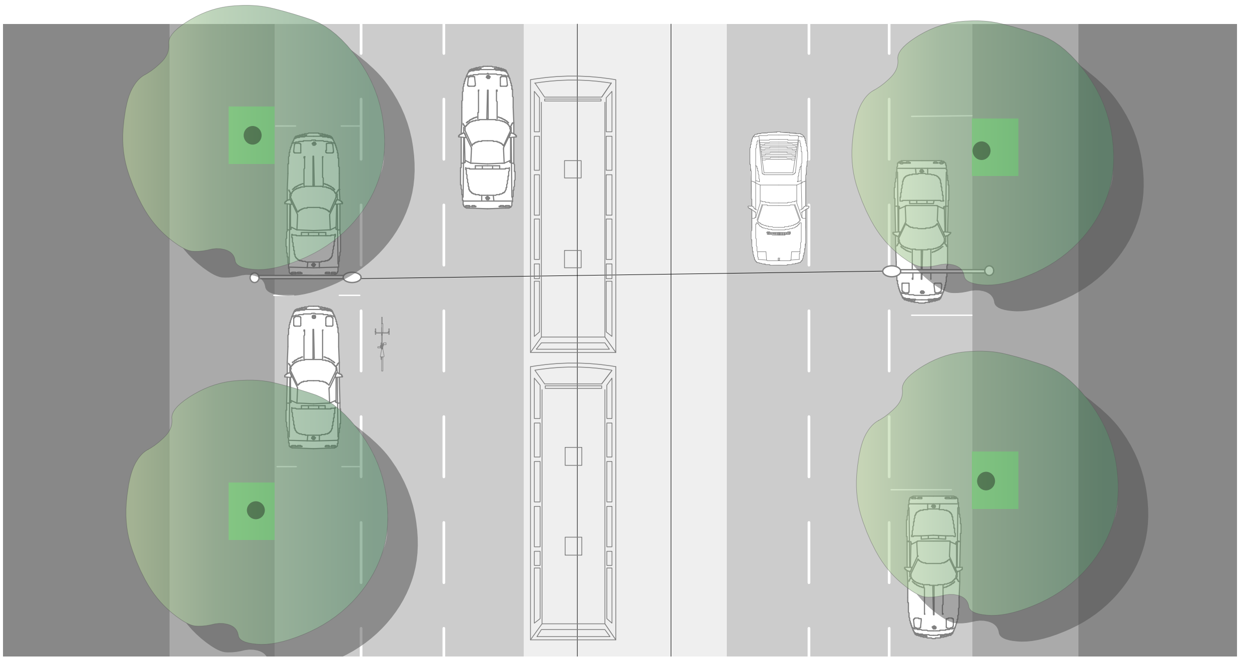
Location Type 2 – CAD Narrow Footpath

Description of Key Characteristics

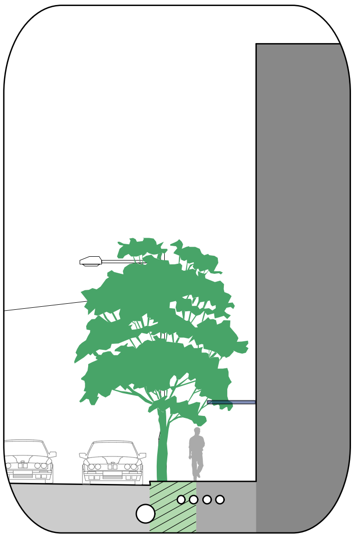
Street Width	30 metre
Traffic Lanes	4 lanes with central tramway, and bike lanes. Predominantly running east/west.
Overhead	Street lights, tram cabling
Buildings	Medium to high buildings at footpath edge
Parking	Parallel kerbside
Road centre	Tramway
Pathways	3.6 metre footpath
Trees	Footpath avenue
Example	Latrobe Street



Typical Section



Typical Plan



Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy < 10m
Height any
Shade rating >2
Pollution rating >2
No powerlines
Litter drop >2

Street Tree Considerations

Requires formative pruning
Limited canopy spread 5-12 m (close to buildings/awnings)
Minimum height clearance of 4.6 m on road
Minimum height clearance of 2.5 m on footpath
Requires shade rating greater than 3
Requires high maintenance
Cope with part shade from building
Low litter drop

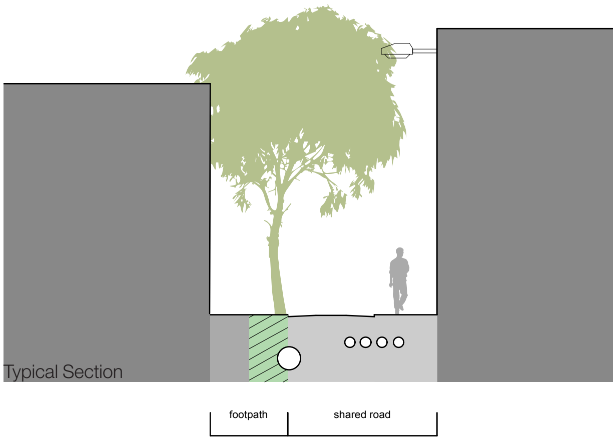
Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer buergerianum
Acer campestre 'Elsrijk'
Acer campestre 'Evelyn'
Acer platanoides 'Crimson Sentry'
Acer platanoides 'Globosum'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Agonis flexuosa
Allocasuarina littoralis
Allocasuarina verticillata
Brachychiton acerifolius
Brachychiton populneus
Brachychiton rupestris
Brachychiton x roseus
Callistemon 'Harkness'
Callistemon salignus
Callistemon viminalis
Casuarina glauca
Catalpa bignonioides 'Nana'
Celtis occidentalis
Cercis siliquastrum
Cinnamomum camphora
Corymbia ficifolia
Cupaniopsis anachardioides
Cupressus glabra (syn. C. arizonica)
Cupressus sempervirens
Eucalyptus bancroftii
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon dwarf form
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus nicholii
Eucalyptus pulchella
Eucalyptus sideroxylon
Eucalyptus spathulata
Eucalyptus stoatei
Ficus microcarpa var. hillii
Ficus platypoda
Ficus rubiginosa
Fraxinus excelsior 'Aurea'
Fraxinus ornus
Fraxinus ornus 'Meczek'
Fraxinus pennsylvanica 'Aerial'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Geijera parviflora
Ginkgo biloba 'Princeton Sentry'
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Lagerstroemia indica x L. fauriei varieties
Leptospermum petersonii
Liquidambar formosana
Lophostemon confertus
Magnolia grandiflora 'Exmouth'
Melia azedarach
Metasequoia glyptostroboides
Phoenix canariensis
Pistacia chinensis
Pyrus calleryana varieties
Quercus robur 'Fastigiata'
Robinia pseudoacacia (Varieties)
Schinus areira
Sophora japonica 'Princeton Upright'
Stenocarpus sinuatus
Syzygium australe 'Pinnacle'
Syzygium paniculatum
Tilia cordata 'Greenspire'
Trachycarpus fortunei
Tristaniopsis laurina
Ulmus parvifolia
Ulmus procera
Ulmus x hollandica
Washingtonia filifera
Washingtonia robusta
Waterhousea floribunda

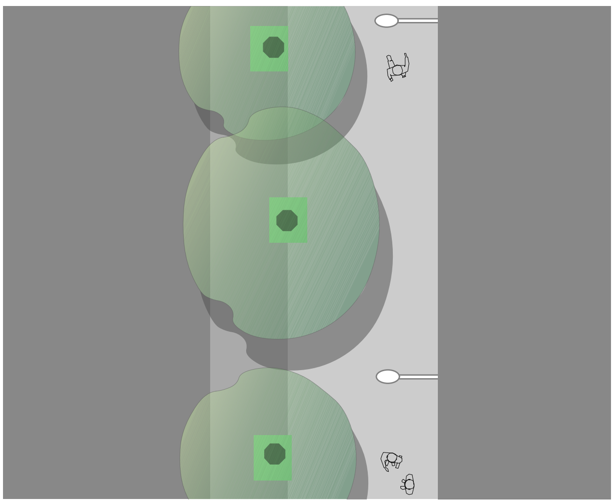
Location Type 3 – CAD Laneway

Description of Key Characteristics

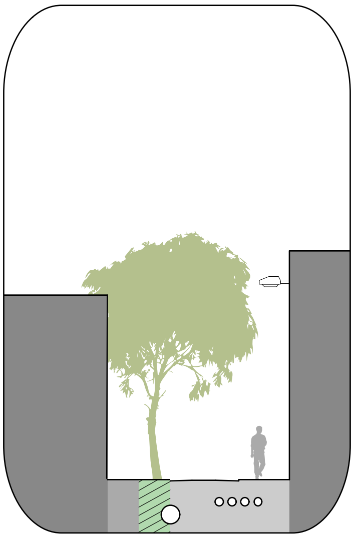
Street Width	6-8 metre
Traffic Lanes	Single lane, often running south/north. Often shared with pedestrians and bike lane
Overhead	
Buildings	Medium to high
Parking	None
Road centre	–
Pathways	1-2 metre footpath, building
Trees	Mostly on single side
Example	Royal Lane, Hardware Lane



Typical Section



Typical Plan



Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy < 10m
Height any
Pollution rating >2
No powerlines
Litter drop >2
Building shade tolerance -yes

Street Tree Considerations

Limited canopy spread 6-8 m
Tolerate shade
Minimum height clearance of 4.6 m

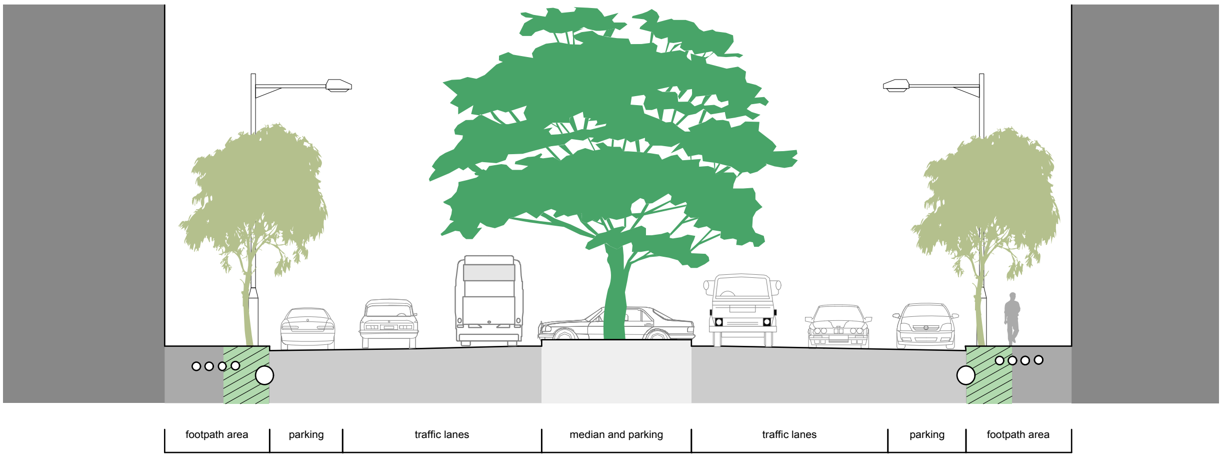
Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer campestre 'Elsrijk'
Acer campestre 'Evelyn'
Catalpa bignonioides 'Nana'
Cercis siliquastrum
Cupaniopsis anachardioides
Eucalyptus leucoxylon dwarf form
Ficus rubiginosa
Ginkgo biloba 'Princeton Sentry'
Gleditsia triacanthos var.inermis Varieties
Koelreuteria paniculata
Liquidambar formosana
Magnolia grandiflora 'Exmouth'
Melia azedarach
Robinia pseudoacacia (Varieties)
Sophora japonica 'Princeton Upright'
Syzygium australe 'Pinnacle'
Tilia cordata 'Greenspire'
Trachycarpus fortunei
Washingtonia filifera
Washingtonia robusta

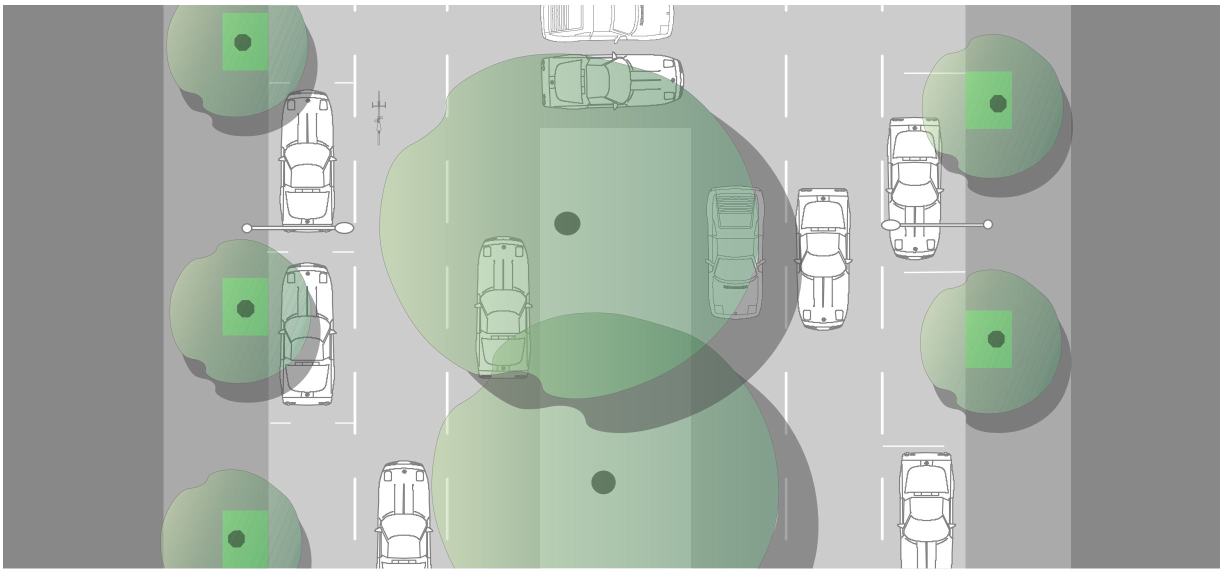
Location Type 4 – CAD Wide Median With Carparking

Description of Key Characteristics

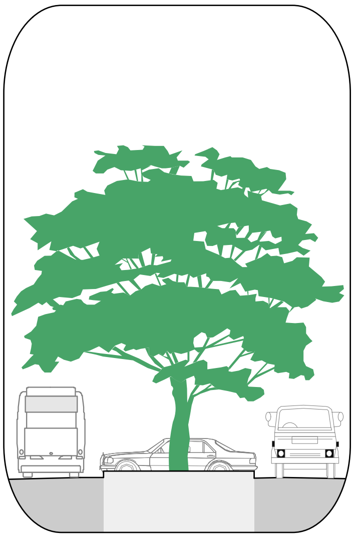
Street Width	30 metre
Traffic Lanes	4 lanes with central median, and bike lanes. Predominantly running north/south
Overhead	Lighting
Buildings	Medium to high. Awnings
Parking	Parallel kerbside. Central median
Road centre	5m median with intermittent parking and trees
Pathways	3.6 metre footpath
Trees	Kerb edge. Central median
Example	Russell Street, Lonsdale Street



Typical Section



Typical Plan



Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m
Shade rating any
Pollution rating >2
No powerlines
Litter drop >2

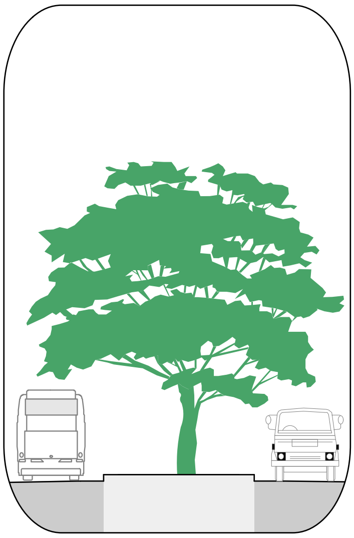
Street Tree Considerations

Tolerate full sun
High Crown/ large canopy spread required
Minimum height clearance of 4.6 m
Longevity

Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer buergerianum
Acer campestre 'Elsrijk'
Acer platanoides 'Crimson Sentry'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Allocasuarina torulosa
Angophora costata
Araucaria cunninghamii
Banksia integrifolia subsp. integrifolia
Brachychiton acerifolius
Brachychiton populneus
Brachychiton x roseus
Casuarina cunninghamiana
Casuarina glauca
Cedrus atlantica
Celtis australis
Celtis occidentalis
Corymbia citriodora
Corymbia maculata
Cupressus glabra (syn. C. arizonica)
Cupressus sempervirens
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus leucoxylon
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Ficus microcarpa var. hillii
Ficus platypoda
Ficus rubiginosa
Fraxinus excelsior 'Aurea'
Fraxinus ornus
Fraxinus pennsylvanica 'Aerial'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Geijera parviflora
Jacaranda mimosifolia
Lagerstroemia indica x L. fauriei varieties
Leptospermum petersonii
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Magnolia grandiflora 'Exmouth'
Melia azedarach
Metasequoia glyptostroboides
Olea europea
Paulownia tomentosa
Phoenix canariensis
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pinus pinea
Pistacia chinensis
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Syzygium paniculatum
Taxodium distichum
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Waterhousea floribunda
Zelkova serrata 'Green Vase'

Location Type 5 – CAD Wide Median With No Carparking



Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

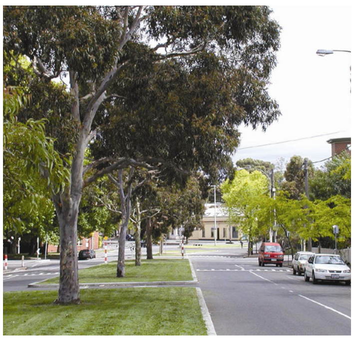
- Canopy > 8m
- Height > 10m
- Shade rating >2
- Pollution rating >2
- No powerlines
- Litter drop >2

Street Tree Considerations

- Tolerate full sun
- High Crown/ large canopy spread required
- Minimum height clearance of 4.6 m
- Longevity

Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Allocasuarina torulosa
Angophora costata
Angophora floribunda
Araucaria cunninghamii
Araucaria heterophylla
Banksia integrifolia subsp. integrifolia
Banksia serrata
Casuarina cunninghamiana
Cedrus atlantica
Cedrus deodara
Celtis australis
Celtis occidentalis
Corymbia maculata
Cupressus glabra (syn. C. arizonica)
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus leucoxylon
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus melliodora
Eucalyptus polyanthemos
Eucalyptus scoparia
Eucalyptus sideroxylon
Ficus macrophylla
Ficus microcarpa var. hillii
Fraxinus excelsior 'Aurea'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Ginkgo biloba
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Metasequoia glyptostroboides
Paulownia tomentosa
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Syzygium paniculatum
Taxodium distichum
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Ulmus x hollandica
Waterhousea floribunda
Zelkova serrata 'Green Vase'



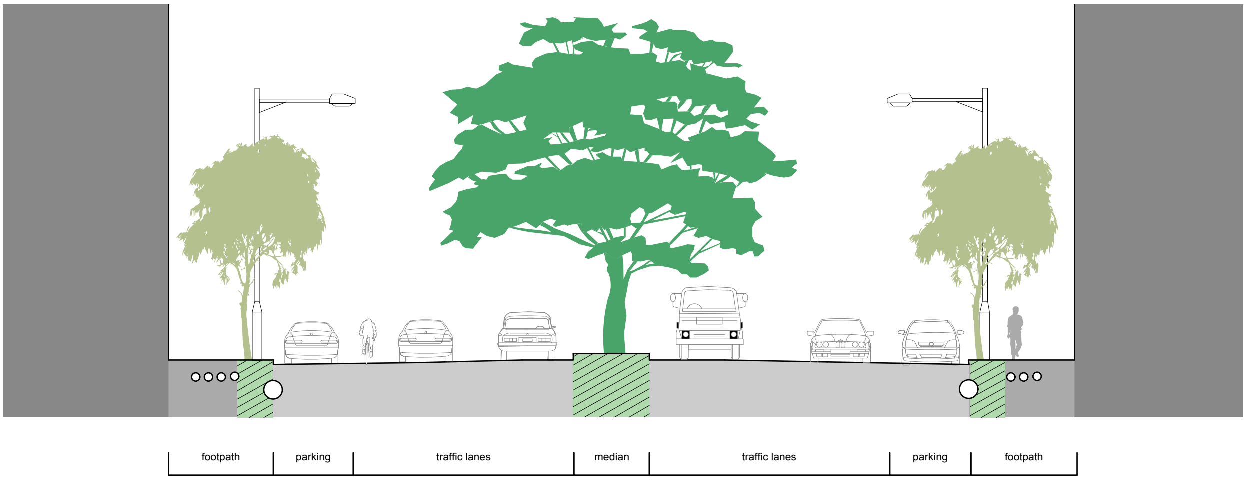
Successful Tree Application

Problematic Tree Application

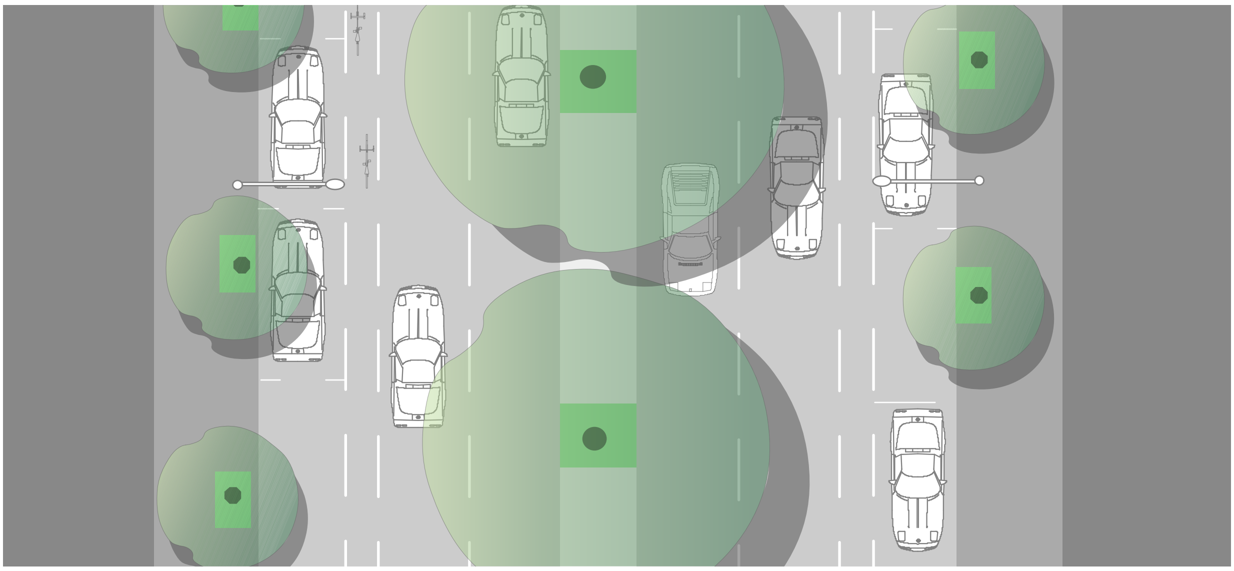
Location Type 6 – CAD Narrow Median

Description of Key Characteristics

Street Width	30 metre
Traffic Lanes	4 lanes with central median, and bike lanes. Predominantly running north/south.
Overhead	Lighting
Buildings	Medium to high. Awnings
Parking	Parallel kerbside
Road centre	2.5m planted median
Pathways	3.6 metre footpath
Trees	Kerb edge and central median
Example	King Street



Typical Section



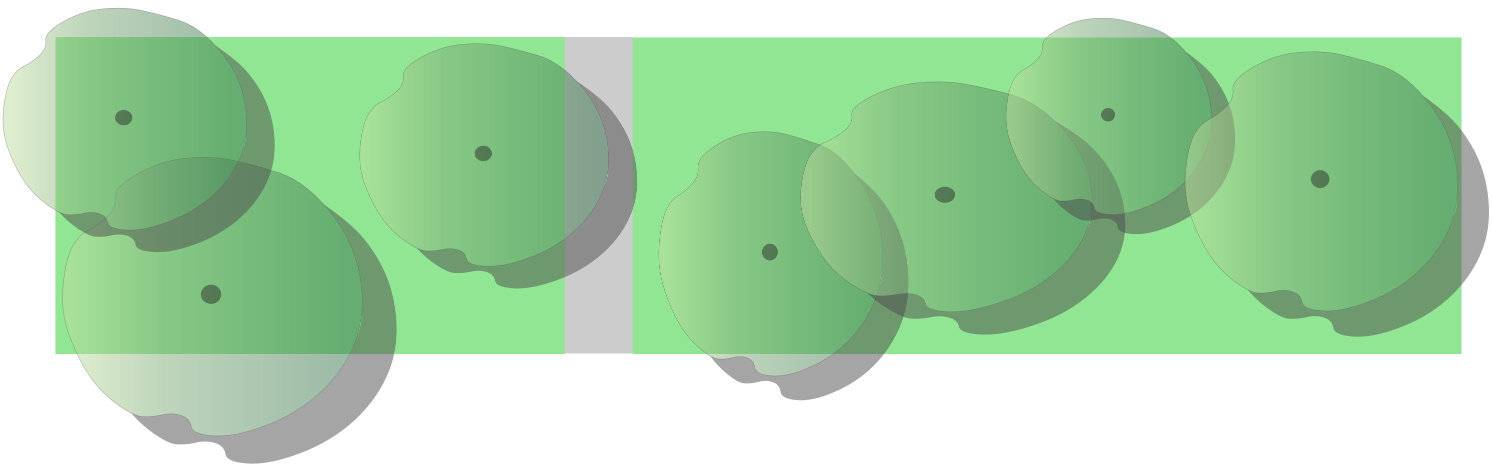
Typical Plan

Location Type 7 – Park

Description of Key Characteristics

Street Width	–
Traffic Lanes	–
Overhead	None
Buildings	–
Parking	Varied
Road centre	–
Pathways	Various pathways from road
Trees	Specimen plantings, mixed
Example	Botanic Park

