CITY OF BUNBURY

Greening Plan

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1 Introduction

The City of Bunbury, known to some as the "second capital city of Western Australia", is a growing, vibrant regional centre, home to over 32,000 people and a diverse range of plant and animal species. Bunbury has a rich history and dynamic potential for the future.

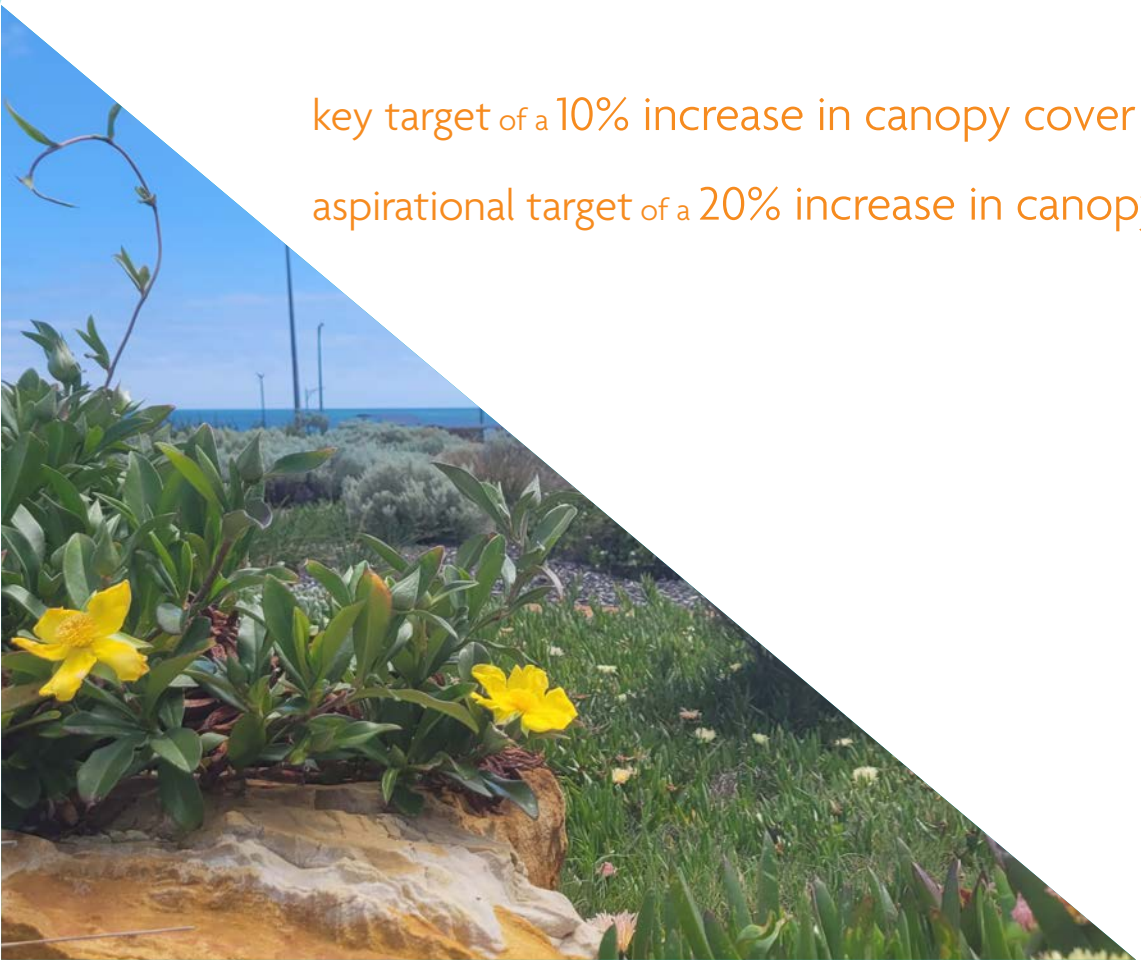
Trees, other plants, and the soil, air and water that support them are essential for the liveability, amenity and sustainability of any city, and Bunbury is no different. However, urban forests around the world are under threat. Tens of thousands of hectares of urban forest are lost globally every year to development, industry, biosecurity risks, and climate change. This trend is concerning, as urban forests bring significant health, economic, environmental, and cultural benefits to cities.

To remain sustainable and liveable into the future, the City is prioritising its greening.

With an average canopy cover level of 13.7% across the City, Bunbury has lower canopy cover than many Western Australian Local Government Areas and is below a measured median of approximately 20% across Perth LGAs. This low canopy level is a result of various factors, but is especially related to human activity in agriculture, forestry, urbanisation, and industry. With the various threats to canopy cover increasing in prevalence, the City needs a comprehensive, targeted plan to improve and expand vegetation cover across Bunbury. This Greening Plan provides a snapshot of the history of and current state of greening in Bunbury, the many benefits of the urban forest including mitigating the Urban Heat Island Effect, key challenges to greening and key opportunities, and a set of goals, targets, costings, and implementation actions for the City to undertake across the next twenty years.
The in-depth analysis of current canopy levels across the City, as well as potential future canopy levels by land use type, has resulted in two suggested canopy targets for the City's urban area over the next 20 years:

key target of a 10% increase in canopy cover over 20 years.

aspirational target of a 20% increase in canopy cover over 20 years.



