City of Melville

URBAN forest strategy

URBAN FOREST STRATEGIC PLAN 2017-2036:

Part A: City-Controlled Land

Acknowledgement

The City of Melville would like to acknowledge the Bibbulmun people as the Traditional Owners of the land on which the City's urban forest grows today.

The City pays its respects to the Whadjuk people and Elders both past and present.

Adopted July 2017

Message from the Mayor

Trees and other vegetation are an integral element of the urban environment and a vital urban asset providing a range of important economic, environmental and social benefits for the community.

The City of Melville's Urban Forest Strategic Plan will give practical effect to the Urban Forest and Green Spaces Policy adopted in 2016. This strategic plan aims to protect, preserve and enhance the leafy character and visual amenity of the City and to support and sustain its natural biodiversity.

This document is Part A of the Urban Forest Strategic Plan, and focuses on land that is owned or controlled by the City itself. About half of the City's urban forest trees grow on land owned or managed by the City, even though this land represents just over one-third of the area within our borders. Urban forest on City-controlled land is the City's green infrastructure, with a community benefit value that rivals that of our "hard" infrastructure.

Developed in consultation with a committed and enthusiastic community reference group, the City's Urban Forest Strategic Plan Part A is about transforming our own approach to emphasise holistic management of the urban forest system in the public realm.

We are committed to ensuring that our urban forest remains integral to the City's sense of place even as the face of the city is changing. This document contributes to the "clean and green environment" and "liveable built environment" aspirations of the City's community.

Through encouraging a sense of shared responsibility for the City's existing natural assets, and promoting an understanding of both the benefits that they bestow and the issues that must be managed, I believe that this document will help the City and its community to work together for a healthy, resilient and beautiful urban forest that defines our City's character.

The City of Melville's Urban Forest Strategic Plan Part A sets out priorities for the renewal of our existing green infrastructure and its enhancement through a series of long term programs, which will be achieved in an environmentally and financially sustainable manner.

This document, and the accompanying information paper, will help you to learn more about the City's urban forest, its benefits and its future challenges. The City welcomes your comments and ideas to ensure the Urban Forest Strategic Plan Part A provides the right guidance to our City managers. I encourage you to join the conversation on Melville Talks and to share your views with us on the way forward.

Later in 2017, the City will develop, in consultation with the community, further strategic plans that will seek to address the challenges of managing the continuing large scale loss of mature backyard trees from our urban forest, and the future management of other green spaces in the City.

Mayor Russell Aubrey

Table of Contents

Executive Summary

A healthy, resilient urban forest provides multiple environmental, social and economic community benefits, and contributes significantly to the character and liveability of an urban area. Just as the benefits of the urban forest are shared across the community, so its protection and enhancement is a shared responsibility between the City and the community.

Protecting and enhancing the urban forest is consistent with the aspirations of "clean and green", "healthy lifestyles" and "sense of community" in the Strategic Community Plan 2016-2026; and with key strategies in the Corporate Business Plan 2016-2020, notably "enhance amenity and vibrancy", "holistic and integrated strategies for protection of the City's natural resources", and "ameliorate loss of vegetation from private property development".

In September 2016, Council approved the ***Urban Forest and Green Spaces Policy*** (CP-102) with the following objectives:

1. To protect, preserve and enhance the aesthetic character of the City of Melville.
2. To realise the social, environmental and economic benefits of trees and other vegetation as an integral element of the urban environment.
3. To contribute to community wellbeing by integrating and aligning the efficient provision of physical, social and green infrastructure and management of natural areas to achieve community wellbeing today and tomorrow.
4. To encourage a sense of shared responsibility and balance individual and community rights to equitably distribute the costs and the benefits of a greener City.
5. To ensure that the urban forest and green spaces that are integral to the City's sense of place are not compromised in areas of increased residential density.

The City will achieve these policy objectives through delivering the following outcomes:

Outcome	Intent
Understanding	We will monitor and analyse the extent, condition, utilisation, constraints and intrinsic community value of the urban forest in the City of Melville and identify sustainable opportunities for its protection and enhancement.
Management	We will use a sound evidential base to manage the City's urban forest system and its assets for optimal health, resilience, diversity, sustainability and contribution to specified outcomes.
Innovation	We will seek to be flexible and innovative in achieving the City's urban forest outcomes and in responding to emerging issues.
Responsiveness	We will inform and engage the community on urban forest management and encourage their participation in monitoring, maintaining and enhancing the urban environment.
Integration	We will aim to incorporate urban forest protection into the City's strategic urban planning, infrastructure and land asset management and corporate objectives, with a focus on maximising the net public benefits of urban vegetation for liveability, amenity and neighbourhood character.

This document is Part A of the Urban Forest Strategic Plan. It deals with the urban forest on City-controlled land and gives practical effect to the City's Urban Forest and Green Space Policy by:

- documenting the goals and indicators that will guide the City's urban forest management on its own land,
- identifying emerging issues and risks for the urban forest and proposing options to address these, and
- specifying operational directions, targets, priorities and performance indicators to support and evaluate operational decisions in managing the urban forest.

This Plan was developed with the benefit of input from a Community Reference Group of 14 randomly selected residents who developed a consensus view that "*the purpose of an urban forest is to provide a healthy and peaceful environment which nurtures the well-being of all the natural and human communities that reside within it*".

The Group also recommended that priority be given to planting additional trees in areas with known urban heat impacts, low vegetation diversity and inadequate vegetation cover, recognized the importance of selecting species that are fit for purpose and climate change resilient, and supported the City committing resources to encourage community-based initiatives. The Group proposed the following actions: upgrade or create new pathways between natural areas, increase planting in foreshores and streets, upgrade verges, develop a tree management education program and create diversity to support fauna.

This plan has been based on input from the Community Reference Group, analysis of existing urban forest data held by the City, research and urban forest strategies elsewhere, the *Urban Forest and Green Space Policy (CP-102)*, Strategic Community Plan, Corporate Business Plan, corporate capacity and consideration of corporate and other risks.

Across the City, on both public and private land, tree canopy (trees more than three metres tall) covers 24% of the land area, with understorey vegetation (plants less than three metres tall) making up a further 18%.

In general, there is no indication that the urban forest in the City of Melville is deficient in the context of our Mediterranean climate and natural ecoregion, and no evidence to suggest that the City suffers societal, environmental or other problems attributable to a deficiency of trees or other vegetation. However, the urban forest is not uniformly distributed across the City, and there are some areas where tree canopy cover is significantly less than the average, particularly in industrial and commercial areas, and locations where amenity would be improved with more trees and understorey vegetation.

Tree canopy cover in some residential areas has significantly declined on private land in the last 30 years due to subdivision for higher density residential development, but the City's capacity to address this issue directly is limited by current legislation. Over the same period, canopy cover on City land, particularly in natural areas and developed parkland, has visibly increased.

The City has a good record of urban forest cover on its own land. Land controlled by the City accounts for 37% of the total land area in the City of Melville boundary, but contains almost half of the total tree canopy cover and almost 40% of the total understorey vegetation cover.

Approximately 30% of all City-controlled land is shaded by the canopies of trees more than three metres tall, with a further 19% covered by understorey vegetation, and about 15% of City land is turfed. By land use within City-controlled land, tree canopy cover comprises 24% of streetscapes, 47% of developed parks and recreational areas (which include active sports reserves) and 62% of natural areas.

The City has traditionally managed its trees and other vegetation from a horticultural or park management perspective, rather than as an inter-related forest system integrated with the broader urban environment. While the health and extent of the urban forest on City land shows that this has been effective, this plan commences a shift to an urban forestry systems management function with a more strategic and long term outcome-based focus, greater use of data analysis to support sustainable decision-making and the application of asset lifecycle management principles.

The City needs to address the following key **challenges** for the City's component of the urban forest:

1. The City does not have a complete and current database of the trees on developed public space (streetscapes, parks and recreational areas) or of suitable but unutilised potential planting sites, on which to base strategic urban forest management decisions.
2. The City has an ageing tree population, with over 50% of the City's street trees (up to 25,000 trees) predicted to reach the end of their expected lifespan in the next 10-20 years. In some suburbs, this figure is up to 90%. Replacement of these large, old street trees with much smaller juvenile trees will have temporary, but in some places locally significant, impacts on tree canopy cover until the young trees mature at around 15-20 years after planting.
3. There is limited diversity among City street trees, with four species making up around 40% of the street tree population, and in some suburbs, just one species (jacaranda) comprising 50% of street trees. Park tree diversity is yet to be assessed.
4. Many of the City's existing mature trees were planted at a time when rainfall averaged 160mm/year (23%) more than now, groundwater recharge rates were higher, average daily maximum temperatures were almost 1^{o}C lower and there were rarely more than 2-3 days each year (and frequently none) with maximum temperatures over 40^{o}C. The Bureau of Meteorology predicts that local rainfall will continue to decline, potentially by up to 15% (compared with a 2011 base) by 2030 and 30% by 2090, that average temperatures will continue to rise, and that the risk of bushfires and frequency of heat waves and storms will increase.
5. There has been no locally-relevant research on the likely vulnerability of common urban tree species to climate change impacts or on ways to mitigate these risks.
6. There is a need to identify urban tree species, which may not currently grow in the City, that have natural climatic tolerances better suited to anticipated local rainfall and temperature conditions over the next 50-100 years.
7. There is no locally-relevant published research on the level of urban forest canopy cover that can be sustained by predicted rainfall alone without depleting groundwater reserves, or on the groundwater levels required to

maintain the viability of the City's seasonal wetlands, which have been showing a drying trend since 1985.

8. The increased driveway and parking requirements associated with increased redevelopment and residential density constrain the number and size of street trees that can be accommodated in some streets, with further restrictions arising from more stringent clearance requirements for utilities and other infrastructure.
9. The City's urban planning instruments and State planning policies do not explicitly recognise the importance of the urban forest or make provision for preserving its integrity.
10. Current City land and infrastructure asset management procedures do not specify urban forest impacts as a decision-making criterion.
11. While community surveys indicate a high level of general support for trees in public places, at an operational level and local scale, concerns are frequently raised by residents about the negative impacts of individual trees on their amenity, lifestyle or perceived risk of harm.
12. The City needs the informed support and active contribution of the community to maximise the effectiveness of its urban forest management, but there are limited accessible, relevant public information resources or public participation programs in place.
13. The City needs to communicate the long-term nature of urban forestry planning necessitated by the slow maturity and long lives of large trees, and will need the community's support and understanding to manage temporary local loss of canopy cover due to the necessary street tree replacement program.

The City has identified the following **goals** for the Urban Forest Strategic Plan Part A 2017-2036:

1. The City will renew its ageing City trees with **no net loss of urban forest canopy** on City land over the period of the plan, and increase planting in targeted areas to achieve **locally optimal levels of tree canopy cover**.
2. The City will establish and maintain a tree database to ensure it has **extensive and current knowledge** of the location, profile and condition of the City's urban forest, and of potential additional planting sites.
3. The City will strive for **excellent urban forest management** delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by **active, innovative community participation**.
4. The City will **integrate urban forest protection into urban planning** instruments and practices and its land and infrastructure asset management.

The City will undertake the following **priority actions** in support of the goals:

1. Complete and maintain a database of key information about its street trees (2018); park trees (2019); suitable street and park tree planting sites (2018/19); and a representative sample of understorey plants in key locations (2020).
2. Work with other local governments, State agencies and research institutions (2017-21) to:

a. Identify the urban forest's vulnerability to predicted local climate change impacts and identify alternative species suited to the expected temperature and rainfall conditions in Perth to 2100;
b. Develop realistic sustainability indicators and record base-line data for long-term monitoring of the urban forest, including water budgets for natural areas (particularly groundwater dependent ecosystems) and non-irrigated parks;
c. Model the financial and canopy cover impacts over time of different street tree replacement schedules;
d. Identify key causes of tree mortality (especially juvenile trees) and options to address these;
e. Develop practical, sustainable localised urban forest targets for suburbs or defined areas based on land use and desired local outcomes;
f. Institute a regular aerial survey regime including canopy cover, thermal performance and NVDI analysis to monitor trends in vegetation extent and condition and trends in urban heat.

3. Analyse the data collected from actions 1 and 2 in order to develop and implement:
   a. A street tree succession plan (from 2018);
   b. A diversity improvement plan (from 2019);
   c. Prioritisation criteria for non-replacement planting (2019);
   d. Local canopy cover improvement plans (from 2020);
   e. Urban forest risk management plan (2020); and
   f. Sustainability monitoring processes to inform long-term urban forest management (2021).
4. Initially increase annual tree planting to 1,500 juvenile trees in streets and parks by 2020 and 5,000 tube-stock in natural areas by 2022, then review planting rates in the context of the research and modelling (action 2) and prepared plans (action 3) to ensure no net loss of tree canopy cover on City land by 2036. Regularly audit progress to update the model and planting program.
5. Develop, in consultation with the community, public information material and public participation and incentive programs to maintain and enhance the urban forest, and monitor community satisfaction.
6. Incorporate urban forest protection explicitly in urban planning instruments and in corporate land and infrastructure asset management processes.

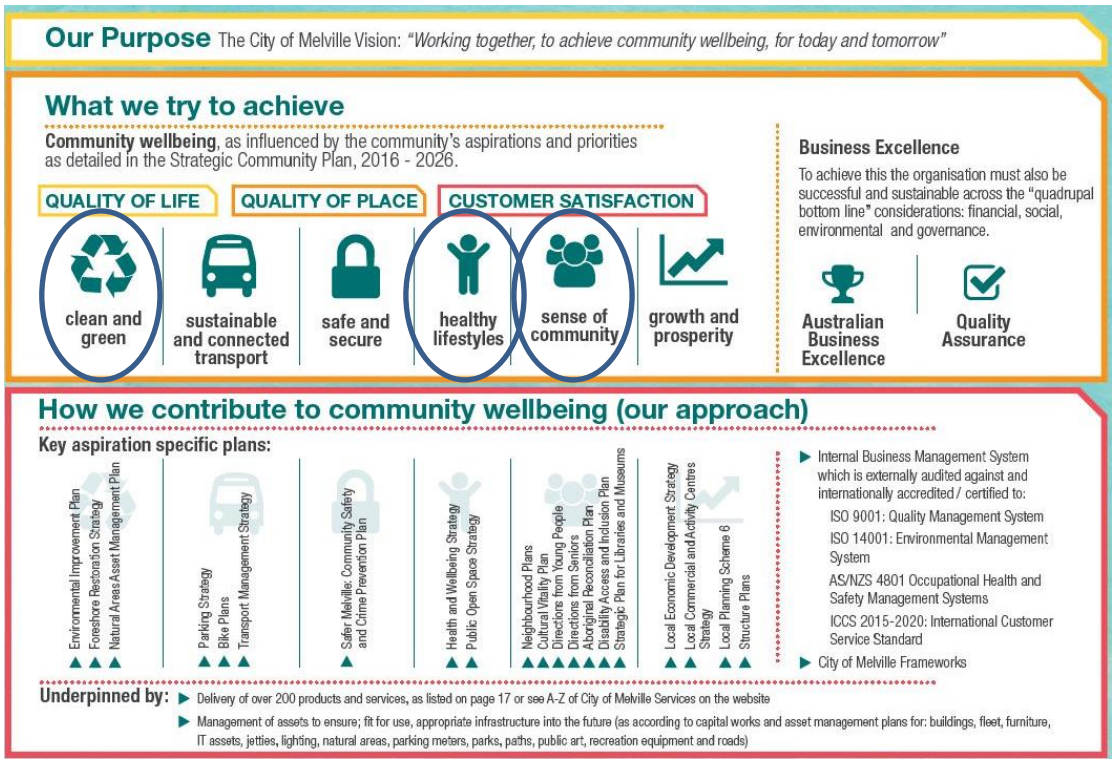
This Plan specifically addresses the **Australian Business Excellence Framework** (ABEF) categories of Strategy and Planning; Information and Knowledge; Results and Sustainable Performance and Customers and Other Stakeholders. The Plan focuses on the following key principles of the Framework:

1. Clear direction and mutually agreed plans enable organizational alignment and a focus on the achievement of goals.
2. Understanding what customers and other stakeholders value, now and in the future, enables organizational direction, strategy and action.
3. Effective use of facts, data and knowledge leads to improved decisions.
4. Sustainable performance is determined by an organisation's ability to create and deliver value for all stakeholders in an ethical, socially and environmentally responsible manner.

1 Linkages to the City of Melville Corporate Business Plan 2016-2020

1.1 Strategic Community Plan and Corporate Business Plan Integration

The City of Melville has developed the Urban Forest Strategic Plan Part A consistent with the Strategic Community Plan 2016-2026 which outlines the community's aspirations as expressed through positive engagement and surveys. The management of the City's urban forest contributes to the community's expressed aspirations of "clean and green", "healthy lifestyles" and "sense of community".



This Plan also contributes to all of the key priorities in the Corporate Business Plan 2016-2020, in that it seeks to improve efficient urban forest management, optimize the urban forest in line with fit-for-purpose criteria, enhance the amenity and vibrancy of our neighbourhoods, protect our natural resources and ameliorate unavoidable loss of vegetation on private property and encourage participatory budgeting and engagement with the business community.

Alignment between Aspirations from the Strategic Community Key Priorities and Strategies from the City of Melville

Document: *People Place Participation 2016 - 2026*	Key Aspirations	Clean and green Sustainable and connected transport Safe and secure Healthy lifestyle Sense of community Growth and prosperity	Clean and green Sustainable and connected transport Safe and secure Healthy lifestyle Sense of community Growth and prosperity	Clean and green Sustainable and connected transport Safe and secure Healthy lifestyle Sense of community Growth and prosperity	Clean and green Sustainable and connected transport Safe and secure Healthy lifestyle Sense of community Growth and prosperity	Sense of community
Document: *City of Melville Corporate Busines Plan 2016 - 2020*	City of Melville Key Priorities	**Key priority:** Restricted current revenue base and increasing/changing service demands impacts on rates **Key strategies:** 1. Explore opportunities for increased residential density and commercial investment in strategic locations, aligned to the local planning objectives and coupled with the exploration of special area rating 2. Creating greater revenue from our current and potential land, property and facility holdings 3. Pursue productivity and efficiency improvements	**Key priority:** Meeting the demand to provide fit for use/appropriate infrastructure into the future **Key Strategies:** 1. Optimise facilities to achieve 'fit for use' facilities for current and future beneficiaries. Includes amalgamation of like groups into hubs and shared use of facilities (private sector, State Govt., other LG and community groups) 2. Review the standards and management model that we assess our asset gap against (the technical standards and from a customer perspective regarding their expectations)	**Key priority:** Urban development creates change in amenity (positive and negative) **Key Strategies:** 1. Ensure higher density developments in strategic locations, consistent with the local planning framework and structure plans, design guidelines for interface areas and ensuring measured change in established areas and consideration of parking and traffic issues 2. Enhance amenity and vibrancy and enhancing community safety through streetscapes, public art, pedestrian and cycle paths, place making and creating well designed, attractive public spaces	**Key priority:** Degredation of natural resources within the City **Key Strategies:** 1. Holistic and integrated strategies for protection of the City's natural resources (includes urban forest, foreshore protection, public open space and streetscapes) 2. Ameliorate loss of vegetation from private property development 3. Explore with current and potential partners the next generation waste treatment technology and implement	**Key priority:** The challenge of meeting community expectations regarding community engagement **Key strategies:** 1. Improve communication mechanisms to make information easy to access regarding community engagement, including improving website, addressing misinformation in the community and optimising use of social media 2. Continue participatory budgeting that involves the community(such as Project Robin Hood) and then taking it further 3. Improve engagement with the business community

1.2 Local Planning Strategy Alignment

The Urban Forest Strategic Plan supports the environmental objectives of the City of Melville Local Planning Strategy (February 2016):

To meet high standards of compliance and have a healthy and sustainable local environment that makes a positive contribution towards the broader environment.

- Ensure that the natural environmental values of the City are protected and conserved for existing and future generations.
- Contribute to the maintenance and enhancement of biodiversity for the preservation of our natural flora and fauna.
- Use natural resources sustainably to reduce our ecological footprint.
- Provide a sustainable built urban environment.

2 Introduction

Well-managed urban forests are internationally recognised as providing significant and varied net public benefits to neighbourhood amenity, human health and wellbeing, economic prosperity and environmental capital (see bibliography in section 8.

The City of Melville commissioned an independent analysis from the McMullen Noland Group in February 2016 which identified a city-wide tree canopy cover of 24% comprising 15.6% from trees more than six metres tall and a further 8.4% from trees and shrubs more than three metres tall. The City of Melville also enjoys city-wide understorey vegetation cover (plants less than 3 metres tall, excluding turf) of 18%, in addition to substantial areas of other green space including grass or turf in recreational and other areas.

By global standards, the overall tree canopy cover in the City of Melville is at a creditable level for an urban area in our global ecoregion (Mediterranean climate with hot-summers). However, there are significant local variations in both tree canopy and understorey cover across the City, driven largely by land use, so the benefits of the urban forest are not evenly distributed. Over the last 30 years, the City has also been experiencing a trend of significant loss of mature vegetation from private property as a result of sub-division and increasing residential density.

The Urban Forest Strategic Plan recognises the importance of the urban forest as an essential part of the City's character and sense of place, regardless of who owns the land on which it grows. A fundamental tenet of the Plan is the crucial role played by the urban forest in making the City of Melville one of the most liveable parts of Perth.

City-controlled land (streetscapes, natural areas, parks and recreational reserves, civic facilities) represents 37% of the area within the City boundary, including street and road surfaces. This land delivers a disproportionate share of the urban forest by land area. Around half of the total existing tree canopy cover and 39% of the understorey vegetation cover across the City grows on City-controlled land. The remainder grows on private property, including land used for residential, commercial, industrial and institutional purposes.