Typical Section



Typical Plan

Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m

Street Tree Considerations

Unlimited canopy spread
Tolerate full sun
Longevity
Biodiversity potential – foraging habitat

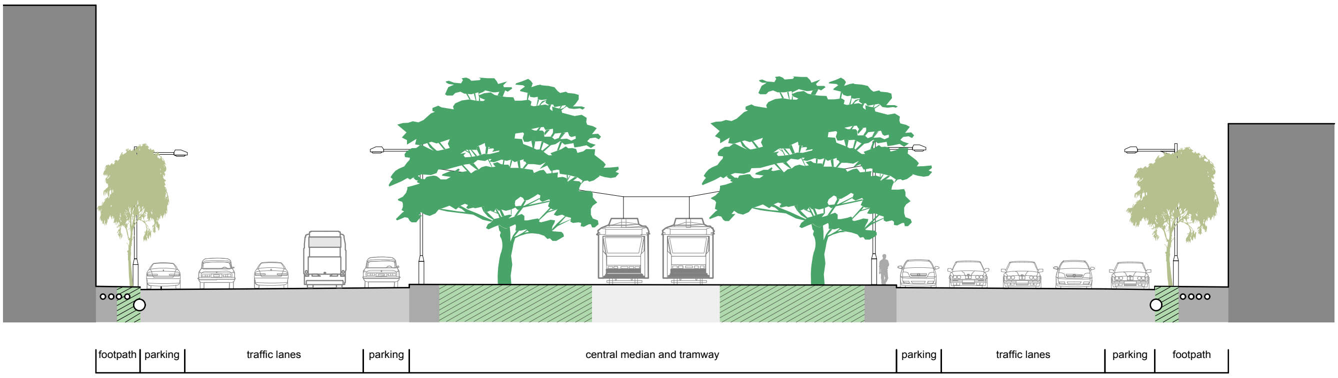
Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer rubrum 'October Glory'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Agathis robusta
Angophora costata
Angophora floribunda
Araucaria cunninghamii
Araucaria heterophylla
Brachychiton acerifolius
Catalpa bignonioides
Cedrus atlantica
Cedrus deodara
Corymbia citriodora
Corymbia maculata
Cupressus torulosa
Ficus macrophylla
Fraxinus pennsylvanica 'Cimmaron'
Liquidambar styraciflua 'Rotundiloba'
Metasequoia glyptostroboides
Phoenix canariensis
Pinus canariensis
Pinus patula
Pinus pinea
Podocarpus falcatus
Quercus coccinea
Quercus phellos
Taxodium distichum
Ulmus parvifolia
Washingtonia filifera
Washingtonia robusta
Zelkova serrata 'Green Vase'

Location Type 8 – Park Edge or Boulevard Median, With Trams

Description of Key Characteristics

Street Width	60 metres
Traffic Lanes	6 lanes with central boulevard and tramway
Overhead	Lighting, Tram cabelling
Buildings	Medium to high
Parking	Parallel kerb and median edge
Road centre	25m wide with tramline, footpath and median tree avenue
Pathways	3.6m roadside footpaths, narrow along median
Trees	Key central avenue, kerbside
Example	Victoria Parade



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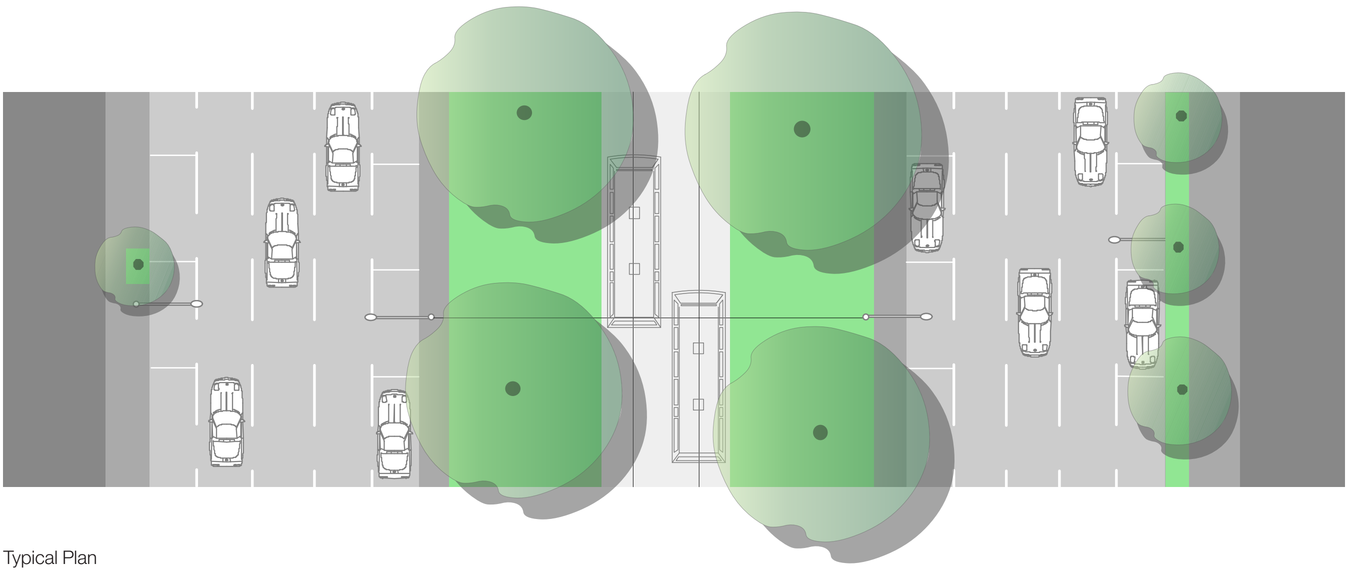
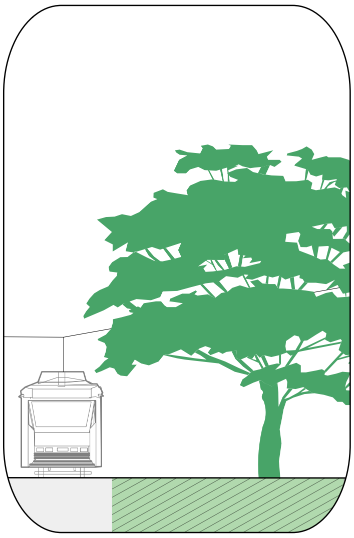


Typical Plan



Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m
Shade rating any
No powerlines

Street Tree Considerations

Tolerate crown pruning to tram wires
Tolerate full sun
Longevity

Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer platanoides 'Crimson Sentry'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Allocasuarina torulosa
Angophora costata
Angophora floribunda
Banksia integrifolia subsp. integrifolia
Banksia serrata
Casuarina cunninghamiana
Casuarina glauca
Cedrus atlantica
Cedrus deodara
Celtis occidentalis
Cercis siliquastrum
Cinnamomum camphora
Corymbia citriodora
Corymbia maculata
Cupaniopsis anachardioides
Cupressus sempervirens
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus nicholii
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Eucalyptus spathulata
Ficus macrophylla
Ficus microcarpa var. hillii
Ficus platypoda
Ficus rubiginosa
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Geijera parviflora
Ginkgo biloba 'Princeton Sentry'
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Lagerstroemia indica x L. fauriei varieties
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Metasequoia glyptostroboides
Paulownia tomentosa
Pinus canariensis
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Zelkova serrata 'Green Vase'

Location Type 9 – Park Edge or Boulevard Median, With No Trams

Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m
Shade rating >3

Street Tree Considerations

Tolerate full sun
Unlimited canopy spread
Minimum height clearance of 4.6 m over road

Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer rubrum 'October Glory'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Agathis robusta
Araucaria cunninghamii
Catalpa bignonioides
Cedrus atlantica
Cedrus deodara
Corymbia citriodora
Corymbia maculata
Cupressus torulosa
Fraxinus pennsylvanica 'Cimmaron'
Liquidambar styraciflua 'Rotundiloba'
Metasequoia glyptostroboides
Phoenix canariensis
Pinus canariensis
Pinus patula
Pinus pinea
Podocarpus falcatus
Quercus coccinea
Quercus phellos
Taxodium distichum
Ulmus parvifolia
Zelkova serrata 'Green Vase'

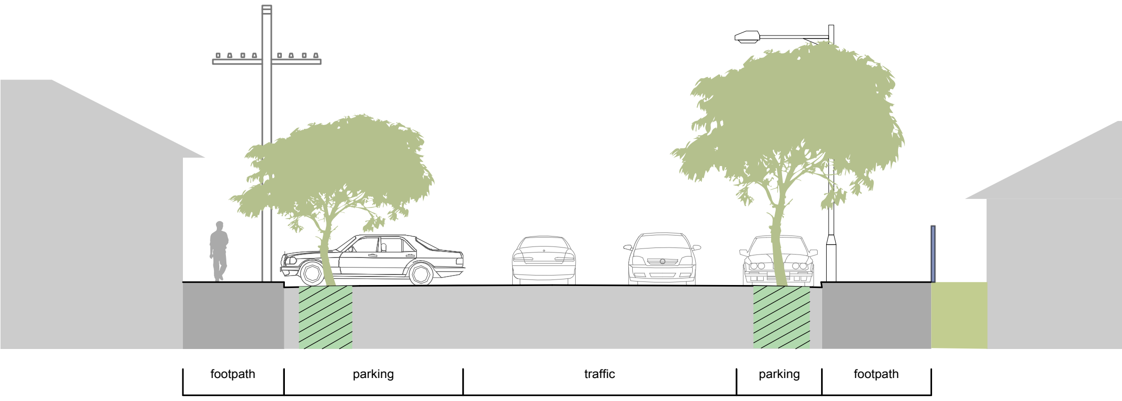
Successful Tree Application

Problematic Tree Application

Location Type 10 – Residential Parking Lane

Description of Key Characteristics

Street Width	20 metre
Traffic Lanes	2 lane
Overhead	Powerlines, lighting
Buildings	Residential, setback
Parking	Mixed
Road centre	–
Pathways	< 2.5 metre footpath
Trees	In roadway between parking bays. Occasional WSUD
Example	Acland Street South Yarra, George Street East Melbourne



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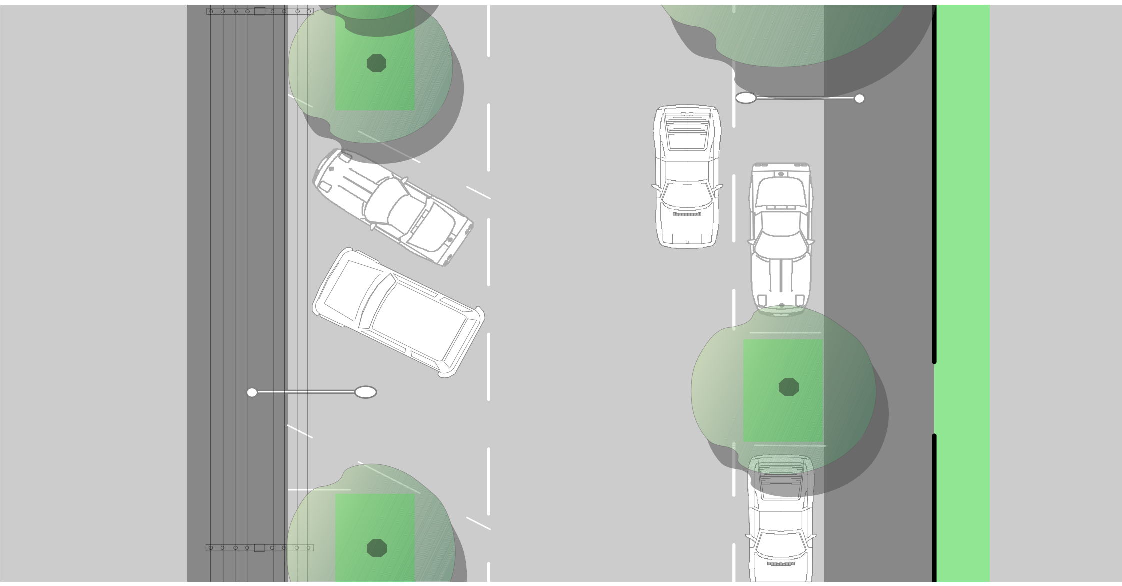
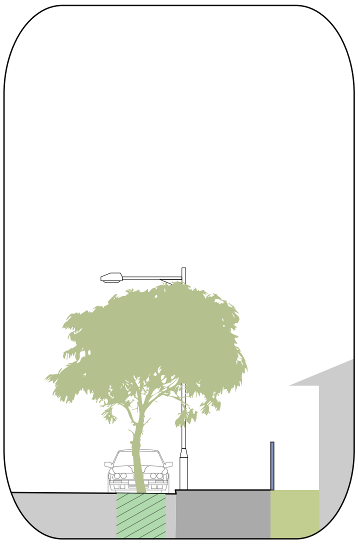


Typical Plan



Street Tree Considerations

Potential large and high canopy
Minimum height clearance of 4.6 m
Tolerate full sun
Variety of shade rating
Potential tolerance to water logging (WSUD)

Successful Tree Application

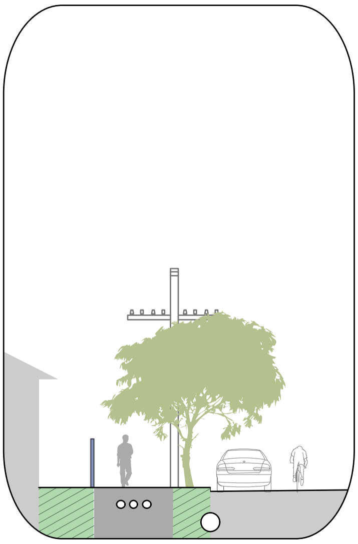
Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m
Shade rating any
WSUD > 3
Pollution rating >3
No powerlines
Litter drop >3
Maintenance >3

Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer x freemanii 'Autumn Blaze'
Allocasuarina torulosa
Angophora costata
Araucaria cunninghamii
Banksia integrifolia subsp. integrifolia
Celtis australis
Celtis occidentalis
Cupressus glabra (syn. C. arizonica)
Eucalyptus bancroftii
Eucalyptus leucoxylon
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus melliodora
Eucalyptus platypus
Eucalyptus polyanthemos
Eucalyptus scoparia
Eucalyptus sideroxylon
Ficus microcarpa var. hillii
Fraxinus excelsior 'Aurea'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Jacaranda mimosifolia
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Metasequoia glyptostroboides
Olea europea
Paulownia tomentosa
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Syzygium paniculatum
Taxodium distichum
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Waterhousea floribunda
Zelkova serrata 'Green Vase'

Location Type 11 – Residential Broad Verge With Powerlines



Tree Selection Criteria

(Key requirements for generating suitable street trees from matrix)

Canopy <10m
Height any
Shade rating >2
Powerlines

Street Tree Considerations

Tolerate crown pruning to powerlines
Tolerate full sun
Minimum height clearance of 2.5 m
Restricted height under powerlines
Tolerate crown pruning to powerlines

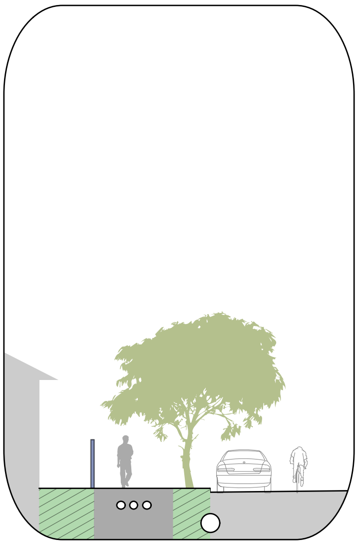
Recommended Trees

(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer buergerianum
Acer campestre ‘Elsrijk’
Acer campestre ‘Evelyn’
Acer platanoides ‘Globosum’
Acer truncatum x A. platanoides ‘Keithsform’
Agonis flexuosa
Allocasuarina littoralis
Allocasuarina verticillata
Angophora hispida (Syn. A. cordifolia)
Banksia integrifolia subsp. integrifolia
Banksia serrata
Brachychiton populneus
Brachychiton rupestris
Callistemon ‘Harkness’
Callistemon salignus
Callistemon viminalis
Catalpa bignonioides ‘Nana’
Celtis australis
Celtis occidentalis
Cercis siliquastrum
Corymbia eximia
Corymbia ficifolia
Cupaniopsis anachardioides
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon dwarf form
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus platypus
Eucalyptus stoatei
Ficus platypoda
Fraxinus excelsior ‘Aurea’
Fraxinus ornus
Fraxinus ornus ‘Meczek’
Fraxinus pennsylvanica ‘Urbanite’
Geijera parviflora
Hakea francisiana
Jacaranda mimosifolia
Koelreuteria paniculata
Lagerstroemia indica x L. fauriei varieties
Leptospermum petersonii
Liquidambar formosana
Lophostemon confertus
Magnolia grandiflora ‘Exmouth’
Melia azedarach
Olea europea
Pistacia chinensis
Pyrus nivalis
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Tilia cordata ‘Greenspire’
Tristaniopsis laurina
Ulmus x hollandica
Zelkova serrata ‘Green Vase’

Location Type 12 – Residential Broad Verge With No Powerlines

To come



Street Tree Considerations

Tolerate crown pruning to powerlines
Tolerate full sun
Minimum height clearance of 2.5 m

Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy >6m
Height > 10m
Shade rating >2
No powerlines

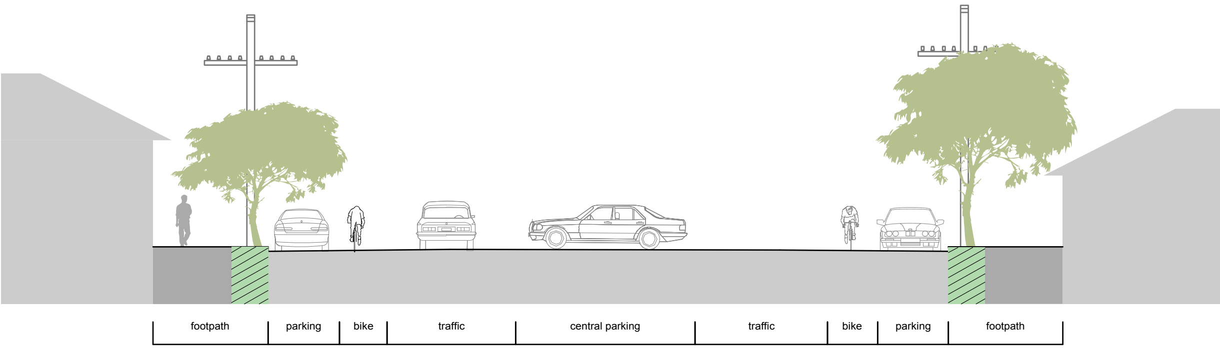
Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Allocasuarina torulosa
Allocasuarina verticillata
Angophora costata
Angophora floribunda
Banksia integrifolia subsp. integrifolia
Banksia serrata
Brachychiton populneus
Brachychiton rupestris
Brachychiton x roseus
Casuarina cunninghamiana
Casuarina glauca
Cedrus atlantica
Cedrus deodara
Celtis australis
Celtis occidentalis
Cinnamomum camphora
Corymbia eximia
Corymbia ficifolia
Corymbia maculata
Cupaniopsis anachardioides
Cupressus glabra (syn. C. arizonica)
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus cosmophylla
Eucalyptus leucoxylon
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus melliodora
Eucalyptus platypus
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Eucalyptus spathulata
Ficus macrophylla
Ficus microcarpa var. hillii
Ficus rubiginosa
Fraxinus excelsior 'Aurea'
Fraxinus pennsylvanica 'Aerial'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Ginkgo biloba
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Koelreuteria paniculata
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Magnolia grandiflora 'Exmouth'
Metasequoia glyptostroboides
Olea europea
Phoenix canariensis
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Syzygium paniculatum
Taxodium distichum
Tilia cordata 'Greenspire'
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Ulmus x hollandica
Waterhousea floribunda
Zelkova serrata 'Green Vase'

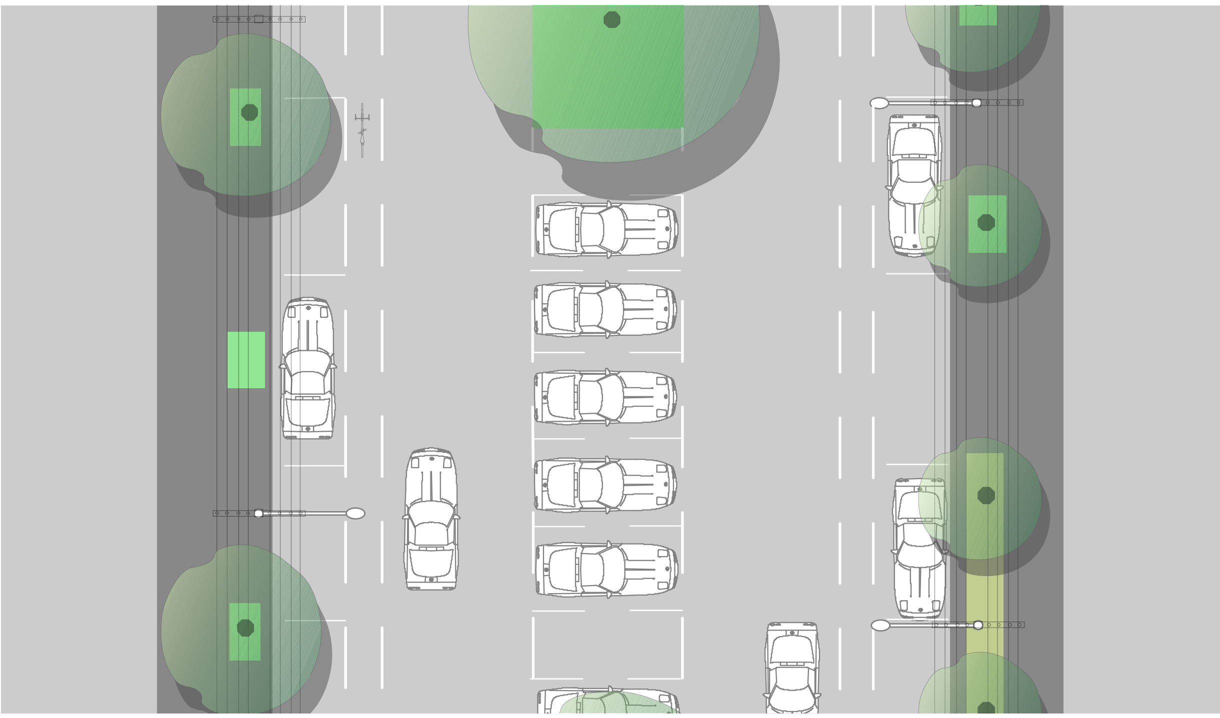
Location Type 13 – Residential Narrow Verge With Powerlines

Description of Key Characteristics

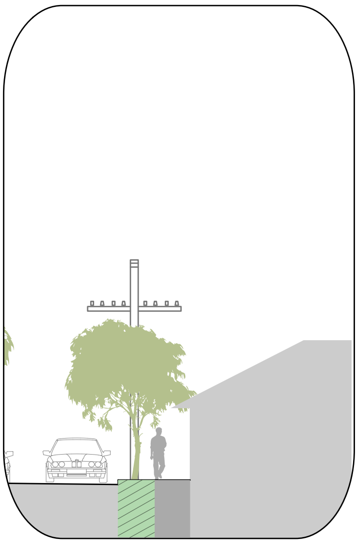
Street Width	30 metre
Traffic Lanes	2 lane with central parking/median area, and bike lanes
Overhead	Powerlines, lighting
Buildings	Residential, setback
Parking	Parallel kerb and perpendicular median parking
Road centre	Median parking. Occasional planting
Pathways	< 3.6 metre footpath
Trees	Kerb edge
Example	Faraday Street, Carlton



Typical Section



Typical Plan



Street Tree Considerations

Limited canopy spread
Tolerate part shade to full sun
Minimum height clearance of 2.5 m
Restricted height under powerlines
Tolerate crown pruning to powerlines

Problematic Tree Application

Tree Selection Criteria

(Key requirements for generating suitable street trees from matrix)