2 Background and Context

2.1 What is Urban Greening?

Urban greening refers to the practice of increasing and improving the coverage and resilience of the vegetation in a city. Often, the vegetation of a city or town is referred to as the 'urban forest'. Usually, urban forest is defined as the trees and vegetation that occur within a municipal boundary. However, the definitions of urban forests can vary. It is important to ensure a definition encompasses the various components of the urban forest, including the soil and water which are essential for the urban forest. This definition is central to the implementation of a Greening Plan, as it will influence exactly what is included as vegetation to target.

Trees have long been a feature of town and city planning, with public open spaces like parks, gardens and town squares featuring trees. In the mid-1960s, the idea of an 'urban forest' began to be formulated, and in following decades, scientists and planners began to investigate the benefits of urban forests (Bolund and Hunhammar 1999, Konijnendijk 2003). Since then, formal urban forest planning and management programs have been developed for cities and towns around the world.

2.2 The Value of Greening

Decades of research, monitoring and management evaluation have demonstrated, unequivocally, that for cities to have high standards of liveability they must have extensive, diverse, and healthy urban vegetation (McPherson et al. 1994, McPherson et al. 1997, Bowler et al. 2010a, Roy et al. 2012, Keniger 2013). Wide-reaching research has found that trees provide sizeable economic, social, health, visual and aesthetic benefits and make significant measurable contributions to ecosystem services (Roy et al. 2012).

Ecosystem services are benefits provided by the environment. The ecosystem services provided by the urban forest include air and water filtration, shade, habitat, oxygen production, carbon sequestration and nutrient cycling. The urban forest also provides a connection to nature that is often perceived to be lacking in urban areas. This connection has many benefits for mental and physical health. From individual property owners who have a more comfortable environment and often increased resale value, to community members who have better recreational opportunities and water and air quality, to the native species that have improved access to quality habitats; all benefit from a robust and extensive urban forest.

The following sections consider these benefits in more detail, with a specific focus on the economic, human health, cultural, and environmental benefits afforded by robust urban forests.

This Plan will guide the City's greening policies and actions, to **nuture and grow** the existing **urban forest**, to contribute to the health and wellbeing of the community and create a **liveable city for future generations**

2.2.1 Health and Social Benefits

Outdoor activity.

Tree-lined streets and attractive natural areas encourage people to walk in their local area and engage in other physical activities further afield in the city like bushwalking and cycling. Urban forests encourage outdoor activity, improving wellbeing and reducing healthcare costs. This is especially important as lifestyle-related illnesses like obesity increase in prevalence (Jerrett and van den Bosch 2018).

Sun and heat protection.

Shady canopy also reduces exposure to harmful ultraviolet rays from the sun (Heisler and Grant 2000, Grant et al. 2009, Bowler 2010b). Shade from urban forests also reduces temperatures both within and outside shaded buildings, significantly reducing the incidence of heat-related illness and mortality (Donovan et al. 2013).

Physical well-being.

Urban forests may also influence our biology in more subtle ways, acting on the autonomous nervous system and reducing chronic stress (Egerov et al. 2017). This can reduce 'systemic inflammation', a common cause of many noncommunicable diseases and related deaths (Jerrett and van den Bosch 2018). xFurthermore, hospital patients who have access to views of trees and green spaces recover more quickly than those without (Ulrich 1984, Brack 2002, Frumkin 2003, Verlarde et al. 2007). The economic implications of these improved recovery times are significant.