This document is Part A of the Urban Forest Strategic Plan and applies only to land owned, managed or controlled by the City of Melville. The City recognises that this relates to only half of the urban forest and cannot address urban forest threats and opportunities on private land. Part B of the Urban Forest Strategic Plan will be developed in 2017-18 to address the protection, maintenance and enhancement of that part of the urban forest that grows on private and institutional land not under the direct control of the City.

The traditional arboriculture/horticulture approach to urban tree management focuses on managing individual trees within parks, reserves and streetscapes: a function that the City performs very effectively. The Urban Forest Strategic Plan takes a more holistic approach, focusing on the urban forest as an integrated and synergistic system that is more than a collection of individual trees. The Plan recognises that the urban forest growing on City-controlled land comprises a vital long-term City asset. Individual trees are long-lived, but a well-managed urban forest is potentially perpetual.

Due to their visual dominance, obvious environmental and socio-cultural impact, and high community esteem, trees tend to be given priority in most urban forest strategies. This Plan has a strong focus on trees for similar reasons, and also because the loss and replacement of understorey is generally simpler than the loss and replacement of a large, mature tree. However, the understorey is also an important part of the urban forest and delivers

significant biodiversity, aesthetic and heat mitigation benefits. In locations where trees may be impractical, non-viable, or result in undesirable consequences, understorey planting may be the only way to secure the local benefits of vegetation or complete ecological linkages. This Plan recognises the need to ensure that the understorey component of the urban forest is not neglected.

2.1 Definitions

There is no universally agreed definition of tree[1], urban forest or urban forestry among practitioners. Definitions of urban forest range from the very broad that include all forms of vegetation growing anywhere within an urban environment to more focused definitions aligned with the usual understanding of forests as tree-dominated ecosystems.

The Urban Forest Community Reference Group noted that the terminology used is unfamiliar to many people and suggested that clear definitions be articulated for the purposes of the City of Melville Urban Forest Strategic Plan.

For the purposes of the City of Melville Urban Forest Strategic Plan, the following definitions have been adopted (derived from a variety of Australian and international sources):

Arboriculture is the branch of horticulture concerned with the cultivation, management and study of individual trees.

City-controlled land means freehold land that is owned by the City, State land vested in or managed by the City under a statutory order, and land that is leased by the City from an external party.

Ecoregion means a large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions. Perth is located within one of the "Mediterranean Forests, Woodlands and Scrub" global ecoregions, of which there are only five in the world[2]. The Swan Coastal Plain is a specific bioregion within this ecoregion[3].

Forest means an area where the dominant vegetation comprises trees and large shrubs with a mature height of more than three metres.

Green infrastructure, for the purposes of this Plan, means all vegetation owned, planted and/or managed by the City of Melville, including trees, shrubs, groundcover, climbers and aquatic plants, and plants integrated into the built form as green roofs/walls, or in atriums and courtyard or balcony gardens, and also includes the non-biological features (soil, water, growing space and solar access) that support the vegetation.

Green space means vegetated outdoor space within the urban environment, whether on public or private land, and includes but is not limited to areas of urban forest.

[1] For example, the minimum mature height threshold for a tree (usually single stem) varies from two to five metres depending on the authority, while the maximum height for shrubs and mallee (multiple stems) may be up to 12 metres. In the widely-used proprietary i-tree urban forest analysis software, a tree is any plant "*that looks like a tree from above*".

[2] WWF Global Ecoregions Framework

[3] Australian Department of the Environment and Energy (2012) IBRA (v7) classification

Open space, in urban planning terms, means a non-enclosed area, usually unroofed and/or open on at least two sides. It includes both natural (vegetated) and artificial ground surfaces. Most green space is open space, but not all open space is green space. Public open space is defined in planning legislation while private open space on residential property is defined under the State's Residential Design Codes (R-Codes).

The **precautionary principle** (in relation to environmental risk) holds that when a proposed action may result in significant environmental harm, lack of scientific certainty about the extent and likelihood of the risk should not be used to preclude a risk-averse decision.

Tree is defined *for the purposes of this Plan* as any perennial woody plant, including single-stemmed trees and multi-stemmed shrubs or mallee, with a potential mature height of more than three metres[4] and a canopy of branches and leaves extending from the upper parts of the stem(s).

Tree canopy is defined as the layer of tree leaves, branches and stems that cover the ground when viewed from above.

Tree canopy cover is the percentage of a given area of land that lies directly below the canopy of trees taller than three metres. It is approximately equal to the area of midday shade provided by the canopy. Climbing plants (vines) and giant grasses (e.g. bamboo, pampas grass) are not counted as part of the tree canopy cover regardless of height.

Understorey plants are defined for the purposes of the City of Melville Urban Forest Strategic Plan as plants with a mature height of less than three metres, and taller plants that are not trees such as vines and giant grasses, but do not include turf.

Understorey vegetation cover is the percentage of a given area of land that lies directly below the foliage of understorey plants and (for the purposes of this Plan) below the canopies of young trees less than three metres tall.

Urban forest means the trees and associated understorey plants on both public and privately owned land, but for the purposes of this Plan does not include significant areas of turf or unirrigated grass.

Urban forestry means the planned, integrated and systematic management of the urban forest for its collective contribution to the physical, social, environmental, and economic well-being of the community. For the purposes of this Plan, the terms urban forestry and urban forest management refer to the management of the component of the urban forest growing on City-controlled land.

2.2 Background

Significant development-related loss of trees has become common in cities across the world. As the awareness of the extent of this loss has grown, the extent of the benefits of trees and other vegetation in urban environments has become better known. Recognition that the

[4] Note that CP-102, *Urban Forest and Green Spaces Policy* used a botanical definition of a tree specifying a minimum height threshold of five metres. In this Plan, a three metre minimum height threshold for measuring tree canopy cover has been selected to align with the WAPC/CSIRO Urban Monitor (regional urban forest assessment) published in support of the *Green Growth Plan for Perth and Peel*. The City's 2016 aerial vegetation analysis was stratified into height bands: <3m, 3-6m, 6-15m, >15m.

aggregated benefit of greener urban areas is more than just the sum of benefits provided by individual trees led to a global movement to preserve and promote positive outcomes by protecting, restoring and enhancing what are now widely referred to as urban forests.

Early residential development in the City of Melville was characterised by large backyards that encouraged shade-tree planting, resulting in a significant urban forest that was maintained throughout most of our residential suburbs until the 1980s.

In recent years, land use policies have focused on urban consolidation, while buyer preferences have been for larger houses. Newer suburbs have favoured narrower verges and much smaller lots with less space for large trees. Rezoning of older suburbs and rising land values in the area have encouraged the disjointed redevelopment of single lots initiated by individual landowners, much of it in the form of grouped housing or “battleaxe” and narrow-lot developments. Redevelopments of this type typically result in most or all existing trees being removed from the original lot.

Urban forests are credited with numerous public benefits, including:

- improving public and private amenity and the aesthetic appeal of neighbourhoods;
- mitigating urban heat and providing shade;
- supporting good mental health and connection to nature;
- improving physical health and public safety through encouraging outdoor activity;
- improving productivity and business patronage;
- increasing property values;
- improving road safety;
- reducing summer energy use in buildings;
- supporting biodiversity;
- atmospheric carbon capture and storage (sequestration);
- reducing air pollution and noise;
- mitigating local flooding;
- soil stability and decontamination; and
- protecting roads and roofs from sun damage.

However, in the interests of objectivity it must also be acknowledged that poorly selected, located or managed trees can be responsible for a variety of urban problems, including:

- reducing perceived amenity;
- reducing property values by blocking views;
- public safety risks (driver and pedestrian visibility, storm damage, trips and falls, hiding places for criminals);
- reducing biodiversity through competition for resources or suppression of other species;
- depleting groundwater reserves through evapotranspiration and reducing groundwater recharge by intercepting rainfall before it reaches the soil;
- reducing solar access leading to loss of efficiency in roof-mounted solar generation and solar water heating, and increased winter energy use
- damaging infrastructure and increasing building and property maintenance costs; and
- causing health problems through the production of allergens, volatile organic compounds or by attracting stinging insects or vermin.

Historically, local governments have focused on planting and managing individual trees (arboriculture), primarily for their aesthetic and shade benefits in public places or their

conservation value on natural reserves, and have mostly limited their attention to property that they own or control and further to areas most accessible to residents. Vegetation was considered easily and cheaply replaceable and aesthetic rather than productive, and therefore of lower value than hard infrastructure. Preference was often given to fast-growing, easily-maintained, "showy" plants.

Modern urban forest management considers trees as components of a larger, complex forest system which delivers multiple synergistic benefits. A systems management, perspective focused on optimisation promotes a more flexible approach which facilitates resolution of competing interests, manages risks and ensures that all vegetation is given due recognition for its ecological contribution to the whole.

Traditional Management	Modern Urban Forest Management
Focus on individual trees and other plants	Focus on the "forest" as an ecosystem
Green infrastructure seen as lower priority and lower value than "hard" City assets	Green infrastructure valued and prioritised equivalent to "hard" City assets
Green infrastructure not assigned a monetary value other than physical replacement cost	Monetary value assigned to trees according to the value of the service benefits they deliver
Green infrastructure viewed as a "lifestyle" asset of ornamental value only	Green infrastructure viewed as a "lifeline" asset essential to community and economic wellbeing
Priority given to species that are smaller, have high aesthetic quality and require minimal management	Prioritised on multiple factors including ecological and aesthetic contribution, and inter-relationships with other urban environmental factors
Individual tree maintenance (arboriculture approach)	Systematic, integrated, asset lifecycle management (forestry approach)
Responsibility restricted to trees on City-controlled land	Shared stewardship of urban forest regardless of land ownership

In Council Policy-102, the Urban Forest and Green Space Policy, the Council stated that "*the protection of a healthy, resilient and diverse urban ecosystem is a shared responsibility of the City, other landowners, residents and businesses*".

The Council further committed to:

- no net loss of plant cover within the City,
- locally targeted increases in tree canopy and understorey cover where it is deficient,
- explicit reference to urban forest and green space objectives in future planning documents, and
- a publicly accessible database of City trees and potential planting sites.

Currently the City has an operating budget for tree management of approximately $2.4 million (2016/17 FY budget) to manage the estimated 80,000+ trees within the City's parks and streetscapes, including replacement. The City's Long Term Financial Plan identified $150,000 in the 2016/17 budget for the Urban Forest Strategy, which is being used for data collection and analysis to support urban forest planning, and an additional $300,000 per year for additional tree planting on City land under the Urban Forest Strategic Plan.

2.3 Purpose: Objectives and Desired Outcomes

In November 2016, the Community Reference Group concluded that the **purpose of the urban forest** is "*providing a healthy and peaceful environment which nurtures the wellbeing of all the natural and human communities that reside within it*." The Community Reference Group adopted this wording to recognise that the urban forest delivers benefits to plants and animals, as well as to the human residents of the City.

The purpose of the Urban Forest Strategic Plan - Part A: City-controlled land (2017-2036) is to facilitate that aspiration and the relevant Strategic Community Plan aspirations and Corporate Business Plan priorities, and to give practical effect to the City's Urban Forest and Green Space Policy by:

- documenting the goals and indicators that will guide the City's urban forest management on its own land,
- identifying emerging issues and risks for the urban forest and proposing options to address these, and
- specifying operational directions, targets, priorities and performance indicators to support and evaluate operational decisions in managing the urban forest.

The **Urban Forest and Green Space Policy** (CP-102) recognised that plants comprise a critical element of the urban ecosystem, contributing many benefits, and that the protection of a healthy, resilient and diverse urban ecosystem is a shared responsibility between the City, other landowners, residents and businesses.

Within this context, the goals of this Plan reflect the objectives and policy commitments of the Urban Forest and Green Space Policy:

1. The City will renew its ageing City trees with **no net loss of urban forest canopy** on City land over the period of the plan, and increase planting in targeted areas to achieve **locally optimal levels of tree canopy cover**.
2. The City will establish and maintain a tree database to ensure it has **extensive and current knowledge** of the location, profile and condition of the City's urban forest, and of potential additional planting sites.
3. The City will strive for **excellent urban forest management** delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by **active, innovative community participation**.
4. The City will **integrate urban forest protection into urban planning** instruments and practices and its land and infrastructure asset management.

In addition to the physical outcome of a healthy, resilient, diverse and sustainable urban forest well-adapted to local land uses and environmental conditions, the Urban Forest Strategic Plan Part A will result in the following outcomes:

Outcome	Intent
Understanding	We will monitor and analyse the extent, condition, utilisation, constraints and intrinsic community value of the urban forest in the City of Melville and identify sustainable opportunities for its protection and enhancement.
Management	We will use a sound evidential base to manage the City's urban forest system and its assets for optimal health, resilience, diversity, sustainability and contribution to specified outcomes.
Innovation	We will seek to be flexible and innovative in achieving the City's urban forest outcomes and in responding to emerging issues.
Responsiveness	We will inform and engage the community on urban forest management and encourage their participation in monitoring, maintaining and enhancing the urban environment.
Integration	We will aim to incorporate urban forest protection into the City's strategic urban planning, infrastructure and land asset management and corporate objectives, with a focus on maximising the net public benefits of urban vegetation for liveability, amenity and neighbourhood character.

2.4 Scope

Although the City's own trees are part of its "green infrastructure" asset base, the urban forest as a whole is ownership-neutral.

Part A of the Urban Forest Strategic Plan (this document) applies to the urban forest that grows on land owned or controlled by the City. It is also relevant to the City's function of informing and providing services to the community. It is intended to provide direction for operational planning and to guide decisions where competing objectives exist.

Two additional Plans will ultimately complement this document to form the Urban Forest and Green Space Policy Framework:

- Part B of the Urban Forest Strategic Plan - land not under the direct control of the City, will be developed in consultation with the community in 2017-18, and will identify opportunities to protect and enhance the urban forest on private and institutional land. A key objective will be to encourage recognition of the benefits of having trees in home gardens and commercial developments, discourage the removal of mature trees on private land during redevelopment, and encourage landowners to retain and to plant trees.
- The Green Space Plan will address the protection and enhancement of green space in circumstances where trees are not expected to be the dominant plant type, including irrigated grassed areas, community gardens and building-related planting such as green roofs, walls, atriums, and similar structures.

2.5 Risks

The key Corporate Business Plan priorities of "*urban development creates change in amenity*" and "*degradation of natural resources within the City*" implicitly recognize that there are risks in not protecting and maintaining the urban forest.

Deterioration in quality, or physical loss, of parts of the urban forest are likely to diminish the public benefits associated with urban trees. However, planting decisions also need to be risk and outcome-based in order to avoid or manage potential negative consequences.

The key risks relating to maintaining and enhancing a healthy, resilient, diverse and sustainable urban forest (on both public and private land) in the City of Melville are shown in Table 1:

Table 1 Urban forest drivers, pressures and risks

Driver	Pressure	Impact or Risk
• Increasing residential density and high land values	Landowners seeking to develop to the maximum building potential permissible under the urban planning framework Higher land values mean that landscaped areas are more expensive to set aside Newer suburbs designed with little space for street trees, small lots and "bare earth" pre-development clearing Lot sizes have decreased while home	Loss of mature trees on private land Loss of neighbourhood character Greater user pressure on parks, streets and public spaces Landowners may be less willing to set aside expensive private land for landscaping and trees Less private land is available for trees and landscaping

Driver	Pressure	Impact or Risk
	sizes have increased: home-buyers are prioritising home size over outdoor space Residential properties without on-site trees do not suffer a market price penalty(although street trees improve property values[5]) A higher population and less private green space will place greater pressures on public spaces (although higher housing density may be offset by smaller household sizes)	
• Climate change	Increased urban heat Lower rainfall Extreme weather events (heat waves, storms) Negative water balance leading to groundwater storage depletion and falling water tables Increased bushfire risk	Reduced health and longevity for some vulnerable tree species with narrow climatic tolerance range Vulnerability of existing groundwater-dependent ecosystems to competition with trees for water Increased cost to manage bushfire risk
• Ageing tree population	More than 50% of the City's street trees (25,000 trees) are expected to reach the end of their useful lives within 20 years, with this proportion up to 90% in some suburbs	Negative impact on local character if a large number of trees fail within a short period Even a gradual replacement program (5%/year for 20 years) will result in a temporary loss of canopy cover while juvenile trees mature
• Historical City tree management practices	Limited species diversity among City trees (in some cases related to neighbourhood character objectives) Existing City tree species selected under historically higher rainfall conditions Limited age diversity (high proportion of tree populations now with similar useful life expectancy) High attrition rates in first three years after planting Information about existing urban forest and unutilised planting sites is neither complete nor current Little environmental monitoring related to urban forest sustainability or consideration of whole forest ecology	Monocultures are more susceptible to pest and disease epidemics Existing trees may be vulnerable to decline due to climate change High proportion of local tree populations must be replaced simultaneously – significant temporary reduction in canopy cover and character Cost inefficiency related to early tree death and replacement Inadequate information to effectively support strategic ecological decision-making on management of urban forest

[5] Reference: Pandit *et al*. 2013 – see bibliography in section 8.3.

Driver	Pressure	Impact or Risk
• Community expectations	Community wants more trees in public places Public preferences for species that may be unsuitable for the site or predicted climate constraints Public pressure for canopy cover that exceeds environmentally sustainable levels under predicted climate conditions Residents reluctant to pay higher local government rates and charges More people want a low-maintenance "lock and leave" lifestyle with less landscaping – reluctance to plant and maintain trees on private land No consistency between local governments over urban forest performance measures or targets – competing views may cause public confusion	Reactive or populist urban forestry decisions – potential for perverse consequences if not evidence/risk based Tree selection and siting driven by public opinion rather than technical expertise may increase costs, reduce survival rates and cause long term environmental harm Increased urban forest spending results in less money for other areas important to the public interest Fewer trees planted or retained on private land
• Community concerns	Opposition to trees impeding views, imposing unwanted shade on property or restricting parking space Tree height/location impedes solar access, reducing solar PV and solar thermal (water heating) efficiency Concerns about increased private maintenance costs due to tree litter or root damage, damage to property or health and safety risks Opposition to forest management practices (planting site selection, pest/weed/ disease control methods, replacement policy)	Public trees are vandalized or destroyed Increased residential energy costs Employee welfare potentially at risk Uncertain level of City liability for property damage/loss of value, injury or health impairment attributable to City trees
• Impacts of State policy decisions	State planning agency requirements for increased residential density have not accounted for urban forest impacts Local government has limited statutory power to counter tree destruction Expectation that local governments will plant more trees in public spaces to compensate for loss of private trees Inadequate research capacity to support evidence-based policy decisions Potential review of water allocations for local government parks	Rate of loss of private trees may accelerate Increased costs to local government Perverse outcomes resulting from policies based on poor understanding of ecological interactions Compensatory over-planting of trees on public land may cause environmental costs without replacing the lost benefits of private trees Future water allocations may be inadequate to support both urban forest maintenance/enhancement and maintenance of grassed recreational areas in a drying climate

The implementation of the Urban Forest Strategic Plan (this Part A and the future Part B) will need to mitigate and manage the above risks at an operational level.

3 Strategic Context

3.1 Legal Requirements

There is no current State legislation that is specific to the provision, protection or maintenance of urban forest elements in Western Australia. Legislation that may be relevant under specific circumstances includes:

- Local Government Act 1995 (WA)
- Planning and Development Act 2005 (WA)
- Environmental Protection Act 1986 (WA)
- Biodiversity Conservation Act 2016 (WA)
- Swan and Canning Rivers Management Act 2006 (WA)
- Rights in Water and Irrigation Act 1914 (WA)
- Heritage of Western Australia Act 1990 (WA)
- Environmental Protection and Biodiversity Conservation Act 1999 (Cwlth)
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)
- Planning and Development (Local Planning Schemes) Regulations 2015 (WA)

3.2 National Initiatives

Government: The Australian Government Department of the Environment and Energy, through the National Landcare Programme, manages a "*20 Million Trees Programme*" which seeks to "work with the community to plant 20 million trees by 2020 to re-establish green corridors and urban forests". It has engaged three service providers to deliver large-scale tree planting projects nationally and funds local planting projects through a competitive grants process for community groups, landcare associations and local governments.

The Clean Air and Urban Landscapes Hub is a research consortium funded under the Australian Government's National Environmental Science Programme. Its mission is to take a comprehensive view of the sustainability and liveability of urban environments, and the "Urban Greening" priorities in its Public Research Plan are relevant to urban forestry.

Non-government: There are national campaigns focused on research, technical advice and advocacy for tree planting/ green spaces. These include the *National Urban Forest Alliance Australian Partnership Plan 2014-20*, and the *202020 Vision* (20% more green space in Australian cities by 2020). Both campaigns were initiated by the horticulture/nursery industry and are now supported by a variety of national and state government agencies, local governments, academic institutions, industry players and community groups.

3.3 Western Australia

There are no existing State Government requirements, policies or initiatives that are specific to urban forest management and protection, although general environmental and planning policy is pertinent in some circumstances. These include:

1. Department of the Premier and Cabinet

Draft Perth and Peel Green Growth Plan for 3.5 million resulted from the Strategic Environmental Assessment of the Perth and Peel Regions undertaken under the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999*, and a parallel regional assessment under the State's own *Environmental Protection Act 1986*.

2. WA Planning Commission / Department of Planning

Bush Forever reservations under the Metropolitan Region Scheme constrain or prohibit clearing and development on property containing designated bushland.

Directions 2031 and Beyond promotes greater infill and higher suburban residential density, with targets for each local government area - a key driver of current residential redevelopment trends in the City of Melville.

Perth and Peel @ 3.5 million is a suite of sub-regional planning frameworks and policy documents that support the State's *Green Growth Plan*.

Urban Forest Strategy for Perth and Peel will be developed in 2017 and form part of the *Perth and Peel @ 3.5 million* planning framework. The City of Melville has approached the Department seeking engagement and has been informed that local government consultation will commence through WALGA in early 2017.