Canopy <10m
Height any
Shade rating >2
Community health >3
No powerlines

Recommended Trees

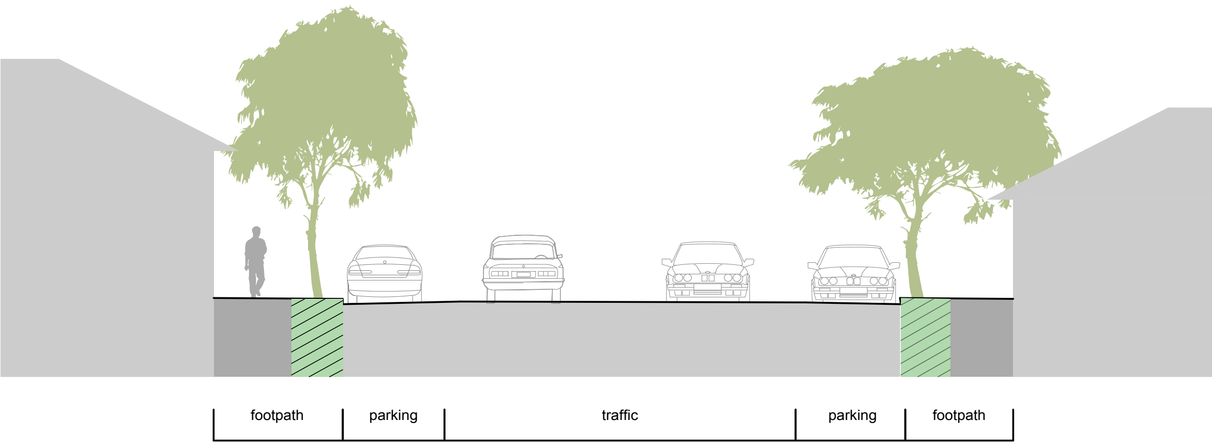
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer buergerianum
Acer campestre 'Elsrijk'
Acer campestre 'Evelyn'
Acer platanoides 'Globosum'
Acer truncatum x A. platanoides 'Keithsform'
Agonis flexuosa
Allocasuarina littoralis
Allocasuarina verticillata
Angophora hispida (Syn. A. cordifolia)
Banksia integrifolia subsp. integrifolia
Banksia serrata
Brachychiton populneus
Brachychiton rupestris
Callistemon 'Harkness'
Callistemon salignus
Callistemon viminalis
Catalpa bignonioides 'Nana'
Celtis australis
Celtis occidentalis
Cercis siliquastrum
Corymbia eximia
Corymbia ficifolia
Cupaniopsis anachardioides
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus platypus
Eucalyptus stoatei
Ficus platypoda
Fraxinus excelsior 'Aurea'
Fraxinus ornus
Fraxinus ornus 'Meczek'
Fraxinus pennsylvanica 'Urbanite'
Geijera parviflora
Jacaranda mimosifolia
Koelreuteria paniculata
Lagerstroemia indica x L. fauriei varieties
Leptospermum petersonii
Liquidambar formosana
Lophostemon confertus
Magnolia grandiflora 'Exmouth'
Melia azedarach
Olea europea
Pistacia chinensis
Pyrus nivalis
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Tilia cordata 'Greenspire'
Tristaniopsis laurina
Ulmus x hollandica
Zelkova serrata 'Green Vase'

Location Type 14 – Residential Narrow Verge With No Powerlines

Description of Key Characteristics

Street Width	20 metre
Traffic Lanes	2 lane
Overhead	Powerlines, lighting
Buildings	Residential, setback
Parking	Parallel or perpendicular kerb parking
Road centre	–
Pathways	2.5 metre footpath
Trees	Kerb planting
Example	Stawell Street North Melbourne



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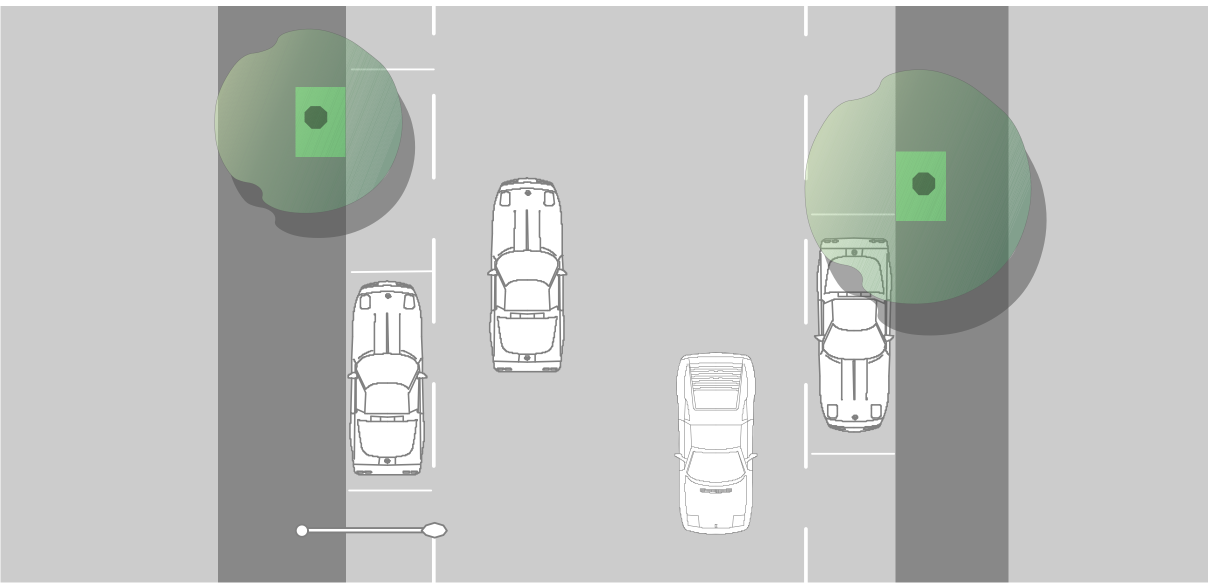

Typical Plan

Tree Selection Criteria

(Key requirements for generating suitable street trees from matrix)

Canopy 5-10m
Height 5-20m
Shade rating >3
Community health >3
No powerlines

Street Tree Considerations

Limited canopy spread
Tolerate part shade to full sun
Minimum height clearance of 2.5 m

Recommended Trees

(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer buergerianum
Acer campestre 'Elsrijk'
Acer campestre 'Evelyn'
Acer platanoides 'Crimson Sentry'
Acer platanoides 'Globosum'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Agonis flexuosa
Allocasuarina littoralis
Allocasuarina torulosa
Allocasuarina verticillata
Angophora costata
Angophora floribunda
Angophora hispida (Syn. A. cordifolia)
Araucaria cunninghamii
Araucaria heterophylla
Banksia integrifolia subsp. integrifolia
Banksia serrata
Brachychiton acerifolius
Brachychiton populneus
Brachychiton rupestris
Brachychiton x roseus
Callistemon 'Harkness'
Callistemon salignus
Callistemon viminalis
Casuarina cunninghamiana
Casuarina glauca
Catalpa bignonioides 'Nana'
Cedrus atlantica
Cedrus deodara
Celtis australis
Celtis occidentalis
Cercis siliquastrum
Cinnamomum camphora
Corymbia eximia
Corymbia ficifolia
Corymbia maculata
Cupaniopsis anachardioides
Cupressus glabra (syn. C. arizonica)
Cupressus sempervirens
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus cinerea
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus nicholii
Eucalyptus platypus
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Eucalyptus spathulata
Eucalyptus stoatei
Ficus macrophylla
Ficus microcarpa var. hillii
Ficus platypoda
Ficus rubiginosa
Fraxinus excelsior 'Aurea'
Fraxinus ornus
Fraxinus ornus 'Meczek'
Fraxinus pennsylvanica 'Aerial'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Geijera parviflora
Ginkgo biloba
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Koelreuteria paniculata
Lagerstroemia indica x L. fauriei varieties
Leptospermum petersonii
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Magnolia grandiflora 'Exmouth'
Melia azedarach
Metasequoia glyptostroboides
Olea europea
Phoenix canariensis
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pistacia chinensis
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus bicolor
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus robur 'Fastigiata'
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Sophora japonica 'Princeton Upright'
Stenocarpus sinuatus
Syzygium paniculatum
Taxodium distichum
Tilia cordata 'Greenspire'
Trachycarpus fortunei
Tristaniopsis laurina
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus x hollandica
Waterhousea floribunda
Zelkova serrata 'Green Vase'

Location Type 15 – Residential Wide Median

Description of Key Characteristics

Street Width	30 metre
Traffic Lanes	2 lane with central median, and bike lanes
Overhead	Powerlines, lighting
Buildings	Residential, setback
Parking	Parallel kerb
Road centre	3-8m wide planted median
Pathways	< 3.6 metre footpath
Trees	Kerb edge and central median
Example	Canning street, Drummond Street, Carlton

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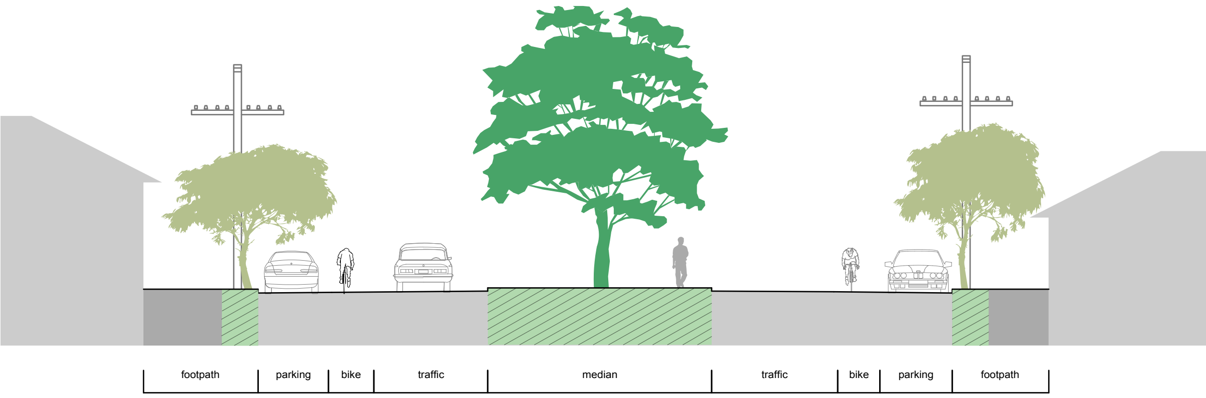
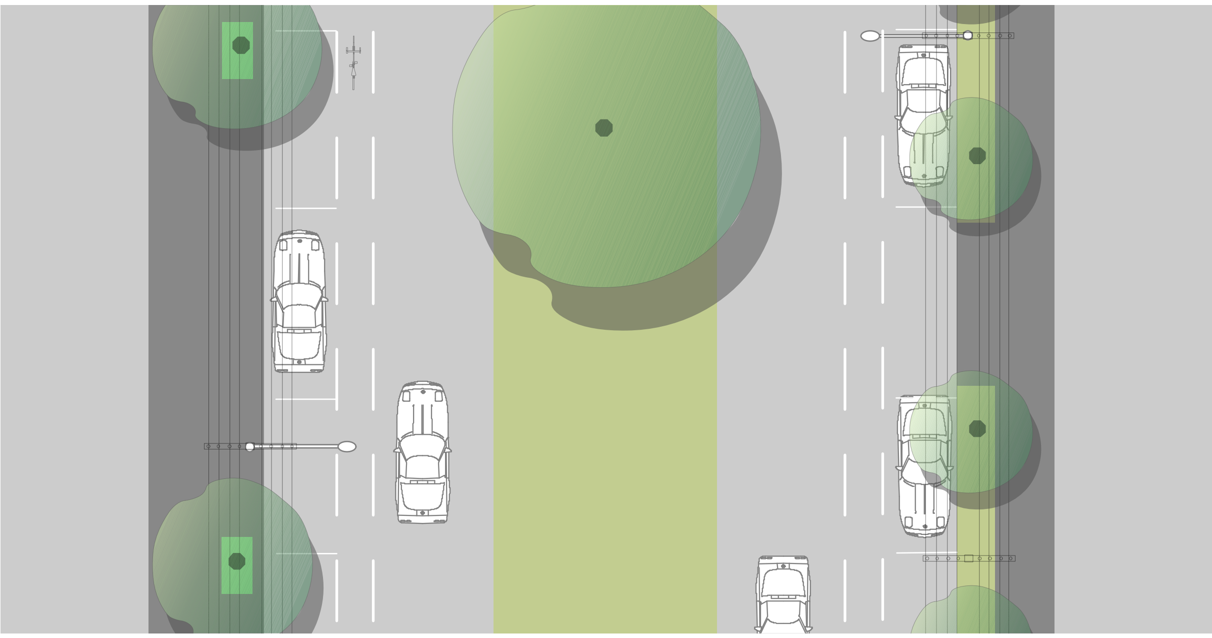


Typical Section



Typical Plan

Street Tree Considerations

Potential large and high canopy
Tolerate full sun
Minimum height clearance of 2.5m
Variety of shade rating

Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

Canopy > 8m
Height > 10m
Shade rating any
Community health >3
No powerlines

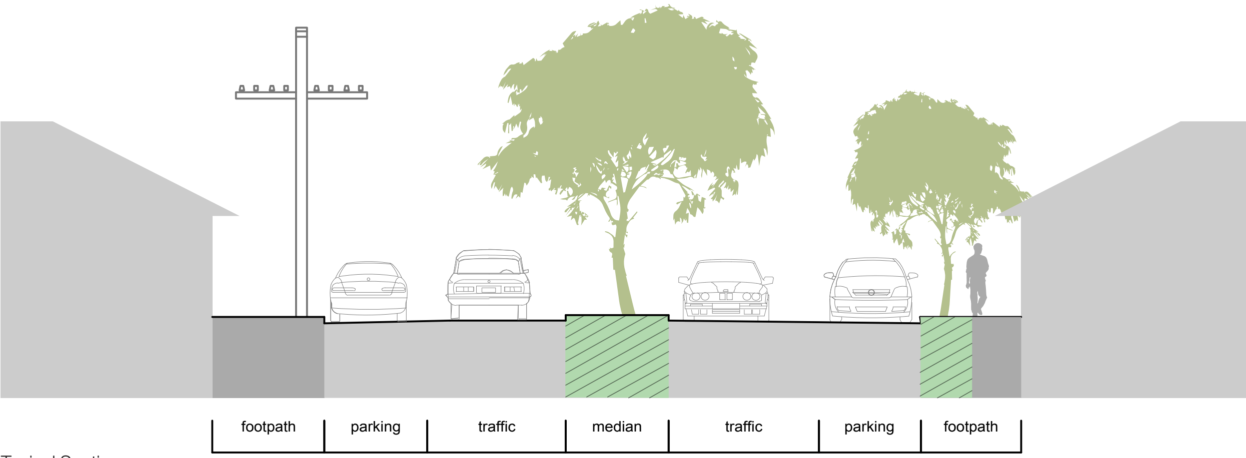
Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer platanoides 'Crimson Sentry'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Allocasuarina torulosa
Angophora costata
Angophora floribunda
Araucaria cunninghamii
Araucaria heterophylla
Banksia integrifolia subsp. integrifolia
Casuarina cunninghamiana
Casuarina glauca
Cedrus atlantica
Cedrus deodara
Celtis occidentalis
Cercis siliquastrum
Cinnamomum camphora
Corymbia citriodora
Corymbia maculata
Cupaniopsis anachardioides
Cupressus sempervirens
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus nicholii
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Eucalyptus spathulata
Ficus microcarpa var. hillii
Ficus platypoda
Ficus rubiginosa
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Geijera parviflora
Ginkgo biloba 'Princeton Sentry'
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Lagerstroemia indica x L. fauriei varieties
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Metasequoia glyptostroboides
Paulownia tomentosa
Pinus canariensis
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Tilia cordata 'Greenspire'
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Zelkova serrata 'Green Vase'

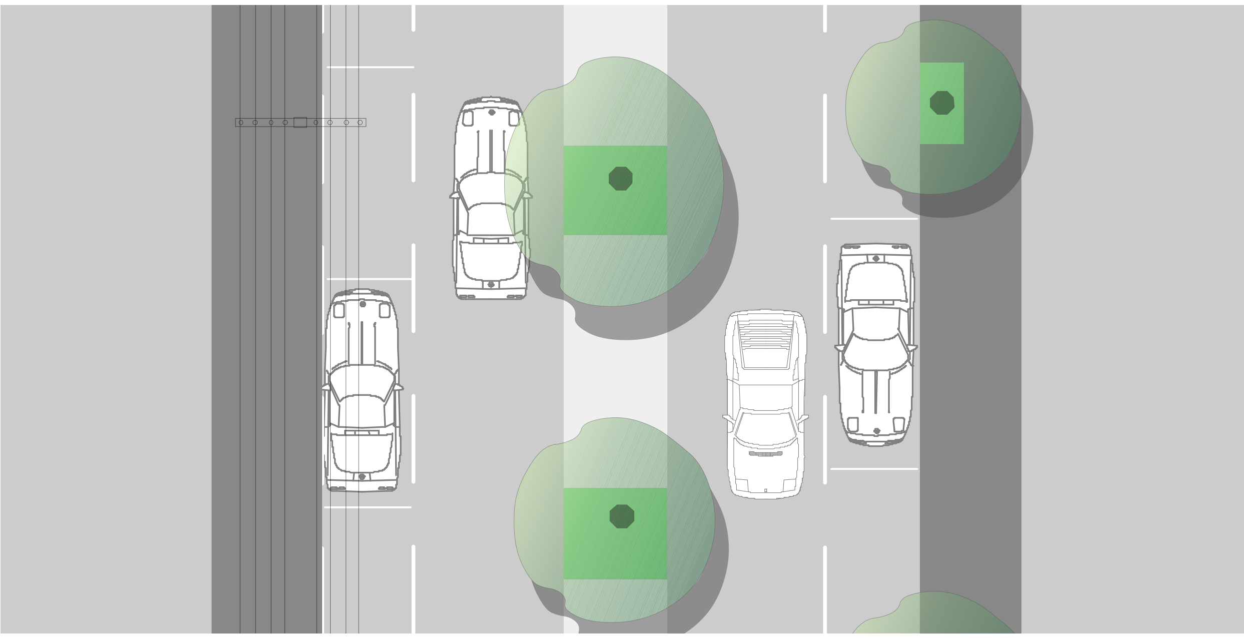
Location Type 16 – Residential Narrow Median

Description of Key Characteristics

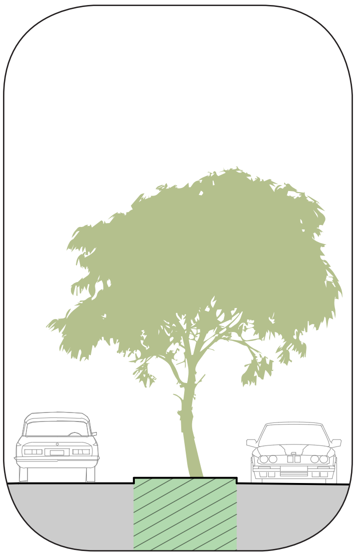
Street Width	20 metre
Traffic Lanes	2 lane with central median
Overhead	Powerlines, lighting
Buildings	Residential, setback
Parking	Parallel kerb
Road centre	2-3m planted/infill median or intermittent parking/median
Pathways	2.5 metre footpath
Trees	Larger median planting, kerb planting
Example	Pitt Street Carlton, Lothian Street North Melbourne



Typical Section



Typical Plan



Street Tree Considerations

- Potential large and high canopy
- Tolerate full sun
- Minimum height clearance of 4.5m
- Variety of shade rating

Tree Selection Criteria
(Key requirements for generating suitable street trees from matrix)

- Canopy <15
- Height > 10m
- Shade rating any
- No powerlines

Recommended Trees
(Based on Tree Selection Criteria relevant to Street Tree Considerations)

Acer buergerianum
Acer campestre 'Elsrijk'
Acer campestre 'Evelyn'
Acer platanoides 'Crimson Sentry'
Acer platanoides 'Globosum'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Agonis flexuosa
Allocasuarina littoralis
Allocasuarina torulosa
Allocasuarina verticillata
Angophora costata
Angophora floribunda
Brachychiton acerifolius
Callistemon salignus
Callistemon viminalis
Casuarina glauca
Cedrus deodara
Corymbia citriodora
Corymbia maculata
Cupressus sempervirens
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus leucoxylon
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus nicholii
Eucalyptus platypus
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Eucalyptus spathulata
Ficus microcarpa var. hillii
Fraxinus pennsylvanica 'Aerial'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Ginkgo biloba 'Princeton Sentry'
Gleditsia triacanthos var.inermis Varieties
Jacaranda mimosifolia
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Maclura pomifera 'Wichita'
Metasequoia glyptostroboides
Paulownia tomentosa
Phoenix canariensis
Pinus pinea
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus phellos
Quercus robur
Quercus robur 'Fastigiata'
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Sophora japonica 'Princeton Upright'
Stenocarpus sinuatus
Tilia cordata 'Greenspire'
Tristaniopsis laurina
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Washingtonia filifera
Washingtonia robusta

Appendices

Appendix 1: References

Asterisked references refer to works not mentioned within the body of the document.

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Appendix 2: The Tree Selection Matrix as Interactive Tool

The Urban Forest Tree Diversity Guidelines employ a tree selection matrix as the interactive tool for tree species selection.

It is this interactive tool that has produced the tree lists by Location Type.

However, because the Tree Selection Matrix can be used interactively, it is able to generate additional specific tree lists for a wide range of criteria above and beyond those used to produce the tree lists presented within the main body of this report.

The Tree Selection Matrix provides an effective was of organising, sorting and prioritising tree species characteristics, tolerances and susceptibilities so as to provide informed and useful tree species selections.

The Tree Selection Matrix requires the user to determine the characteristics required for tree species within a given environment – for instance the verge of a busy east-west CAD street – thus encouraging a relationship to be established between tree selection and site specifics across the City's streetscapes and parks.

In order to aid the City of Melbourne's objectives, the Tree Selection Matrix provides three distinct tree lists from which appropriate tree selections can be made. The range of selection criteria across the three tree species lists is consistent. The three tree species lists are:

- Street trees: The principle component of the urban forest within the public domain.
- Park trees: These contribute significant avenues of tree planting to the cities greenery. While most street trees can be grown in parks, the reverse is not always possible. The park tree list includes species that require greater root volumes than those generally achievable in the streetscape environment, and species of large size.
- Trial trees: Included to expand the diversity of the tree species population, through streetscape trialing. Once the performance of these trees can be determined the matrix can be updated to reflect this new knowledge – the Tree Selection Matrix is a 'live' tool, intended to be reviewed on a regular basis.

Detailed instructions on how to use the Tree Selection Matrix follow.

Using the Matrix

To understand how to use the matrix as an interactive tool, these Guidelines demonstrate a simple staged process of producing the street tree list for one Location Type (in the example the location is Location Type 1 – CAD Wide Footpath), and then further refining that list (in the example, the list is refined to show only trees suitable for shady conditions).

The matrix is a highly flexible tool able to generate plant lists for effectively all locations and conditions throughout the City of Melbourne.

A profile of a typical street can be constructed using the type parts much like a mix and match book. This can help profile any typical scenario in a street type and provide a tree list that is flexible to cover differing scenarios such as powerlines, narrow verge, median planting opportunities. Therefore a truly diverse list of trees can be generated for any given street. This list can then be filtered further in the precinct plans.

Dimensional criteria are probably the most important, and the best place to start when refining tree lists. Remember trees may fail the criteria by being, for example, 1 metre too short or narrow. It is up to the discretion of Council to change the field to capture trees that are perceived as still being useful in this application and satisfying the objectives.

The selection criteria are supplemented by further information included in the Tree Selection Matrix that can be used by Council to scrutinise the tree candidates for the application after initial sorting and refining.

It is anticipated that this matrix will be supported by the graphic cross sections and that a street cross section can be generated to cover most variables found in the extent of a street, such as awnings, powerlines that switch verges, etc. The inclusion of such Location Types is a future exercise that may be explored.

The Matrix at a Glance

Tree Species
Botanical and common name

Tree Information Data
Botanical and horticultural information

Base Criteria for Adaptability to Urban Conditions
The criteria by which each street species must fulfill to be acceptable for planting in City of Melbourne.

Adaptability to Urban Conditions Rating

Additional Selection Criteria

Location Types
Showing which trees are suitable.