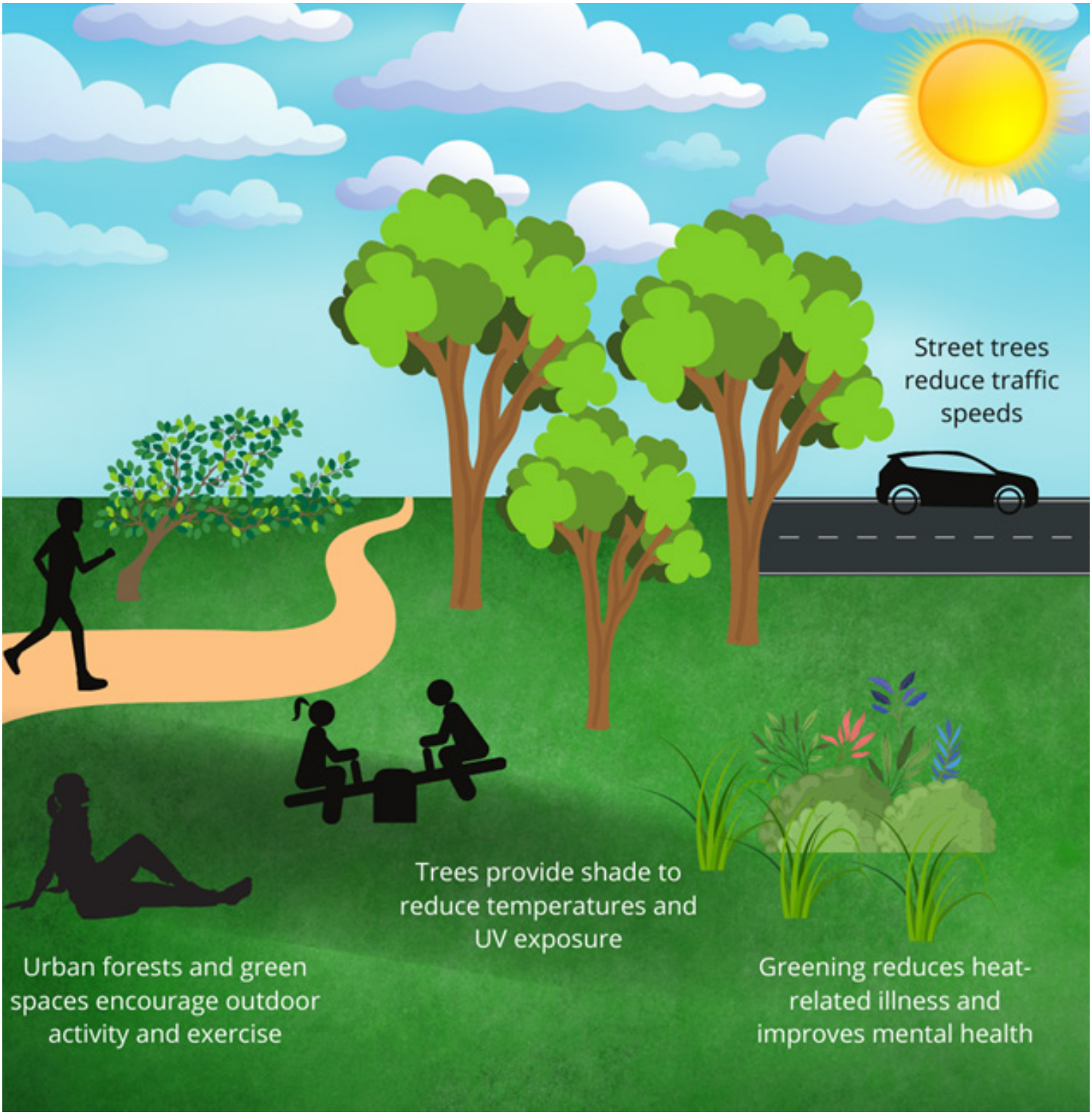
Mental well-being.

Added to physical health benefits, the mental health and wellbeing of people living in cities is significantly influenced by a robust and extensive urban forest. A world-first scientific study found a 63% decrease in depression and "feelings of worthlessness" in groups who had access to community gardens or green spaces (South et al. 2018). Urban forests may also have direct effects on brain structure and function, reducing the symptoms of depression (Bratman et al. 2015). Maintaining and extending the urban forest, especially in lower-socioeconomic areas, is an important contribution to the mental health and wellbeing of the community. This study implies that failing to establish and maintain an extensive urban forest can negatively impact mental health.

Traffic calming.

Other social benefits of greening have been found, including traffic calming and road safety effects (Mouratidis 2019). Slowing traffic as an effect of greening is likely to vary significantly depending on location, but the potential of this occurring adds to the positive social and health outcomes of urban vegetation.

Extensive scientific evidence and community feedback highlights the positive impacts of urban forests for human health. Minor negative health effects have been identified, such as seasonal allergies, however these are significantly outweighed by the benefits.


Street trees reduce traffic speeds
Trees provide shade to reduce temperatures and UV exposure
Urban forests and green spaces encourage outdoor activity and exercise
Greening reduces heat-related illness and improves mental health

2.2.2 Environmental Benefits

Robust urban forests use water, nutrients, and carbon dioxide to grow and remain resilient. The by-products of these processes are shade, oxygen, and air that has been filtered of a significant concentration of pollutants. Urban forests also regulate water relations and support biodiversity (Bolund and Hunhammar 1999, Chiesura 2004, Roy et al. 2004). They also provide noise reduction and act as quiet spaces within the built urban environment, with associated benefits for humans and animals (Bolund and Hunhammar 1999).

Greenhouse gas mitigation and reduction.

Through photosynthesis and transpiration, trees, shrubs, and understorey convert carbon dioxide to stored carbon. Urban trees thus make a significant contribution to greenhouse gas mitigation and reduction. The aquatic plants and algae in natural swamps and wetlands also store carbon (Chmura et al. 2003). Urban forests also improve overall air quality through absorption of gaseous pollutants including nitrogen dioxides and sulphur dioxide, while at the same time producing oxygen from photosynthesis (Dwyer et al. 1992; Brack et al. 2002).

Water cycling.