The draft *Design WA* suite of guidance documents, including *State Planning Policy 7 – Design of the Built Environment*, and a companion document: *Apartment Design* addresses tree retention and provision of deep soil areas (suitable for tree growth) in proposed design criteria for multiple dwelling and mixed use developments.

Better Urban Water Management is a strategy for incorporating water sensitive urban design principles into urban planning in the Perth and Peel regions and supports *State Planning Policy 2.9 Water Resources* and the *State Water Strategy for Western Australia* (Department of Water).

3. Department of Water

The Department of Water allocates water to local governments for their irrigation requirements. The Department has indicated that falling groundwater reserves may require a reduction in local government water allocations. If this occurs, the City will need to prioritise its water use and may have to resolve the competing requirements of irrigated grassed sports fields and play areas, drought-stressed trees, and seasonal wetlands.

4. State infrastructure providers

Policies and standards managed by Main Roads WA (road safety) or Western Power (electrical safety), sometimes restrict the size and location of trees near roads or power infrastructure, but this tends to affect individual trees rather than the urban forest as a whole.

3.4 City of Melville

The primary function of the Urban Forest Strategic Plan Part A is to give effect to Council Policy 102: the Urban Forest and Green Space Policy and meet the strategic objectives of that policy.

Other Council Policies relevant to this Plan are:

- CP-029 Street Tree Policy

- CP-086 Verge Treatment Policy
- CP-002 Stakeholder Engagement Policy

Relevant Operational Policies and Informing Plans include:

- OP-20 Public Open Space Water Usage Policy
- Corporate Environmental Strategic Plan
- Long Term Financial Plan
- Natural Area Asset Management Plan
- Infrastructure Asset Strategy and Plan

Urban Planning Instruments:

- Local Planning Scheme No. 6
- Local Planning Strategy 2016
- Open Space Strategy
- Local structure and precinct plans

Table 2 shows how the policy objectives are reflected in the Urban Forest Strategic Plan goals, and how they are aligned to the Community Strategic Plan aspirations, the Corporate Business Plan key strategies and the Local Planning Strategy.

Table 2. Linkages between CP-102 objectives, Urban Forest Strategic Plan – Part A goals, relevant Community Strategic Plan (SCP) aspirations, relevant Corporate Business Plan (CBP) key strategies and Local Planning Strategy (LPStrategy) environmental objectives

	Objectives of CP-102 Urban Forest and Green Space Policy	To protect, preserve and enhance the aesthetic character of the City of Melville. To realise the social, environmental and economic benefits of trees and other vegetation as an integral element of the urban environment.	To contribute to community wellbeing by integrating and aligning the efficient provision of physical, social and green infrastructure and management of natural areas to achieve community wellbeing today and tomorrow. To ensure that the urban forest and green spaces that are integral to the City's sense of place are not compromised in areas of increased residential density.		To encourage a sense of shared responsibility and balance individual and community rights to equitably distribute the costs and the benefits of a greener City.
	Goals of the Urban Forest Strategic Plan Part A – City-controlled Land	The City will renew its ageing City trees with **no net loss of urban forest canopy** on City land over the period of the plan, and increase planting in targeted areas to achieve **locally optimal levels of tree canopy cover**.	The City will establish and maintain a tree database to ensure it has **extensive and current knowledge** of the location, profile and condition of the City's urban forest, and of potential additional planting sites.	The City will strive for **excellent urban forest management** delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by **active, innovative community participation**.	The City will **integrate urban forest protection into urban planning** instruments and practices and its land and infrastructure asset management.
SCP **aspirations**	Clean and Green	★	★	★	★
	Healthy Lifestyle	★		★	
	Sense of Community	★	★	★	★
CBP **key strategies**	Pursue productivity and efficiency improvements		★	★	
	Optimise facilities to achieve fit-for-use facilities for current and future beneficiaries	★	★	★	
	Enhance amenity, vibrancy and community safety	★	★	★	★
	Holistic and integrated strategies for the protection of the City's natural resources	★	★	★	★
	Ameliorate loss of vegetation from private property development	★		★	★
	Continue participatory budgeting that involves the community			★	
	Improve engagement with the business community			★	
LP Strategy	Ensure that the natural environmental values of the City are protected and conserved for existing and future generations	★		★	★
	Contribute to the maintenance and enhancement of biodiversity for the preservation of our natural flora and fauna	★		★	★
	Provide a sustainable built urban environment	★	★	★	★

3.5 Core Beliefs and Principles

Plants comprise a critical element of the urban ecosystem contributing social, economic and environmental benefits to the community and defining the character of the local area.

The protection of a healthy, resilient and diverse urban ecosystem is a shared responsibility of the City, other landowners, residents and businesses.

The City of Melville recognises the challenges posed by its ageing street tree population. It is committed to progressive forest renewal that preserves local character, ensures no net loss of tree canopy cover within the City's lands by 2036, and increased tree canopy and understorey cover where it is locally deficient.

The City seeks to achieve and maintain locally optimal levels of urban tree canopy cover and understorey vegetation cover that balance:

- the community benefits of trees,
- community aspirations and perceptions of liveability,
- the benefits of biodiversity and an urban ecosystem sustainable over the long term,
- the needs and aspirations of land owners and land users, and
- the health, safety and quality of life of the community.

The City will welcome and foster innovative ways to engage the community and invite their participation in enhancing the urban forest and other green space across the City in all urban environments including streetscapes, parks, natural areas, civic facilities, infrastructure reserves and private land.

The City's urban forest planning and management will be based on sound data and risk analysis, with a long term focus consistent with the longevity of urban trees, environmental carrying capacity, and the predicted impacts of climate change. The City recognises that information is incomplete concerning the impacts of, and the impacts on, the urban forest and will apply the precautionary principle as appropriate.

In natural bushland areas, intervention will be aimed at maintaining the ecological balance as close as possible to natural pre-development states, subject to the need to address land and plant degradation, disease and invasive pests, and to manage bushfire and other public safety risks.

Where the loss of trees on private land requires the City to undertake compensatory planting on public land to maintain urban forest cover, the principle of causer-pays should apply.

3.6 Goals and Objectives 2017 - 2036

Goal	Objectives within Urban Forest Strategic Plan Timeframe
The City will renew its ageing City trees with **no net loss of urban forest canopy** on City land over the period of the plan, and increase planting in targeted areas to achieve **locally optimal levels of tree canopy cover.**	Despite necessary replacement of ageing trees in streets and parks, the City's tree canopy cover on its own land will be at least 30%, with understorey vegetation cover of at least 19%. By 2036, each City property and streetscape will have a level of tree canopy cover that optimises urban forest benefits consistent with its land use and environmental constraints, and which achieves a fair balance between competing local objectives.

Goal	Objectives within Urban Forest Strategic Plan Timeframe
The City will establish and maintain a tree database to ensure it has **extensive and current knowledge** of the location, profile and condition of the City's urban forest, and of potential additional planting sites.	A complete inventory of trees on City land and of suitable unutilised planting sites will be created by 2018 (street trees) and 2019 (park trees) and maintained as publicly accessible data.
The City will strive for **excellent urban forest management** delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by **active, innovative community participation.**	The urban forest in the public realm will be managed through evidence and risk based decisions designed to achieve the goals of the Urban Forest Strategic Plan Part A and the objectives of CP-102. A robust system of monitoring urban forest performance against targets and sustainability criteria will be in place by 2020. Ongoing programs will seek to inform and encourage the community to actively contribute to the stewardship of the City's urban forest
The City will **integrate urban forest protection into urban planning** instruments and practices and its land and infrastructure asset management.	The City's urban planning instruments, approval processes, and its own land asset management plans will make explicit provision for identifying, protecting, maintaining and enhancing the urban forest.

4 Stakeholder Consultation

The City is the custodian of the urban forest in the public realm on behalf of the community. The City-owned component of the urban forest is an integral part of the urban landscape. The whole community is affected by its presence and quality, and ratepayers contribute the financial resources required to manage it.

While the management of trees in the City's streetscapes, parks, sporting grounds, bushland reserves and other City property is an operational responsibility of the CEO under the *Local Government Act*, the stewardship of the City's urban forest as an integrated living system is a shared responsibility between the City, its Council, its residents and its businesses.

To contribute effectively to this shared responsibility, it is necessary to foster a broad understanding of the urban forest and its influence on our urban environment. Residents and businesses will be encouraged to play a part in how it is protected, managed and enhanced for the public good.

The following people and groups have a stake in the success of the Urban Forest Strategic Plan Part A (City land). The nature of their interest and their levels of impact or influence differ, and this will be taken into account in the engagement process.

1. Internal stakeholders:
    a. Council (collectively) and elected members (individually)
    b. CEO

c. Executive and operational managers of the City
d. Employees directly involved in urban forest management
e. Employees engaged in activities which affect or are affected by urban forest management
f. Other employees

2. External stakeholders who may be directly affected:
    a. Community:
        i. Residents
        ii. Business operators
        iii. Non-resident landowners
        iv. Indigenous heritage groups
        v. Local community groups
        vi. Local sport and recreational clubs
        vii. Visitors
    b. Institutional landholders and their users (schools, churches)
    c. Developers and planning consultants
    d. Suppliers of relevant goods and services
    e. Utilities and infrastructure providers
        i. Public (Western Power, Water Corporation, MRWA, PTA)
        ii. Private (ATCO Gas, telecommunications infrastructure providers)
    f. State government
        i. Landholder agencies
        ii. Regulatory and policy-making agencies
        iii. Emergency services
        iv. Ministers and local Members of Parliament

3. External stakeholders who may be indirectly affected or are interested
    a. National government
        i. Department of Environment and Energy
        ii. CSIRO
    b. State government
        i. Landgate
    c. Other local governments
        i. Councils and local government administration
        ii. peak bodies (WALGA, LGMA)
        iii. Park Managers Network
    d. State and national NGOs and peak bodies
        i. Community and environment
        ii. Sport and recreation
        iii. Industry and professional associations
    e. Universities and research institutions

4.1 City managers and employees

In the last quarter of 2015, several meetings/discussions were held with key internal stakeholders to initiate the development of an urban forest strategic management understanding. These meetings focused on identifying concerns and gaps in understanding/ data currently available within the City. These initial discussions culminated in the procurement of aerial imagery on early 2016 and the commencement of the tree asset data collection and City Tree Database.

A workshop was held in August 2016 to discuss and refine the task with approximately 25 City employees and managers with professional and personal interests in urban forest planning. This discussion identified the inter-related issues that need to be considered and the functions of the City that may be affected by the Urban Forest Strategic Plan.

4.2 Other local governments

A number of local governments in the Perth metropolitan area have prepared or are in the process of preparing urban forest strategies. The Perth Metropolitan Park Managers' network is a community of interest where knowledge, experience and approaches to urban forest planning have been shared. However, despite considerable goodwill and commitment to cooperation, there is currently little consensus on definitions, methodologies or target setting criteria, and each local government is developing its own custom strategy.

Engagement will continue with other local governments in the interests of harmonization of approaches to urban forest management in the Perth metropolitan areas, and to explore opportunities to share knowledge and resources, and if appropriate, jointly commission research.

4.3 Community

Given that the urban forest has a significant direct impact on the community, the City has recognised that the community has a right to have fair and meaningful involvement in setting strategic directions (Stakeholder Engagement Policy, 2016).

The Stakeholder Engagement Process is aligned with the Project Management Process so that citizen participation can occur in the developmental and/or implementation phases of major projects, which in this case, was to be the development of an Urban Forest Strategic Plan for the City to give effect to the Council's policy decision.

Phase 1 of community engagement
The first phase involved selecting and directly recruiting 14 residents from the Customer Service database and Melville Talks users to serve on a Community Reference Group (CRG). Stratified random sampling of people who responded to the email invitation to express an interest ensured that all four City neighbourhoods were represented and the group represented diverse demographic groups and community interests. Their role was to contribute a community perspective to the development of Part A of the draft Urban Forest Strategic Plan, relating to land owned or controlled by the City.

Over a five week period in October/November 2016, the Community Reference Group members met five times and communicated electronically to consider the purpose of an urban forest and suggest priority actions that could deliver on that purpose, align with community aspirations and achieve the objectives of the policy with respect to urban forest in the public realm. Responses were filtered through an iterative voting process.

Although there are many different benefits attributed to urban forests (see section 3.3), the Community Reference Group felt that the primary purpose of the urban forest in the City of Melville from the community's perspective is to enhance liveability, which they defined as "*to provide a healthy and peaceful environment which nurtures the wellbeing of all the natural and human communities that reside within it.*" The Community Reference Group recognised that plants, animals and humans are all beneficiaries of a healthy and sustainable urban forest.

The Group felt that the actions to be undertaken to support the liveability function of the public urban forest fell into four broad categories: infrastructure (increase planting and functionality of open space), diversity (in urban forest species to support diverse fauna), participation (involvement in planting/maintaining the urban forest) and education (urban forest management education).

Members identified a number of possible actions, including: upgrade or create new pathways between natural areas, increase planting in foreshores and streets, upgrade verges, develop a tree management education program and create diversity to support fauna. The Group then made two specific recommendations to the City, which have been captured within the goals of this plan as shown in Table 3 below:

Table 3 Alignment between Community Reference Group recommendations and Urban Forest Strategic Plan Part A goals

Community Reference Group Recommendations	Incorporated in the following Urban Forest Strategic Plan Part A Goals
1. "Using data from GIS maps on heat impacted areas, the variety and extent of vegetation cover across the City and the community's preferred locations for planting; plan and deliver a targeted planting program to begin in May 2017. Plants to be selected based on site suitability, water requirements and environmental benefit, including habitat.	• The City will renew its ageing City trees with **no net loss of urban forest canopy** on City land over the period of the plan, and increase planting in targeted areas to achieve **locally optimal levels of tree canopy cover.** • The City will establish and maintain a tree database to ensure it has **extensive and current knowledge** of the location, profile and condition of the City's urban forest, and of potential additional planting sites. • The City will strive for **excellent urban forest management** delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by **active, innovative community participation.**
2. "Provide human and financial resources to develop, drive and coordinate long-term community based initiatives that contribute to an urban forest in the City of Melville by January 2018".	• The City will strive for **excellent urban forest management** delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by **active, innovative community participation.**

Phase 2 of community engagement

This draft Urban Forest Strategic Plan Part A has been completed following the Community Reference Group's deliberations and feedback on the draft document. The Plan has regard for the Group's views as well as insights drawn from research, the experience of other local governments and in-house technical and management expertise.

Community stakeholders will have ongoing opportunities to participate in the implementation of the Urban Forest Strategic Plan Part A, and their support and active contribution will be essential to its success.

4.4 Western Australian State Government

The Department of Planning, on behalf of the WA Planning Commission, has advised that it will prepare an Urban Forest Strategy for the Perth-Peel Region as part of the *Perth and Peel Green Growth Plan for 3.5 million*.

The Department expects to commence this work in 2017 and has given an assurance that it will consult extensively with WALGA and with local governments that have been developing urban forest strategies and plans, including the City of Melville. The City attended an initial workshop in April 2017.

It is unclear what status or purpose is intended for the State's regional urban forest strategy for Perth and Peel. The City will seek to ensure that the proposed strategy has a sound evidential base, is realistic and practical to implement, and that it is consistent with the needs, aspirations and risk management obligations of local government.

5 Data Analysis

5.1 Land use

The City of Melville encompasses a land area of 5,287 hectares (53 square kilometres) and is home to about 107,000 people (2015). It has a population density of 20.2 people per hectare (a little less than South Perth and East Fremantle and a little more than Canning and Fremantle).

Most of the land within the City is in private ownership (see Figure 1), with approximately 2,530 hectares of residential land and over 260 hectares of commercial and industrial land. Approximately 470 hectares belongs to institutions such as churches, sporting bodies, and public or private schools and hospitals. Schools may have significant areas of grassed sport and play areas.

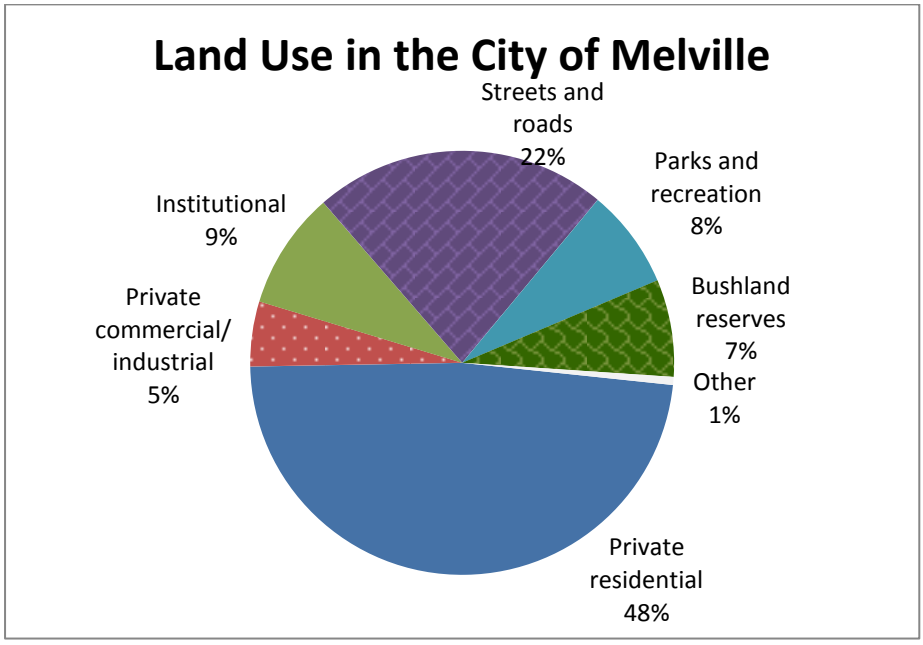


Figure 1 Approximate proportions of land use areas in the City of Melville.

The City is directly responsible for approximately 529 kilometres of local streets and their verges, accounting for almost 1,200 hectares, and manages multiple stormwater drainage sumps, most of which occupy 1,000 square metres or less.

The City owns or manages about 711 hectares of parks, reserves, river foreshore and other public open space. This includes 183 parks (see Figure 2), of which 20 are active recreational reserves used for a variety of outdoor sports. Some active reserves are leased to sporting groups.

Natural bushland areas comprise about half of the parks and reserves land managed by the City, excluding the foreshore.

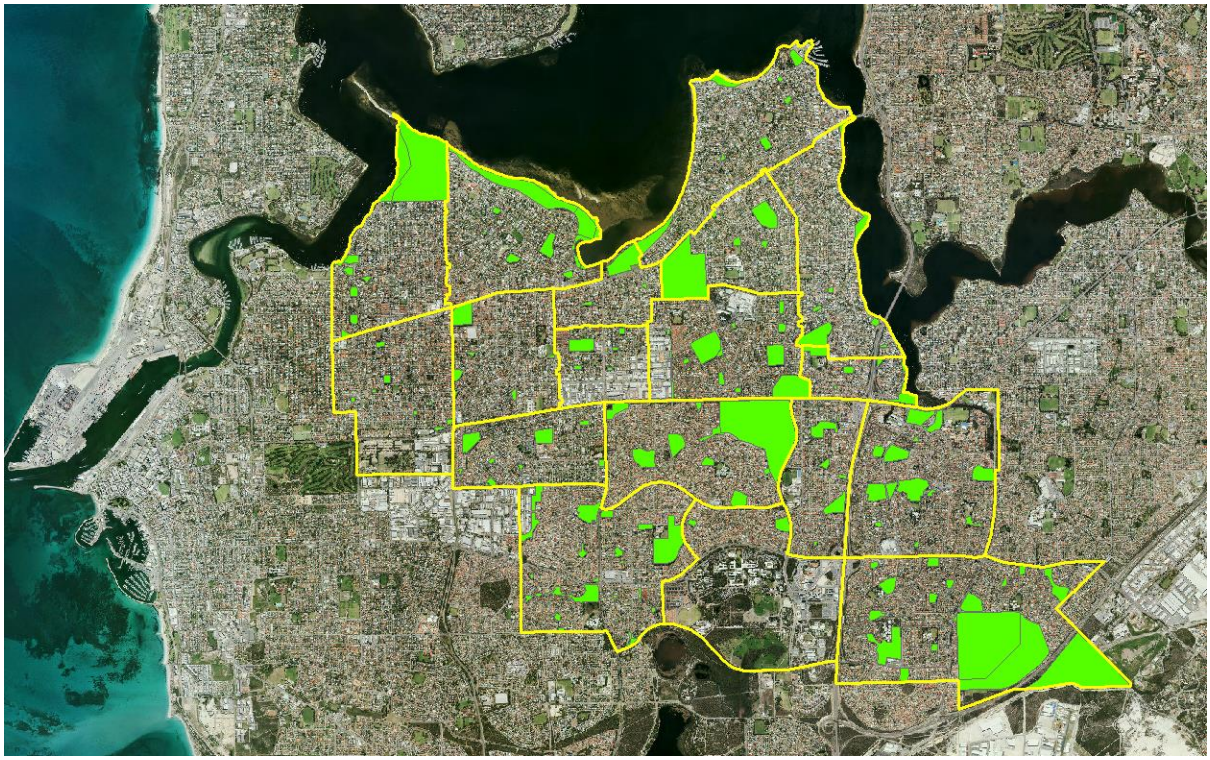


Figure 2 Parks and reserves in the City of Melville

5.2 Urban heat

The Urban Heat Island effect describes the phenomenon of cities being hotter overall than the surrounding rural areas due to the concentration of high thermal mass materials and heat-creating human activity. Within cities, the effect can be mitigated by large contiguous areas of vegetation or water. Low density suburban areas tend to be cooler than more densely built-up areas.

The City commissioned a thermal imaging survey in February 2016 to gain an understanding of the impacts of urban heat and identify the hottest/coolest places within the City. Aerial thermal imagery was captured over two nights between 9pm and midnight using a FLIR A615 thermal imaging camera with a 24.6mm lens.