Tree Species / Tree Information Data

Tree Species		Origin	Growth Rate	Height	Canopy Widths	Type	Biodiversity Potential- Foraging habitat	Common Availability
Acer buergerianum	Trident Maple	Eastern China, Korea & Japan. Mountain woods	Moderate	7	5	Deciduous	Unknown	Common. Bare root, container, advanced
Acer campestre 'Elsrijk'	Elsrijk Maple	Cultivar	Moderate	7	5	Deciduous	Unknown	Becoming available. Bare root and containers
Acer campestre 'Evelyn'	Queen Elizabeth Maple	Cultivar	Moderate	6	5	Deciduous	Unknown	Common. Bare root, container
Acer platanoides 'Crimson Sentry'	Crimson Sentry Norway Maple	Cultivar	Moderate	9	5	Deciduous	Unknown	Common. Bare root, container
Acer platanoides 'Globosum'	Globe Norway Maple	Cultivar	Slow	5	4	Deciduous	Unknown	Becoming available. Bare root and containers
Acer rubrum 'October Glory'	October Glory Red Maple	Princeton Nurseries	Fast	15	9	Deciduous	Unknown	Common. Bare root, container
Acer rubrum 'Scarsen'	Scarlet Sentinel Freeman Maple	Garden & natural occuring A.saccharinum x A.rubrum	Moderate to Fast	11	5	Deciduous	Unknown	Common. Bare root, container
Acer truncatum x *A. platanoides* 'Keithsform'	Hybrid Shantung Norwegian Sunset	Cultivar	Moderate to Fast	9	5	Deciduous	Unknown	Common. Bare root, container
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Freeman Maple	Garden & natural occuring A.saccharinum x A.rubrum	Fast	15	9	Deciduous	Unknown	Common. Bare root, containerised.
Afrocarpus falcata	Yellow Wood	East coast South Africa	Moderate	14	10	Evergreen	Seed eaters	Occasional
Agathis robusta	Queensland Kauri	Queensland, lowlands & tablelands	Moderate	22	11	Evergreen	Seed eaters	Common. Container & advanced
Agonis flexuosa	Willow Myrtle	WA	Moderate	6	5	Evergreen	Seed eaters	Common
Allocasuarina littoralis	Black She-Oak	Eastern Victoria & NSW. Lighter forests	Fast	8	4	Evergreen	Seed eaters	Common
Allocasuarina torulosa	Forest She-Oak	Coastal forests NSW & Qld	Moderate	11	7	Evergreen	Seed eaters	Common
Allocasuarina verticillata	Drooping She-Oak	NSW, Vic., Tas., SA. Coastal & Inland	Fast	8	7	Evergreen	Seed eaters	Common
Angophora costata	Smooth-Barked Apple	Qld, NSW	Fast	19	14	Evergreen	Flowers, insect-eaters, seed	Common
Angophora floribunda	Rough-Barked Apple	Qld, NSW	Moderate to Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common
Angophora hispida (Syn. *A. cordifolia*)	Dwarf Apple	NSW	Moderate	6	6	Evergreen	Flowers, insect-eaters, seed	Common to rare. Specialist nurseries
Araucaria cunninghamii	Hoop Pine	New Guinea, coastal ranges from Cape York Peninsula in Queensland south to northern New South Wales	Moderate	30	11	Evergreen	Seed eaters	Common
Araucaria heterophylla	Norfolk Island Pine	Norfolk Island	Moderate to Fast	23	8	Evergreen	Seed eaters	Common
							Flowers, insect-	

Base Criteria / Location Type Criteria

Tree Species	Drought Tolerance	Heat Tolerance	Wind Tolerance	Longevity	Pollution Tolerance	Pathogen and Pest Susceptability and Manageability	Potential as Allergen	Shade Cast	Maintenance Required	Tree Litter	ADAPTABILITY TO URBAN CONDITIONS	Soil Compaction Tolerance	ADAPTABILITY WITHIN STREET TYPES	Beneath overhead powerlines (or with pruning-P)	Shade Tolerance
Acer buergerianum	3	3	3	2	3	5	3	3	3	2	30	3	33	Yes	No
Acer campestre 'Elsrijk'	5	5	3	4	3	5	5	3	3	5	41	5	46	Yes	Yes
Acer campestre 'Evelyn'	5	5	3	4	3	5	5	3	3	5	41	5	46	Yes	Yes
Acer platanoides 'Crimson Sentry'	3	4	3	2	3	5	5	4	3	5	37	5	42	No	No
Acer platanoides 'Globosum'	3	3	5	2	3	5	5	2	5	5	38	5	43	Yes	No
Acer rubrum 'October Glory'	3	3	3	3	3	5	5	3	3	5	36	5	41	No	No
Acer rubrum 'Scarsen'	3	3	3	3	3	5	5	3	3	5	36	5	41	No	Yes
Acer truncatum x *A. platanoides* 'Keithsform'	4	4	3	3	5	5	5	3	3	5	40	4	44	Yes (P)	No
Acer x freemanii 'Autumn Blaze'	4	4	3	3	3	5	5	3	3	5	38	4	42	No	No
Afrocarpus falcata	3	3	5	5	3	5	5	5	3	5	42	4	46	No	No
Agathis robusta	3	4	3	5	3	5	5	4	3	5	40	3	43	No	Yes
Agonis flexuosa	5	5	3	2	3	5	5	3	3	5	39	2	41	Yes	No
Allocasuarina littoralis	5	5	3	2	3	5	5	2	3	5	38	2	40	Yes	No
Allocasuarina torulosa	5	5	3	2	3	5	5	3	3	2	36	4	40	No	No
Allocasuarina verticillata	5	5	5	2	3	5	5	2	3	2	37	3	40	Yes	No
Angophora costata	5	5	5	5	3	5	3	2	3	4	40	3	43	Yes (P)	No
Angophora floribunda	4	4	3	2	3	5	5	2	3	5	36	3	39	No	No
Angophora hispida (Syn. *A. cordifolia*)	5	5	5	2	3	5	5	3	3	5	41	4	45	Yes	No
Araucaria cunninghamii	3	3	5	4	3	5	5	3	5	5	41	3	44	No	No
Araucaria heterophylla	3	4	5	4	2	5	5	2	3	2	35	4	39	No	No

Location Types

Tree Species	Location Type 1 – CAD Wide Footpath	Location Type 2 – CAD Narrow Footpath	Location Type 3 – CAD Laneway	Location Type 4 – CAD Wide Median With Carparking	Location Type 5 – CAD Wide Median With No Carparking	Location Type 8 – Park Edge or Boulevard Median, With Trams	Location Type 10 – Residential Parking Lane	Location Type 11 – Residential Broad Verge With Powerlines	Location Type 12 – Residential Broad Verge With No Powerlines	Location Type 13 – Residential Narrow Verge With Powerlines	Location Type 14 – Residential Narrow Verge With No Powerlines	Location Type 15 – Residential Wide Median	Location Type 16 – Residential Narrow Median
Acer buergerianum	No	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	No	Yes
Acer campestre 'Elsrijk'	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes	No	Yes
Acer campestre 'Evelyn'	No	Yes	Yes	No	No	No	No	Yes	No	Yes	Yes	No	Yes
Acer platanoides 'Crimson Sentry'	No	Yes	No	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes
Acer platanoides 'Globosum'	No	Yes	No	No	No	No	No	Yes	No	Yes	Yes	No	Yes
Acer rubrum 'October Glory'	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Acer rubrum 'Scarsen'	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Acer truncatum x *A. platanoides* 'Keithsform'	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Acer x freemanii 'Autumn Blaze'	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Afrocarpus falcata	Yes	No	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
Agathis robusta	Yes	No	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
Agonis flexuosa	No	Yes	No	No	No	No	No	Yes	No	Yes	Yes	No	Yes
Allocasuarina littoralis	No	Yes	No	No	No	No	No	Yes	No	Yes	Yes	No	Yes
Allocasuarina torulosa	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Allocasuarina verticillata	No	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes
Angophora costata	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Angophora floribunda	Yes	No	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
Angophora hispida (Syn. *A. cordifolia*)	No	No	No	No	No	No	No	Yes	No	Yes	Yes	No	No
Araucaria cunninghamii	Yes	No	No	Yes	Yes	No	Yes	No	No	No	Yes	Yes	No
Araucaria heterophylla	Yes	No	No	No	Yes	No	No	No	No	No	Yes	Yes	No

Example

Demonstrating how to produce a street tree list for Location Type 1 – CAD Wide Footpath, and refine that list to sho only trees suitable for shady conditions.

Step 1

Identify the column on the Tree Selection Matrix that shows Location Type 1 – CAD Wide Footpath

Tree Species		Tree Information Data	Origin	Growth Rate	Height	Canopy Widths	Type	Biodiversity Potential- Foraging habitat	Common Availability
Acer buergerianum	Trident Maple		Eastern China, Korea & Japan. Mountain woods	Moderate	7	5	Deciduous	Unknown	Common. Bare root, container, advanced
Acer campestre 'Elsrijk'	Elsrijk Maple		Cultivar	Moderate	7	5	Deciduous	Unknown	Becoming available. Bare root and containers
Acer campestre 'Evelyn'	Queen Elizabeth Maple		Cultivar	Moderate	6	5	Deciduous	Unknown	Common. Bare root, container
Acer platanoides 'Crimson Sentry'	Crimson Sentry Norway Maple		Cultivar	Moderate	9	5	Deciduous	Unknown	Common. Bare root, container
Acer platanoides 'Globosum'	Globe Norway Maple		Cultivar	Slow	5	4	Deciduous	Unknown	Becoming available. Bare root and containers
Acer rubrum 'October Glory'	October Glory Red Maple		Princeton Nurseries	Fast	15	9	Deciduous	Unknown	Common. Bare root, container
Acer rubrum 'Scarsen'	Scarlet Sentinel Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Moderate to Fast	11	5	Deciduous	Unknown	Common. Bare root, container
Acer truncatum x A. platanoides 'Keithsform'	Hybrid Shantung Norwegian Sunset		Cultivar	Moderate to Fast	9	5	Deciduous	Unknown	Common. Bare root, container
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Fast	15	9	Deciduous	Unknown	Common. Bare root, containerised.
Afrocarpus falcata	Yellow Wood		East coast South Africa	Moderate	14	10	Evergreen	Seed eaters	Occasional
Agathis robusta	Queensland Kauri		Queensland, lowlands & tablelands	Moderate	22	11	Evergreen	Seed eaters	Common. Container & advanced
Agonis flexuosa	Willow Myrtle		WA	Moderate	6	5	Evergreen	Seed eaters	Common
Allocasuarina littoralis	Black She-Oak		Eastern Victoria & NSW. Lighter forests	Fast	8	4	Evergreen	Seed eaters	Common
Allocasuarina torulosa	Forest She-Oak		Coastal forests NSW & Qld	Moderate	11	7	Evergreen	Seed eaters	Common
Allocasuarina verticillata	Drooping She-Oak		NSW, Vic., Tas., SA. Coastal & Inland	Fast	8	7	Evergreen	Seed eaters	Common
Angophora costata	Smooth-Barked Apple		Qld, NSW	Fast	19	14	Evergreen	Flowers, insect-eaters, seed	Common
Angophora floribunda	Rough-Barked Apple		Qld, NSW	Moderate to Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common
Angophora hispida (Syn. A. cordifolia)	Dwarf Apple		NSW	Moderate	6	6	Evergreen	Flowers, insect-eaters, seed	Common to rare. Specialist nurseries
Araucaria cunninghamii	Hoop Pine		New Guinea, coastal ranges from Cape York Peninsula in Queensland south to northern New South Wales	Moderate	30	11	Evergreen	Seed eaters	Common
Araucaria heterophylla	Norfolk Island Pine		Norfolk Island	Moderate to Fast	23	8	Evergreen	Seed eaters	Common
Banksia integrifolia subsp. integrifolia	Coastal Banksia		Vic, NSW, Tas, Qld	Moderate	15	8	Evergreen	Flowers, insect-eaters, seed	Common
Banksia serrata	Saw Banksia		East coast Australia, Sth Qld. To Wilsons Prom.	Moderate	11	8	Evergreen	Flowers, insect-eaters, seed	Common
Brachychiton acerifolius	Flame Tree		Qld., NSW	Moderate	11	5	Semi-Deciduous	Flowers, insect-eaters	Common
Brachychiton populneus	Kurrajong		Inland Vic., Nsw, & Qld.	Moderate	8	6	Evergreen	Flowers, insect-eaters	Occasional
Brachychiton rupestris	Queensland Bottle Tree		Central Qld. Northern NSW	Moderate to Slow	9	10	Deciduous	Flowers, insect-eaters	Occasional
Brachychiton x roseus	Hybrid Flame Tree		Hybrid	Slow to Moderate	9	6	Deciduous	Flowers, insect-eaters	Occasional
Callistemon 'Harkness'			Garden Hybrid	Fast	5	3	Evergreen	Flowers, insect-eaters	Common
Callistemon salignus	Willow leaf Callistemon		Qld. & NSW	Fast	6	4	Evergreen	Flowers, insect-eaters	Common
Callistemon viminalis	Weeping Bottlebrush		NSW & Qld.	Fast	6	4	Evergreen	Flowers, insect-eaters	Common
Casuarina cunninghamiana	River She-Oak		NSW, Qld.	Moderate	19	11	Evergreen	Seed eaters	Common
Casuarina glauca	Swamp She-oak		East coast Australia	Fast	15	7	Evergreen	Seed eaters	Common
Catalpa bignonioides 'Nana'	Dwarf Indian Bean		Cultivar	Moderate to Slow	4	4	Deciduous	Unknown	Common
Cedrus atlantica	Atlas Cedar		North Africa; Morocco, Algeria	Moderate	19	11	Evergreen	Seed eaters	Common
Cedrus deodara	Deodar Cedar		India and Pakistan	Moderate	15	11	Evergreen	Seed eaters	Common
Celtis australis	European Nettle Tree		Southern Europe	Moderate to Slow	11	6	Deciduous	Unknown	Occasional
Celtis occidentalis	Common Hackberry		North America	Moderate to Fast	11	11	Deciduous	Unknown	Occasional
Cercis siliquastrum	Judas Tree		Mediterranean	Moderate	8	5	Deciduous	Flower, insect - eaters, seeds	Occasional
Cinnamomum camphora	Camphor Laurel		Japan, Taiwan, & China	Fast	9	8	Evergreen	Foilage grazers, seed eaters	Common
Corymbia citriodora	Lemon-Scented Gum		Qld	Fast	15	15	Evergreen	Flowers, insect - eaters, seed.	Common
Corymbia eximia	Yellow Bloodwood		NSW	Fast	9	6	Evergreen	Flowers, insect-eaters, seed	Rare. Specialist nurseries or seed
Corymbia ficifolia	Red-Flowering Gum		Southern WA	Moderate	8	7	Evergreen	Flowers, insect-eaters, seed	Common. Specialist nurseries for grafted stock
Quercus bicolor	Swamp White Oak		USA	Moderate	15	15	Deciduous	Seed eaters	Occasional
Quercus canariensis	Algerian Oak		Nth Africa & S/W Europe	Moderate	19	19	Semi-Deciduous	Seed eaters	Occasional
Quercus cerris	Turkey Oak		Sth. Europe & Western Asia	Moderate	15	15	Deciduous	Foliage grazers, seed eaters	Occasional
Quercus coccinea	Scarlet Oak		USA- Alabama to Maine	Moderate	19	15	Deciduous	Seed eaters	Common
Quercus ilex	Holly Oak		Mediterranean region	Slow	15	15	Evergreen	Seed eaters	Occasional
Quercus macrocarpa	Bur Oak		USA	Moderate	19	15	Deciduous	Unknown	Occasional
Quercus palustris	Pin Oak		Eastern USA	Moderate	19	11	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced.
Quercus phellos	Willow Oak		USA; New Jersey to Texas	Moderate to Fast	19	15	Deciduous	Unknown	Common
Quercus robur	English Oak		Europe & Mediterranean region	Moderate	15	12	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced
Quercus robur 'Fastigiata'	English Oak		Europe & Mediterranean region	Moderate	15	4	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced
Quercus rubra	Red Oak		USA	Moderate	19	15	Deciduous	Seed eaters	Common. Bare rooted, advanced
Robinia pseudoacacia (Varieties)	Black Locust		Appalachian & Ozark Mountains	Fast	11	8	Deciduous	Unknown	Common
Sapium sebiferum	Chinese Tallowtree		China, Japan	Moderate	11	9	Deciduous	Fruit eaters	Common
Schinus areira	Peppercorn Tree		Peru	Moderate	11	11	Evergreen	Foliage grazers, seed eaters	Common
Sophora japonica 'Princeton Upright'	Upright Pagoda Tree		Hybrid. Parents from China & Korea	Fast	11	5	Deciduous	Unknown	Bare rooted
Stenocarpus sinuatus	Firewheel Tree		Qld. NSW	Slow	12	4	Evergreen	Flowers, insect-eaters, seed	Common
Syzygium australe 'Pinnacle'	Pinnacle Scrub Cherry		Hybrid variety	Moderate to Slow	6	2	Evergreen	Fruit eaters	Common
Syzygium paniculatum	Brush Cherry		NSW & Qld coastal forest	Moderate	9	8	Evergreen	Fruit eaters	Common
Taxodium distichum	Baldcypress		South/east coast USA, Mississippi valley	Moderate to Fast	23	11	Deciduous	Unknown	Occasional. Specialist nursery
Tilia cordata 'Greenspire'	Upright Small Leafed Linden		Hybrid	Moderate	11	6	Deciduous	Unknown	Common. Container, Bare rooted
Trachycarpus fortunei	Chusan Fan Palm		China	Slow	5	2	Evergreen	Unknown	Occasional. Specialists. Not in large numbers
Tristaniopsis laurina	Kanooka, Water Gum		Qld, NSW, Vic	Slow	7	5	Evergreen	Flowers, insect-eaters	Common
Ulmus glabra 'Lutescens'	Golden Elm		cultivar	Moderate to Fast	15	15	Deciduous	Low	Common
Ulmus parvifolia	Chinese Elm		China & Japan	Moderate to Fast	19	11	Semi-E/green	Low	Common
Ulmus procera	English Elm		Western & Southern Europe	Moderate to Fast	19	19	Deciduous	Low	Common. Bare root, container or advanced
Ulmus x hollandica	Dutch Elm		Southern England, Northern France	Moderate to Fast	15	15	Deciduous	Low	Common. Bare root, container or advanced
Washingtonia filifera	California Fan Palm		South-eastern California, western Arizona and thru to Baja California	Moderate to Slow	12	3	Evergreen	Unknown	Common
Washingtonia robusta	Washington Palm, Mexican Fan Palm		North-western Mexico and Baja Californi	Moderate to Slow	15	3	Evergreen	Unknown	Common
Waterhousea floribunda	Weeping Lilly Pilly		Qld, NSW	Moderate	18	15	Evergreen	Fruit eaters	Common
Zelkova serrata 'Green Vase'	Japanese Zelkova		Hybrid, parent Japan	Fast	11	15	Deciduous	Unknown	Common. Bare rooted

Tree Species	Base Criteria	Drought Tolerance	Heat Tolerance	Wind Tolerance	Longevity	Pollution Tolerance	Pathogen and Pest Susceptability and Manageability	Potential as Allergen	Shade Cast	Maintenance Required	Tree Litter	ADAPTABILITY TO URBAN CONDITIONS	Location Type Criteria	Soil Compaction Tolerance	ADAPTABILITY WITHIN STREET TYPES	Beneath overhead powerlines (or with pruning P)	Shade Tolerance	Location Type 1 – CAD Wide Footpath	Location Type 2 – CAD Narrow Footpath	Location Type 3 – CAD Laneway	Location Type 4 – CAD Wide Median With Carparking	Location Type 5 – CAD Wide Median With No Carparking
Acer buergerianum		3	3	3	2	3	5	3	3	3	2	30		3	33	Yes	No	No	Yes	No	Yes	No
Acer campestre 'Elsrijk'		5	5	3	4	3	5	5	3	3	5	41		5	46	Yes	Yes	No	Yes	Yes	Yes	No
Acer campestre 'Evelyn'		5	5	3	4	3	5	5	3	3	5	41		5	46	Yes	Yes	No	Yes	Yes	No	No
Acer platanoides 'Crimson Sentry'		3	4	3	2	3	5	5	4	3	5	37		5	42	No	No	No	Yes	No	Yes	No
Acer platanoides 'Globosum'		3	3	5	2	3	5	5	2	5	5	38		5	43	Yes	No	No	Yes	No	No	No
Acer rubrum 'October Glory'		3	3	3	3	3	5	5	3	3	5	36		5	41	No	No	Yes	Yes	No	Yes	Yes
Acer rubrum 'Scarsen'		3	3	3	3	3	5	5	3	3	5	36		5	41	No	Yes	Yes	Yes	No	Yes	Yes
Acer truncatum x A. platanoides 'Keithsform'		4	4	3	3	5	5	5	3	3	5	40		4	44	Yes (P)	No	No	Yes	No	Yes	No
Acer x freemanii 'Autumn Blaze'		4	4	3	3	3	5	5	3	3	5	38		4	42	No	No	Yes	Yes	No	Yes	Yes
Afrocarpus falcata		3	3	5	5	3	5	5	5	3	5	42		4	46	No	No	Yes	No	No	No	Yes
Agathis robusta		3	4	3	5	3	5	5	4	3	5	40		3	43	No	Yes	Yes	No	No	No	Yes
Agonis flexuosa		5	5	3	2	3	5	5	3	3	5	39		2	41	Yes	No	No	Yes	No	No	No
Allocasuarina littoralis		5	5	3	2	3	5	5	2	3	5	38		2	40	Yes	No	No	Yes	No	No	No
Allocasuarina torulosa		5	5	3	2	3	5	5	3	3	2	36		4	40	No	No	Yes	No	No	Yes	Yes
Allocasuarina verticillata		5	5	5	2	3	5	5	2	3	2	37		3	40	Yes	No	No	Yes	No	No	No
Angophora costata		5	5	5	5	3	5	3	2	3	4	40		3	43	Yes (P)	No	Yes	No	No	Yes	Yes
Angophora floribunda		4	4	3	2	3	5	5	2	3	5	36		3	39	No	No	Yes	No	No	No	Yes
Angophora hispida (Syn. A. cordifolia)		5	5	5	2	3	5	5	3	3	5	41		4	45	Yes	No	No	No	No	No	No
Araucaria cunninghamii		3	3	5	4	3	5	5	3	5	5	41		3	44	No	No	Yes	No	No	Yes	Yes
Araucaria heterophylla		3	4	5	4	2	5	5	2	3	2	35		4	39	No	No	Yes	No	No	No	Yes
Banksia integrifolia subsp. integrifolia		3	4	5	4	3	5	5	2	3	5	39		4	43	Yes (P)	No	Yes	No	No	Yes	Yes
Banksia serrata		4	4	3	3	3	5	5	4	2	5	38		2	40	Yes (P)	No	Yes	No	No	No	Yes
Brachychiton acerifolius		4	5	3	4	3	5	5	2	5	2	38		3	41	No	No	No	Yes	No	Yes	No
Brachychiton populneus		5	5	5	4	3	5	5	3	5	5	45		3	48	Yes	No	No	Yes	No	Yes	No
Brachychiton rupestris		5	5	5	4	3	5	5	2	5	5	44		3	47	Yes	No	No	Yes	No	No	No
Brachychiton x roseus		3	4	3	4	3	5	5	3	5	5	40		3	43	No	No	No	Yes	No	Yes	No
Callistemon 'Harkness'		3	5	3	2	3	5	5	2	3	5	36		5	41	Yes	No	No	Yes	No	No	No
Callistemon salignus		3	4	5	2	3	5	5	3	3	5	38		5	43	Yes	No	No	Yes	No	No	No
Callistemon viminalis		5	4	3	2	3	5	5	2	3	5	37		5	42	Yes	No	No	Yes	No	No	No
Casuarina cunninghamiana		5	5	5	2	3	5	5	2	3	2	37		5	42	No	No	Yes	No	No	Yes	Yes
Casuarina glauca		5	5	5	2	3	5	5	2	3	2	37		5	42	No	No	No	Yes	No	Yes	No
Catalpa bignonioides 'Nana'		3	2	3	2	3	5	5	2	3	5	33		3	36	Yes	Yes	No	Yes	Yes	No	No
Cedrus atlantica		4	4	3	4	3	5	3	3	3	5	37		1	38	No	No	Yes	No	No	Yes	Yes
Cedrus deodara		3	4	3	4	3	4	3	3	3	4	34		4	38	No	No	Yes	No	No	No	Yes
Celtis australis		5	4	5	4	2	5	5	3	2	5	40		3	43	Yes (P)	Yes	Yes	No	No	Yes	Yes
Celtis occidentalis		5	4	3	4	3	5	5	3	2	5	39		4	43	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Cercis siliquastrum		3	5	3	2	3	5	5	2	3	5	36		3	39	Yes	Yes	No	Yes	Yes	No	No
Cinnamomum camphora		3	4	5	2	3	5	5	3	3	5	38		2	40	No	No	No	Yes	No	No	No
Corymbia citriodora		4	3	3	4	3	5	5	1	3	5	36		3	39	No	No	No	No	No	Yes	No
Corymbia eximia		5	4	3	4	3	5	5	3	3	5	40		3	43	Yes (P)	No	No	No	No	No	No
Corymbia ficifolia		5	4	3	3	3	5	5	5	3	2	38		2	40	Yes	No	No	Yes	No	No	No
Quercus bicolor		5	5	3	4	3	5	5	4	3	5	42		4	46	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus canariensis		5	5	3	4	3	5	5	4	3	5	42		3	45	No	No	Yes	No	No	No	Yes
Quercus cerris		5	3	3	4	3	5	5	3	3	2	36		3	39	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus coccinea		4	3	3	4	3	5	5	4	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Quercus ilex		5	5	5	4	3	5	5	5	3	5	45		3	48	No	No	Yes	No	No	Yes	Yes
Quercus macrocarpa		5	4	3	4	3	5	5	3	3	5	40		5	45	No	No	Yes	No	No	Yes	Yes
Quercus palustris		3	3	3	4	5	5	5	3	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Quercus phellos		4	4	5	4	5	5	5	4	3	5	44		4	48	No	No	Yes	No	No	Yes	Yes
Quercus robur		3	4	3	4	3	3	5	4	3	4	36		4	40	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus robur 'Fastigiata'		3	3	3	4	3	3	5	3	5	5	37		4	41	No	No	No	Yes	No	No	No
Quercus rubra		4	3	3	4	5	5	5	3	3	5	40		4	44	Yes (P)	No	Yes	No	No	Yes	Yes
Robinia pseudoacacia (Varieties)		5	4	5	2	3	5	5	2	3	5	39		5	44	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sapium sebiferum		5	4	3	3	3	5	3	3	3	5	37		5	42	Yes (P)	No	Yes	No	No	Yes	Yes
Schinus areira		5	5	3	4	3	5	5	2	2	2	36		5	41	No	Yes	Yes	Yes	No	Yes	Yes
Sophora japonica 'Princeton Upright'		5	5	3	3	5	5	5	2	3	5	41		4	45	No	Yes	No	Yes	Yes	No	No
Stenocarpus sinuatus		3	2	3	3	1	5	5	4	3	5	34		2	36	No	Yes	No	Yes	No	No	No
Syzygium australe 'Pinnacle'		3	3	3	2	3	5	5	1	3	2	30		3	33	Yes	Yes	No	Yes	Yes	No	No
Syzygium paniculatum		3	4	3	3	3	5	5	5	3	2	36		4	40	No	Yes	Yes	Yes	No	Yes	Yes
Taxodium distichum		4	3	3	4	3	5	5	3	3	5	38		4	42	No	No	Yes	No	No	Yes	Yes
Tilia cordata 'Greenspire'		3	3	3	3	5	5	5	4	3	5	39		4	43	Yes (P)	Yes	No	Yes	Yes	No	No
Trachycarpus fortunei		3	4	3	3	3	5	5	2	5	5	38		3	41	No	Yes	No	Yes	Yes	No	No
Tristaniopsis laurina		3	4	3	3	3	5	5	3	3	5	37		5	42	Yes	No	No	Yes	No	No	No
Ulmus glabra 'Lutescens'		3	2	3	3	5	1	5	4	1	3	30		4	34	No	No	Yes	No	No	Yes	Yes
Ulmus parvifolia		5	5	3	3	3	5	5	4	2	5	40		5	45	No	Yes	Yes	Yes	No	Yes	Yes
Ulmus procera		2	2	5	3	5	1	5	4	1	5	33		5	38	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Ulmus x hollandica		2	2	3	3	5	1	5	4	1	5	31		5	36	Yes (P)	Yes	Yes	Yes	No	No	Yes
Washingtonia filifera		5	4	3	4	3	5	5	1	5	5	40		4	44	No	Yes	No	Yes	Yes	No	No
Washingtonia robusta		5	4	3	4	3	5	5	1	5	5	40		4	44	No	Yes	No	Yes	Yes	No	No
Waterhousea floribunda		3	4	3	2	3	5	5	5	3	5	38		4	42	No	Yes	Yes	Yes	No	Yes	Yes
Zelkova serrata 'Green Vase'		3	4	5	4	5	3	5	3	3	5	40		4	44	Yes (P)	No	Yes	No	No	Yes	Yes