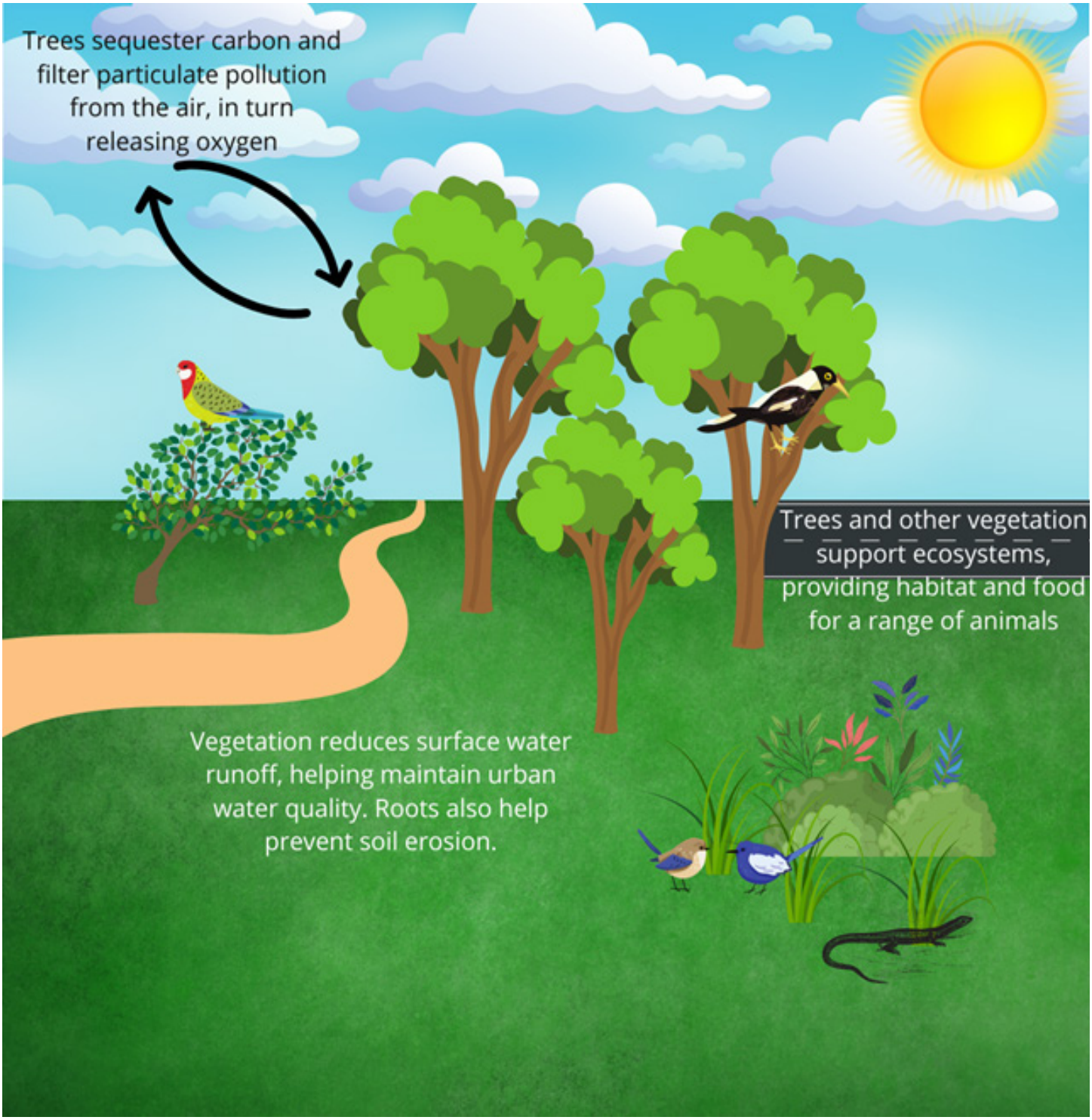
Furthermore, tree canopies, understorey vegetation, gardens and roots intercept, filter and absorb rainfall and reduce stormwater flows (Xiao et al. 1998, Kuehler et al. 2016). This reduces runoff rates and pollutants entering watercourses and stabilises the volume of water within the water cycle. Additionally, roots provide structure to soil, reducing erosion. Robust canopy and understorey also provide a buffer from strong winds, further reducing erosion (and improving liveability!).

Biodiversity.