An example of the images obtained is shown in Figure 3 below. Areas of high thermal absorption such as roads and driveways show as hotter at night as they release heat stored during the day. Note that although buildings with metal roofs show as apparently cool, the roof surface may actually be above the ambient temperature. This anomaly is due to the low thermal emissivity of metal surfaces.

> "*Ensure car parks are made from permeable and lighter coloured materials and are heavily treed.*" – Community Reference Group member

Vegetation generally stores little heat and so cools quickly when no longer exposed to sunlight. Preserving and enhancing the urban forest, and minimising its fragmentation, has the potential to mitigate urban heat in the City as temperatures increase due to climate change. Other heat reducing mechanisms include changing the material and/or colour of roads and other paved surfaces and of building exteriors, including the use of green roofs.

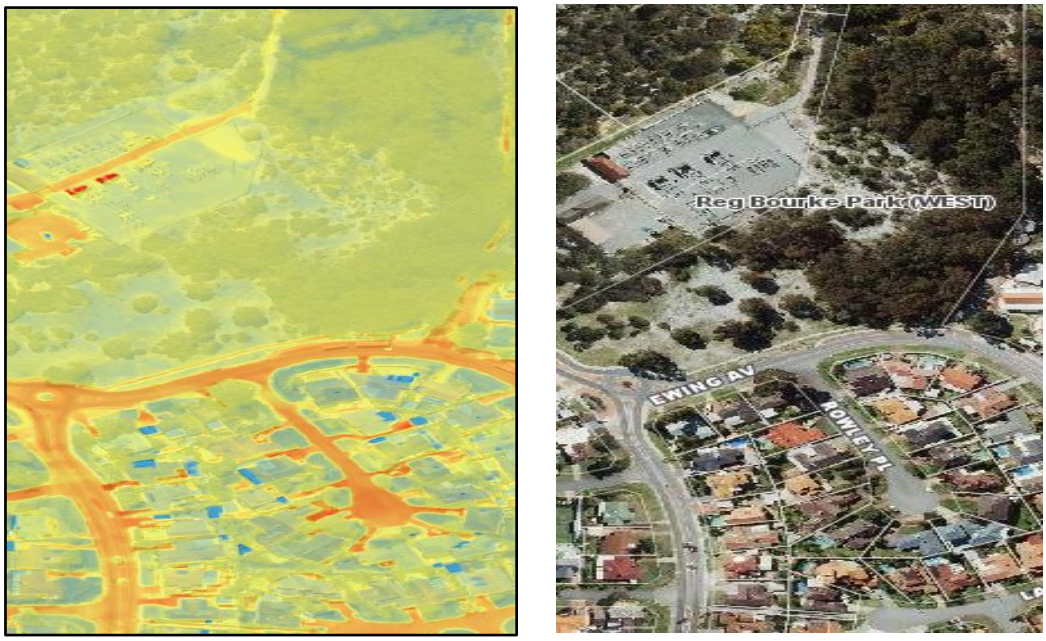


Figure 3 **Aerial thermal image taken at 9.00pm (left) and daytime aerial photograph (right) of an area in Bullcreek in February 2016, showing residential housing and streets/footpaths, a transformer station and surrounding natural area.** (Source: McNullen Noland Group, 2016)

5.3 Community Wellbeing Survey 2015

In the Community Wellbeing Survey conducted in 2015, 73% of residents were very happy (42%) or happy (31%) about the way the City and community are making efforts to protect and maintain the natural environment. Only 7% of respondents (28 people) reported being not very happy with these efforts, although the reasons for their dissatisfaction were not recorded.

All the young families who responded reported that they used a local park or playground, compared with 85% of the community as a whole, and 75% of young families surveyed said they were very happy with the availability of places to be physically active. The survey did not differentiate between outdoor and indoor activity.

90% of respondents believed that the City has an attractive environment that the community can be proud of, that the City has a sufficient range of open spaces for leisure activities and that they are able to walk around their neighbourhood. 94% felt it is a good place to raise a family and 91% that it is a good place to grow old (see Figure 4).

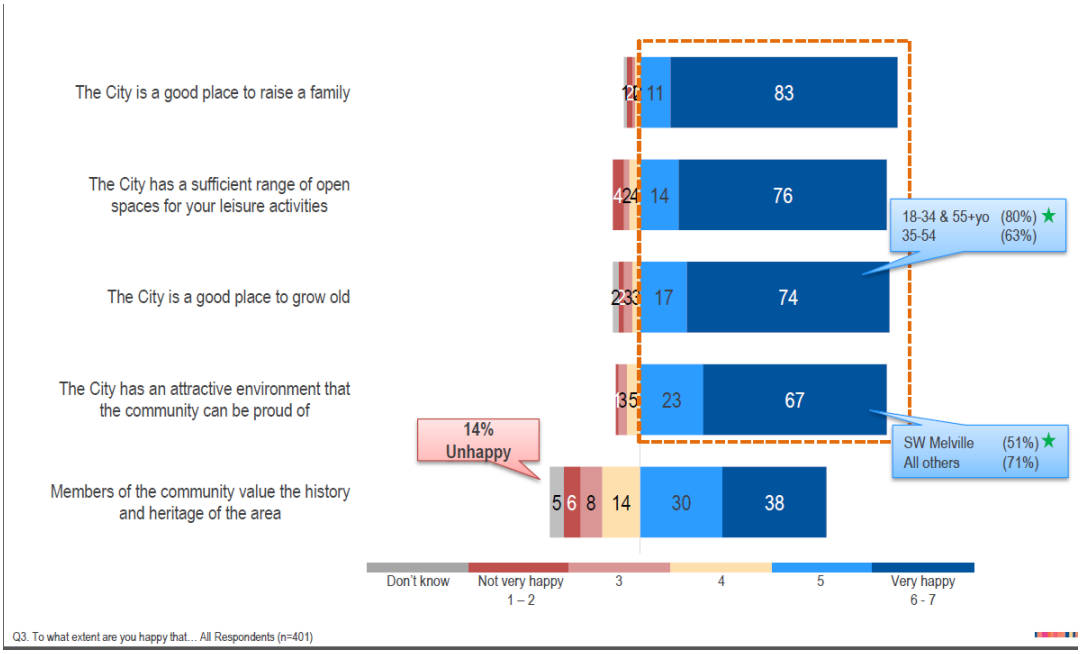


Figure 4 Extract from the 2015 Community wellbeing survey report.

5.4 The existing urban forest

Tree canopy cover is the percentage of ground covered by the leafy area (crown) of trees as seen from above. Tree canopy cover may be shading hard surfaces, bare ground or smaller plants including grass.

For the purposes of this Plan, tree canopy cover is defined as the cover provided by trees and large shrubs that are three metres or more tall, and "vegetation cover" is used when referring to the understorey (plants less than three metres tall).

For analytical simplicity, the measure has been applied to the existing height of the vegetation at the time of the survey, rather than potential mature height as used in more academic forest definitions. Immature trees with a potential mature height of more than three metres, but which have not yet reached that threshold height, have not been included in the canopy cover measurements, potentially understating actual urban forest coverage. In areas of closed canopy cover (the crowns of adjoining trees meet or overlap), the total area covered is counted, ignoring overlap between adjoining tree crowns.

5.4.1 Data collection

Between 7 and 11 February 2016, the City commissioned McMullen Noland Group (MNG) to undertake an aerial data overview. In addition to the thermal imagery mentioned in section 5.2, the following data was collected on the urban forest:

1. LIDAR (Light Detection and Ranging) imagery, to map the canopy cover at varying heights (stratification) within the City. The imagery was captured from an altitude of 1500 feet, resulting in 2-4 points per square metre and an accuracy of 0.1 metre.
2. Multi-spectral imagery, including near-infra-red, to assess the health of the vegetation. At the flight altitude of 1500 feet, a resolution of 0.41 x 0.41m was achieved.

The data was analysed across the City as whole, by suburb and within individual parks. The February 2016 data will be utilised as a baseline to measure the urban forest development in the City. It is acknowledged that the tree canopy cover derived from these data differs from some other published reports. However, the City is confident that the MNG data is more detailed, more current, and therefore significantly more reliable than that used by the authors of those reports.

The City undertook an individual street tree survey in selected suburbs between 2012 and 2015, and is currently undertaking a more extensive census of all its street trees. This will allow it to build a reliable urban forest profile that can support informed management decisions and resource allocation. Over the two data collection projects, almost 20,000 street trees had been assessed and recorded by January 2017. The current data collection project also includes identifying suitable but unutilised planting sites that can be used for infill or additional planting.

5.4.2 Tree canopy and vegetation coverage

Land controlled by the City accounts for 37% of the total land area in the City of Melville boundary, but City land provides almost half of the tree canopy cover (trees >3m in height) and almost 40% of the understorey vegetation cover (see Figure 5).

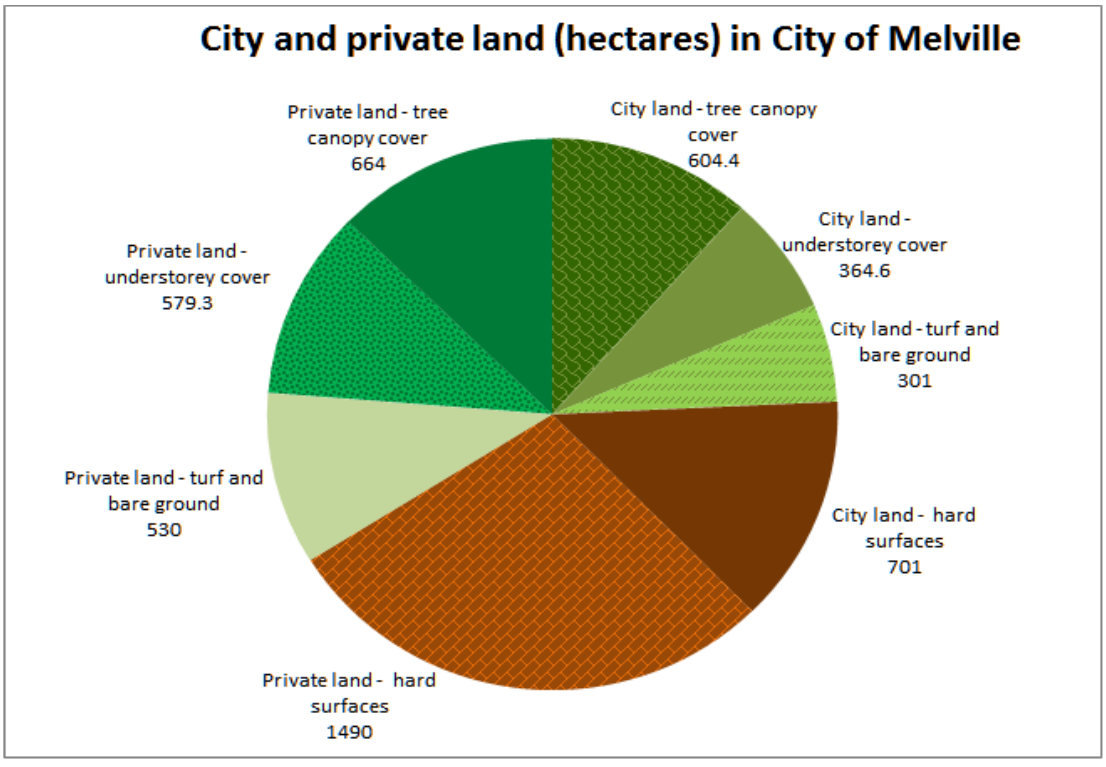


Figure 5 Vegetation cover on public and private land in the City of Melville (hectares).

Figures 6 and 7 show surface cover across the City and vegetation cover by suburb, including both public and private land. Figure 8 shows the surface cover across all City-controlled land. Figures 8, 9 and 10 show coverage on City-controlled streetscapes, parks and recreation reserves, and natural areas.

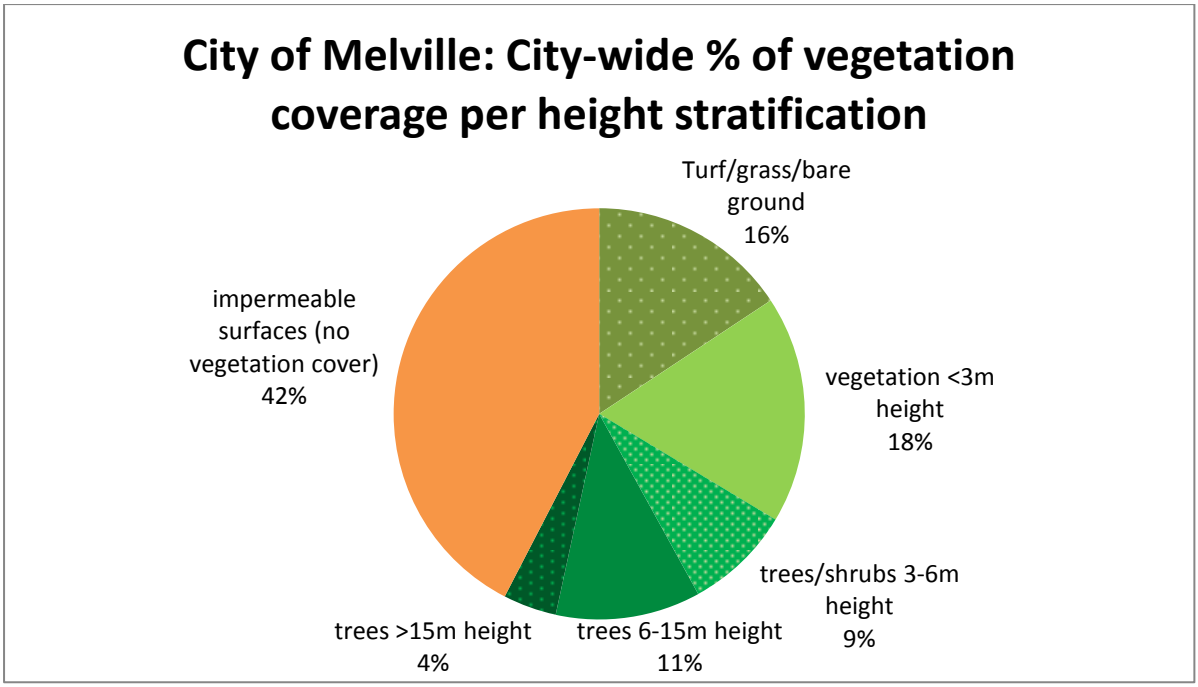


Figure 6 **Surface cover across the City including public and private land and all land uses.**

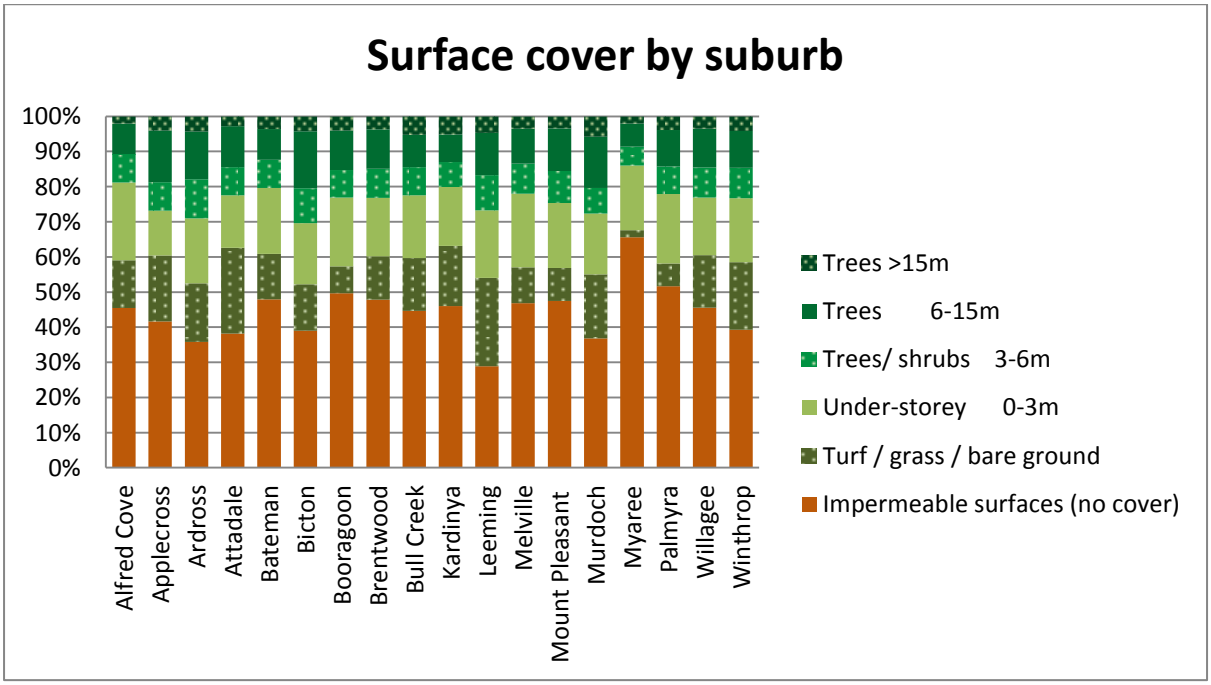


Figure 7 Percentage vegetation cover by suburb, including all land uses and land ownership types.

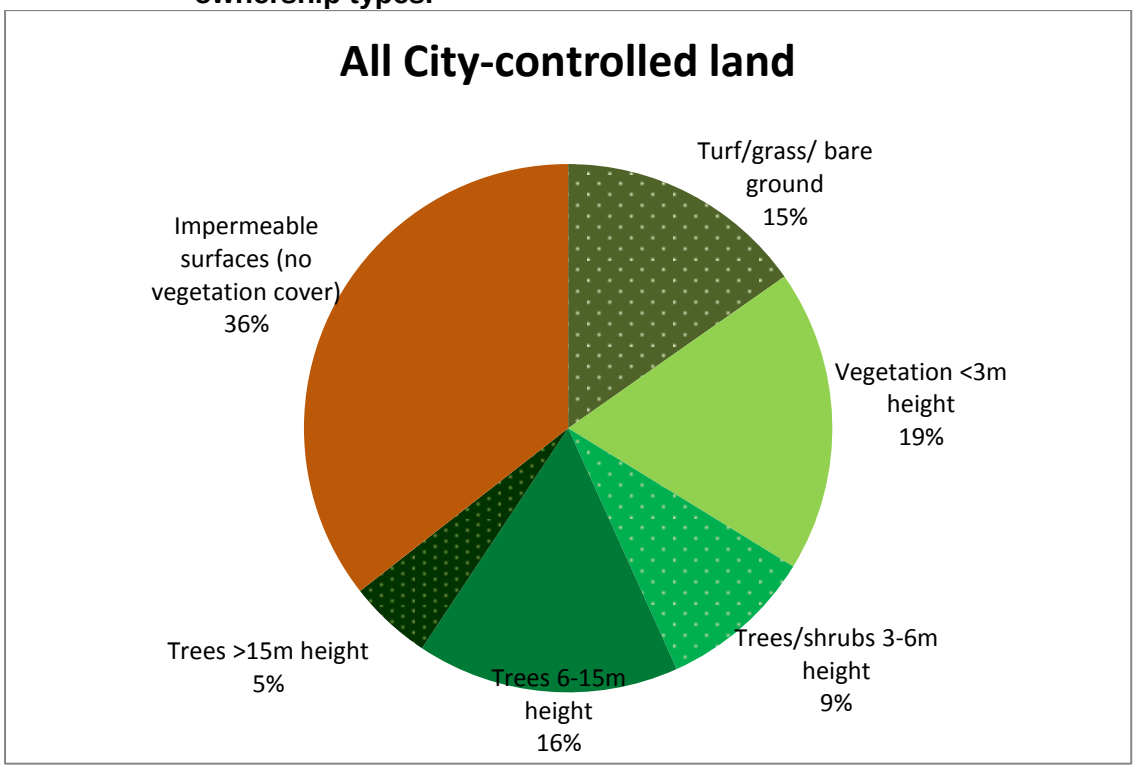


Figure 8 Surface cover on all City-controlled land in February 2016.

Approximately 30% of all City land is covered by tree canopy (more than three metres tall) and 19% is covered by understorey vegetation. This compares with about 20% tree canopy cover and 18% understorey cover on private and institutional land. The following charts show vegetation on City-controlled land by land use.