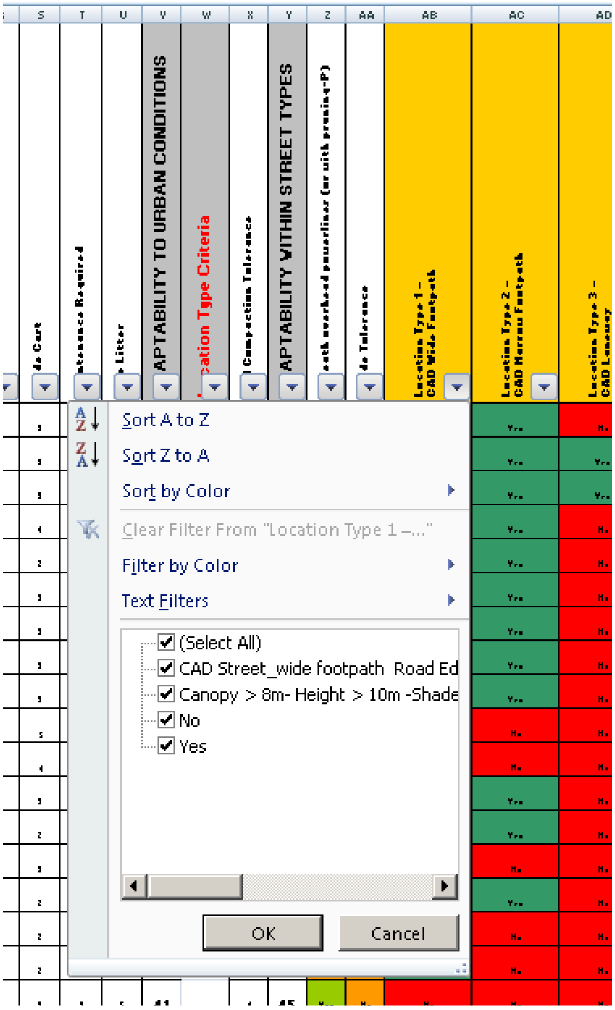
Step 2

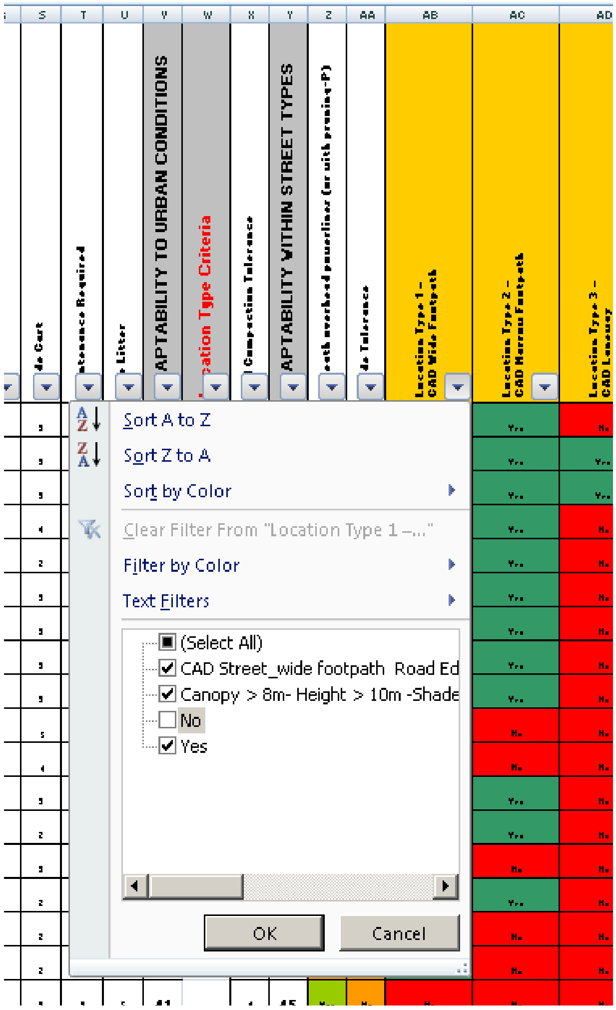
Alter the sort criteria for this column of the Matrix to exclude all trees maked "No".

To do this click on the symbol in the top cell of the Location Type 1 – CAD Wide Footpath column. Click on the checkbox next to "No" to deselect that sort option and thus exclude all trees marked "No" from being displayed. Click OK to finish this step.

Note that here you can identify the selection criteria used to establish which trees are marked suitable (yes) and unsuitable (no).

In this example the criteria are Canopy >8m, Height > 10m, Shade rating > 2, Pollution rating > 2, and suitable for growing where there are no powerlines.





Step 2 continued

You can see here that only trees marked "Yes" in the Location Type 1 – CAD Wide Footpath column are being displayed.

This is the list of trees considered adaptable to urban conditions and suitable to Location Type 1 – CAD Wide Footpath, and shown on page 45.

Tree Species		Tree Information Data	Origin	Growth Rate	Height	Canopy Widths	Type	Biodiversity Potential- Foraging habitat	Common Availability	Base Criteria	Drought Tolerance	Heat Tolerance	Wind Tolerance	Longevity	Pollution Tolerance	Pathogen and Pest Susceptability and Manageability	Potential as Allergen	Shade Cast	Maintenance Required	Tree Litter	ADAPTABILITY TO URBAN CONDITIONS	Location Type Criteria	Soil Compaction Tolerance	ADAPTABILITY WITHIN STREET TYPES	Beneath overhead powerlines (or with pruning-P)	Shade Tolerance	Location Type 1 – CAD Wide Footpath	Location Type 2 – CAD Narrow Footpath	Location Type 3 – CAD Laneway	Location Type 4 – CAD Wide Median With Carparking	Location Type 5 – CAD Wide Median With No Carparking
Acer rubrum 'October Glory'	October Glory Red Maple		Princeton Nurseries	Fast	15	9	Deciduous	Unknown	Common. Bare root, container		3	3	3	3	3	5	5	3	3	5	36		5	41	No	No	Yes	Yes	No	Yes	Yes
Acer rubrum 'Scarsen'	Scarlet Sentinel Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Moderate to Fast	11	5	Deciduous	Unknown	Common. Bare root, container		3	3	3	3	3	5	5	3	3	5	36		5	41	No	Yes	Yes	Yes	No	Yes	Yes
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Fast	15	9	Deciduous	Unknown	Common. Bare root, containerised.		4	4	3	3	3	5	5	3	3	5	38		4	42	No	No	Yes	Yes	No	Yes	Yes
Afrocarpus falcata	Yellow Wood		East coast South Africa	Moderate	14	10	Evergreen	Seed eaters	Occasional		3	3	5	5	3	5	5	5	3	5	42		4	46	No	No	Yes	No	No	No	Yes
Agathis robusta	Queensland Kauri		Queensland, lowlands & tablelands	Moderate	22	11	Evergreen	Seed eaters	Common. Container & advanced		3	4	3	5	3	5	5	4	3	5	40		3	43	No	Yes	Yes	No	No	No	Yes
Allocasuarina torulosa	Forest She-Oak		Coastal forests NSW & Qld	Moderate	11	7	Evergreen	Seed eaters	Common		5	5	3	2	3	5	5	3	3	2	36		4	40	No	No	Yes	No	No	Yes	Yes
Angophora costata	Smooth-Barked Apple		Qld, NSW	Fast	19	14	Evergreen	Flowers, insect-eaters, seed	Common		5	5	5	5	3	5	3	2	3	4	40		3	43	Yes (P)	No	Yes	No	No	Yes	Yes
Angophora floribunda	Rough-Barked Apple		Qld, NSW	Moderate to Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common		4	4	3	2	3	5	5	2	3	5	36		3	39	No	No	Yes	No	No	No	Yes
Araucaria cunninghamii	Hoop Pine		New Guinea, coastal ranges from Cape York Peninsula in Queensland south to northern New South Wales	Moderate	30	11	Evergreen	Seed eaters	Common		3	3	5	4	3	5	5	3	5	5	41		3	44	No	No	Yes	No	No	Yes	Yes
Araucaria heterophylla	Norfolk Island Pine		Norfolk Island	Moderate to Fast	23	8	Evergreen	Seed eaters	Common		3	4	5	4	2	5	5	2	3	2	35		4	39	No	No	Yes	No	No	No	Yes
Banksia integrifolia subsp. *integrifolia*	Coastal Banksia		Vic, NSW, Tas, Qld	Moderate	15	8	Evergreen	Flowers, insect-eaters, seed	Common		3	4	5	4	3	5	5	2	3	5	39		4	43	Yes (P)	No	Yes	No	No	Yes	Yes
Banksia serrata	Saw Banksia		East coast Australia, Sth Qld. To Wilsons Prom.	Moderate	11	8	Evergreen	Flowers, insect-eaters, seed	Common		4	4	3	3	3	5	5	4	2	5	38		2	40	Yes (P)	No	Yes	No	No	No	Yes
Casuarina cunninghamiana	River She-Oak		NSW, Qld.	Moderate	19	11	Evergreen	Seed eaters	Common		5	5	5	2	3	5	5	2	3	2	37		5	42	No	No	Yes	No	No	Yes	Yes
Cedrus atlantica	Atlas Cedar		North Africa; Morocco, Algeria	Moderate	19	11	Evergreen	Seed eaters	Common		4	4	3	4	3	5	3	3	3	5	37		1	38	No	No	Yes	No	No	Yes	Yes
Cedrus deodara	Deodar Cedar		India and Pakistan	Moderate	15	11	Evergreen	Seed eaters	Common		3	4	3	4	3	4	3	3	3	4	34		4	38	No	No	Yes	No	No	No	Yes
Celtis australis	European Nettle Tree		Southern Europe	Moderate to Slow	11	6	Deciduous	Unknown	Occasional		5	4	5	4	2	5	5	3	2	5	40		3	43	Yes (P)	Yes	Yes	No	No	Yes	Yes
Celtis occidentalis	Common Hackberry		North America	Moderate to Fast	11	11	Deciduous	Unknown	Occasional		5	4	3	4	3	5	5	3	2	5	39		4	43	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Corymbia maculata	Spotted Gum		S/E Qld & coastal NSW	Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common. Tube, Container or advanced		5	4	3	3	3	5	5	2	3	5	38		4	42	No	No	Yes	No	No	Yes	Yes
Cupressus glabra (syn. *C. arizonica*)	Smooth Arizona Cypress		USA, central Arizona	Moderate to Fast	11	7	Evergreen	Low - nesting	Common		5	4	5	2	3	5	3	5	3	5	40		2	42	No	No	Yes	Yes	No	Yes	Yes
Cupressus torulosa	Bhutan Cypress		Himalaya, SW China	Moderate	23	8	Evergreen	Nesting	Common		3	5	3	4	3	5	5	5	5	5	43		3	46	No	No	Yes	No	No	Yes	Yes
Eucalyptus bancroftii	Orange Gum		Qld., NSW	Fast	15	9	Evergreen	Flower, insect - eaters, seed.	Occasional		3	4	3	4	3	5	5	2	3	5	37		3	40	No	No	Yes	Yes	No	Yes	Yes
Eucalyptus camaldulensis	River Red Gum		Australia, mainland states	Fast	23	19	Evergreen	Flowers, insect-eaters, seed	Common		3	4	3	3	3	5	5	2	3	5	36		5	41	No	No	Yes	No	No	Yes	Yes
Eucalyptus cinerea	Argyle Apple		NSW tablelands & Vic.	Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common		3	4	3	4	3	5	5	3	3	5	38		5	43	No	No	Yes	No	No	Yes	Yes
Eucalyptus leucoxylon	Yellow Gum		SA & Vic	Fast	14	11	Evergreen	Flowers, insect-eaters, seed	Commom. Check source and subspecies		5	4	3	2	3	5	5	2	3	3	35		5	40	No	No	Yes	No	No	Yes	Yes
Eucalyptus melliodora	Yellox Box		Open woodland. Vic to Qld.	Fast	15	9	Evergreen	Flowers, insect-eaters, seed	Common		5	5	5	2	3	5	5	2	3	5	40		4	44	No	No	Yes	Yes	No	Yes	Yes
Eucalyptus polyanthemos	Red Box		Vic & NSW. Dry foothill country	Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Occasional. Specialist native nurseries		5	5	3	2	5	5	5	3	3	5	41		4	45	No	No	Yes	No	No	Yes	Yes
Eucalyptus scoparia	Wallangarra White Gum		NSW Qld border.	Fast	11	9	Evergreen	Flowers, insect-eaters, seed	Common		5	3	3	2	3	5	5	2	3	5	36		3	39	No	No	Yes	No	No	Yes	Yes
Eucalyptus sideroxylon	Red Ironbark		Vic., NSW	Fast	15	8	Evergreen	Flowers, insect-eaters, seed	Common		5	5	3	2	3	5	5	2	2	5	37		4	41	No	No	Yes	Yes	No	Yes	Yes
Ficus macrophylla	Moreton Bay Fig		Northern Queensland to southern coast of NSW	Moderate	26	26	Evergreen	Flowers, insect-eaters, seed	Common		3	5	5	2	3	5	4	5	3	3	38		3	41	No	Yes	Yes	No	No	No	Yes
Ficus microcarpa var. *hillii*	Hill's Fig		Qld	Moderate	11	11	Evergreen	Flowers, insect-eaters, fruit	Common		4	4	3	4	3	3	5	5	2	5	38		4	42	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Fraxinus excelsior 'Aurea'	Golden Ash		Garden Origin	Moderate	11	11	Deciduous	Unknown	Common. Bare root, container or advanced		3	4	3	4	3	5	5	3	3	5	38		4	42	Yes (P)	No	Yes	Yes	No	Yes	Yes
Fraxinus pennsylvanica 'Cimmaron'	Cimmaron Green Ash		Cultivar	Moderate	15	8	Deciduous	Unknown	Fleming's		5	5	5	4	3	5	5	3	3	5	43		4	47	No	No	Yes	Yes	No	Yes	Yes
Fraxinus pennsylvanica 'Urbanite'	Urbanite Green Ash		Cultivar	Moderate	15	8	Deciduous	Unknown	Fleming's		5	5	5	4	3	5	5	3	3	5	43		4	47	Yes (P)	No	Yes	Yes	No	Yes	Yes
Ginkgo biloba	Maidenhair Tree		China	Slow	15	9	Deciduous	Unknown	Occasional		3	5	3	4	3	5	5	2	3	4	37		4	41	No	Yes	Yes	No	No	No	Yes
Gleditsia triacanthos var.*inermis* Varieties	Thornless Common Honey Locust		Cultivar	Fast	15	9	Deciduous	Unknown	Common. Bare root. Container		5	4	3	2	3	5	5	2	3	5	37		4	41	No	Yes	Yes	Yes	Yes	No	Yes
Jacaranda mimosifolia	Jacaranda		Brazil	Moderate	15	8	Deciduous	Flowers, insect-eaters	Common. Container, advanced		3	4	3	2	3	5	5	2	3	4	34		4	38	Yes (P)	No	Yes	Yes	No	Yes	Yes
Liquidambar formosana	Formosan Sweetgum		Central & South China, & Taiwan	Moderate	14	8	Deciduous	Unknown	Occasional. Not large numbers		3	3	3	3	3	5	5	3	3	5	36		3	39	Yes (P)	Yes	Yes	Yes	Yes	Yes	Yes
Liquidambar styraciflua 'Rotundiloba'	Rotundiloba Sweetgum		Cultivar	Moderate	19	11	Deciduous	Unknown			3	4	3	4	5	5	5	3	3	5	40		4	44	No	Yes	Yes	No	No	Yes	Yes
Lophostemon confertus	Queensland Brush Box		Coastal forests NSW & Qld	Moderate	11	8	Evergreen	Flowers, insect-eaters, seed	Common		3	4	3	4	3	5	5	4	3	5	39		4	43	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Maclura pomifera 'Wichita'	Osage Orange		Arkansas & Texas	Moderate	11	11	Deciduous	Unknown	Occasional		5	4	5	2	3	5	5	4	3	5	41		4	45	No	No	Yes	No	No	Yes	Yes
Metasequoia glyptostroboides	Dawn Redwood		China	Moderate to Fast	15	8	Deciduous	Unknown	Common		3	5	5	4	3	5	5	3	5	5	43		3	46	No	No	Yes	Yes	No	Yes	Yes
Paulownia tomentosa	Empress Tree, Princess Tree		Central & Western China	Fast	19	19	Deciduous	Unknown	Common		5	5	1	4	3	3	5	3	3	5	37		4	41	No	No	Yes	No	No	Yes	Yes
Pinus canariensis	Canary Island Pine		In the western Canary Islands and Gomera (W of N Africa), an area of subhumid Mediterreanean climate	Moderate to Fast	30	15	Evergreen	Seed eaters	Common		5	5	5	2	3	5	3	3	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Pinus halepensis	Aleppo Pine		Mediterranean region	Moderate to Fast	19	12	Evergreen	Seed eaters	Common		5	5	3	3	3	5	3	3	3	5	38		3	41	No	No	Yes	No	No	Yes	Yes
Pinus patula	Mexican Pine		Mexico	Moderate	15	15	Evergreen	Seed eaters	Occasional. Specialised nursery		5	5	5	3	3	5	3	3	3	5	40		3	43	No	No	Yes	No	No	Yes	Yes
Pinus pinaster	Maritime Pine		Western Mediterranean	Moderate to Fast	23	12	Evergreen	Seed eaters	Common. Not large quantaties		5	5	5	2	3	5	3	3	3	5	39		3	42	No	No	Yes	No	No	Yes	Yes
Pinus pinea	Stone Pine		Iberian Peninsula	Moderate to Fast	19	19	Evergreen	Seed eaters	Occasional. Specialists. Not in large numbers		5	5	5	3	3	5	3	4	3	5	41		4	45	No	No	Yes	No	No	Yes	Yes
Platanus orientalis 'Digitata'	Cyprian Plane		S/E Europe to Western Asia	Moderate	19	15	Deciduous	Seed eaters	Common		3	2	3	4	4	3	1	3	3	2	28		4	32	Yes (P)	No	Yes	No	No	Yes	Yes
Platanus X acerifolia	London Plane Tree		Hybrid	Moderate	19	15	Deciduous	Seed eaters	Common		4	3	5	3	5	5	1	4	3	2	35		4	39	Yes (P)	No	Yes	No	No	Yes	Yes
Podocarpus elatus	Plum Pine		Qld, NSW	Moderate	18	15	Evergreen	Seed eaters	Occasional		2	4	3	4	3	3	5	5	3	5	37		2	39	No	No	Yes	No	No	Yes	Yes
Pyrus calleryana varieties	Callery's Pear varieties		Hybrid	Fast	13	8	Deciduous	Unknown	Common		3	3	3	3	5	5	5	3	3	5	38		4	42	No	No	Yes	Yes	No	Yes	Yes
Pyrus nivalis	Snow Pear		South Europe	Moderate	11	8	Deciduous	Unknown	Common		3	4	3	4	3	5	5	3	2	5	37		4	41	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus acutissima	Sawtooth Oak		China, Japan, Korea	Moderate	12	11	Deciduous	Seed eaters	Occasional		3	4	3	4	3	5	5	3	3	5	38		3	41	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus agrifolia	Coast Live Oak		California to Mexico	Moderate	19	19	Evergreen	Seed eaters	Occasional		3	4	3	4	3	5	5	5	3	5	40		3	43	No	No	Yes	No	No	Yes	Yes
Quercus bicolor	Swamp White Oak		USA	Moderate	15	15	Deciduous	Seed eaters	Occasional		5	5	3	4	3	5	5	4	3	5	42		4	46	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus canariensis	Algerian Oak		Nth Africa & S/W Europe	Moderate	19	19	Semi-Deciduous	Seed eaters	Occasional		5	5	3	4	3	5	5	4	3	5	42		3	45	No	No	Yes	No	No	No	Yes
Quercus cerris	Turkey Oak		Sth. Europe & Western Asia	Moderate	15	15	Deciduous	Foliage grazers, seed eaters	Occasional		5	3	3	4	3	5	5	3	3	2	36		3	39	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus coccinea	Scarlet Oak		USA- Alabama to Maine	Moderate	19	15	Deciduous	Seed eaters	Common		4	3	3	4	3	5	5	4	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Quercus ilex	Holly Oak		Mediterranean region	Slow	15	15	Evergreen	Seed eaters	Occasional		5	5	5	4	3	5	5	5	3	5	45		3	48	No	No	Yes	No	No	Yes	Yes
Quercus macrocarpa	Bur Oak		USA	Moderate	19	15	Deciduous	Unknown	Occasional		5	4	3	4	3	5	5	3	3	5	40		5	45	No	No	Yes	No	No	Yes	Yes
Quercus palustris	Pin Oak		Eastern USA	Moderate	19	11	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced.		3	3	3	4	3	5	5	5	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Quercus phellos	Willow Oak		USA; New Jersey to Texas	Moderate to Fast	19	15	Deciduous	Unknown	Common		4	4	5	4	5	5	5	4	3	5	44		4	48	No	No	Yes	No	No	Yes	Yes
Quercus robur	English Oak		Europe & Mediterranean region	Moderate	15	12	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced		3	4	3	4	3	5	5	3	3	3	36		4	40	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus rubra	Red Oak		USA	Moderate	19	15	Deciduous	Seed eaters	Common. Bare rooted, advanced		4	3	3	4	3	5	5	5	3	5	40		4	44	Yes (P)	No	Yes	No	No	Yes	Yes
Robinia pseudoacacia (Varieties)	Black Locust		Appalachian & Ozark Mountains	Fast	11	8	Deciduous	Unknown	Common		5	4	5	2	3	5	5	2	3	5	39		5	44	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sapium sebiferum	Chinese Tallowtree		China, Japan	Moderate	11	9	Deciduous	Fruit eaters	Common		5	4	3	3	3	5	3	3	3	5	37		5	42	Yes (P)	No	Yes	No	No	Yes	Yes
Schinus areira	Peppercorn Tree		Peru	Moderate	11	11	Evergreen	Foliage grazers, seed eaters	Common		5	5	3	4	3	5	5	2	2	2	36		5	41	No	Yes	Yes	Yes	No	Yes	Yes
Syzygium paniculatum	Brush Cherry		NSW & Qld coastal forest	Moderate	9	8	Evergreen	Fruit eaters	Common		3	4	3	3	3	5	5	5	3	2	36		4	40	No	Yes	Yes	Yes	No	Yes	Yes
Taxodium distichum	Baldcypress		South'east coast USA, Mississippi valley	Moderate to Fast	23	11	Deciduous	Unknown	Occasional. Specialist nursery		4	3	3	4	3	5	5	3	3	5	38		4	42	No	No	Yes	No	No	Yes	Yes
Ulmus glabra 'Lutescens'	Golden Elm		cultivar	Moderate to Fast	15	15	Deciduous	Low	Common		3	2	3	3	5	1	5	4	1	3	30		4	34	No	No	Yes	No	No	Yes	Yes
Ulmus parvifolia	Chinese Elm		China & Japan	Moderate to Fast	19	11	Semi-Evergreen	Low	Common		5	5	3	3	3	5	5	4	2	5	40		5	45	No	Yes	Yes	Yes	No	Yes	Yes
Ulmus procera	English Elm		Western & Southern Europe	Moderate to Fast	19	19	Deciduous	Low	Common. Bare root, container or advanced		2	2	5	3	5	1	5	4	1	5	33		5	38	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Ulmus x hollandica	Dutch Elm		Southern England, Northern France	Moderate to Fast	15	15	Deciduous	Low	Common. Bare root, container or advanced		2	2	3	3	5	1	5	4	1	5	31		5	36	Yes (P)	Yes	Yes	Yes	No	No	Yes
Waterhousea floribunda	Weeping Lilly Pilly		Qld, NSW	Moderate	18	15	Evergreen	Fruit eaters	Common		3	4	3	2	3	5	5	5	3	5	38		4	42	No	No	Yes	Yes	No	Yes	Yes
Zelkova serrata 'Green Vase'	Japanese Zelkova		Hybrid, parent Japan	Fast	11	15	Deciduous	Unknown	Common. Bare rooted		3	4	5	4	5	3	5	3	3	5	40		4	44	Yes (P)	No	Yes	No	No	Yes	Yes