Total vegetated area is not the only consideration for the resilience of terrestrial ecosystems. They also rely on a diversity of groundcover, understorey, midstorey, and canopy vegetation. This 'vertical complexity', along with a well-connected canopy, expands habitat and improves the biodiversity of mammals, birds, and insects, supporting conservation outcomes (Alvey 2006; Craig, 2004; Garkaklis et al. 2004; Gibson et al. 2004; S trehlow et al. 2004). Connecting areas of habitat, especially core areas of native vegetation, improves access to resources and allows for repopulation of areas where particular species have become uncommon. Bunbury is part of the Southwest Australia Global Biodiversity Hotspot and contains several distinct flora communities such as the mangroves in the Leschenault Inlet, Tuart forest, and Banksia woodland as well as the various species outlined in Section 2.5 below. Improved urban forest design should link areas of habitat through canopy connection and wildlife corridors. Large roads such as the Bunbury Outer Ring Road have resulted in habitat loss and fragmentation of unique native vegetation communities, such as Banksia woodland. These vegetation communities are habitat to populations of western ringtail possum (Pseudocheirus occidentalis), common brushtail possum (Trichosurus vulpecula hypoleucus), brush-tailed phascogale (Phascogale tapoatafa), Carnaby's black cockatoo(Calyptorhynchus latirostris), Baudin's black cockatoo(Calyptorhynchus baudiini), and the red tailed black cockatoo (Calyptorhynchus banksii) as well as many other species with conservation significance.

Diverse and robust urban forests will provide a range of **environmental benefits,** from improved air and water quality to increased biodiversity.

Linking habitats through **wildlife corridors** and connected canopies will promote the movement and **resilience** of local animal populations.


Trees sequester carbon and filter particulate pollution from the air, in turn releasing oxygen
Trees and other vegetation support ecosystems, providing habitat and food for a range of animals
Vegetation reduces surface water runoff, helping maintain urban water quality. Roots also help prevent soil erosion.

2.2.3 Cultural benefit

Incorporation of Aboriginal knowledge.

A review of the pre-colonisation extent of vegetation in the Bunbury area in Section 2.5.1, and initial consultation with Elders in Section 2.6.1 will consider the cultural benefits that are derived for Wardandi people of the Noongar nation with traditional custodianship and ownership of the boodjar (land). Expanding and improving the urban forest provides an opportunity to strengthen these cultural connections and to include Aboriginal knowledge and cooperation in managing this urban forest. These are important elements to include as drivers for the maintenance and expansion of the City's urban forest.

Social connection.

Furthermore, urban forests provide tangible connection through which people interact with each other and the environment. Urban forests improve social connection; they offer a sense of place and support community interaction through events, festivals, and passive daily interaction. Parts of the urban forest can become closely linked with people's identities also.

Community cohesiveness.

Studies have also shown that green space in major Australian cities is unevenly distributed, with less green space in areas with a higher proportion of low-income residents (Astell-Burt et al., 2014). Improving the distribution of green space and urban forests in Bunbury may foster improved community cohesiveness and a sense of shared identity across the City.

2.2.4 Aesthetic value

Community engagement.

Trees and naturally vegetated areas are considered beautiful by many people. The aesthetic value of trees enhances many of the advantages already discussed, including the economic, mental health and cultural values of urban forests. Added to that, the beauty of trees encourages community engagement; aesthetic value motivates individuals and groups to enhance the urban forest for present and future generations (Dwyer et al. 1991).

Aesthetic quality is a useful asset for the City in promoting the benefits of an urban forest. By appealing to the links people form with parts of the urban forest, as well as communicating its other benefits, leaders and planners can encourage locals to become active participants in establishing and maintaining the urban forest. This might come in the form of encouraging locals to improve their gardens.

2.2.5 Economic Benefits

Urban forests provide economic benefits in specific locations and to the City as a whole. Economists have assessed and quantified the economic benefits of urban forests for a range of industries and urban management disciplines. These cover the diverse areas of sustainability, the health sector, urban planning, and real estate. Some of the economic benefits of an urban forest include:

Health system savings.

Health savings associated with urban forest benefits are considerable. Health system benefits include improved incentive for and access to recreation, and the mental health benefits of increased greenery. The wellness value of street trees is often greater than $100,000 over their lifespan (Burden 2006). One example comes from Canada, where trees in eighty-six cities removed 16,500 tonnes of air pollution in one year. The human health effects were valued at $227.2 million Canadian dollars (Nowak et al. 2018)

Reducing energy costs.

Canopy provides shade for buildings, reducing heat effects and cutting the energy costs associated with cooling. Increasing tree cover by 10% (around 3 trees per building lot) saves annual cooling costs by around $50 to $90 per dwelling (McPherson and Rowntree 1993, City of Melbourne 2012).

Increasing property values.

Property prices are higher in areas with an attractive and extensive urban forest compared to similar areas without extensive urban forests. People are attracted to tree-lined streets with well-maintained gardens. Research shows that street trees in Perth can increase the economic value of residential properties by around $17,000 (Pandit et al. 2013).

Improving retail performance.

Studies have shown that shoppers will spend more time and money, return more often, and travel further to visit retail areas featuring high-quality trees (Joye et al. 2003; Wolfe 2007). Shopping precincts with high-quality and well-maintained urban forest within the precinct itself and in the surrounding area, are likely to be more successful.