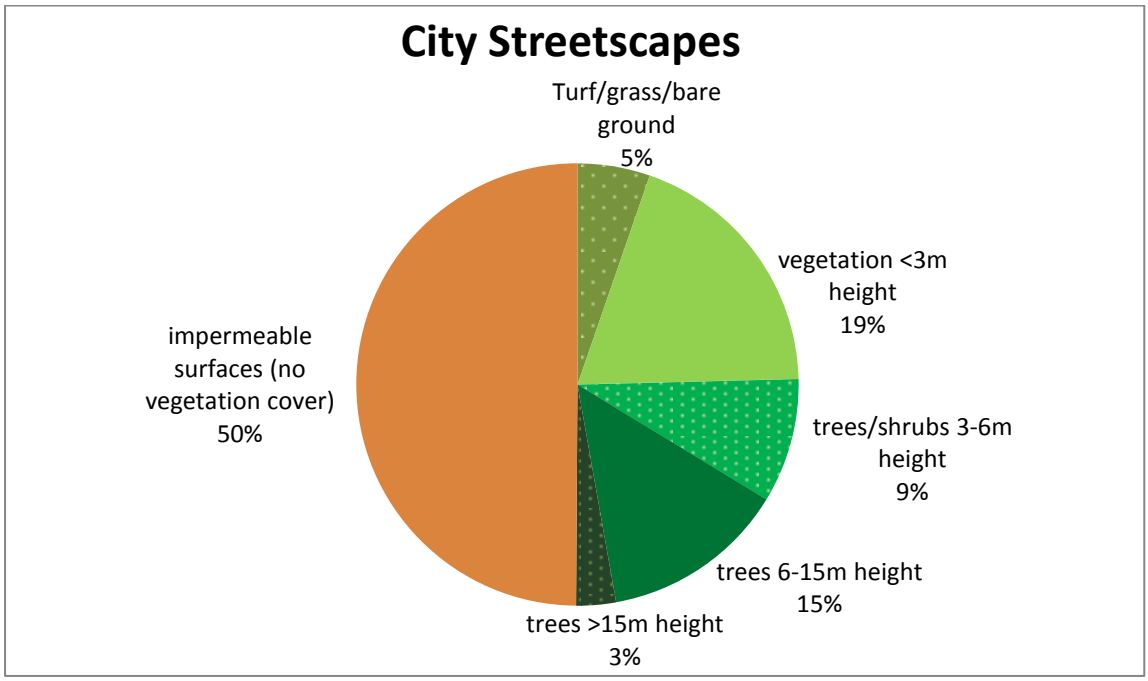


Figure 9 **Surface cover in City of Melville streetscapes in February 2016.**

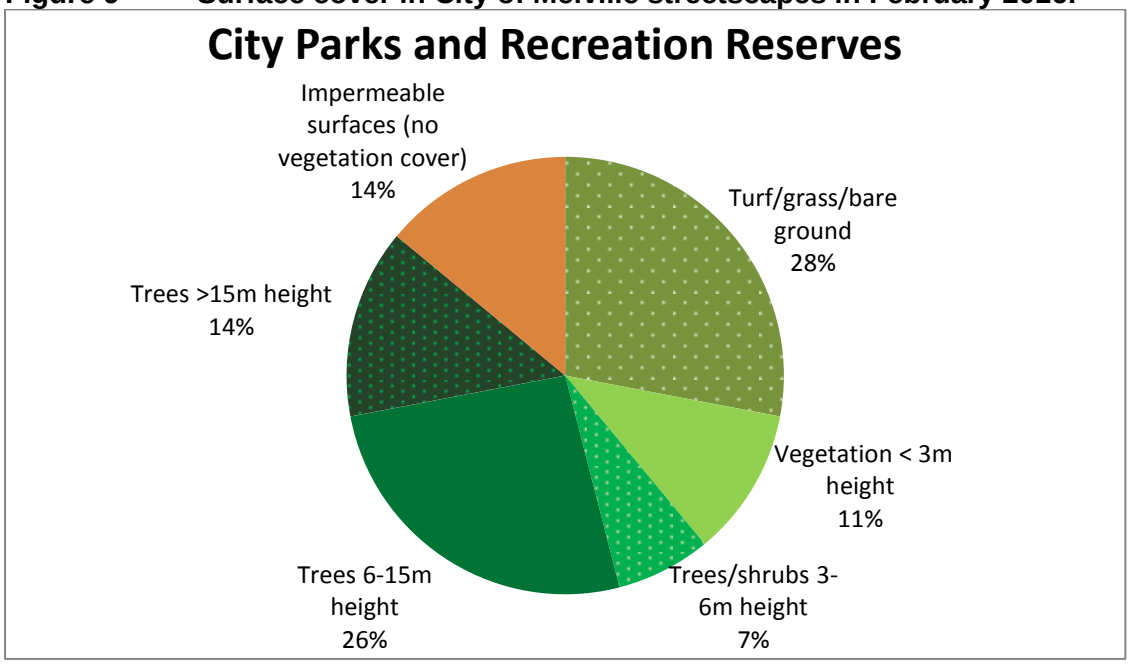


Figure 10 **Surface cover in City of Melville parks and recreation reserves in February 2016 excluding natural bushland areas. The high proportion of turf and grass shown in this chart reflects that these parks and reserves include 20 "active reserves" used for outdoor sports and recreation. .**

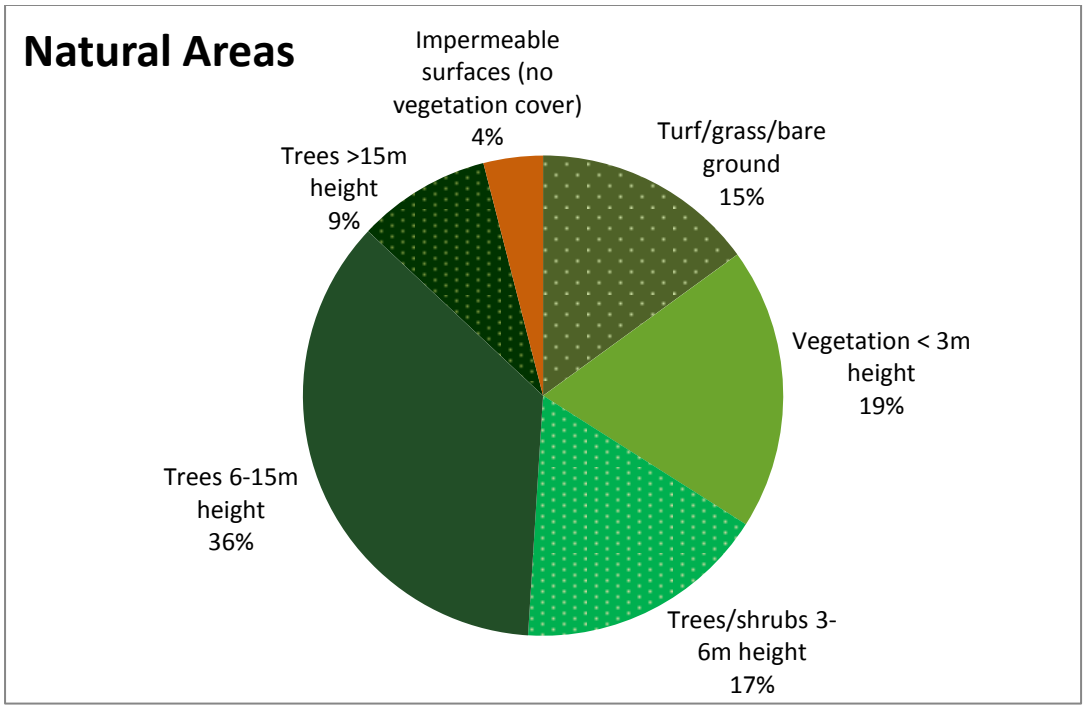


Figure 11 **Surface cover in City of Melville natural (bushland) areas in February 2016. (Most tree species indigenous to the Swan Coastal Plain have a natural mature height of less than 15 metres.)**

5.4.3 Trees under the care and control of the City

The City has approximately 40,000 street trees, a ratio of about 380 trees/1,000 residents[6]. The City has a target of at least one street tree for each residential property frontage (equivalent to approximately 50 street trees/kilometre of local road verge), although practical density is influenced by the canopy diameter of the mature trees.

In addition, approximately 40,000 trees grow in the City's parks, recreational areas and reserves.

The City currently plants approximately 800 juvenile trees per year in street verges and parks, and about 2,000 trees as tube-stock in natural areas. Of the trees planted by the City, about 600 are replacements for dead or diseased trees, or for trees removed for safety or other reasons, with the rest being additions to the urban forest. Resident requests accounted for 134 new street trees planted by the City in 2016.

The following analyses are based on almost 20,000 street trees surveyed to date in the 2012-15 survey and the current survey data collected up to January 2017.

5.4.3.1 Species diversity

The City of Melville plants a variety of tree species, from a master list of species known to grow successfully here. These include local and other Australian native species and a number of exotic trees. Selection is based on suitability for the conditions of each site and management practicalities.

Across the City, over 200 species are represented among our street trees, although in some cases representation consists of a single specimen.

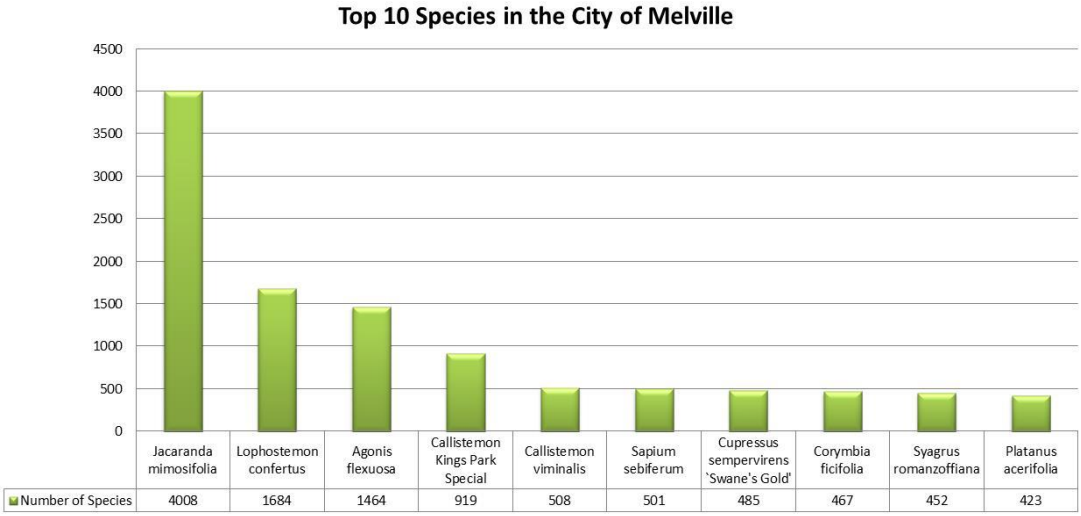


Figure 12 City-owned trees: most common street tree species distribution (based on two surveys with a combined total of 19,482 trees across 17 suburbs). Common names are listed in the table following Figure 13**.**

[6] This ratio is relatively high by global city standards, but could decline with increasing residential density in existing areas if the plantable verge area and street tree population remain stable. By comparison, Californian cities average 260 street trees/1,000 residents (McPherson *et al*. 2016) and northern European cities average 50-80 street trees/1,000 residents (Baró *et al.* 2014).

However, in some suburbs there is very little biodiversity among street trees, with some streets overwhelmingly dominated by with just one species. This uniformity gives streets a distinctive character, but monocultures suffer increased risk of disease and pest epidemics and do not support local biodiversity.

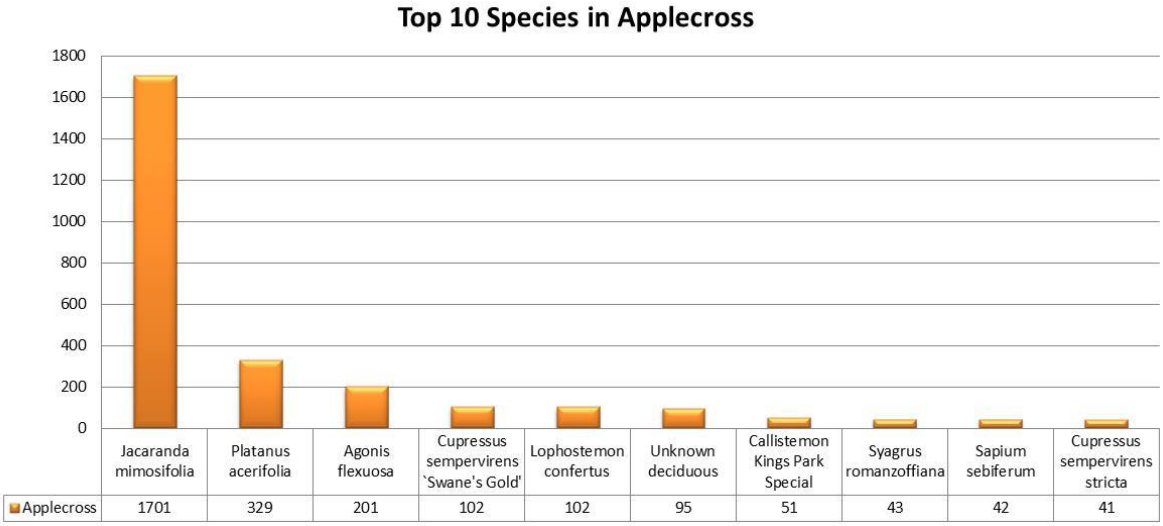


Figure 13 City-owned trees: street tree species distribution in Applecross showing dominance by jacarandas (based on survey of 3,278 trees).

Table 4 Scientific and common names of most common street trees

Latin name	Common names	Origin
Jacaranda mimosifolia	Jacaranda	South America
Lophostemon confertus	Brush Box, Queensland Box	Queensland, NSW
Agonis flexuosa	Sweet Peppermint, Willow Myrtle	Western Australia (SW)
Callistemon hybrid "Kings Park Special"	Callistemon "Kings Park Special"	Western Australia (modern cultivar)
Callistemon viminalis	Weeping Bottlebrush	Western Australia, NSW, Queensland
Sapium sebiferum (Also known as *Triadica sebifera*)	Chinese tallow, Candleberry Tree	Southern China
Cupressus sempervirens	Mediterranean Cypress	Eastern Mediterranean region
Corymbia ficifolia	Red Flowering Gum, Albany Flowering Gum	Western Australia (SW)
Syagrus romanzoffiana	Queen Palm, Cocos Palm	South America
Platanus x acerifolia	London Plane Tree, Hybrid Plane	Thought to be a 17th century hybrid between the Oriental Plane (Greece/Asia Minor) and the American Sycamore (North America)

As part of its long term risk management for the urban forest, the City needs to assess the climate change vulnerability of its street trees and identify alternative species well-suited to

expected future climate conditions. Non-local trees growing at the extreme of their climatic tolerance (temperature and rainfall) and local trees with a narrow tolerance range may be particularly vulnerable to the impacts of climate change.

Research in Melbourne (Kendall and Bauman 2016) on temperature (but not rainfall) tolerance found that many existing trees in the public realm in Melbourne would be vulnerable to climate change, but identified a number of species not currently used that could withstand expected hotter conditions. The City of Melville will advocate for this research to be extended to include seasonal water demand and rainfall requirements so that it can be used by Perth urban forest managers.

5.4.3.2 Age diversity

Immature and senescent trees generally require more management resources than trees in their mature stage. Senescent trees are also more vulnerable to the impacts of pests and diseases, and to structural damage as a result of storms or wind stress. A diverse age profile among trees permits more effective allocation of staff and financial resources for tree management.

Since different species have different longevity characteristics, urban forest managers use the concept of “Useful Life Expectancy” (ULE), meaning the expected remaining lifespan of the tree before it needs to be replaced. This is estimated for individual trees by qualified arboriculturalists who take into account species, age/life stage and tree condition.

In contrast to commercial forestry, it is preferable for the urban forest in a suburb to have a diverse range of ULE scores to avoid the need to simultaneously replace a high proportion of mature trees with much smaller trees.

The chart in Figure 14 reveals that the City has a large number of street trees that will reach the end of their expected lifespan in the next 10-20 years. This is a result of the development pattern of the City of Melville which has led to some neighbourhoods having large cohorts of trees of similar ages. It highlights an emerging challenge as these mature trees reach post-maturity stage and start to decline in health. The City will develop a managed replacement program to minimise the impact of mature tree loss on streetscapes.

This requirement is likely to dominate the future planting program. The City currently replaces about 400 trees annually, which compensates for natural attrition and addresses emerging problems. Priority is given to the replacement of trees which are assessed as posing a risk to public safety. The City must also replace about 25% of young urban trees which die in the first three years after planting.

The City needs to plan to increase its planting program to at least 1,500 juvenile street trees annually to deal with predicted street tree replacement requirements over the next 10-20 years, with an additional allowance for replacement of park trees. While this rate of planting will ensure that ageing trees are replaced, it is likely to result in a temporary reduction in canopy cover until the trees mature.

Where possible, infill planting will be used to defer the removal of old trees until the young trees are close to their mature size. However, the density of street tree planting in some streets may necessitate the removal of an old tree to provide space to plant a new tree.

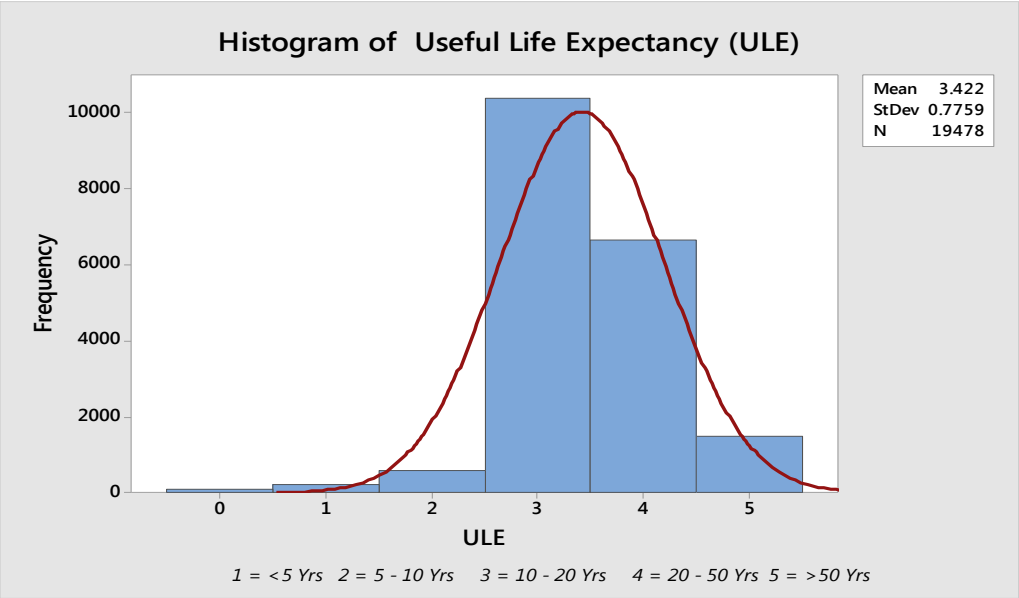


Figure 14 Useful Life Expectancy (ULE) distribution based on a survey of approximately half of the City's street trees.

Some suburbs are more at risk than others because of the narrow time range in which their street trees were originally planted (see Figure 14). An accelerated replacement planting schedule will be required in these areas to minimise the impact on neighbourhood character that would occur with natural age-related tree mortality over a short period.

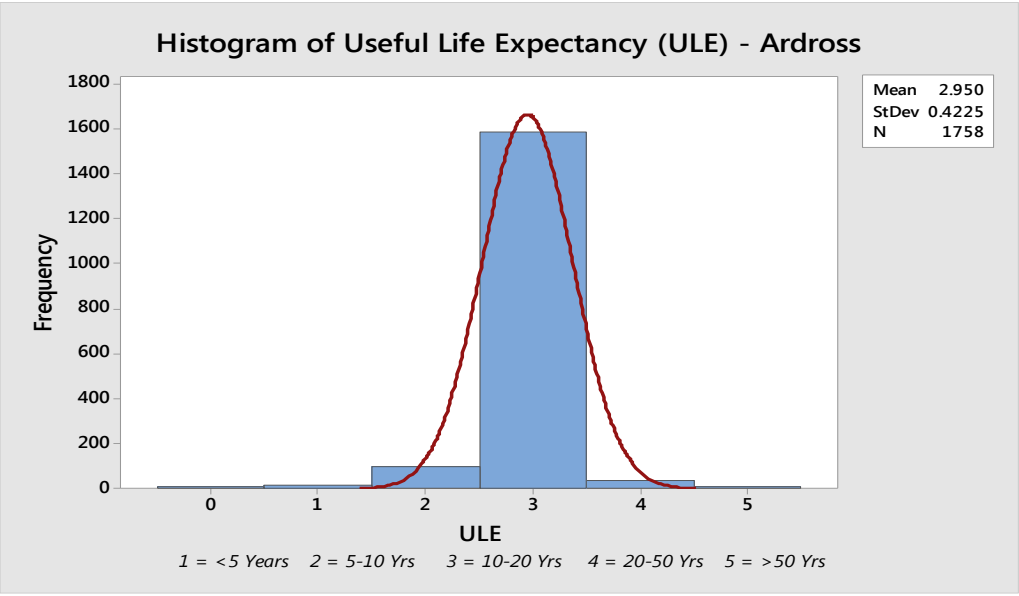


Figure 15 More than 90% of street trees in Ardross are likely to reach the end of their natural lives within 20 years.

5.4.3.3 Size diversity – height and canopy area

A spread of sizes is generally a reflection of both age and species diversity. In areas with overhead power lines, tree height may also be affected by frequent top pruning.