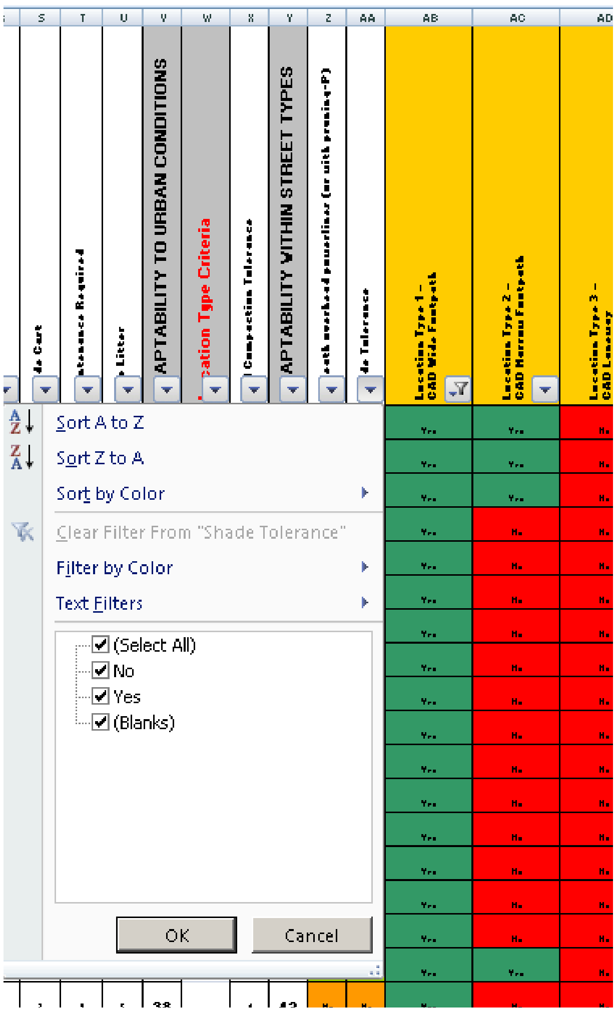
Step 3

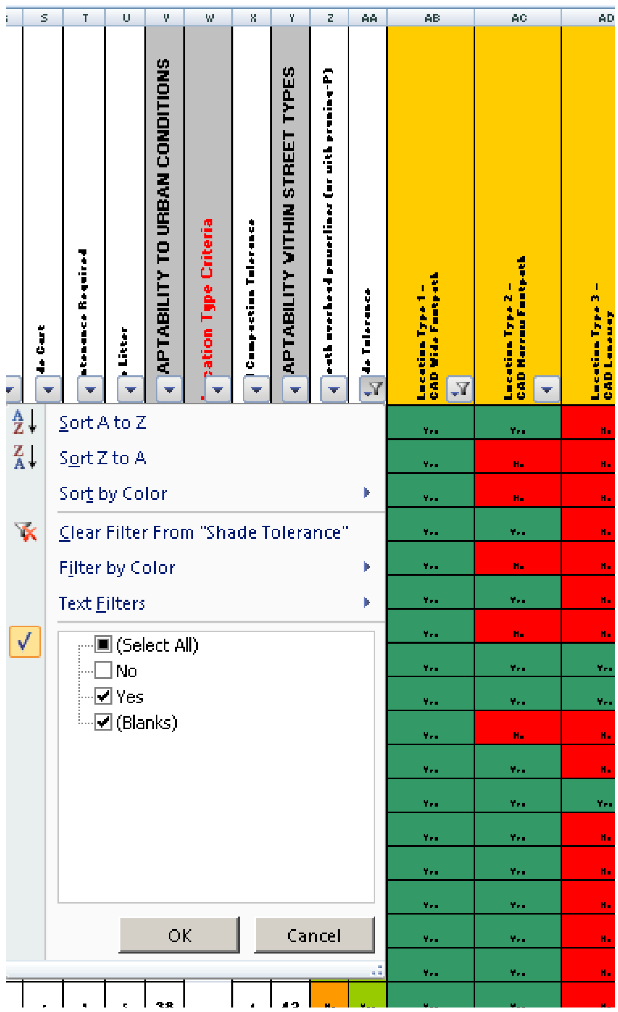
To further refine this list to show only trees suitable to shady conditions, it is necessary now to sort the Matrix by the column "Shade Tolerance"

Tree Species		Tree Information Data	Origin	Growth Rate	Height	Canopy Widths	Type	Biodiversity Potential- Foraging habitat	Common Availability	Base Criteria	Drought Tolerance	Heat Tolerance	Wind Tolerance	Longevity	Pollution Tolerance	Pathogen and Pest Susceptibility and Manageability	Potential as Allergen	Shade Cast	Maintenance Required	Tree Litter	ADAPTABILITY TO URBAN CONDITIONS	Location Type Criteria	Soil Compaction Tolerance	ADAPTABILITY WITHIN STREET TYPES	Beneath overhead powerlines (or with pruning P)	Shade Tolerance	Location Type 1 – CAD Wide Footpath	Location Type 2 – CAD Narrow Footpath	Location Type 3 – CAD Laneway	Location Type 4 – CAD Wide Median With Carparking	Location Type 5 – CAD Wide Median With No Carparking
Acer rubrum 'October Glory'	October Glory Red Maple		Princeton Nurseries	Fast	15	9	Deciduous	Unknown	Common. Bare root, container		3	3	3	3	3	5	5	3	3	5	36		5	41	No	No	Yes	Yes	No	Yes	Yes
Acer rubrum 'Scarsen'	Scarlet Sentinel Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Moderate to Fast	11	5	Deciduous	Unknown	Common. Bare root, container		3	3	3	3	3	5	5	3	3	5	36		5	41	No	Yes	Yes	Yes	No	Yes	Yes
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Fast	15	9	Deciduous	Unknown	Common. Bare root, containerised.		4	4	3	3	3	5	5	3	3	5	38		4	42	No	No	Yes	Yes	No	Yes	Yes
Afrocarpus falcata	Yellow Wood		East coast South Africa	Moderate	14	10	Evergreen	Seed eaters	Occasional		3	3	5	5	3	5	5	5	3	5	42		4	46	No	No	Yes	No	No	No	Yes
Agathis robusta	Queensland Kauri		Queensland, lowlands & tablelands	Moderate	22	11	Evergreen	Seed eaters	Common. Container & advanced		3	4	3	5	3	5	5	4	3	5	40		3	43	No	Yes	Yes	No	No	No	Yes
Allocasuarina torulosa	Forest She-Oak		Coastal forests NSW & Qld	Moderate	11	7	Evergreen	Seed eaters	Common		5	5	3	2	3	5	5	3	3	2	36		4	40	No	No	Yes	No	No	Yes	Yes
Angophora costata	Smooth-Barked Apple		Qld, NSW	Fast	19	14	Evergreen	Flowers, insect-eaters, seed	Common		5	5	5	5	3	5	3	2	3	4	40		3	43	Yes (P)	No	Yes	No	No	Yes	Yes
Angophora floribunda	Rough-Barked Apple		Qld, NSW	Moderate to Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common		4	4	3	2	3	5	5	2	3	5	36		3	39	No	No	Yes	No	No	No	Yes
Araucaria cunninghamii	Hoop Pine		New Guinea, coastal ranges from Cape York Peninsula in Queensland south to northern New South Wales	Moderate	30	11	Evergreen	Seed eaters	Common		3	3	5	4	3	5	5	3	5	5	41		3	44	No	No	Yes	No	No	Yes	Yes
Araucaria heterophylla	Norfolk Island Pine		Norfolk Island	Moderate to Fast	23	8	Evergreen	Seed eaters	Common		3	4	5	4	2	5	5	2	3	2	35		4	39	No	No	Yes	No	No	No	Yes
Banksia integrifolia subsp. *integrifolia*	Coastal Banksia		Vic, NSW, Tas, Qld	Moderate	15	8	Evergreen	Flowers, insect-eaters, seed	Common		3	4	5	4	3	5	5	2	3	5	39		4	43	Yes (P)	No	Yes	No	No	Yes	Yes
Banksia serrata	Saw Banksia		East coast Australia, Sth Qld. To Wilsons Prom.	Moderate	11	8	Evergreen	Flowers, insect-eaters, seed	Common		4	4	3	3	3	5	5	4	2	5	38		2	40	Yes (P)	No	Yes	No	No	No	Yes
Casuarina cunninghamiana	River She-Oak		NSW, Qld.	Moderate	19	11	Evergreen	Seed eaters	Common		5	5	5	2	3	5	5	2	3	2	37		5	42	No	No	Yes	No	No	Yes	Yes
Cedrus atlantica	Atlas Cedar		North Africa; Morocco, Algeria	Moderate	19	11	Evergreen	Seed eaters	Common		4	4	3	4	3	5	3	3	3	5	37		1	38	No	No	Yes	No	No	Yes	Yes
Cedrus deodara	Deodar Cedar		India and Pakistan	Moderate	15	11	Evergreen	Seed eaters	Common		3	4	3	4	3	4	3	3	3	4	34		4	38	No	No	Yes	No	No	No	Yes
Celtis australis	European Nettle Tree		Southern Europe	Moderate to Slow	11	6	Deciduous	Unknown	Occasional		5	4	5	4	2	5	5	3	2	5	40		3	43	Yes (P)	Yes	Yes	No	No	Yes	Yes
Celtis occidentalis	Common Hackberry		North America	Moderate to Fast	11	11	Deciduous	Unknown	Occasional		5	4	3	4	3	5	5	3	2	5	39		4	43	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Corymbia maculata	Spotted Gum		S/E Qld & coastal NSW	Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common. Tube, Container or advanced		5	4	3	3	3	5	5	2	3	5	38		4	42	No	No	Yes	No	No	Yes	Yes
Cupressus glabra (syn. *C. arizonica*)	Smooth Arizona Cypress		USA, central Arizona	Moderate to Fast	11	7	Evergreen	Low - nesting	Common		5	4	5	2	3	5	3	5	3	5	40		2	42	No	No	Yes	Yes	No	Yes	Yes
Cupressus torulosa	Bhutan Cypress		Himalaya, SW China	Moderate	23	8	Evergreen	Nesting	Common		3	5	3	4	3	5	5	5	5	5	43		3	46	No	No	Yes	No	No	Yes	Yes
Eucalyptus bancroftii	Orange Gum		Qld., NSW	Fast	15	9	Evergreen	Flower, insect - eaters, seed.	Occasional		3	4	3	4	3	5	5	2	3	5	37		3	40	No	No	Yes	Yes	No	Yes	Yes
Eucalyptus camaldulensis	River Red Gum		Australia, mainland states	Fast	23	19	Evergreen	Flowers, insect-eaters, seed	Common		3	4	3	3	3	5	5	2	3	5	36		5	41	No	No	Yes	No	No	Yes	Yes
Eucalyptus cinerea	Argyle Apple		NSW tablelands & Vic.	Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Common		3	4	3	4	3	5	5	3	3	5	38		5	43	No	No	Yes	No	No	Yes	Yes
Eucalyptus leucoxylon	Yellow Gum		SA & Vic	Fast	14	11	Evergreen	Flowers, insect-eaters, seed	Commom. Check source and subspecies		5	4	3	2	3	5	5	2	3	3	35		5	40	No	No	Yes	No	No	Yes	Yes
Eucalyptus melliodora	Yellox Box		Open woodland. Vic to Qld.	Fast	15	9	Evergreen	Flowers, insect-eaters, seed	Common		5	5	5	2	3	5	5	2	3	5	40		4	44	No	No	Yes	Yes	No	Yes	Yes
Eucalyptus polyanthemos	Red Box		Vic & NSW. Dry foothill country	Fast	15	11	Evergreen	Flowers, insect-eaters, seed	Occasional. Specialist native nurseries		5	5	3	2	5	5	5	3	3	5	41		4	45	No	No	Yes	No	No	Yes	Yes
Eucalyptus scoparia	Wallangarra White Gum		NSW Qld border.	Fast	11	9	Evergreen	Flowers, insect-eaters, seed	Common		5	3	3	2	3	5	5	2	3	5	36		3	39	No	No	Yes	No	No	Yes	Yes
Eucalyptus sideroxylon	Red Ironbark		Vic., NSW	Fast	15	8	Evergreen	Flowers, insect-eaters, seed	Common		5	5	3	2	3	5	5	2	2	5	37		4	41	No	No	Yes	Yes	No	Yes	Yes
Ficus macrophylla	Moreton Bay Fig		Northern Queensland to southern coast of NSW	Moderate	26	26	Evergreen	Flowers, insect-eaters, seed	Common		3	5	5	2	3	5	4	5	3	3	38		3	41	No	Yes	Yes	No	No	No	Yes
Ficus microcarpa var. *hillii*	Hill's Fig		Qld	Moderate	11	11	Evergreen	Flowers, insect-eaters, fruit	Common		4	4	3	4	3	3	5	5	2	5	38		4	42	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Fraxinus excelsior 'Aurea'	Golden Ash		Garden Origin	Moderate	11	11	Deciduous	Unknown	Common. Bare root, container or advanced		3	4	3	4	3	5	5	3	3	5	38		4	42	Yes (P)	No	Yes	Yes	No	Yes	Yes
Fraxinus pennsylvanica 'Cimmaron'	Cimmaron Green Ash		Cultivar	Moderate	15	8	Deciduous	Unknown	Fleming's		5	5	5	4	3	5	5	3	3	5	43		4	47	No	No	Yes	Yes	No	Yes	Yes
Fraxinus pennsylvanica 'Urbanite'	Urbanite Green Ash		Cultivar	Moderate	15	8	Deciduous	Unknown	Fleming's		5	5	5	4	3	5	5	3	3	5	43		4	47	Yes (P)	No	Yes	Yes	No	Yes	Yes
Ginkgo biloba	Maidenhair Tree		China	Slow	15	9	Deciduous	Unknown	Occasional		3	5	3	4	3	5	5	2	3	4	37		4	41	No	Yes	Yes	No	No	No	Yes
Gleditsia triacanthos var.*inermis* Varieties	Thornless Common Honey Locust		Cultivar	Fast	15	9	Deciduous	Unknown	Common. Bare root. Container		5	4	3	2	3	5	5	2	3	5	37		4	41	No	Yes	Yes	Yes	Yes	No	Yes
Jacaranda mimosifolia	Jacaranda		Brazil	Moderate	15	8	Deciduous	Flowers, insect-eaters	Common. Container, advanced		3	4	3	2	3	5	5	2	3	4	34		4	38	Yes (P)	No	Yes	Yes	No	Yes	Yes
Liquidambar formosana	Formosan Sweetgum		Central & South China, & Taiwan	Moderate	14	8	Deciduous	Unknown	Occasional. Not large numbers		3	3	3	3	3	5	5	3	3	5	36		3	39	Yes (P)	Yes	Yes	Yes	Yes	Yes	Yes
Liquidambar styraciflua 'Rotundiloba'	Rotundiloba Sweetgum		Cultivar	Moderate	19	11	Deciduous	Unknown			3	4	3	4	5	5	5	3	3	5	40		4	44	No	Yes	Yes	No	No	Yes	Yes
Lophostemon confertus	Queensland Brush Box		Coastal forests NSW & Qld	Moderate	11	8	Evergreen	Flowers, insect-eaters, seed	Common		3	4	3	4	3	5	5	4	3	5	39		4	43	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Maclura pomifera 'Wichita'	Osage Orange		Arkansas & Texas	Moderate	11	11	Deciduous	Unknown	Occasional		5	4	5	2	3	5	5	4	3	5	41		4	45	No	No	Yes	No	No	Yes	Yes
Metasequoia glyptostroboides	Dawn Redwood		China	Moderate to Fast	15	8	Deciduous	Unknown	Common		3	5	5	4	3	5	5	3	5	5	43		3	46	No	No	Yes	Yes	No	Yes	Yes
Paulownia tomentosa	Empress Tree, Princess Tree		Central & Western China	Fast	19	19	Deciduous	Unknown	Common		5	5	1	4	3	3	5	3	3	5	37		4	41	No	No	Yes	No	No	Yes	Yes
Pinus canariensis	Canary Island Pine		In the western Canary Islands and Gomera (W of N Africa), an area of subhumid Mediterreanean climate	Moderate to Fast	30	15	Evergreen	Seed eaters	Common		5	5	5	2	3	5	3	3	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Pinus halepensis	Aleppo Pine		Mediterranean region	Moderate to Fast	19	12	Evergreen	Seed eaters	Common		5	5	3	3	3	5	3	3	3	5	38		3	41	No	No	Yes	No	No	Yes	Yes
Pinus patula	Mexican Pine		Mexico	Moderate	15	15	Evergreen	Seed eaters	Occasional. Specialised nursery		5	5	5	3	3	5	3	3	3	5	40		3	43	No	No	Yes	No	No	Yes	Yes
Pinus pinaster	Maritime Pine		Western Mediterranean	Moderate to Fast	23	12	Evergreen	Seed eaters	Common. Not large quantaties		5	5	5	2	3	5	3	3	3	5	39		3	42	No	No	Yes	No	No	Yes	Yes
Pinus pinea	Stone Pine		Iberian Peninsula	Moderate to Fast	19	19	Evergreen	Seed eaters	Occasional. Specialists. Not in large numbers		5	5	5	3	3	5	3	4	3	5	41		4	45	No	No	Yes	No	No	Yes	Yes
Platanus orientalis 'Digitata'	Cyprian Plane		S/E Europe to Western Asia	Moderate	19	15	Deciduous	Seed eaters	Common		3	2	3	4	4	3	1	3	3	2	28		4	32	Yes (P)	No	Yes	No	No	Yes	Yes
Platanus X acerifolia	London Plane Tree		Hybrid	Moderate	19	15	Deciduous	Seed eaters	Common		4	3	5	3	5	5	1	4	3	2	35		4	39	Yes (P)	No	Yes	No	No	Yes	Yes
Podocarpus elatus	Plum Pine		Qld, NSW	Moderate	18	15	Evergreen	Seed eaters	Occasional		2	4	3	4	3	3	5	5	3	5	37		2	39	No	No	Yes	No	No	Yes	Yes
Pyrus calleryana varieties	Callery's Pear varieties		Hybrid	Fast	13	8	Deciduous	Unknown	Common		3	3	3	3	5	5	5	3	3	5	38		4	42	No	No	Yes	Yes	No	Yes	Yes
Pyrus nivalis	Snow Pear		South Europe	Moderate	11	8	Deciduous	Unknown	Common		3	4	3	4	3	5	5	3	2	5	37		4	41	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus acutissima	Sawtooth Oak		China, Japan, Korea	Moderate	12	11	Deciduous	Seed eaters	Occasional		3	4	3	4	3	5	5	3	3	5	38		3	41	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus agrifolia	Coast Live Oak		California to Mexico	Moderate	19	19	Evergreen	Seed eaters	Occasional		3	4	3	4	3	5	5	5	3	5	40		3	43	No	No	Yes	No	No	Yes	Yes
Quercus bicolor	Swamp White Oak		USA	Moderate	15	15	Deciduous	Seed eaters	Occasional		5	5	3	4	3	5	5	4	3	5	42		4	46	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus canariensis	Algerian Oak		Nth Africa & S/W Europe	Moderate	19	19	Semi-Deciduous	Seed eaters	Occasional		5	5	3	4	3	5	5	4	3	5	42		3	45	No	No	Yes	No	No	No	Yes
Quercus cerris	Turkey Oak		Sth. Europe & Western Asia	Moderate	15	15	Deciduous	Foliage grazers, seed eaters	Occasional		5	3	3	4	3	5	5	3	3	2	36		3	39	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus coccinea	Scarlet Oak		USA- Alabama to Maine	Moderate	19	15	Deciduous	Seed eaters	Common		4	3	3	4	3	5	5	4	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Quercus ilex	Holly Oak		Mediterranean region	Slow	15	15	Evergreen	Seed eaters	Occasional		5	5	5	4	3	5	5	5	3	5	45		3	48	No	No	Yes	No	No	Yes	Yes
Quercus macrocarpa	Bur Oak		USA	Moderate	19	15	Deciduous	Unknown	Occasional		5	4	3	4	3	5	5	3	3	5	40		5	45	No	No	Yes	No	No	Yes	Yes
Quercus palustris	Pin Oak		Eastern USA	Moderate	19	11	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced.		3	3	3	4	5	5	5	3	3	5	39		4	43	No	No	Yes	No	No	Yes	Yes
Quercus phellos	Willow Oak		USA; New Jersey to Texas	Moderate to Fast	19	15	Deciduous	Unknown	Common		4	4	5	4	5	5	5	4	3	5	44		4	48	No	No	Yes	No	No	Yes	Yes
Quercus robur	English Oak		Europe & Mediterranean region	Moderate	15	12	Deciduous	Foliage grazers, seed eaters	Common. Container, bare rooted, advanced		3	4	3	4	3	3	5	4	3	4	36		4	40	Yes (P)	No	Yes	No	No	Yes	Yes
Quercus rubra	Red Oak		USA	Moderate	19	15	Deciduous	Seed eaters	Common. Bare rooted, advanced		4	3	3	4	5	5	5	3	3	5	40		4	44	Yes (P)	No	Yes	No	No	Yes	Yes
Robinia pseudoacacia (Varieties)	Black Locust		Appalachian & Ozark Mountains	Fast	11	8	Deciduous	Unknown	Common		5	4	5	2	3	5	5	2	3	5	39		5	44	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sapium sebiferum	Chinese Tallowtree		China, Japan	Moderate	11	9	Deciduous	Fruit eaters	Common		5	4	3	3	3	5	3	3	3	5	37		5	42	Yes (P)	No	Yes	No	No	Yes	Yes
Schinus areira	Peppercorn Tree		Peru	Moderate	11	11	Evergreen	Foliage grazers, seed eaters	Common		5	5	3	4	3	5	5	2	2	2	36		5	41	No	Yes	Yes	Yes	No	Yes	Yes
Syzygium paniculatum	Brush Cherry		NSW & Qld coastal forest	Moderate	9	8	Evergreen	Fruit eaters	Common		3	4	3	3	3	5	5	5	3	2	36		4	40	No	Yes	Yes	Yes	No	Yes	Yes
Taxodium distichum	Baldcypress		South/east coast USA, Mississippi valley	Moderate to Fast	23	11	Deciduous	Unknown	Occasional. Specialist nursery		4	3	3	4	3	5	5	3	3	5	38		4	42	No	No	Yes	No	No	Yes	Yes
Ulmus glabra 'Lutescens'	Golden Elm		cultivar	Moderate to Fast	15	15	Deciduous	Low	Common		3	2	3	3	5	1	5	4	1	3	30		4	34	No	No	Yes	No	No	Yes	Yes
Ulmus parvifolia	Chinese Elm		China & Japan	Moderate to Fast	19	11	Semi-E/green	Low	Common		5	5	3	3	3	5	5	4	2	5	40		5	45	No	Yes	Yes	Yes	No	Yes	Yes
Ulmus procera	English Elm		Western & Southern Europe	Moderate to Fast	19	19	Deciduous	Low	Common. Bare root, container or advanced		2	2	5	3	5	1	5	4	1	5	33		5	38	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Ulmus x hollandica	Dutch Elm		Southern England, Northern France	Moderate to Fast	15	15	Deciduous	Low	Common. Bare root, container or advanced		2	2	3	3	5	1	5	4	1	5	31		5	36	Yes (P)	Yes	Yes	Yes	No	No	Yes
Waterhousea floribunda	Weeping Lilly Pilly		Qld, NSW	Moderate	18	15	Evergreen	Fruit eaters	Common		3	4	3	2	3	5	5	5	3	5	38		4	42	No	Yes	Yes	Yes	No	Yes	Yes
Zelkova serrata 'Green Vase'	Japanese Zelkova		Hybrid, parent Japan	Fast	11	15	Deciduous	Unknown	Common. Bare rooted		3	4	5	4	5	3	5	3	3	5	40		4	44	Yes (P)	No	Yes	No	No	Yes	Yes

Step 3 Continued

To sort the Shade Tolerance column click on the symbol in the top cell of the Shade Tolerance column. Click on the checkbox next to "No" to deselect that sort option and thus exclude all trees marked "No" from being displayed. Click OK to finish this step.





Step 3 Continued

You can see here that only trees both marked "Yes" in the Shade Tolerance column and in the Location Type 1 – CAD Wide Footpath column are being displayed.

This is the list of trees considered adaptable to urban conditions and suitable to Location Type 1 – CAD Wide Footpath, and suitable for being grown in shady conditions.