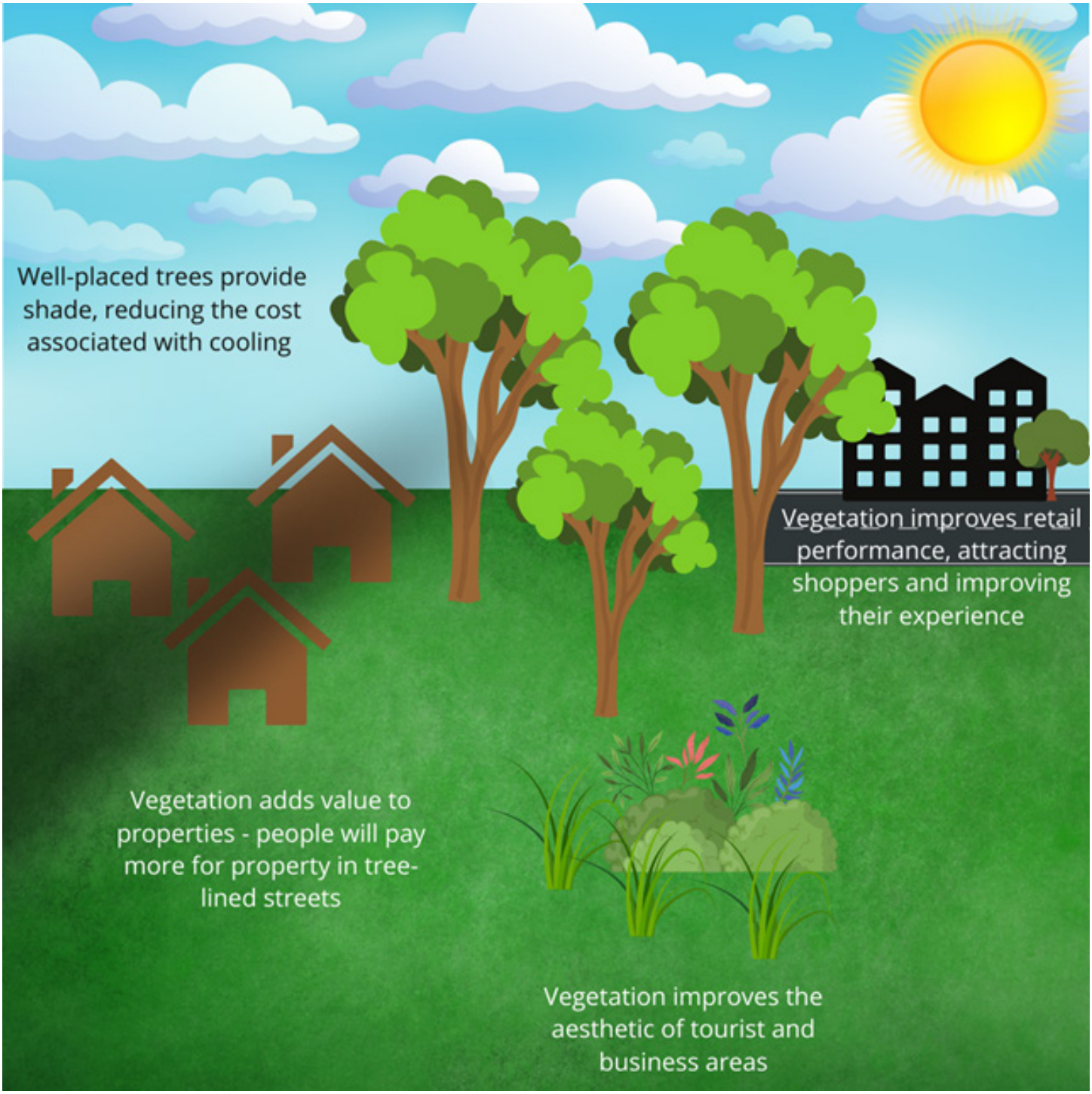
Avoiding costs of infrastructure degradation.

Tree canopy coverage shades municipal assets like roadways and buildings, improving their useful life expectancy by protecting from damaging UV rays (McPherson 2009, City of Melbourne 2012).). Vegetated stormwater systems can also reduce the requirement for expensive upgrading of degraded stormwater pipe networks as well as reduce c ostly environmental rectification of downstream waterways from excessive pollution. This produces significant savings in infrastructure maintenance costs and assists with management and maintenance.

Marketing the City.

Urban forests, gardens and open spaces contribute to the culture and image of a city. A city with an extensive urban forest and innovative design is likely to communicate an attractive image for both locals and visitors. Tourism is of increasing importance to many cities, and green spaces can help to promote tourism, as main attractions themselves or as attractive settings for events and activities that boost the local economy (Konijnendijk 2010). Improved urban forests can improve the perception of a place as a tourist destination and improve its political and economic influence more broadly.

It is a common misconception that urban forests are solely an environmental issue. In fact, it is now well-established that urban forests have a range of economic benefits, producing a strong business case for their expansion.