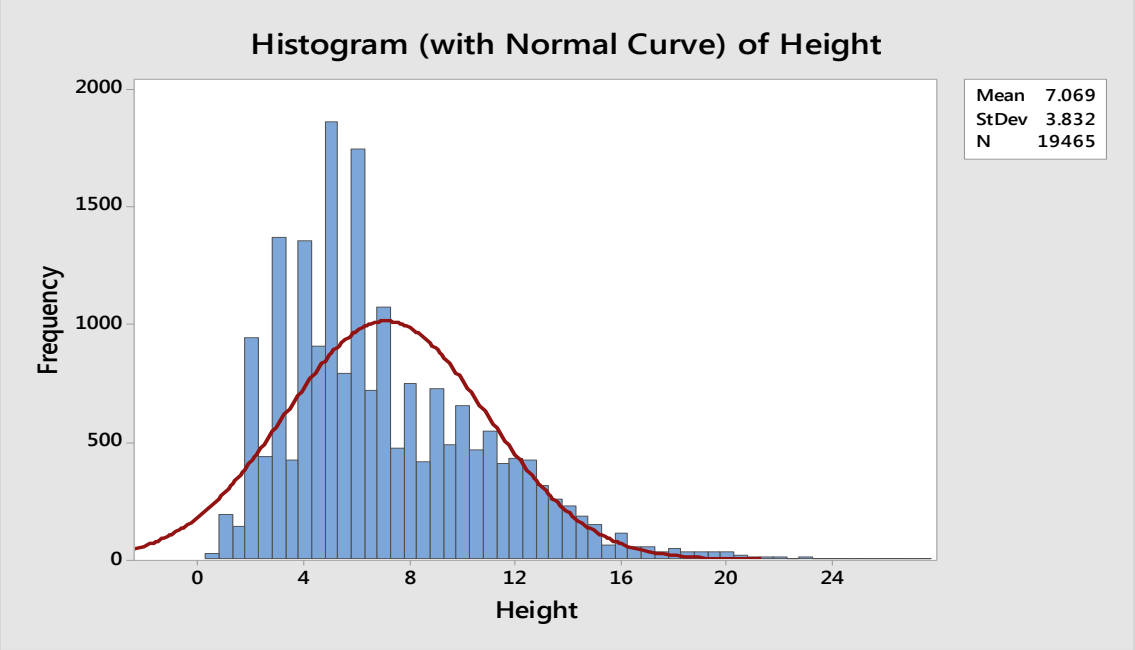


Figure 16 **Street trees in City of Melville: height distribution (sample includes young trees under three metres tall).**

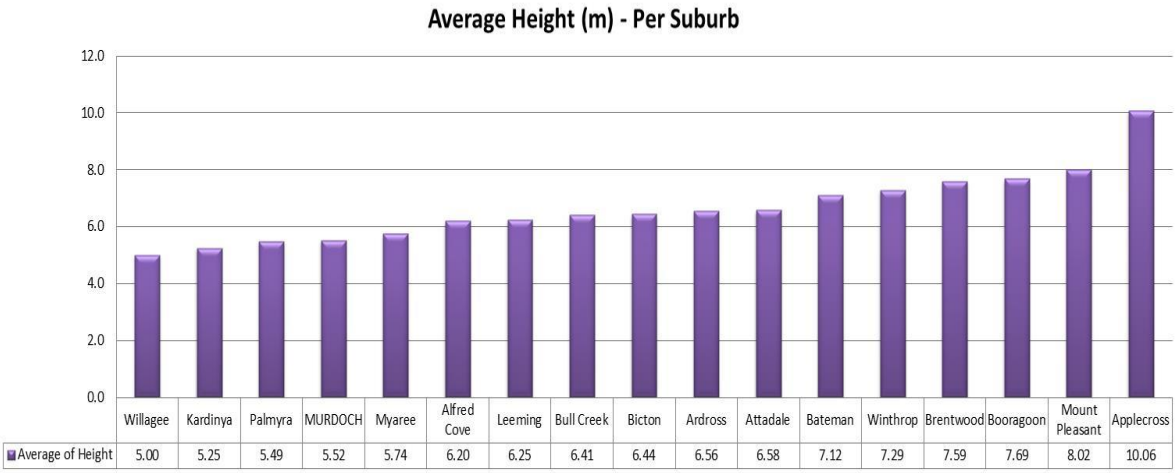


Figure 17 **Average (mean) height of street trees by suburb.**

Based on almost 20,000 trees surveyed to date, about 93% of the City's street trees have a canopy area of 100 square metres or less. Approximately one-third of the City's street trees have a canopy area of less than 15 square metres (Figure 18).

A tree with a canopy extending out from the trunk (all directions)	has a diameter of	and provides tree canopy cover of about
2 metres	4 metres	12.5 square metres
4 metres	8 metres	50 square metres
6 metres	12 metres	113 square metres
10 metres	20 metres	314 square metres

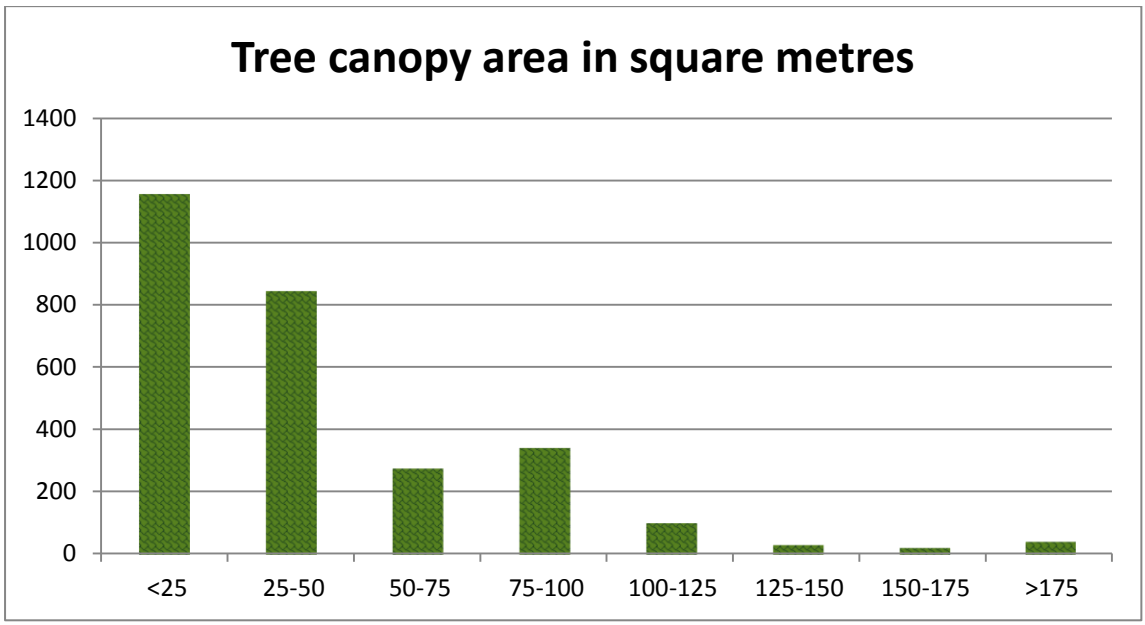


Figure 18 Street trees in City of Melville: canopy size (area) distribution.

5.4.3.4 Urban Forest Condition

Near-infra-red imagery is utilised to calculate the Normalised Difference Vegetation Index (NVDI). All plants absorb and reflect radiation, and a specific colour range indicates an actively growing plant, which is generally correlated with health other than in periods of seasonal dormancy. The colour variation can be analysed to determine the health and growth activity of the vegetation from the aerial imagery.

Multiple near-infra-red scans can give early warning of emerging urban forest health concerns such as pest or disease epidemics or a reduction in water availability. Spectral indices can potentially detect plant stress before it results in structural vegetation change, thus helping urban forest managers to act before irreversible damage occurs. Preferably, scans are repeated over timescales long enough to distinguish actual trends from seasonal variability or weather events.

The vegetation depicted in ochre in Figures 19 and 20 displays low growth activity in non-irrigated vegetation, which typically results from biological stress. However, this image results from a single data collection which coincided with an exceptional summer heatwave of five consecutive days over 40^{o}C in February 2016. The data is presented here to demonstrate the technique, but a single dataset is inadequate to draw assumptions about the general condition of the vegetation.

It should also be noted that many plants adapted to the hot dry summers of a Mediterranean climate conserve water by adjusting their photosynthetic pigmentation and reducing their biological activity in response to exceptionally hot, dry conditions. Exotic, deciduous plants without that capacity may suffer heat and drought stress during a similar temperature event. Both conditions may return a similar NVDI reading.

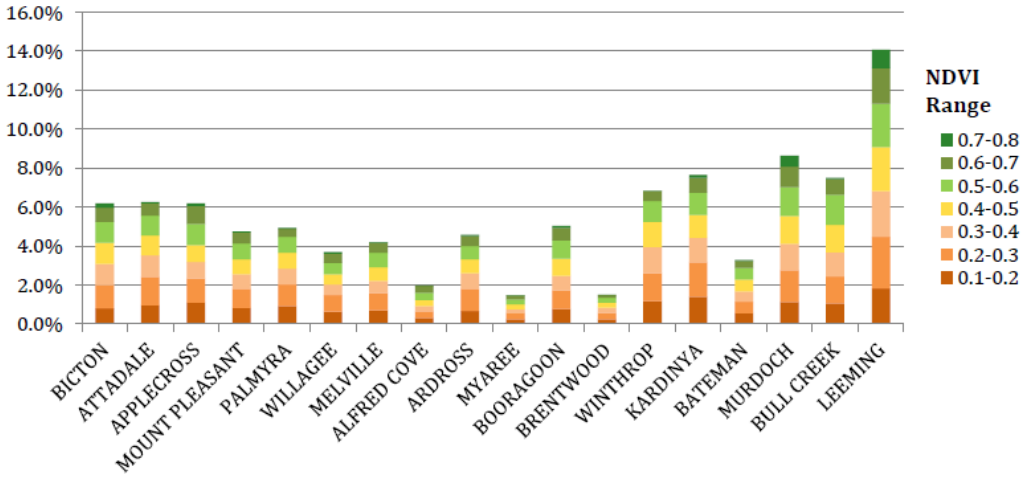


Figure 19 Vegetation performance by suburb (measured February 2016). A NDVI score of less than 0.2 indicates low photosynthetic activity, while a score of more than 0.5 indicates healthy growth activity. Additional measurement is needed to eliminate seasonal and weather effects. (Graph: MNG)

Most of the bright green areas in Figure 20 indicate irrigated vegetation, primarily turfed sports areas, although some vegetation adjacent to wetlands shows a similar NVDI score.

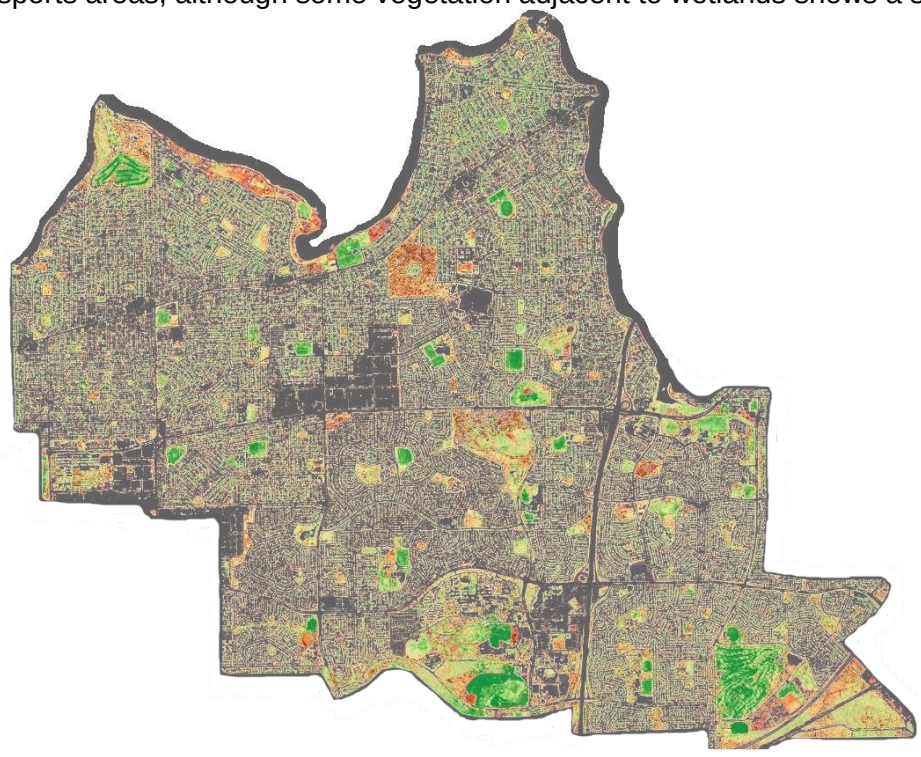


Figure 20: Aerial near-infra-red image of City of Melville showing Normalised Difference Vegetation Index (NDVI). (Image: McNullen Noland Group, February 2016)

Legend:
High biological activity Medium biological activity Low biological activity

The data in Figures 19 and 20 are merely a forest management tool indicating to forest managers where field inspections may be needed. They should be interpreted cautiously in the absence of ground-level verification. A low NVDI score may indicate heat and drought stress in exotic plants, whereas the same score in non-irrigated areas dominated by locally indigenous plants may indicate a normal response to extreme heat. Many indigenous plants can temporarily reduce photosynthetic activity to minimise transpiration and avoid drought stress, although they may suffer harm if the conditions continue for more than a short period.

5.5 Risks to the urban forest

5.5.1 Increased temperature

Average annual maximum daily temperatures recorded in Perth have increased over the last century, as have the average number of very hot days and the incidence of heatwaves (three or more consecutive very hot days). This is likely to be due to a combination of general climate changes and the urban heat island effect resulting from increased development and human activity. The Bureau of Meteorology predicts that the warming trend will continue.

20 year period[7]	Annual mean maximum temperature	Number of years with 4 or more days exceeding 40°C	Number of years with 3 or more consecutive days exceeding 40°C (heatwave)
1897 – 1916	22.8°C	2	0
1947 – 1966	23.3°C	5	2
1997 – 2016	24.8°C	10	4

Trees adapted to cooler conditions, even if they have access to unlimited water, may be unable to draw sufficient water quickly enough to replace water lost through transpiration on very hot days. They may suffer hydraulic failure and heat stress, with taller trees likely to be at higher risk (since they must "pump" water further to replace water lost through the leaves). If the condition is severe and prolonged, irreversible and potentially fatal damage may result.

Native trees adapted to minimise or cease transpiration in very hot conditions can avoid dehydration by reducing their water loss, but this response also prevents photosynthesis, nutrient flow and carbohydrate production. After several consecutive very hot days, these trees may begin to starve (Symes 2016).

5.5.2 Rainfall reduction[5]

A century ago, in the twenty years between 1897 and 1916, the average annual rainfall in Perth was 843mm, with more than 900mm received in eight of those years (two years with more than 1,000mm) and only two years with rainfall below 650mm.

In the twenty years between 1951 and 1970, when many of the trees in our older suburbs were planted, the average annual rainfall was 872mm, with more than 900mm received in

[7] 1897-1916 and 1951-1970 data from Perth Regional Office weather station (9034). 1997-2016 data from Perth Metro weather station (9225).

ten of those years (three years with more than 1,000mm) and two years with rainfall below 650mm.

However, in the twenty years between 1997 and 2016, the annual Perth rainfall averaged only 710mm, with no year exceeding 900mm and six years with rainfall below 650mm. This period includes the driest year on record: 467mm in 2006.

On average, winter rainfall (the period of most importance for native plant growth in the Perth region) has decreased by over 17% in south-western Western Australia since the 1970s and further reduction is predicted over coming decades.

Greater reliance on irrigation, if water is available, may be necessary to maintain existing mature trees adapted to a higher rainfall regime. Increased heat- or drought-related mortality is likely to require more resources to be invested in tree replacement.

The City's urban foresters will need to review species selection criteria on the basis of natural rainfall range and expected seasonal and annual water demand over the life of a tree.

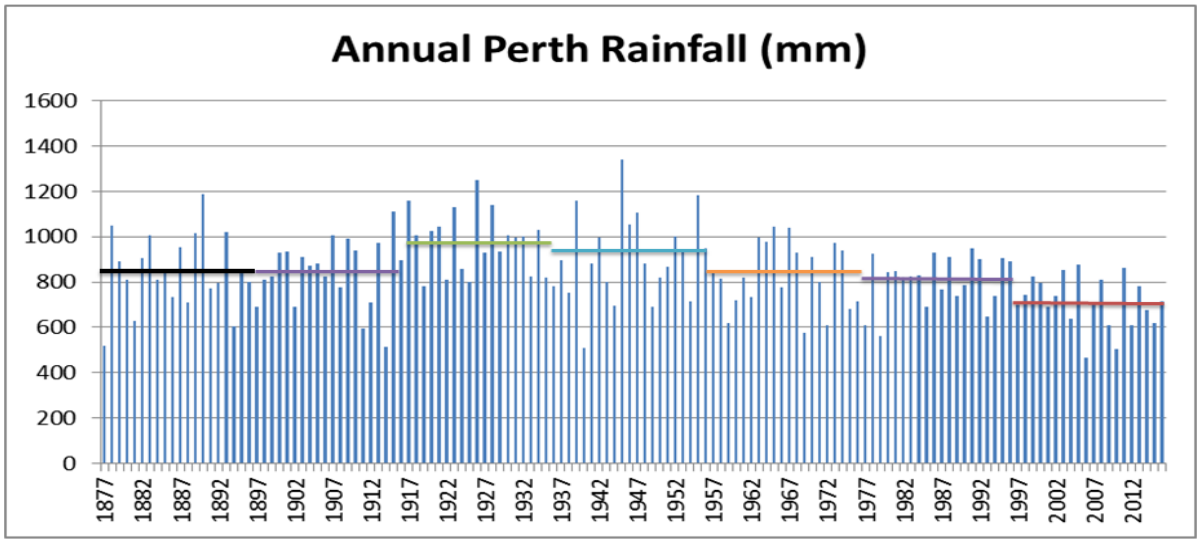


Figure 21 **Perth annual rainfall 1877 – 2016[8]. The horizontal lines represent 20 year averages. The average annual rainfall over the 140 years of Bureau of Meteorology records is 844mm. Many of our existing street trees were planted between the late 1940s and the mid-1960s.**

5.5.3 Groundwater depletion and quality

The Department of Water has reported a significant decline in groundwater levels not only in the superficial aquifer that underlies the Perth South subregion, but also in the deeper Leederville confined aquifer.

The rate of groundwater decline in different areas varies with local rainfall recharge, soil types, the extent of perennial vegetation (trees) and abstraction rates for human use. Recharge rates are higher in sandy soils and cleared areas and lower in areas of significant perennial vegetation or high abstraction.

[8] Source: Bureau of Meteorology, rainfall data from weather stations 9034 (1877-1991), 9151 (1992-93) and 9225 (1994-2016).

A negative water balance (water lost from evapotranspiration is greater than rainfall) in an area leads to groundwater depletion and lowering of the water table. This is exacerbated when there is also high abstraction from bores in the area.

The potential consequences of groundwater depletion include increased soil and water acidity and salinity, shrinking or loss of groundwater dependent ecosystems such as wetlands and damp-lands and the creation of acid sulphate soils in susceptible areas.

Understanding and monitoring the interaction between the urban forest and hydrology will be essential to protect the long term regional water balance in a drying climate and maintain the viability of our urban wetlands and groundwater-dependent species. Species selected for new planting should ideally have an annual water demand (evaporation plus transpiration) at maturity that is less than the expected rainfall.

In some City-controlled reserves, the water demand of existing vegetation may already exceed current annual rainfall. The average rainfall over the last 20 years has been about 710mm, equating to about 7.1 million litres of water received per hectare. If the vegetation at a location has an evapotranspiration demand that exceeds the amount of water received from rainfall, then it will be drawing on groundwater reserves.

In a no-intervention scenario, natural ecosystem adaptation will eventually result in changes to species mix and reductions in the plant population (natural thinning) to match water availability. However, to control the aesthetic impact of the transition to a permanently dryer climate, or to extend the life of wetlands, the City may need to consider the merits of targeted reduction of urban forest leaf area and sapwood volume in vulnerable areas to slow the rate of groundwater decline.

Supplementing natural or created wetlands with water from deep aquifers or treated stormwater is possible and may be appropriate as a transitional measure, but has proven problematic elsewhere in Perth as it can inhibit natural adaptation to dryer conditions. Dredging is another option to retain surface water area, although temporary negative environmental consequences must be managed.

Figure 22 Groundwater dependent ecosystem: Blue Gum Lake June 1985 (left) and June 2016 (right). The encroachment of trees on the historical shoreline shows where areas that were previously seasonally inundated are now almost permanently dry.

The Department of Water has granted two groundwater licences to the City of Melville: 2,223,810 kL from the Swan superficial aquifer and 96,750 kL from the deeper Leederville confined aquifer. This water is primarily used for irrigating active reserves (turf) and landscaped areas around civic facilities.

The Department of Water has warned that it may review allocation levels for local governments if rainfall and water tables continue to decline and the current allocation of 7,500 kL/hectare appears to be unsustainable.

The City already has to prioritise its use of water at times of high demand to stay within its licence allocation, and has in place a hierarchy of parks and reserves based on land use and utilisation. The City does not generally irrigate street trees after the first two years.

Current water allocation priorities may need to be reviewed if additional tree and understorey planting is undertaken and to allow for future supplementary watering in high priority areas when trees are drought stressed. Future selection of tree and understorey species for streets and parks will need to apply more stringent water demand criteria.

5.5.4 Bushfires

Hotter, drier conditions are expected to increase natural bushfire risk. In urban environments, there is also an increased risk of bushfires started through deliberate or unintentional human activity.

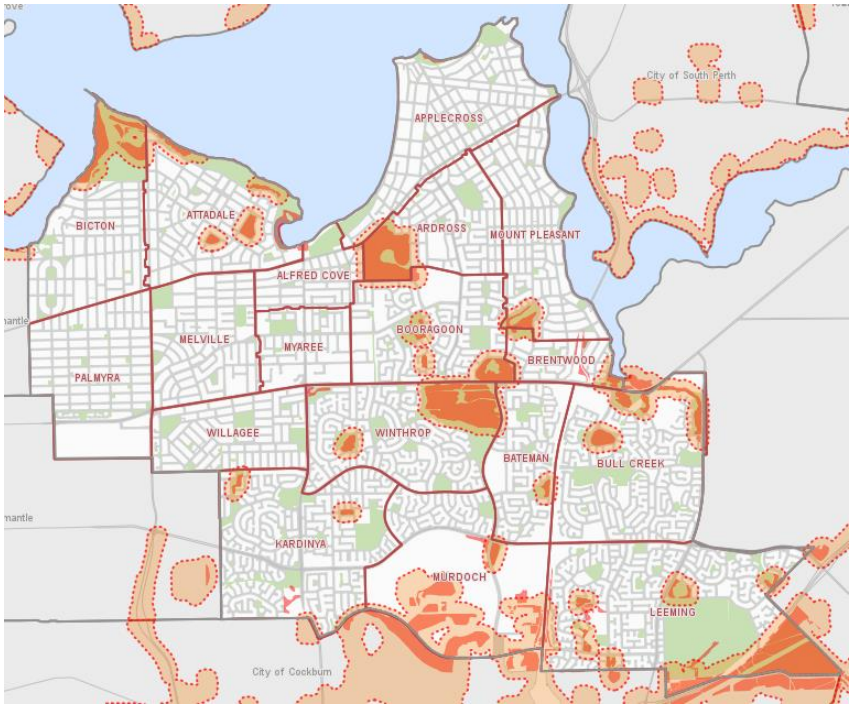


Figure 23 Bushfire prone areas in City of Melville (source DFES December 2015)

Bushfire prone areas

Bushfire prone vegetation (draft identification)

Bushfire risk must be managed for the urban forest, especially in and around natural area reserves. Urban forest managers must try to achieve a balance between:

Minimising ground level fuel load	and	limiting the loss of nutrients and natural fauna habitat caused by removal of organic material (leaves, branches, dead trees).
Ensuring fire breaks are big enough to be effective	and	minimal removal of trees on boundaries between natural and built-up areas to retain visual character.
Selecting known fire-resistant species as "living firebreaks" particularly bordering larger areas of bushland	and	selecting trees and other plants with low water requirements and visual impact similar to the natural area.
Providing necessary propagation conditions to conserve fire-adapted indigenous species in natural areas	and	controlling the frequency and intensity of fires that may pose a risk to residents near natural areas.