Tree Species		Tree Information Data	Origin	Growth Rate	Height	Canopy Widths	Type	Biodiversity Potential- Foraging habitat	Common Availability
Acer rubrum 'Scarsen'	Scarlet Sentinel Freeman Maple		Garden & natural occuring A.saccharinum x A.rubrum	Moderate to Fast	11	5	Deciduous	Unknown	Common. Bare root, container
Agathis robusta	Queensland Kauri		Queensland, lowlands & tablelands	Moderate	22	11	Evergreen	Seed eaters	Common. Container & advanced
Celtis australis	European Nettle Tree		Southern Europe	Moderate to Slow	11	6	Deciduous	Unknown	Occasional
Celtis occidentalis	Common Hackberry		North America	Moderate to Fast	11	11	Deciduous	Unknown	Occasional
Ficus macrophylla	Moreton Bay Fig		Northern Queensland to southern coast of NSW	Moderate	26	26	Evergreen	Flowers, insect-eaters, seed	Common
Ficus microcarpa var. *hillii*	Hill's Fig		Qld	Moderate	11	11	Evergreen	Flowers, insect-eaters, fruit	Common
Ginkgo biloba	Maidenhair Tree		China	Slow	15	9	Deciduous	Unknown	Occasional
Gleditsia triacanthos var.*inermis* Varieties	Thornless Common Honey Locust		Cultivar	Fast	15	9	Deciduous	Unknown	Common. Bare root. Container
Liquidambar formosana	Formosan Sweetgum		Central & South China, & Taiwan	Moderate	14	8	Deciduous	Unknown	Occasional. Not large numbers
Liquidambar styraciflua 'Rotundiloba'	Rotundiloba Sweetgum		Cultivar	Moderate	19	11	Deciduous	Unknown	
Lophostemon confertus	Queensland Brush Box		Coastal forests NSW & Qld	Moderate	11	8	Evergreen	Flowers, insect-eaters, seed	Common
Robinia pseudoacacia (Varieties)	Black Locust		Appalachian & Ozark Mountains	Fast	11	8	Deciduous	Unknown	Common
Schinus areira	Peppercorn Tree		Peru	Moderate	11	11	Evergreen	Foliage grazers, seed eaters	Common
Syzygium paniculatum	Brush Cherry		NSW & Qld coastal forest	Moderate	9	8	Evergreen	Fruit eaters	Common
Ulmus parvifolia	Chinese Elm		China & Japan	Moderate to Fast	19	11	Semi-E/green	Low	Common
Ulmus procera	English Elm		Western & Southern Europe	Moderate to Fast	19	19	Deciduous	Low	Common. Bare root, container or advanced
Ulmus x hollandica	Dutch Elm		Southern England, Northern France	Moderate to Fast	15	15	Deciduous	Low	Common. Bare root, container or advanced
Waterhousea floribunda	Weeping Lilly Pilly		Qld, NSW	Moderate	18	15	Evergreen	Fruit eaters	Common

Tree Species	Base Criteria	Drought Tolerance	Heat Tolerance	Wind Tolerance	Longevity	Pollution Tolerance	Pathogen and Pest Susceptability and Manageability	Potential as Allergen	Shade Cast	Maintenance Required	Tree Litter	ADAPTABILITY TO URBAN CONDITIONS	Location Type Criteria	Soil Compaction Tolerance	ADAPTABILITY WITHIN STREET TYPES	Beneath overhead powerlines (or with pruning-P)	Shade Tolerance	Location Type 1 – CAD Wide Footpath	Location Type 2 – CAD Narrow Footpath	Location Type 3 – CAD Laneway	Location Type 4 – CAD Wide Median With Carparking	Location Type 5 – CAD Wide Median With No Carparking
Acer rubrum 'Scarsen'		3	3	3	3	3	5	5	3	3	5	**36**		5	**41**	No	Yes	Yes	Yes	No	Yes	Yes
Agathis robusta		3	4	3	5	3	5	5	4	3	5	**40**		3	**43**	No	Yes	Yes	No	No	No	Yes
Celtis australis		5	4	5	4	2	5	5	3	2	5	**40**		3	**43**	Yes (P)	Yes	Yes	No	No	Yes	Yes
Celtis occidentalis		5	4	3	4	3	5	5	3	2	5	**39**		4	**43**	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Ficus macrophylla		3	5	5	2	3	5	4	5	3	3	**38**		3	**41**	No	Yes	Yes	No	No	No	Yes
Ficus microcarpa var. *hillii*		4	4	3	4	3	3	5	5	2	5	**38**		4	**42**	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Ginkgo biloba		3	5	3	4	3	5	5	2	3	4	**37**		4	**41**	No	Yes	Yes	No	No	No	Yes
Gleditsia triacanthos var.*inermis* Varieties		5	4	3	2	3	5	5	2	3	5	**37**		4	**41**	No	Yes	Yes	Yes	Yes	No	Yes
Liquidambar formosana		3	3	3	3	3	5	5	3	3	5	**36**		3	**39**	Yes (P)	Yes	Yes	Yes	Yes	Yes	Yes
Liquidambar styraciflua 'Rotundiloba'		3	4	3	4	5	5	5	3	3	5	**40**		4	**44**	No	Yes	Yes	No	No	Yes	Yes
Lophostemon confertus		3	4	3	4	3	5	5	4	3	5	**39**		4	**43**	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Robinia pseudoacacia (Varieties)		5	4	5	2	3	5	5	2	3	5	**39**		5	**44**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Schinus areira		5	5	3	4	3	5	5	2	2	2	**36**		5	**41**	No	Yes	Yes	Yes	No	Yes	Yes
Syzygium paniculatum		3	4	3	3	3	5	5	5	3	2	**36**		4	**40**	No	Yes	Yes	Yes	No	Yes	Yes
Ulmus parvifolia		5	5	3	3	3	5	5	4	2	5	**40**		5	**45**	No	Yes	Yes	Yes	No	Yes	Yes
Ulmus procera		2	2	5	3	5	1	5	4	1	5	**33**		5	**38**	Yes (P)	Yes	Yes	Yes	No	Yes	Yes
Ulmus x hollandica		2	2	3	3	5	1	5	4	1	5	**31**		5	**36**	Yes (P)	Yes	Yes	Yes	No	No	Yes
Waterhousea floribunda		3	4	3	2	3	5	5	5	3	5	**38**		4	**42**	No	Yes	Yes	Yes	No	Yes	Yes

Tree information data

Tree name

Provides botanical name, (genus, species, variety and cultivar) according to accepted international code of taxonomic classification, and common name.

Origin

Country or region where tree species grows naturally. Cultivated plants (cultigens) have been listed as cultivars – plants bred or selected for certain characteristics.

Rate

Estimated growth rate of particular tree species. Based on expected extension growth; slow 100mm to 300mm per annum, moderate 300mm to 500mm per annum, fast up to or greater than 500mm per annum.

Height and width

Estimated canopy height and width, in metres, of the species or cultivar growing in urban landscapes in Melbourne. Estimation based on referenced literature and experience.

Tree form

Broad domed = Broad spread, rounded.

Generally crown is as wide as it is high.

Sub form – Broad domed, pendulous. As above with pendulous branchlets.

Broad domed, ascending. As above with ascending, upright branches

Narrow domed = narrow spread, oval, ovoid.

Generally crown taller than it is wide.

Sub form – Narrow domed, pendulous. As above with pendulous branchlets.

Narrow domed, ascending. As above with ascending, upright branches

Pyramidal = conical.

Crown generally wider at base than at apex.

Sub form – Pyramidal, tiered. Branches layered or arranged in whorls

Columnar = fastigiate, spired

Vase = ascending branches, fanning out from trunk. Crown wider at top than at base.

Palm. Generally, one straight stem and crown of large evergreen leaves that are either palmately (‘fan-leaved’) or pinnately (‘feather-leaved’).

Availability

Indicates whether species or variety is commonly available from commercial nurseries in sufficient numbers, or is rarely available from specialist nurseries. This may indicate whether a desired species or cultivar should be contract grown. Also indicates different production methods.

Biodiversity Potential

The study of urban ecology is relatively recent, with research on how living organisms interact with each other in cities relatively limited. Climate change and the planning of the built environment have resulted in shifts within the urban ecology. Urban ecology research has, as an example, been able to explain the presence of the normally warm temperate and subtropical Grey Headed Flying Fox set up in permanent camps in the city. Research by the Australian Research Centre for Urban Ecology has shown that the heat island effect, reduction in frosts, increased planting of flowering eucalypts (whose flowering is stimulated by irrigation and a lack of natural pests) has allowed these mammals to colonise Melbourne. It is information such as this that can inform how planning for the urban forest can be beneficial in achieving biodiversity goals. As with research input generally, more data is required to better define these goals. Information has been provided in the tree selection that does provide some guidance on trees that have a value for food or foraging.

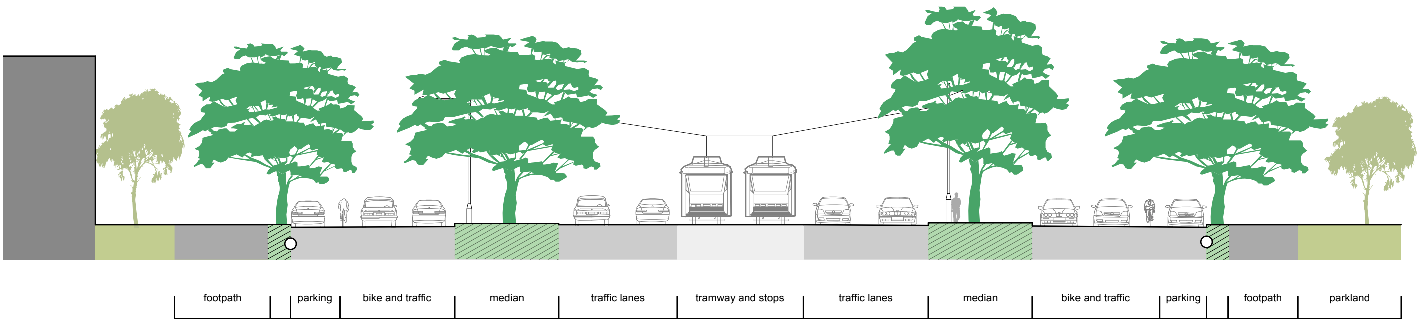
Appendix 3: Location Typology – Additional Location Types

The following pages show Location Types considered for, but not included in, the final Location Typology for Trees Within City of Melbourne Streets and Parks.

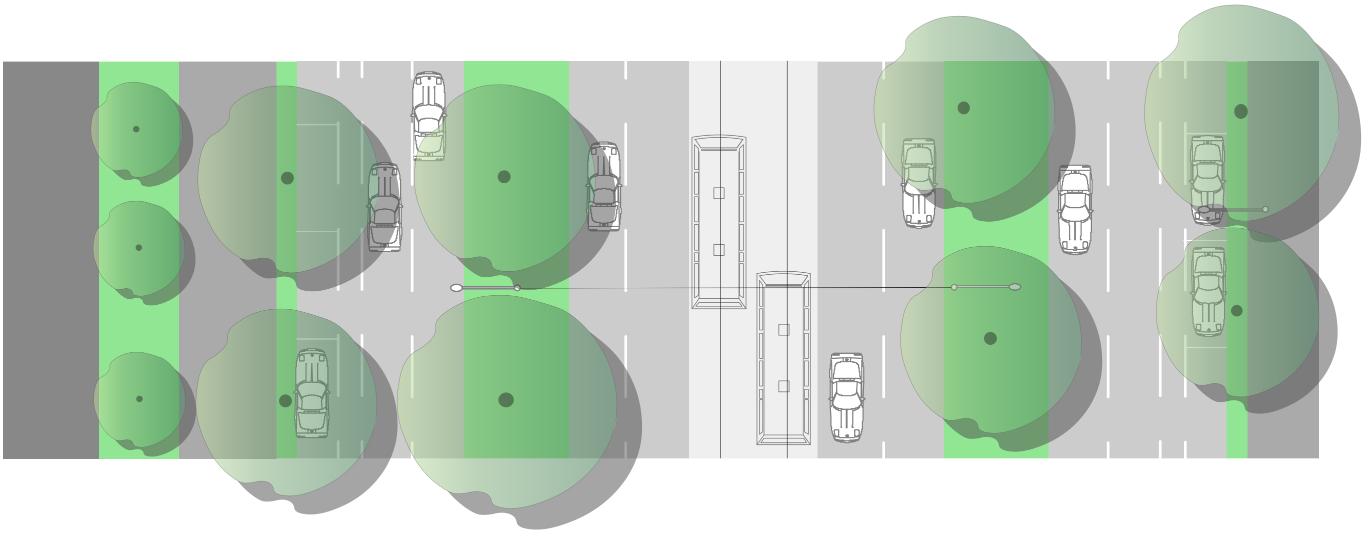
CAD Boulevard Median With No Trams near Median Planting

Description of Key Characteristics

Street Width	60 metre
Traffic Lanes	8 lane boulevard with double medians and central tramway. Bike lanes at road edge.
Overhead	Lighting, Tram cabelling in centre
Buildings	Medium and/or parkland
Parking	Parallel kerbside
Road centre	Two planted and grassed medians
Pathways	3 metre/various width footpath. Setback from road edge
Trees	4 main avenues
Example	St Kilda Road, Royal Parade, Flemington Road



Typical Section

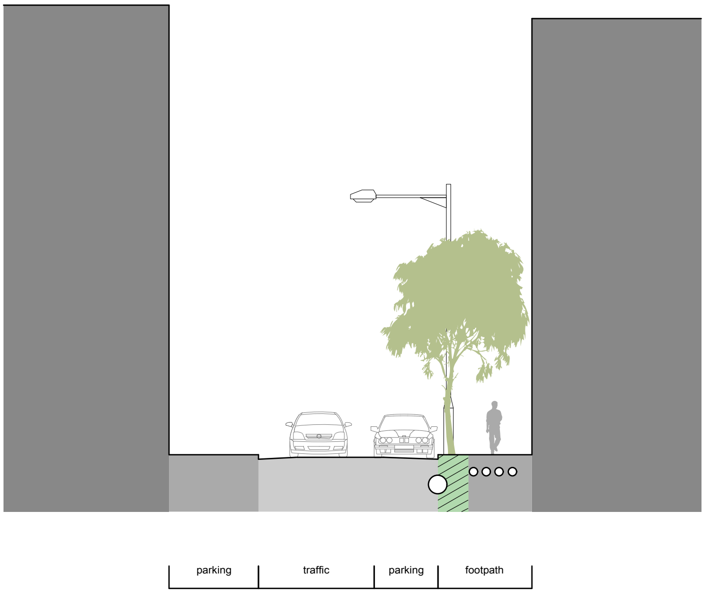


Typical Plan

CAD Laneway Wide

Description of Key Characteristics

Street Width	10-12 metres
Traffic Lanes	Mostly single lane. Often running east/west
Overhead	Lighting
Buildings	Medium to high at footpath edge
Parking	Parallel kerbside mostly on one side
Road centre	–
Pathways	< 3 metre footpath at roadside
Trees	Often on one side of street
Example	Little Collins Street, Flinders Lane



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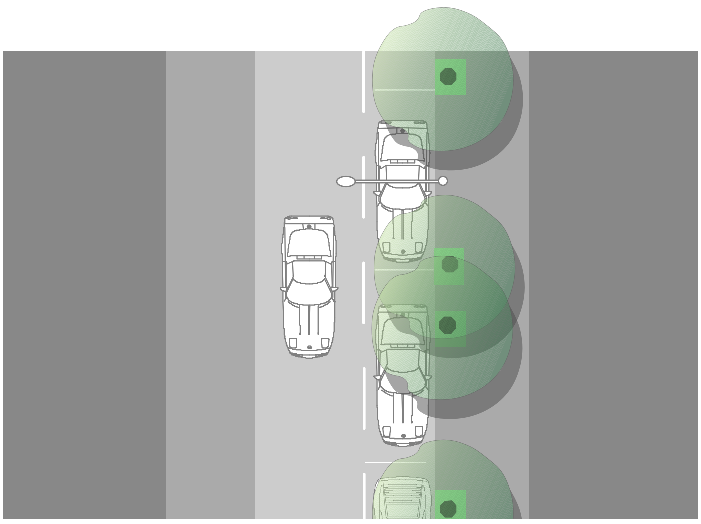
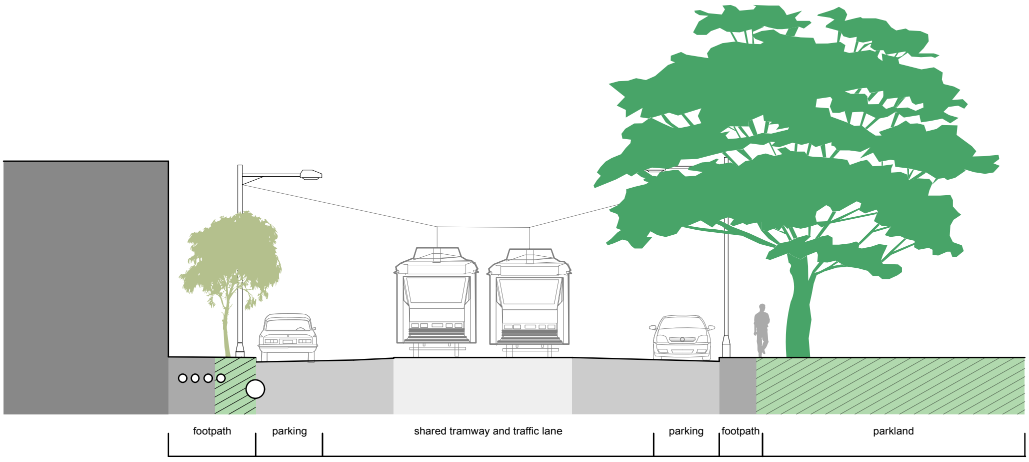


Typical Plan

Park and Road

Description of Key Characteristics

Street Width	20 -30 metres
Traffic Lanes	2 lane shared with tramway
Overhead	Lighting, tram cabling
Buildings	Medium height and parkland
Parking	Parallel kerbside
Road centre	May have tramway
Pathways	Narrow to wide. Often setback off road
Trees	Larger trees in park
Examples	The Avenue Parkville, Rathdowne Street, Domain Road



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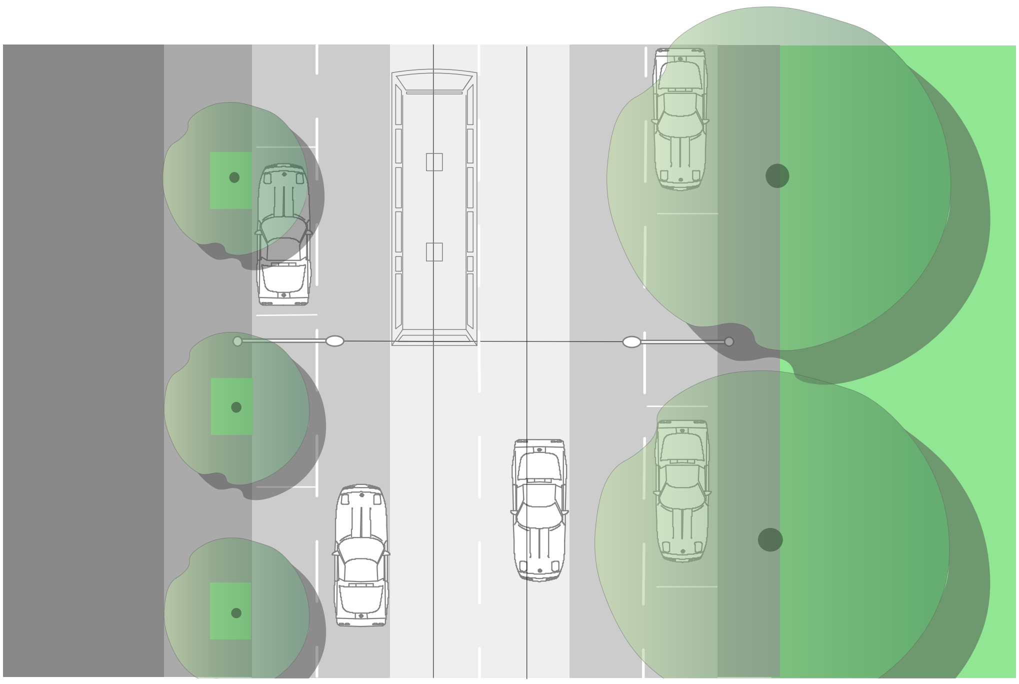
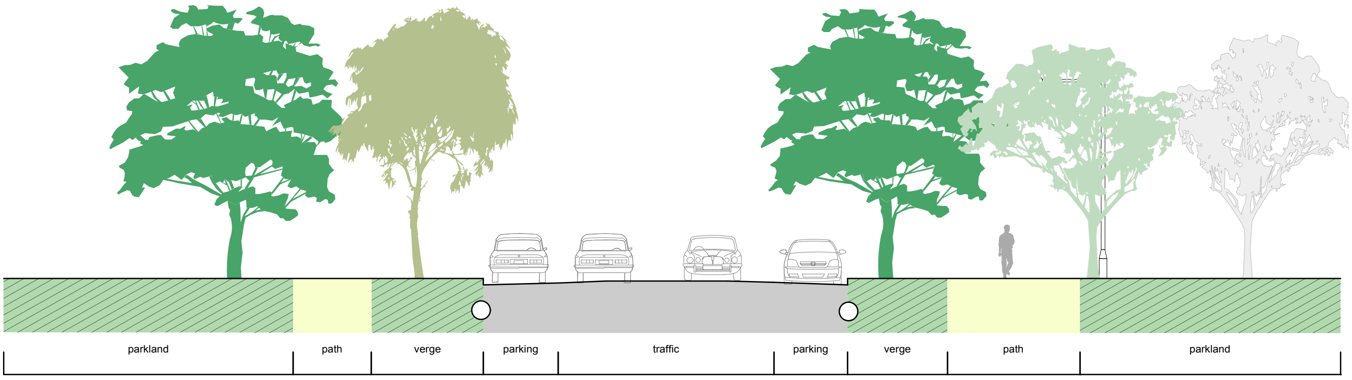


Typical Plan

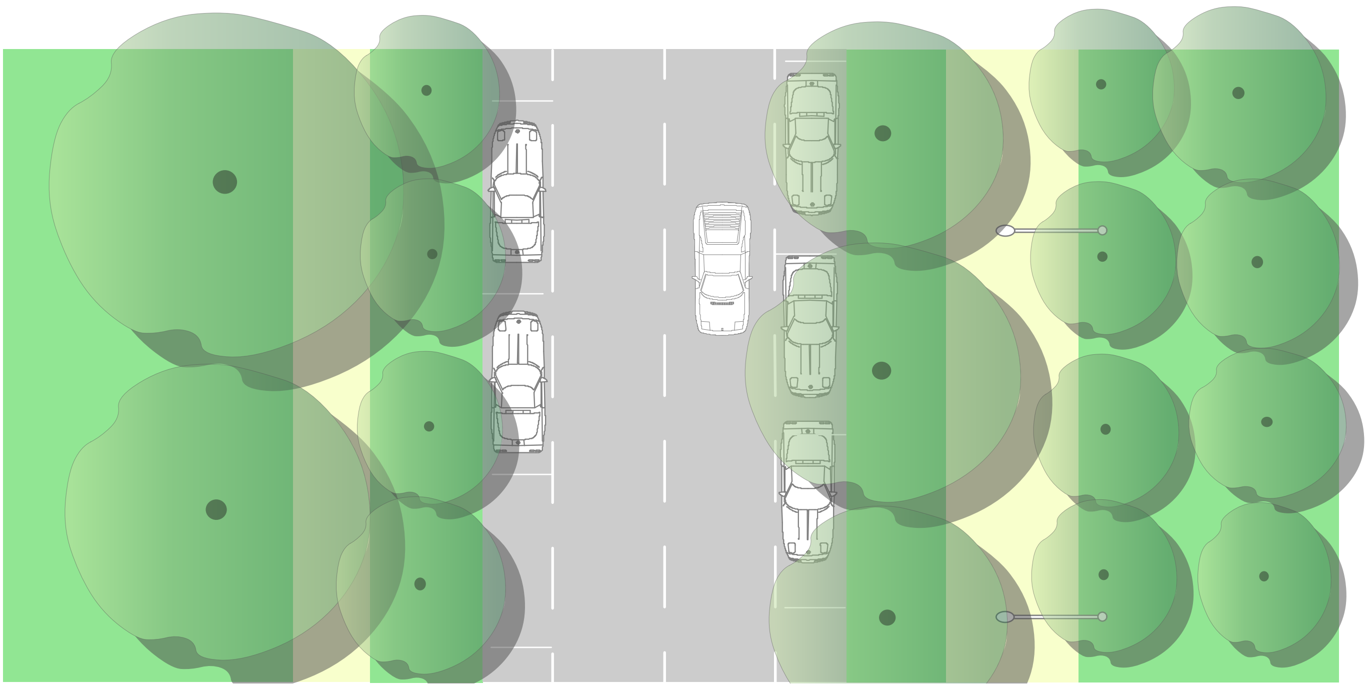
Park Road Through

Description of Key Characteristics

Street Width	20 metre
Traffic Lanes	2 lane
Overhead	Lighting
Buildings	None
Parking	Varied or none
Road centre	–
Pathways	Varied pathways, with setback from road edge
Trees	Avenues along road and pathways
Example	Birdwood Avenue