Well-placed trees provide shade, reducing the cost associated with cooling
Vegetation improves retail performance, attracting shoppers and improving their experience
Vegetation adds value to properties - people will pay more for property in tree-lined streets
Vegetation improves the aesthetic of tourist and business areas

2.3 Urban Heat Island Effect

2.3.1 Introduction

The build-up of heat in a city is referred to as the Urban Heat Island Effect (UHIE). The UHIE is common worldwide, as cities become warmer than the surrounding peri-urban and rural environments (USDA 1993). Due to a range of drivers, especially the concentration of artificial surfaces and limited canopy cover, cities can often be four to seven degrees hotter than surrounding rural areas on hot days (Portland City Council 2004). During heatwaves, the UHIE is a critical issue for vulnerable people.

2.3.2 What are the Drivers for Urban Heat Islands?

There are two different types of urban heat islands: surface and atmospheric (EPA 2014). During hot sunny days, hard, impermeable surfaces in cities, such as roads and building roofs, can be 25 to 50 degrees Celsius hotter than the air. Shaded areas are typically closer to the actual air temperature. Heat in these exposed surfaces builds up during the day, and then is slowly released. As this heat is released through the evening and night, the air temperature increases relative to rural areas with fewer hard surfaces. This means the UHIE is felt even when the sun goes down.

Green spaces and vegetation, especially trees, have been shown to be cooler than exposed surfaces, including in the City of Bunbury (ArborCarbon 2020a). Vegetated surfaces therefore contribute to cooler air temperatures.

2.3.3 What are the Impacts of Urban Heat Islands?

The UHIE in cities intensifies summer temperatures. With increasing maximum, minimum and average temperatures associated with global warming, the UHIE in the City of Bunbury will become even more pressing with time.
Heatwaves already kill more Australians than any other natural disasters (Bi et al. 2010). Reducing the impacts of the UHIE through improving and extending the urban forest is crucial to limit increases in heat-stress-related deaths. The UHIE also affects the amenity and recreation opportunities for residents: increasing temperatures and urban hot spots mean people are less able to go outdoors c omfortably, exacerbating health issues and the economic costs of cooling buildings.

An increasing UHIE also has significant environmental costs. Energy use will increase, water resources will become scarcer, and the remaining street trees, vegetation and green spaces will be placed under increasing stress. Vegetation, including native vegetation, can struggle to survive and remain healthy at increasingly extreme temperatures and under water stress, both of which are exacerbated by the UHIE. The costs to maintain infrastructure will also increase because of heat-exposure degradation.

2.3.4 Reducing Urban Heat Islands and Their Effects

Trees, conservation areas, parks and gardens all reduce the UHIE with trees reducing surface temperatures more than turf and vegetation below canopy height (<3m). To address the effects of urban heat in the face of a heating climate, the City must extend, improve, and maintain a vibrant, diverse and well-linked urban forest, across land use types.
Setting targets for canopy and vegetation increases in the urban forest is the most important first step in reducing the UHIE. Current vegetation cover levels are unlikely to reduce the UHIE, so investment in increased vegetation (especially canopy) cover and maintenance of existing cover is essential. Limiting tree clearing for development, revegetating watercourses, and encouraging green development in the City will shift the proportion of ground cover in the City from hard, artificial surfaces to vegetation.

Community engagement will be essential for this. Public awareness will improve engagement with greening by empowering the public as managers of the urban forest on their properties, in their local area and in the wider City.

2.3.5 Green Space, Urban Heat and Social Equity

Research has demonstrated that green space is inequitably distributed across major Australian cities. Areas with a higher percentage of low-income residents have lower green space availability than others (Astell-Burt et al. 2014).

A clear representation of this effect in Bunbury is observed in the urban heat data collected for the City (ArborCarbon 2020a). As discussed in this Section and Section 2.3, greening an area is likely to have a cooling effect. Therefore, improving the equitable distribution of the urban forest can have a positive effect in terms of reducing the inequalities in health and social outcomes

2.4 Policy Context

The City of Bunbury Greening Plan will be integrated into the existing framework of the City's urban planning policies, to support and extend their aims and priorities. Furthermore, this Plan exists within a broader policy context, encompassing state, national, and international legislation, and recommendations, which will guide and mandate particular aspects.

2.4.1 Bunbury Policy Documents

2.4.1.1 Strategic Community Plan

This Plan supports several aims of the Bunbury Strategic Community Plan 2018-2028 (the SCP). This document includes community feedback on priorities and a vision for the City's future. These responses, in the 'What Our Community Told Us' section, included priorities like:

"Dealing with the effects of global warming"
"Becoming an environmentally friendly, sustainable, caring city"
Being "a city that embraces outdoor passion"

This Greening Plan will address each of these comments and many others from this document. Perhaps even more importantly, it will also address each of the document's four overarching themes:

Our community and culture
Our economy
Our places and spaces
Our city

The diverse benefits of robust urban vegetation systems explored above will aid the City's progress with each of these Themes. Theme 1, 'Our community and culture' and Theme 3, 'Our places and spaces', are particularly relevant. Theme 1's guiding goal is to achieve "a safe, healthy and cohesive community, with a rich cultural life, and supportive social environment." Theme 3's goal is to create "a natural and built environment that reflects Bunbury's core values." As outlined above, urban forests and greenery contribute significantly to these goals through a range of social and environmental benefits and will do so to an even greater extent as greening actions are implemented.