5.5.5 Other climate change impacts

In addition to the issues raised above, climatologists predict that climate change impacts in the Perth area will include hotter summers (and less night-time cooling), more extreme weather events (heatwaves and storms), and sea level rise of up to 0.9 metres by 2100.

Tree and understorey plant selection for City planting will need to take into account the climatic tolerance range of candidate species and assess this against predicted future climate parameters.

Some existing trees may need to be replaced earlier than expected if they are unable to adapt. Conversely, tree species that are not currently planted in the City may prove to be well-suited to predicted local conditions. The trial and use of new urban tree species will be subject to meeting regulatory requirements for importation and quarantine, or to commercial availability for native plants. The City is aware of research recently initiated by the horticulture industry to prepare a database for landscapers that will match species climatic requirements to Australian locations.

Long term succession planning is required to progressively replace vulnerable plants and plant species, both trees and understorey, with selections more likely to be suited to the predicted climate. This will require access to a high confidence predictive model for the future local climate. Consideration will also need to be given to developing an irrigation supply that is sustainable and not dependent on Department of Water groundwater extraction allocations.

5.5.6 Biodiversity

5.5.6.1 Improving age and life stage diversity

Different species have different growth rates and longevity characteristics, which are also influenced by location and growing conditions. Useful Life Expectancy (ULE) rather than just tree age is used to plan for tree replacement[9].

[9] For example, a 60-year-old tree of one species may be only three-quarters through its expected life, with a ULE of another 20 years, whereas a 25-year-old tree of a shorter-lived species may already be entering senescence and have a ULE of only 5 years. A street tree can generally be expected to have a lower ULE than a tree of the same age and species growing in a natural area because of the additional environmental stress inherent in street locations.

As noted in subsection 5.3.1.1, some local tree populations have relatively uniform age and species profiles due to mass planting when particular areas were first developed. Many of these trees are ageing and will need to be replaced within 10-20 years. Diversifying ULE reduces the risk having a high proportion of trees in an area that need to be replaced simultaneously, significantly changing the visual character of the area. Where space and resources allow, infill planting can contribute to improving age diversity.

Good urban forestry practice favours a proactively managed replacement program that progressively replaces trees in the last 10 years of their expected life to avoid the impact of losing a high proportion of the larger trees over a short period. This approach provides a manageable transition period where about one in ten of the identified older trees is replaced each year.

This would deliver a better aesthetic and environmental outcome than waiting for the trees to reach the end of their natural lives in areas where most of the trees are of a similar age cohort. However, the removal of biologically senescent but visually healthy trees may be distressing for some members of the local community and will require sensitive community engagement.

5.5.6.2 Increasing species diversity

Some older parts of the City have limited species diversity among City trees, in part due to early decisions to plant single species to define a special neighbourhood character (e.g. jacarandas – see Figure 11). The benefits of progressively increasing tree species diversity (to reduce the risk of disease/pest epidemics or attract a greater range of fauna) through infill planting and replacement must be weighed against the loss of the unique visual character of an area defined by the domination of a single species.

In addition to seeking species diversity, tree selection for maximum sustainability needs to consider:

- Suitability for urban environments (constrained growing space, increased heat load, soil compaction, pollution, wind tunnel effects, etc.).
- Capacity to survive predicted climate change impacts including hotter average temperatures, more frequent heat waves, lower rainfall and lower water table.
- Desired outcomes – different species are better suited to producing summer shade, allowing winter solar access, acting as noise or pollution buffers, cooling the immediate environment, providing food, shelter or nesting sites for different fauna species.
- Undesirable characteristics – some species are more likely to produce allergens, toxins, volatile organic compounds, irritating leaf hairs/down, high leaf or fruit/nut fall; roots that break the ground surface, cause suppression of other species, or are more susceptible to storm damage, diseases and pests).
- Competing objectives at the location (infrastructure conflicts, sight lines for drivers or passive surveillance, height clearance, solar access, view protection);
- Mature height, girth and crown area, maturation time, and longevity.

As a general guide, other than in defined areas of distinctive character reliant on street tree uniformity, the City will aim to have no more than 15% of the street trees in a given area belonging to a single species. This will be achieved progressively through infill planting and replacement of end-of-life trees. Similar levels of diversity will be pursued for understorey plantings.

5.5.7 Maintaining ecological linkages

Ecosystem fragmentation is a significant problem in urban areas, particularly where smaller natural areas do not contain adequate populations of individual species to maintain genetic health and diversity, and the distance between remnants precludes cross-pollination, seed dispersal or migration of individuals.

The City of Melville has identified local and regional ecological linkages (Figure 24). The understorey and groundcover strata of the urban forest are as critical as trees in providing viable linkages across highly built-up areas. At a small scale, corridors may be needed to allow fauna to safely traverse the distance between nesting and feeding sites, for example for waterbirds or amphibians around wetlands, while managing urban risks to individual animals such as vehicles and predatory pet animals.

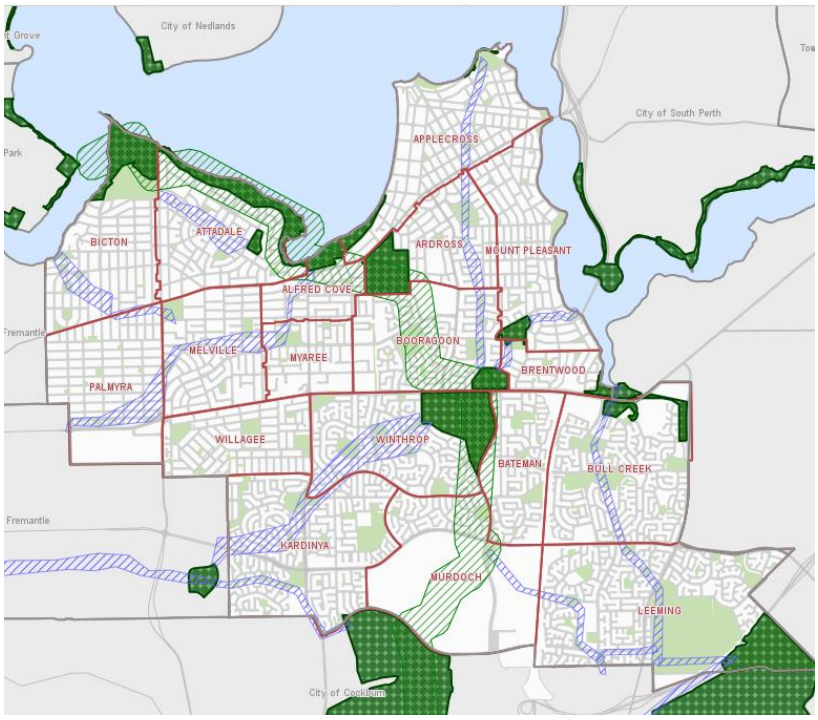


Figure 24 Ecological linkages in the City of Melville.

Ensuring that these corridors meet the needs not only of highly mobile fauna such as larger birds, but of ground-dwelling and smaller flying fauna and of plant propagation becomes increasingly challenging as subdivision eliminates gardens, and corridors become restricted to verges and parks. Wide roads and dense residential development with minimal green space may prove impassable for smaller animals, and maintaining corridor continuity for them will require innovative urban forest and infrastructure design based on a good understanding of the dispersal capacity of both the plants and animals in the area.

The Community Reference Group recommended extending the scope of cross-City linkages beyond their ecological values. The Group proposed that the City identify routes where the urban forest could be extended to provide shaded, accessible paths for people to walk easily

between natural areas, public open spaces and other amenities. The City will seek opportunities to combine ecological linkages and walkable green corridors.

5.5.8 Diseases and pests

Phytophthera cinnamomi (dieback – see Figure 25) is an endemic fungal disease affecting multiple native species and continues to spread, particularly in bushland areas where many susceptible plants grow in close proximity, facilitating cross-infection.

Environmental stress from heat or inadequate water makes all trees more susceptible to pests and diseases. Pest and disease control may become an increasingly important issue for our urban forest as it adapts to climate change.

Figure 25 Dieback in native trees caused by *Phytophthera spp*. (Image credit: Department of Parks and Wildlife)

Natural bushland areas near urban gardens are particularly vulnerable to invasive exotic weeds and pests, which must be controlled to protect the integrity of the native ecosystem.

The City will need to deal sensitively with increasing community intolerance towards some management practices, including the use of chemical control agents, at the same time that more aggressive management of pests and diseases is likely to be required. The City will seek to ensure the community is well informed about relevant risks, management policies, processes and safeguards.

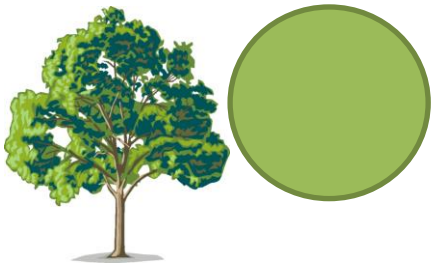
5.5.9 The tyranny of time

Trees are long-lived organisms and the management of the urban forest within the City of Melville is an ongoing activity requiring a long-term planning focus. The nature of the urban forest as a living, growing asset of the city means that the full benefits of changes in planting and management regimes will be realised over several decades, well beyond the 20-year time horizon of this Urban Forest Strategic Plan. The unintended negative consequences of decisions may also only become clear over the long term, by which time some may be irreversible, so effective risk management practices are essential.

When a mature tree is felled, the benefits of its canopy area, particularly the shade, cooling and visual appeal in its immediate vicinity, are lost immediately. A young replacement tree of a similar type will not develop a canopy area comparable to the tree it replaced until it grows to maturity, possibly taking 15-20 years or more.

Attempting to instantly replace lost canopy area by replacing a single tree with multiple new trees at the same site may appear superficially attractive but costs often outweigh benefits.

These include the expense of planting more trees than necessary; pressure on resources such as water and soil nutrients (young actively growing trees use more than mature trees); potential stunting of growth due to competition for growing space, sunlight and water; and wasteful inefficiency if some of the trees need to be culled as they get older to protect the continued health of others.



Mature tree:
Canopy diameter 8m
Canopy area 50m^2

Newly planted tree:
Canopy diameter 1m
Canopy area 0.8 m^2

We can buy:
Land
Young trees
Water
Fertiliser
Labour to plant and nurture

We can't buy:
Time
Patience

Figure 26 Comparison of canopy size in mature and young trees.

5.5.10 Community attitudes

City of Melville residents generally express a high degree of satisfaction with the City's parks, streetscapes and neighbourhood amenity. There are no significant identified social problems in the City that can be attributed to a deficiency of trees or other plants on City land, although there are areas where more vegetation may improve local amenity.

The Community Reference Group broadly concurred with that view, and did not identify any critical deficiencies in the current urban forest performance or management. The Group's recommendations focused on incremental improvements, primarily related to amenity and neighbourhood liveability ("healthy and peaceful environment").

5.5.10.1 Opposition to individual trees

Widespread public support for the urban forest and trees in general does not always apply at the very local and immediate level. City employees frequently report opposition from residents about perceived disadvantage caused by existing or proposed trees on public land, although relatively few formal complaints are received.

Concerns may include potential loss of views, increased property maintenance or risk of property damage, loss of solar access for solar PV systems, hot water systems or pool heaters, unwanted shading of outdoor living areas, perceived personal health and safety risks, or loss of parking space on the verge. Other than competition for space on verges,

understorey plants on public land generally have a lower impact than trees and tend to attract less opposition.

A systems approach to urban forest management will promote a flexible, outcome-based approach that emphasises a whole-picture perspective and diminish the importance in most circumstances of whether a particular tree is planted in a particular place. An inventory of unutilised suitable planting sites and transparent, documented planting prioritisation criteria will support such flexibility and facilitate community understanding.

5.5.10.2 Unrealistic or unsustainable expectations

Responsible urban forest management may be equally challenged by well-intentioned demands to plant more trees at a location than the site can sustainably support, to plant trees in locations that are unsuitable or where they are incompatible with the surrounding land use, or to plant species that are unlikely to survive or thrive in the proposed location.

The City will aim to address this issue by providing educational material that will help to inform the community about responsible and sustainable urban forest management. The City will also seek opportunities to support, participate in, and publicise research that will provide better data on which to make decisions, address misinformation as the need arises, and be open and transparent about its urban forest decisions.

The street tree replacement program is essential for the long term preservation of neighbourhood character and urban forest benefits. However, it is likely to result in temporary local loss of canopy cover, especially in streets where all the trees are expected to reach the ends of their lives in the next 20 years. While the City will seek to minimise the impact through undertaking infill planting, in some streets there is insufficient growing space for additional trees to thrive, and an old tree will need to be removed to provide space for a new tree.

It will be important to communicate to affected residents that the target of no net loss of canopy cover by 2036 applies to total canopy cover across all City land, not to individual streets. While detailed year-on-year modelling is yet to be done, initial estimates indicate that achieving the target may require that least two young trees be planted to replace each old tree removed. In many cases, growing space constraints will require the second tree to be planted in a different street. Young trees need time to grow, and full restoration of the canopy cover in each individual street affected by the street tree replacement program will take longer than 20 years.

By 2036, total canopy cover in the City's streets may be no more than it was in 2017, but the street tree population will have increased from approximately 40,000 trees to at least 65,000 trees, and many of these will have not yet reached their mature size. The period 2036-2056 will therefore see a significant increase in canopy cover in the City's streetscapes.

5.5.11 City capacity

5.5.11.1 Money

The City allocated funds from the Public Open Space reserve in 2016-17 for urban forest data collection and management. This allocation needs to continue to complete and maintain the database.

Currently, 600 juvenile trees are planted annually. About 400 are as-needed replacement trees, with priority given to managing public safety risk, with 200 being non-replacement

planting, including meeting residents' requests for street trees. Each juvenile tree currently costs $450 for planting and initial care for two years, so the current annual street and park tree planting cost is approximately $270,000. Approximately 2,000 tube-stock are planted annually in natural areas at an estimated cost of $13,000 including plants and labour.

As noted in a previous section, over the next 20 years the City needs to replace approximately 25,000 street trees nearing the ends of their expected useful lives. A one-for-one replacement program would be inadequate to ensure no net loss of canopy cover over the next 20 years assuming new trees take 20 years to reach a mature canopy area.

To complete the replacement program while achieving the target of no net loss of canopy by 2036, a higher average replacement planting rate is likely to be required (with a contingency for expected attrition), and the City will develop a predictive scenario model of the canopy impacts of different replacement rates, but a minimum two-for-one replacement program is expected to be required. This is in addition to replacement of end-of-life park trees and additional planting to improve the amenity parks and sports areas as needed.

The costs of an urban tree do not end when it is planted. As with hard assets, lifecycle management must be budgeted for each new tree, and funds allocated to pay for its cultivation, maintenance and eventual removal.

The City will need to open conversations with the community concerning how greater investment in the urban forest program should be resourced in the longer term, including reprioritisation of existing functions and potentially special surcharges to fund discrete urban forest improvement projects.

5.5.11.2 Human resources

There is considerable technical expertise within the Parks and Environment team to manage the operational aspects of implementing this plan. Staff skills will be expanded to make the transition from traditional arboriculture activities to an urban forestry function.

Community support, understanding and participation will be essential to achieving our urban forest goals. A new position of Urban Forest Community Coordinator (or similar title) is proposed to help foster a culture of co-stewardship of the urban forest so that everyone has an opportunity to make an informed contribution. This person will have responsibility for facilitating dissemination of information, leading the City's community engagement on emerging urban forest issues and developing/managing active community participation programs. These programs need not be restricted to urban forest on City land.

A significant amount of research is being undertaken globally on urban forest management, and practice is evolving rapidly to incorporate the new knowledge. Commitment to excellent urban forest management requires the City to be aware of key research findings, promote locally relevant adaptation and contribute to the local knowledge base through appropriate data-gathering and analysis related to the City's own urban ecosystem. This will provide a sound, evidential foundation for a systems management approach to urban forest outcomes and risks.

The City will seek to engage appropriate expertise in urban forest systems analysis to manage and analyse local data for actionable insights, synthesise external research and local experience, provide strategic technical and operational policy advice to the urban forest management team and liaise with local research institutions on collaborative projects. Options will be considered to select an appropriate mechanism for accessing such expertise.

6 Goals

6.1 Setting Targets

Traditionally, urban forest strategies focus on tree canopy cover targets, as a percentage of land surface area. Tree canopy cover is a simple, easily understood and easily communicated headline indicator for monitoring spatial urban forest trends over time, despite its drawbacks of being two-dimensional and not measuring fitness for purpose.

Tree canopy cover targets, if used, need to be set with consideration for the local climate and natural limits of the environment. They should achieve an optimum balance between desired environmental, social and economic benefits and associated environmental, social and economic costs over the lifetime of the trees (Nowak, 2010). According to recent analysis by the U.S. Forest Service, a global leader in urban forest research, a 40-60% urban tree canopy is attainable under ideal conditions in naturally well-forested areas, while realistic baseline targets for cities located in natural grassland and desert areas are recommended as 20% and 15% respectively[10] (Leahy 2017).

The real objective of urban forest management is not to maximise the number of trees or the area of canopy cover, but to optimise the benefits realisable from the urban forest, meaning that quality, form and strategic location are as important as quantity, and that the contribution of understorey vegetation should not be underestimated, particularly in locations unsuitable for larger trees.

However, as the most visible element of the urban forest, trees will inevitably continue to dominate both community attention and urban forest management.

Good practice urban forest performance criteria include age and species diversity, tree health, outcome-appropriate location (such as providing shade in public places, reduction of stormwater runoff, stabilisation of soil, and/or mitigation of noise, pollution or unattractive views), and equitable distribution across socio-economic areas. Effective information management is generally regarded by urban forest experts as essential for establishing baselines, setting realistic goals, prioritising planting locations, managing risks to the health and welfare of the urban forest, and monitoring change.

In pursuing urban forest goals, strategic risks must also be identified and managed to avoid inadvertently jeopardising other things that the community values, such as water resources and wetland sustainability, or causing unintended consequences such as increasing bushfire or road safety risks, or facilitating the introduction of invasive species or diseases to natural areas. Sustainability measures need to be developed to monitor these risks.

The City of Melville has a current city-wide (public and private land) tree canopy cover of 24% and understorey vegetation cover of almost 18%. On public (City-controlled) land, tree canopy cover is 30% with understorey vegetation cover of 19%, compared with about 20% tree canopy cover and 18% understorey cover on private and institutional land.

The City of Melville is experiencing significant and irreversible loss of mature trees on private land as a result of increasing residential density. In addition, almost half of the City's street trees are likely to reach the end of their natural lives within the next 10-20 years, with a further third having a life expectancy of 20-50 years. Analysis has shown that some areas of

[10] This contrasts with the generic 40% "benchmark" set by American Forests in 1997 and still widely quoted.

the City have extensive canopy cover, but other areas, as a result of urban design and land use constraints, display low local coverage.

Given these pressures, the City believes that a realistic initial canopy cover goal in the next 20 years is to achieve no net loss of City-wide canopy cover on City land, and to improve its distribution and diversity. Because of the need to replace a large number of ageing trees in that period, achieving this canopy cover target will result in a significant increase in the actual number of trees on City land.

Other goals and targets are intended to reduce barriers to urban forest optimisation by improving forest management information, increasing community engagement and participation, implementing continuous forest management improvement, monitoring the sustainability of the urban forest and its environment, and giving due regard to urban forest considerations in mainstream urban and corporate planning.

It should be noted that information collection is not complete and in some cases generic assumptions have been necessary because there is no locally-relevant research on which to draw. Targets may be reviewed as better information becomes available. Among the key short-term targets of the Urban Forest Strategic Plan Part A is completion of the City's tree database and advocacy for locally relevant environmental research to inform urban forest decision-making.

6.2 Achieving the Goals

The following tables set out the indicators for each goal, aspirational targets, current status and allocate responsibility.