Typical Section



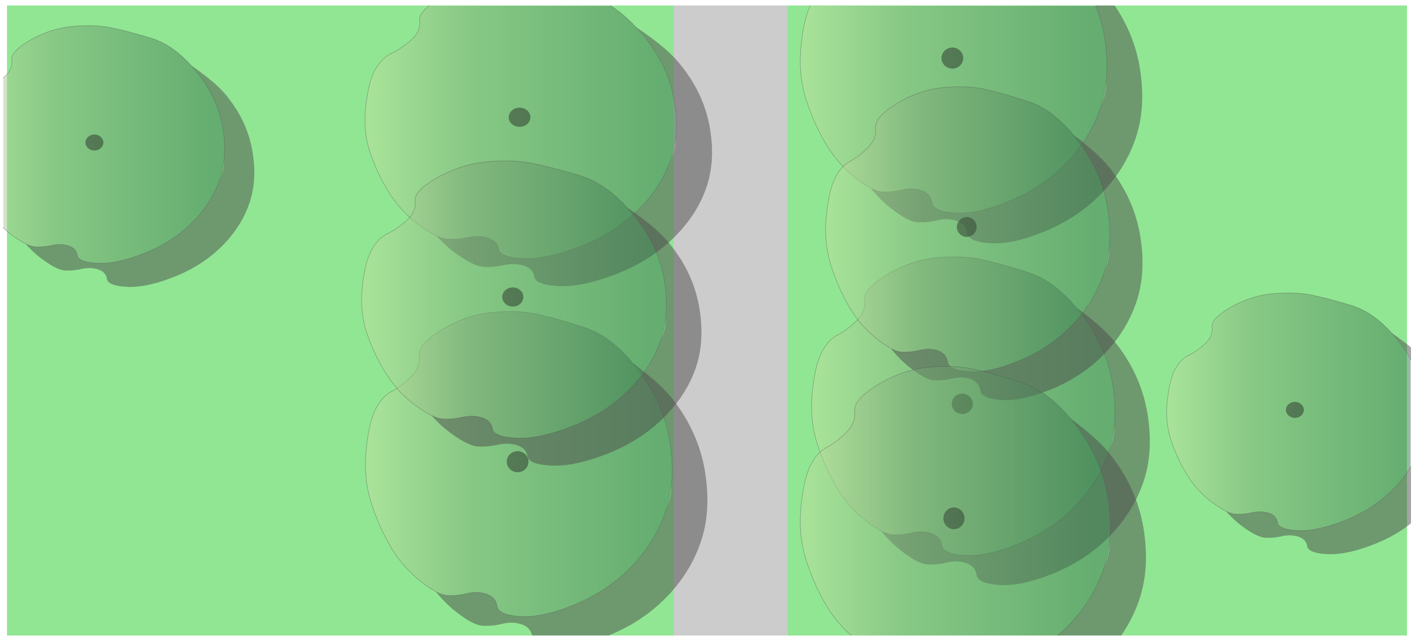
Typical Plan

Park Avenue

Description of Key Characteristics

Street Width	–
Traffic Lanes	–
Overhead	–
Buildings	–
Parking	–
Road centre	–
Pathways	Narrow to wide pedestrian pathway network
Trees	Avenue plantings
Example	University Square

Typical Section

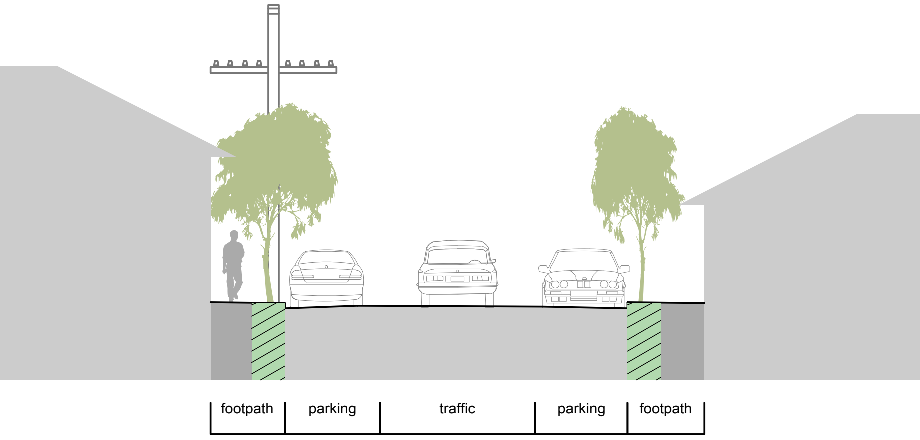


Typical Plan

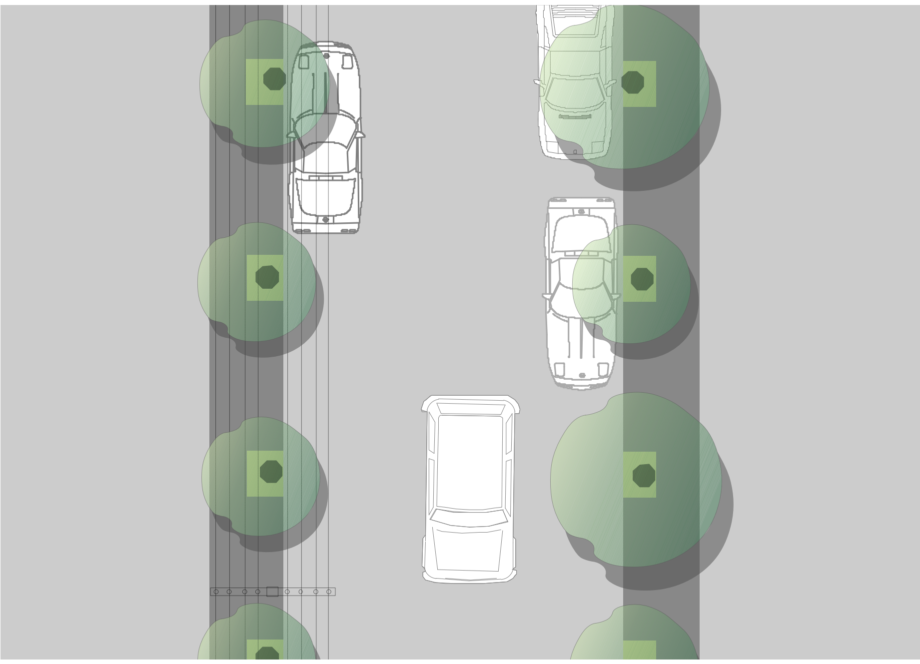
Residential Narrow Street

Description of Key Characteristics

Street Width	12-15 metres
Traffic Lanes	Single lane, or shared
Overhead	Powerlines, lighting
Buildings	Residential
Parking	Parallel kerb
Road centre	–
Pathways	< 2.5 metre footpath at road edge
Trees	Kerb edge
Example	Bayswater Road Kensington



Typical Section

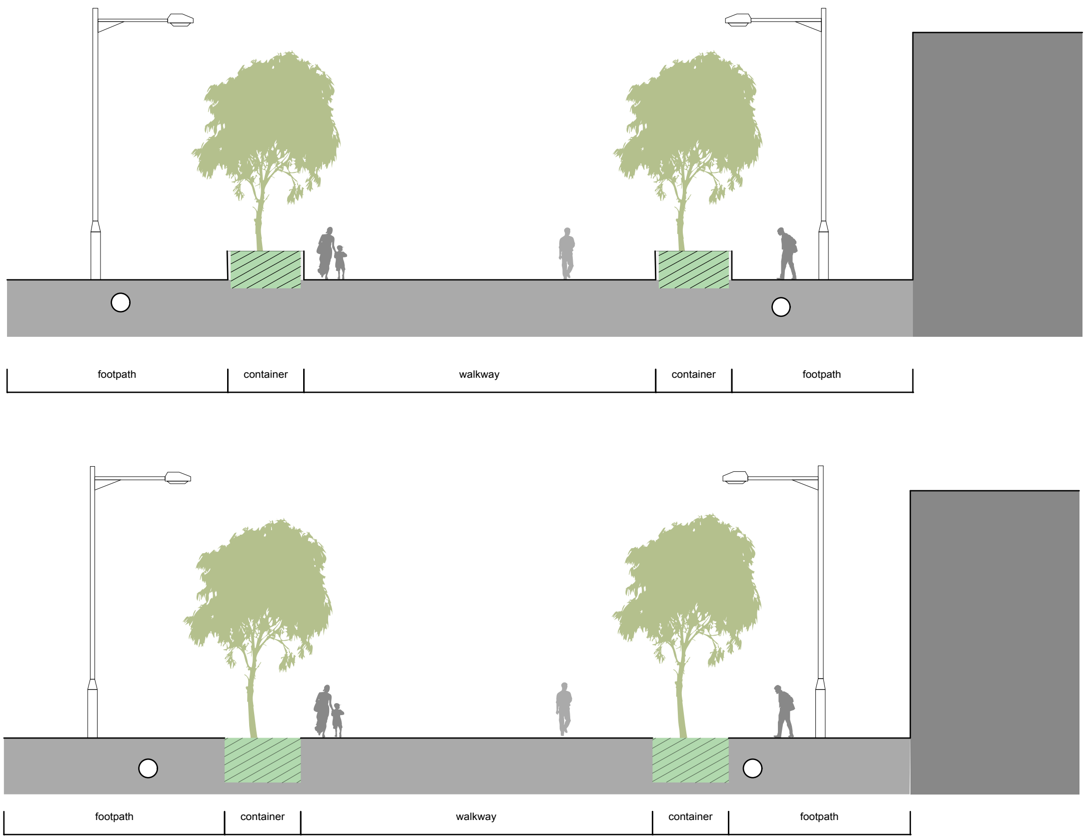


Typical Plan

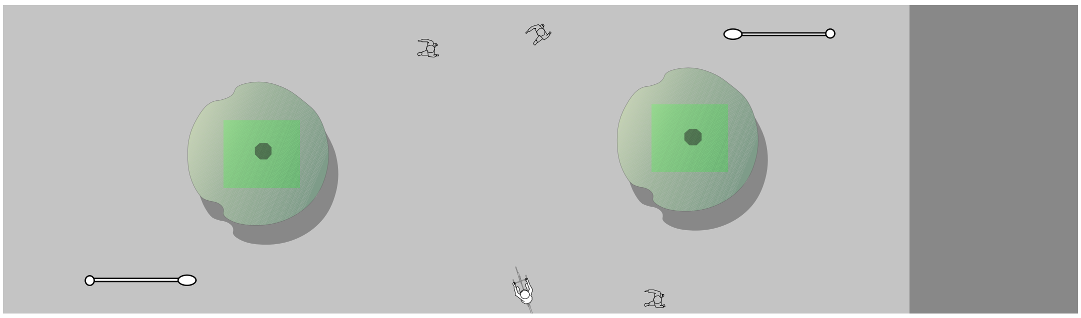
Container

Description of Key Characteristics

Street Width	Varied
Traffic Lanes	Pedestrian traffic primarily
Overhead	Lighting
Buildings	Varied heights
Parking	–
Road centre	–
Pathways	Varied width pathway and open space
Trees	Container plantings
Example	Bourke St Mall, Docklands, Roof Gardens, Southbank.



Typical Sections



Typical Plan

Appendix 4: Adaptability and Vigour

What makes a useful street tree for Melbourne according to the tree selection matrix ?

An adaptable street tree that is vigorous is desirable in Melbourne's future urban forest. The scoring of the Base Criteria shows that careful consideration of the species was considered initially. All the 148 species pass. There are no trees that can be considered as having a low adaptability as they have been culled in the first instance. All trees have a moderate adaptability or higher. The trees can be given intervals of adaptability to help analyse the list and determine which trees can be used in priority tree replacement streets.

Intervals for analysis can include:

1) Moderate Adaptability: 25-33. Examples of species in this lower ranking bracket that comprises 10% of the list include:

- Trident Maple
- Lilly Pilly
- Norfolk Island Pine
- Moreton Bay Fig
- Pistachio
- *Stenocarpus*
- Golden, English and Dutch Elms

There are no clear patterns, as there are many genera found in the moderate adaptability found in the next higher. However trees that benefit from water and shelter such as the cool climate Maples, Australian rainforest species and Elms tend to be found in this range.

2) Moderate to High Adaptability: 33-41. Examples of species in this median range bracket comprising 71% of the list include:

- Norway Maple
- She-Oak
- Coastal Banksia
- Common Hackberry
- Bottlebrush
- *Corymbia* sp.
- *Eucalyptus* sp.
- Port Jackson Fig
- Ash
- *Melaleuca*
- Pines
- Pears
- Oaks
- Fan Palms
- Weeping Lilly Pilly

A large representation of the Australian myrtaceous trees such as *Eucalypts*, *Corymbias* and *Melaleucas*. There are also number of hardier deciduous trees from Asia, southern Europe, the Mediterranean and America. Piles also dominate.

3) High Adaptability: 42-50. Examples of species in this higher range bracket comprising 5% of the list include:

- Kurrajong
- Cypress Pines
- Cypress
- Liquidamber
- Holly Oak

An eclectic group of trees, this includes Australian native trees from the interior and dry slopes, the Cypress from USA and the Middle East and evergreen oaks. All trees from harsh dry climates.

Appendix 5: Limitations, Qualitative Judgments and Research Data

The assessment criteria for the street tree diversity list have been developed with expert technical opinion that covers arboricultural experience, from landscape architectural advice and also from Council's own experience and input. The application of urban forest management practice within Australian cities is relatively recent. There is a lack of critical data and research. As a consequence, to make the assessment of the tree selection criteria the limitations need to be identified to define qualitative judgment.

Research Data

The performance of street trees in Melbourne is based on what has been growing in the City's streets over time and what has been growing in similar climates in adjoining Council Local Government Areas with similar climates. There are horticultural factors such as frosts, soil types and planting methods and practices that vary across the Greater Melbourne area. The tree diversity list is intentionally 'live' to allow trialing of new species and consequent research data to be incorporated. Research from universities and technical institutes is limited by funding provided both publicly and privately. It is unfortunate in Australia that such funding is limited, though it is hoped that this will change. Research data is critical for Council to manage the urban forest effectively.

Shade Rating

The quality of shade that trees provide in the city is an important attribute. The quality and extent of shade has a direct impact on street microclimate, personal comfort and ultimately the liveability and success of our streets. Shade rating like biodiversity potential is an important goal for planning the urban forest. However the methods for determining shade quality are not easily qualified by scientific data. While the Leaf Area Index (LAI) is a measurement of leaf area per unit ground surface area, it is not a determinant for shade quality. LAI is used in agriculture and forestry to predict crop and tree growth for production. Other techniques include hemispherical (or fisheye) photography. This technique involves analyzing tree canopy photography, however is applicable to ecological or canopy forest cover. It measures the amount of solar penetration in the canopy, not for individual street trees. Light sensors can be used for individual trees, however data would need to be logged over time to determine solar radiation levels and canopy architecture. (Rich, P.M. 1990. Characterizing plant canopies with hemispherical photographs.)

For this study the shade quality is determined by what we assess to be a comfortable shade level. The shade levels were defined in intervals from heavy to light. These patterns of shade have been identified with photographs as a gauge of shade intensity.

Appendix 6: Crown Projection Method

To calculate how much soil is needed for a given size tree, the Urban Horticulture Institute (2003) based at Cornell University in the United States has developed a step-by-step methodology. The following is a shortcut version of that methodology that can be used to approximate soil volume requirements.

1. Measure the distance from the tree's main trunk to the dripline, or consult a reference book to find the optimum mature spread of the tree you are considering. Estimate that the tree will reach 75% of the optimum. Take half of the realistic spread, which is the radius, r.
2. Calculate 3.1416 x r2. That's the crown projection, the area under the dripline of the tree.
3. For every square meter of crown projection, provide 0.6m3 of soil.

Example: *Platanus x acerifolia* (London Plane) has the ability to reach 20m height x 18m canopy width (avg.) with a trunk diameter of 45cm measured at 1.4m from ground level. Tree is growing in Melbourne with no irrigation. The canopy radius would be 9.0m.

The crown projection would be (3.14)x(9.0 x 9.0)= 254.46m2

254.46m2 x 0.6 = 152.68 cubic meters of soil volume needed.

Tree roots generally will not be found deeper than one meter; consequently one meter is used as a depth dimension (unless you know the planting site will be shallower). 15270cm/100cm = 152.7m2; the area of useable soil in your planter (equivalent to a planting site that's approximately 12.3 meters wide, 12.3 meters long, and 1.0 meter deep).

(http://www.hort.cornell.edu/department/faculty/bassuk/uhi/walk5.html)

Watson & Himelick (1997) also use the crown projection method and suggest as a general guide that root space should be 60cm deep within the projected crown area. This method is also supported in part by the notion that fine root density is usually greater beneath the canopy than beyond (Gilman, 1997).

Appendix 7: Master Lists of All Street Trees, Park Trees and Trial Trees

Master List of Street Trees

Acer buergerianum
Acer campestre 'Elsrijk'
Acer campestre 'Evelyn'
Acer platanoides 'Crimson Sentry'
Acer platanoides 'Globosum'
Acer rubrum 'October Glory'
Acer rubrum 'Scarsen'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Afrocarpus falcata
Agathis robusta
Agonis flexuosa
Allocasuarina littoralis
Allocasuarina torulosa
Allocasuarina verticillata
Angophora costata
Angophora floribunda
Angophora hispida (Syn. A. cordifolia)
Araucaria cunninghamii
Araucaria heterophylla
Banksia integrifolia subsp. integrifolia
Banksia serrata
Brachychiton acerifolius
Brachychiton populneus
Brachychiton rupestris
Brachychiton x roseus
Callistemon 'Harkness'
Callistemon salignus
Callistemon viminalis
Casuarina cunninghamiana
Casuarina glauca
Catalpa bignonioides 'Nana'
Cedrus atlantica
Cedrus deodara
Celtis australis
Celtis occidentalis
Cercis siliquastrum
Cinnamomum camphora
Corymbia citriodora
Corymbia eximia
Corymbia ficifolia
Corymbia maculata
Cupaniopsis anachardioides
Cupressus glabra (syn. C. arizonica)
Cupressus sempervirens
Cupressus torulosa
Eucalyptus bancroftii
Eucalyptus camaldulensis
Eucalyptus cinerea
Eucalyptus cosmophylla
Eucalyptus gregsoniana
Eucalyptus leucoxylon
Eucalyptus leucoxylon dwarf form
Eucalyptus leucoxylon ssp. megalocarpa
Eucalyptus mannifera subsp. maculosa
Eucalyptus melliodora
Eucalyptus nicholii
Eucalyptus platypus
Eucalyptus polyanthemos
Eucalyptus pulchella
Eucalyptus scoparia
Eucalyptus sideroxylon
Eucalyptus spathulata
Eucalyptus stoatei
Ficus macrophylla
Ficus microcarpa var. hillii
Ficus platypoda
Ficus rubiginosa
Fraxinus excelsior 'Aurea'
Fraxinus ornus
Fraxinus ornus 'Meczek'
Fraxinus pennsylvanica 'Aerial'
Fraxinus pennsylvanica 'Cimmaron'
Fraxinus pennsylvanica 'Urbanite'
Fraxinus velutina
Geijera parviflora
Ginkgo biloba
Ginkgo biloba 'Princeton Sentry'
Gleditsia triacanthos var.inermis Varieties
Hakea francisiana
Jacaranda mimosifolia
Koelreuteria paniculata
Lagerstroemia indica x L. fauriei varieties
Leptospermum petersonii
Liquidambar formosana
Liquidambar styraciflua 'Rotundiloba'
Lophostemon confertus
Maclura pomifera 'Wichita'
Magnolia grandiflora 'Exmouth'
Melia azedarach
Metasequoia glyptostroboides
Olea europea
Paulownia tomentosa
Phoenix canariensis
Pinus canariensis
Pinus halepensis
Pinus patula
Pinus pinaster
Pinus pinea
Pistacia chinensis
Platanus orientalis 'Digitata'
Platanus X acerifolia
Podocarpus elatus
Pyrus calleryana varieties
Pyrus nivalis
Quercus acutissima
Quercus agrifolia
Quercus bicolor
Quercus canariensis
Quercus cerris
Quercus coccinea
Quercus ilex
Quercus macrocarpa
Quercus palustris
Quercus phellos
Quercus robur
Quercus robur 'Fastigiata'
Quercus rubra
Robinia pseudoacacia (Varieties)
Sapium sebiferum
Schinus areira
Sophora japonica 'Princeton Upright'
Stenocarpus sinuatus
Syzygium australe 'Pinnacle'
Syzygium paniculatum
Taxodium distichum
Tilia cordata 'Greenspire'
Trachycarpus fortunei
Tristaniopsis laurina
Ulmus glabra 'Lutescens'
Ulmus parvifolia
Ulmus procera
Ulmus x hollandica
Washingtonia filifera
Washingtonia robusta
Waterhousea floribunda
Zelkova serrata 'Green Vase'

Master List of Park Trees

Acer rubrum 'October Glory'
Acer truncatum x A. platanoides 'Keithsform'
Acer x freemanii 'Autumn Blaze'
Agathis robusta
Angophora costata
Angophora floribunda
Araucaria cunninghamii
Araucaria heterophylla
Brachychiton acerifolius
Catalpa bignonioides
Cedrus atlantica
Cedrus deodara
Corymbia citriodora
Corymbia maculata
Cupressus torulosa
Ficus macrophylla
Fraxinus pennsylvanica 'Cimmaron'
Liquidambar styraciflua 'Rotundiloba'
Metasequoia glyptostroboides
Phoenix canariensis
Pinus canariensis
Pinus patula
Pinus pinea
Podocarpus falcatus
Quercus coccinea
Quercus phellos
Taxodium distichum
Ulmus parvifolia
Washingtonia filifera
Washingtonia robusta
Zelkova serrata 'Green Vase'

Master List of Trial Trees

Abies pinsapo 'Glauca'
Acer monspessulanum
Alnus cordata
Callitris glaucophylla (formerly C. columellaris)
Callitris preissii
Carpinus betulus 'Fastigiata'
Cercis canadensis 'Forest Pansy'
Eucalyptus curtisii
Eucalyptus gardneri
Eucalyptus haemastoma
Eucalyptus polybractea
Eucalyptus risdonii
Eucalyptus wimmerensis 'Honey Pots'
Flidersia maculosa
Flindersia australis
Fraxinus americana var.
Lithocarpus densiflorus
Phellodendron amurense
Pyrus betulaefolia 'Southworth' Dancer™
Searsia pendulina
Tilia tomentosa 'Sterling'
Tipuana tipu

Proposed timing for the development of Tree Precinct Plans and Master Plans

The tree precinct plans and master plans will be undertaken in collaboration with the community and key stakeholders to guide City of Melbourne's approach to implementing tree species diversity.

It is proposed that the development of the tree precinct plans commence when the Urban Forest strategy is endorsed by Council.

Year 1 April 2012 – March 2013

- Carlton *Tree Precinct Plan*
- East Melbourne & Jolimont *Tree Precinct Plan*
- South Yarra *Tree Precinct Plan*
- CBD *Tree Precinct Plan*
- St Kilda Rd *Master Plan* – Year 1 &2

Year 2 April 2013 – March 2014

- North & West Melbourne *Tree Precinct Plan*
- Kensington *Tree Precinct Plan*
- St Kilda Rd *Master Plan* Year 1 &2
- Royal Parade *Master Plan* Year 2 &3
- Flemington Rd *Master Plan* Year 2 &3

Year 3 April 2014 – March 2015

- Parkville *Tree Precinct Plan*
- Southbank *Tree Precinct Plan*
- Fishermans Bend *Tree Precinct Plan*
- Elizabeth St (Haymarket – Victoria St) *Master Plan*
- Royal Parade *Master Plan* Year 2 &3
- Flemington Rd *Master Plan* Year 2 &3

CITY OF MELBOURNE

COMMUNITY ENGAGEMENT GOALS

1. Build understanding of the challenges facing Melbourne's Urban Forest and the value of healthy urban landscapes and gauge community support for the strategy.
2. Understand the community's thoughts, perceptions and concerns about the urban forest strategy and to respond to them in a meaningful way.

COMMUNITY ENGAGEMENT HISTORY

Preliminary consultations were undertaken during the development of strategy to gauge support for the strategy's principles. Presentations were given and feedback was provided. The following groups and individuals were consulted:

- Parks & Gardens Advisory – extensive input into the development of the strategy
- VicUrban
- VicHealth & Department of Health
- Landcare Australia
- Royal Botanic Gardens
- Friends of the Elms
- Residents groups
- Dr Cecil C. Konijnendijk, Danish Centre for Forest, Landscape and Planning, University of Copenhagen

EXTERNAL STAKEHOLDERS

Business
- Citywide & Serco
- Developers
- Special event organisers
- Sporting groups
- Allied Health Industries (i.e. Heart Foundation)
- Melbourne Business Precincts Program

Community organisations & groups
- Residents Associations
- Precinct Associations
- Wurundjeri Tribe Land Cultural Heritage Council Inc
- Koorie Heritage Trust
- Boon Wurrung Foundation
- Melbourne South Yarra Group
- National Trust
- Friends of the Elms
- Royal Park Protection Group
- Protectors of Public Land
- Australian Garden History
- Landcare Australia
- Northern Alliance for Greenhouse Action (NAGA)
- Committee for Melbourne

CoM Reference Groups
- Parks and Gardens Advisory Group
- Melbourne Hospitality Advisory Board
- Melbourne Retail Advisory Board
- Future Melbourne Reference Group
- City of Melbourne Water Reference Group
- Indigenous Advisory Panel

General
- Residents
- Employees/workers
- Visitors
- Children
- Media
- Artists

Government & Government Agencies
- Neighbouring Councils & IMAP
- Vicurban
- Vicroads
- Heritage Victoria
- Bicycle Victoria
- Parks Victoria
- Dept. of Sustainability and Environment
- Department of Planning & Community Engagement
- Department of Primary Industries
- Department of Health
- Melbourne Water, CityWest Water & South East Water
- Port of Melbourne
- Urban Renewal Authority Victoria
- Victorian Major Events Commission (VMEC)
- VicHealth
- Royal Botanic Gardens

PEER REVIEW
- Australian Research Centre for Urban Ecology (ARCUE)
- Victorian Centre for Climate Change Adaptation Research (VCCCAR)
- Monash University
- Melbourne University
- Danish Centre for Forest, Landscape and Planning
- USDA Forest Service, New York