Goal 1 - The City will renew its ageing City trees with no net loss of urban forest canopy on City land over the period of the plan, and increase planting in targeted areas to achieve locally optimal levels of tree canopy cover

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
Change in extent of total urban forest over time as measured by aerial analysis	In 2036, tree canopy / understorey cover on City land will equal or exceed: **Total:** 30% trees/19% understorey **Natural areas**: 62% trees/19% understorey **Other parks and recreational areas**: 47% trees/11% understorey **Streetscapes**: 27% trees/19% understorey	Aerial collection of extent and height stratification imagery shows that: • City land provides almost half of the total urban forest tree canopy cover and about 39% of the total understorey cover within the municipality, and • Overall, City land (inclusive of road surfaces) has about 31% tree canopy and 18% of total understorey cover: **Natural areas**: 62% trees/19% understorey; **Parks and recreational areas**: 47% trees/11% understorey; **Streetscapes**: 27% trees/19% understorey. Pathway reports of dead, diseased and damaged public trees are responded to within 10 working days. Approximately 800 juvenile trees planted every winter in street verges and parks, of which about 600 are replacements. Not all dead or removed trees can be replaced in the following winter. Approximately 2,000 trees are planted as tube-stock in natural areas as both replacement and regeneration. Understorey plants are replaced as needed.	Develop and implement a succession plan for all City-owned street and park trees with a ULE of <20 years, aiming for progressive replacement while maintaining local visual character. Develop a predictive model to demonstrate changes to canopy cover, including temporary loss of overall cover due to replacement program and recovery as trees mature. Use this model to adjust planting rates to ensure target is met. Increase planting rates of juvenile trees to at least 1500 annually by 2020, then adopt annual planting rates that will meet the objectives of the succession plan, local canopy targets, green corridors and urban heat mitigation. Progressively increase tube-stock planting in natural areas from 2,000 to 5,000 annually. Develop and commence a strategic understorey planting program. Develop and implement an incentive program for residents to improve their verges with water-wise low-growing (understorey) plants. Update aerial analysis of canopy cover every 5 years and integrate with IntraMaps.	Renewal of old street and park trees is achieved without significant loss of local aesthetic character while increasing diversity and improving climate change resilience. The ULE profile of street and park trees is well-distributed and maintained with a consistent annual replacement planting program. Canopy cover temporarily lost due to replacement of end-of-life trees is fully restored by 2036. Take-up of incentives for resident-initiated understorey planting on verges and extent of vegetation cover.	Director Technical Services	★
Progress towards specific local urban forest canopy cover targets by land use and by priority areas	Plant sufficient trees and understorey vegetation by 2036 to deliver a canopy/vegetation cover on maturity that will meet targets for defined areas consistent with existing land use. Key City amenities are connected by walkable green corridors.	No local area Urban Forest canopy targets have been set within the City No specific plan to create, extend or maintain identified green walking routes between public spaces and amenities. No tree planting prioritisation program currently in place.	Develop evidence-based, achievable and sustainable canopy cover targets by land use and suburb. Key walking routes are identified and enhanced between key public open spaces, public transport routes and other amenities, and are aligned with biodiversity corridors where possible. Develop planting prioritisation criteria,	Targets are environmentally sustainable, practical, and supported by the community. Walkable green corridors are identified, managed, recognised and used by the community. Canopy cover is increased in areas where 2016 cover is significantly below the City average for the land use.	Director Technical Services	

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
			and prepare a planting program required to achieve these in consultation with affected residents and businesses. Incorporate funding provision in the long term financial plan to ensure sufficient planting and tree care to meet targets.	Urban forest management reporting includes progress towards targets and how prioritisation criteria have been applied.		
"*Upgrade or create new pathways between natural areas, increase planting in foreshores and streets, upgrade verges, develop a tree management education program and create diversity to support fauna*." – Community Reference Group						
Urban heat performance	All public gathering places have shade available. Areas identified in 2016 thermal analysis as being in the top quartile of night-time temperature are cooler following increase in tree canopy cover.	Aerial collection of thermal imagery. City average 9pm temperature in January 2016 was 26ºC, Hottest spot 46.9ºC.	Update thermal imaging analysis every five years and integrate with IntraMaps. Plan for additional tree planting to mitigate local urban heat concerns: • In unshaded public gathering places; • in locations with night-time temperatures in the top decile as measured by thermal imaging.	User satisfaction with the amount of tree shade in public gathering places. Locations selected for additional tree planting demonstrate reduced night-time heat within 10 years of planting.	Director Technical Services	★

Goal 2 – The City will establish and maintain a tree database to ensure it has extensive and current knowledge of the location, profile and condition of the City's urban forest, and of potential additional planting sites, and will support locally relevant urban forest research.

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
Completeness and currency of City tree database	Complete, current, publicly accessible database of street trees, park trees, tree planting sites and significant understorey plantings in key locations. Complete and current natural area urban forest profiles.	No complete public tree database exists or is maintained currently. Data collection is currently underway for street trees. Natural Area Asset Management Plans contain information on species profile and vegetation condition for each area.	Complete the current data collection on street trees (by 2018) and undertake data collection on park trees (2018-19) and understorey (2020-21). Assign resources in budget for database maintenance, integration with GIS resources (IntraMaps) and development of an open-data interface to allow public access to datasets. Establish operational procedures to ensure all tree planting, removal, key management activities (eg disease treatment) and causes of mortality are recorded in the database on a continuous basis. Audit the condition of each tree every five years to maintain database currency.	Tree databases are complete, current, reliable, publicly accessible and used to support urban forestry management decisions and public reports. Information is available to inform the community on the state of the City's urban forest.	Director Technical Services	
"*Compile a full inventory of large trees and track them*." – Community Reference Group member						

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
Identification and utilisation of planting sites on City land	Database of suitable planting sites on City land, including characteristics and constraints, completed by: • 2018 for streets • 2019 for parks and recreation reserves	No database on suitable potential planting sites exists or is maintained currently. Data collection is currently underway for suitable potential street tree planting sites.	Complete the current data collection of unutilised suitable street tree planting sites and expand to planting sites in parks and recreational reserves. Identify suitable understorey planting sites along walkable green corridors to inform planting programs. Encourage the community to suggest potential planting sites for investigation.	Planting site database is complete, current, reliable, integrated with IntraMaps and used to support development and review of planting program.	Director Technical Services	
Locally relevant environmental research and valuation models are available to inform decision-making	The City contributes to and collaborates in local research related to local urban forest sustainability. An economically robust urban forest valuation model is developed to support investment decisions.	City of Melville has undertaken multi-spectral imagery for its own use Limited locally relevant and readily available research specific to urban forest management issues City of Melville has a tree valuation model used to estimate compensation payable for destruction or damage of individual City-owned trees	Promote cooperative locally relevant urban forest research with other local governments, State agencies and local research institutions Engage with government agencies, interested universities and other research institutions to encourage relevant research projects and the development of a local forest valuation model.	Local government urban forest managers have access to reliable, locally relevant and practically focused urban forest research. The City has access to a well-supported urban forest valuation model for use in business case development for urban forest investment.	Director Technical Services	

Goal 3 – The City will strive for excellent urban forest management delivering resilient, diverse, sustainable, fit-for-purpose urban forest on City land supported by active, innovative community participation.

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
Efficient delivery of a healthy, diverse and sustainable urban forest on City-controlled land that defines and supports the character of the City.	The City's urban forest scores highly on measures of: • Age/ULE diversity • Biodiversity • Plant health • Low tree attrition • Tree longevity compared with expected life • Demonstrated sustainability • Community satisfaction Measures are in place to deal with long term strategic risk management and emerging issues affecting the urban forest, including factors related to climate change. A single tree species will comprise no more than 15% of the population, other than in defined local character	No coordinated strategic program for public urban forest management in place. Programs exist for components eg Natural Area Asset Management Plans (NAAMPs). Focus has primarily been on managing trees as individual assets, rather than urban forestry which considers the forest as an integrated ecosystem No hydrology data currently collected related to urban forest water demand. Dept of Water has warned that local government groundwater extraction allocations are likely to be reduced Staff have anecdotal knowledge and understanding of attrition rate in juvenile	Make Urban Forest Management a defined activity within the City, with appropriately trained staff. Establish an urban forest information management system to harvest maximum value from the City's urban forest datasets, monitor global and local research and provide advice to improve management outcomes. Develop and use a comprehensive urban forest risk management plan. Develop a succession plan for all City trees based on ULE analysis, including diversity and climate change resilience objectives. Analyse the costs and causes of mortality of City trees and actively seek	Urban Forest Management is recognised as a discrete function within the City's structure, budget and long term financial plan. Urban forest data is routinely collected, analysed and used to derive actionable insights that inform strategic management. An urban forest risk management plan is in place, implemented and regularly reviewed. Tree mortality declines in the first three years after planting. Reduction of the dominance of individual tree species in local areas. Age/ULE profile of trees is normalised	Director Technical Services	

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
	areas. City of Melville's urban forest management is recognised as best local practice.	tree plantings but no formal program is in place to document or reduce it. Causes of mortality not routines recorded or analysed when trees must be removed.	to reduce young tree attrition. Work with appropriate research institutions to develop a sustainability monitoring toolkit to assess the impact on the local environment of expanding the urban forest, and model the impacts of climate change.	across localities with succession planning in place. The average annual water demand in each park does not exceed average annual rainfall. Monitoring of the urban forest and related ecosystems shows that management is sustainable and responsive.		
The City's urban forest is adapted to future climate change impacts	The City's urban forest proves resilient to climate change and suffers minimal losses or poor condition attributable to drought, groundwater depletion and heat stress.	Master tree list currently in place. This has not been reviewed for climate change vulnerability, or for potential new species that may be suitable for the City in a changed climate	Identify current species likely to be vulnerable to predicted climate conditions and develop plans to support or replace these trees. Identify species not currently used that would be well-adapted to urban conditions and predicted climate. Develop a risk management plan to deal with climate change impacts on the urban forest.	Urban forest risk management plan includes climate change risks and mitigation mechanisms is in place, implemented and regularly reviewed. All new and replacement tree and understorey plants are selected for suitability under predicted future temperature and rainfall regimes.	Director Technical Services	
Public awareness and participation "*…we can achieve much better outcomes if we have the broader community on board …actually having their active support and participation*." – Community Reference Group member	The community is knowledgeable about urban forest issues, supports the City's urban forestry activities and has a sense of shared responsibility for the urban forest There is significant community participation in tree planting, nurturing and monitoring programs The community is satisfied with their access to urban forest participation and opportunity to contribute to decision-making processes	No current public participation programs available for the developed open space. Multiple events, especially tree planting, available for natural areas. Schools currently invited to participate in selected local projects and natural area regeneration	Appoint an Urban Forest Community Liaison Officer. Obtain/prepare appropriate information materials and undertake a community awareness program on responsible urban forest management. Aerial photography, canopy analysis and thermal imaging information are published on website. In consultation with the community, investigate and implement: • suitable public participation programs; • vegetation incentive programs (e.g. verge planting); • potential for integration of community urban forest projects into existing programs such as Project Robin Hood. Encourage community discussion of urban forest matters through Melville Talks. Include urban forest issues in community surveys to measure level of awareness and satisfaction with the City's approach.	Information and education material available to the public, commencing in 2017. At least one public participation program in place by end-2017. Local schools/community groups support urban forest related events and City-initiated programs – all schools are invited to participate by 2022. 80% of survey respondents indicate satisfaction with information and opportunities to participate. Community broadly supports City's urban forest management decisions.	Director Technical Services and Director Community Development	

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
Community satisfaction	At least 80% of community survey respondents report being satisfied with local urban forest cover and condition on public land Residents are satisfied with the City's resolution of their urban forest-related concerns.	Community satisfaction currently assessed as general customer satisfaction with Parks and Environment function through customer satisfaction surveys. Community wellbeing survey in 2015 did not specifically ask about perceptions of urban forest, but showed 90% satisfaction with attractiveness of environment and availability of open space, and 73% happy/very happy with City's environmental protection performance Residents' objections to tree planting dealt with on case by case basis Community engagement commenced for Urban Forest Strategic Plan Part A	Community is consulted on tree planting prioritisation criteria and local planting programs Adopt operational procedures to deal with residents' concerns and achieve mutually acceptable outcomes	Community is engaged in consultation in key decision processes A significant number of website visitors view on-line information on the urban forest	Director Technical Services and Director Community Development	★

Goal 4 – The City will integrate urban forest protection into urban planning instruments and practices and its land and infrastructure asset management.

Indicators	Aspirational Targets	Current Status	Tactics	Measures of Success	Responsible Officer	EPR
The urban forest is specifically referenced in planning and development instruments. Due regard is given to urban forest protection in planning and development approvals processes and in land and infrastructure asset management.	Urban planning instruments explicitly promote the protection and enhancement of the urban forest and facilitates the optimum distribution of urban forest benefits. Management of the City's land assets preserves and contributes to the quality of the City's urban forest. Infrastructure asset management incorporates urban forest components.	Currently only inclusion of specific references for tree protection, not the broader urban forest in strategic planning documents including LPS, master plans, structure plans No significant tree register, provision for tree protection orders or similar processes to identify trees of exceptional value for special attention and protection Consideration of urban forest contribution not currently a key element of land asset management or the City's own developments A master planting list has been developed for key activity centres as part of master planning process	Insert reference to the urban forest protection in the LPS at next review All future structure plans and master plans contain reference to the level of urban forest canopy appropriate for the land uses included in them, regardless of ownership, and make adequate provision for large trees in land reserved for City management such as streets and public spaces Open Space Strategy makes reference to the importance of public open space in maintaining adequate urban forest coverage Road reserve requirements in future major brownfields developments or greenfield developments provide for adequate verge widths to support street trees large enough to deliver shade, cooling and habitat benefits to people using the streets Identify significant or local-character-defining trees on City land, in consultation with the community, and establish procedures to protect them.	The Local Planning Scheme, precinct and other Structure Plans and design guidelines make reference to urban forest importance and the City's intention to protect and preserve it, with such recognition becoming an accepted element of planning and development in the City of Melville. Activity Centres, major redevelopments and regeneration projects make adequate provision for significant urban forest elements to be integrated into their public spaces. The City's most significant trees have adequate protection from destruction, with their preservation given priority in City infrastructure and land asset management planning.	Director Urban Planning Director Technical Services	

"When green spaces must be given up – e.g. because of new developments – compensate the loss of such spaces within the immediate locality." –Community Reference Group member

7 Review

The Urban Forest Strategic Plan Part A will be revised if necessary in light of information to be obtained through developing the City tree and planting site databases, and after completion of Part B in 2018.

The Urban Forest Strategic Plan Part A will be reviewed in 2020/21 and every five years thereafter. A review may be initiated at any time if performance monitoring indicates that this is desirable or as a result of a review of CP 102: Urban Forest and Green Space Policy.

8 Bibliography and references

8.1 Government policy documents

Department of Agriculture and Water Resources (1992) National Forest Policy Statement (Australia).

Department of Planning, Office of the Government Architect and Western Australian Planning Commission (2016) Design WA Perth WA.

Department of the Premier and Cabinet (2015) Green Growth Plan for 3.5 million (consultation documents) Perth WA.

National Landcare Programme 20 Million Trees Programme (accessed Dec 2016).

Western Australian Planning Commission (2010) Directions 2031 and Beyond Perth WA. 103 pages.

Western Australian Planning Commission (2015) Draft Central sub-regional planning framework (supporting document to Green Growth Plan for 3.5 Million) Perth WA.

8.2 Data and statistics

202020 Vision Where are all the trees? (accessed Dec 2016).

Cochran, T (2008) Protecting and developing the urban tree canopy: A 135-city survey. US Conference of Mayors Best Practice Report, 34pp.

Department of Planning (2014) The Urban Forest of Perth and Peel Statistical Report: CSIRO 2009 Urban Monitor (18 pages).

Jacobs, B., Mikhailovich, N., and Delaney, C. (2014) Benchmarking Australia's UrbanTree Canopy: An i-Tree Assessment, prepared for Horticulture Australia Limited by the Institute for Sustainable Futures, University of Technology Sydney.

8.3 Urban forest benefits

Baró, F, Chaparro, L, Gómez-Baggethun, E, Langemeyer, J, Nowak, DJ and Terradas, J (2014) Contribution of Ecosystem Services to Air Quality and Climate Change Mitigation Policies: The Case of Urban Forests in Barcelona, Spain AMBIO 43(4) pp 466-479.

Brown, H, Katscherian, Carter, M and Spickett, J (2013) Cool Communities: Urban trees, climate and health 37 pages. Curtin University.

Cook, N., Hughes, R., Taylor, E., Livesley, S. and Davern, M. (2015). Shading Liveable Cities: exploring the ecological, financial and regulatory dimensions of the urban tree canopy. Working Paper 1, The University of Melbourne.

Lohr, VI, Pearson-Mims, CH, Tarnai, J and Dillman, DA (2004) How Urban Residents Rate and Rank the Benefits and Problems Associated with Trees in Cities *Journal of Arboriculture 30(1)* pp 28-35.

Loughnan, ME, Tapper, NJ, Phan, T, Lynch, K, McInnes, JA 2013, A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities, National Climate Change Adaptation Research Facility, Gold Coast, 128 pp.

McPherson, EG, van Doorn, N and de Goede, J (2016) Structure, function and value of street trees in California USA *Journal of Urban Forest & Urban Greening 17* pp 104-115.

Nowak, DJ and Dwyer, JF (2007) Understanding the Benefits and Costs of Urban Forest Ecosystems *Urban and Community Forestry in the Northeast* 2nd ed. pp25-46.

Pandit, R, Polyakov, M, Tapsuwan, S and Moran T (2013) The effect of street trees on property value in Perth, Western Australia *Journal of Landscape and Urban Planning 110* pp 134-142.

8.4 Urban forest management and research

202020 Vision How to Grow an Urban Forest (Horticulture Innovation Australia and Victorian Dept Environment, Water, Land and Planning (accessed Dec 2016).

Connellan, G (2008) Water Management Strategies for Urban Trees in an uncertain environment. Downloaded from Treenet.

Dear, G (2013) The Benefits of Using a Tree Inventory for Managing Urban Trees International Public Works Conference 2013.

Diamond Head Consulting Ltd (2016) Urban Forest Climate Adaptation Framework for Metro Vancouver (Prepared for Metro Vancouver) 107pp.

Fisher, P (2016) Concrete jungle? We'll have to do more than plant trees to bring wildlife back to our cities. The Conversation (January 20, 2016).

Hurley, J, Parmehr, E, Phelan, K, Amati, M and Livesley, S (2016) Does higher-density city development leave urban forests out on a limb? (2016) The Conversation (April 14, 2016).

Kendal, D and Baumann, J (2016) The City of Melbourne's Future Urban Forest: Identifying vulnerability to future temperatures City of Melbourne (69 pages) published by the Clean Air and Urban Landscapes Hub.

Leahy, I (2017) Why we no longer recommend a 40 percent urban tree canopy goal. American Forests website (accessed January 2017).

Leff, M (2016) The Sustainable Urban Forest: A Step-by-Step Approach. Davey Institute / USDA Forest Service 102pp.

McPherson, EG, Simpson, JR, Xiao, Q and Wu, C (2008) Los Angeles 1-Million Tree Canopy Cover Assessment. United States Dept Agriculture Forest Service General Technical Report PSW-GTR-207 54pp.

Moll, G (1997) America's Urban Forests: Growing Concerns. American Forests, Autumn 1997 18pp.

Nowak, DJ, Stein, SM, Randler, PB, Greenfield, EJ, Comas, SJ, Carr, MA and Alig, RJ (2010). Sustaining America's Urban Trees and Forests. USDA Forest Service General Technical Report NRS-62 June 2010 27pp.

Piana, M and Troxel, B (2014) Beyond Planting: An Urban Forest Primer, published in Scenario Journal, Scenario 04: Building the Urban Forest, Spring 2014.

Roman, LA (2014) How Many Trees are Enough? Tree Death and the Urban Canopy, published in Scenario Journal, Scenario 04: Building the Urban Forest, Spring 2014.

Royal Botanic Gardens Victoria (2016) Landscape succession strategy Melbourne Gardens 2016-2036 39pp.

Salbitano, F, Borelli, S, Conigliaro, M and Chen, Y (2016) Guidelines on urban and peri-urban forestry, Food and Agriculture Organisation Forestry Paper 178, Rome 160pp.

Symes, P and Connellan, G (2013) Water Management Strategies for Urban Trees in Dry Environments: Lessons for the Future. Arboriculture & Urban Forestry 39(3): pp 116-124.

Ursic, M, Satel, AL, and van Wassenaer, P (2012) Tools for Engaging the Community in Urban Forest Stewardship (13 pages) CUFC presentation published by TreeCanada.

8.5 Water

Department of Parks and Wildlife. A guide to managing and restoring wetlands in Western Australia: Managing Hydrology : Managing Wetlands Chapter 3 (accessed Dec 2016).

Department of Water (2014) Water resources inventory 2014. Government of Western Australia 147pp (accessed December 2016).

Department of Water Shallow Groundwater System Planning for the Future: Groundwater Investigations (accessed Dec 2016).

Department of Water (2016) Water for Growth: Urban. Government of Western Australia (accessed January 2017).

Macfarlane, C, Ogden, G and Silberstein, R (2011) Water balance of 31 Mile Brook, Western Australia CSIRO Technical Report. 53pp.

Prosser, I P and Walker, G R (2009) A review of plantations as a water-intercepting land use in South Australia. CSIRO: Water for a Healthy Country National Research Flagship.

8.6 General background information

Department of Agriculture and Water Resources Australia's Forests (accessed Dec 2016).

Department of Agriculture and Water Resources Australia's bioregion framework The National Reserve System (accessed Dec 2016).

Global Forest Resources Assessment 2015. Food and Agriculture Organisation Rome 54 pp.

MacDicken, K (2012) Forest Resources Assessment Working Paper 180: FRA 2015 Terms and Definitions. Food and Agriculture Organisation Rome. 36pp.

WWF Global Mediterranean Forests, Woodlands and Scrub Ecoregions (accessed Dec 2016).

8.7 Websites

202020 Vision (accessed Dec 2016)
Clean Air and Urban Landscapes Hub (accessed Dec 2016)
Climate Change in Australia (accessed December 2016)
Heat Island Group, Berkeley Lab (accessed December 2016)
i-Tree (urban forest management software) (accessed Dec 2016)
National Urban Forest Alliance (accessed Dec 2016)

8.8 Examples of Other Urban Forest Strategies and Plans

Armadale (WA)
Banyule (Victoria)
Bassendean (WA)
Belmont (WA)
Brimbank (Victoria)
Brisbane
Greater Geelong (Victoria)
London (Canada) – also their 1 million tree challenge
Melbourne
Perth
San Diego (USA)
San Francisco (USA): 2006 City and County Urban Forest Plan and 2014 Urban Forest Plan Phase 1 Street Trees
Sydney
Vancouver (Canada)

***** End of Document*****