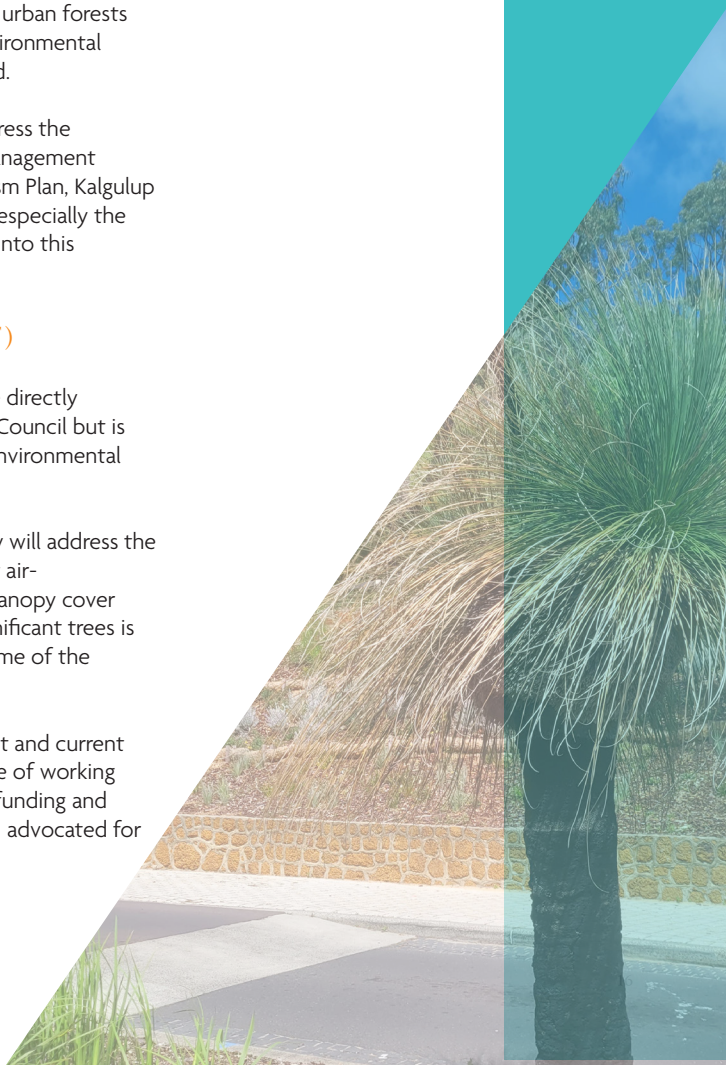
Robust urban vegetation systems and effective vegetation management will also address the priorities of policy documents other than the SCP, including elements of the Tree Management Policy, Flood Management Plan, Bunbury Wellington and Boyup Brook Regional Tourism Plan, Kalgulup Regional Park Management Plan 2021, and the Infrastructure Asset Management Plan (especially the Open Space subsection). Elements from these Strategies and Plans will be integrated into this Greening Plan.

2.4.1.2 Sustainability Action Plan (DRAFT)

The City's Draft Sustainability Action Plan (SAP) includes 11 themes, many of which are directly addressed by this Greening Plan. The SAP is under review and yet to be endorsed by Council but is a useful complementary document. Key themes of the document focus on various environmental priorities, as well as heritage and cultural aspects.

It is clear from the many benefits of vegetation explored above that greening the city will address the sustainability goals of this document. Canopy shade reduces energy used for summer air-conditioning; vegetation improves rainwater infiltration for drought resilience; good canopy cover creates beneficial health outcomes and improved social equity; the protection of significant trees is important for Aboriginal heritage and the cultural identity of a City. These are just some of the benefits of extensive, robust urban greenery that address the themes of the SAP.

Furthermore, the SAP is a useful reference document for understanding the City's past and current sustainability actions which link into this Greening Plan and emphasise the importance of working with other governments and with the community. In the past, the City has provided funding and support for the Habitat Bunbury school-based environmental education program and advocated for the establishment of the Kalgulup Regional Park, among other sustainability actions.



2.4.1.3 Local Planning Scheme 8

The City's Local Planning Scheme 8 (LPS 8) sets out the way that the land is to be used and developed, classifying areas for land use, and including provisions to coordinate infrastructure and development within the local government area.
The aims of the LPS 8 are:

1) To implement the intentions and desired outcomes of the Local Planning Plan in support of the Strategic Community Plan as amended;
2) To coordinate and integrate planning at the local level with planning at regional and state levels;
3) To avoid and/or mitigate land use and development impacts on environmental and public health;
4) To provide for the adequate and efficient servicing of development;
5) To facilitate the effective implementation of the State Planning Framework, including the Greater Bunbury Plan, Greater Bunbury Region Scheme and Greater Bunbury Structure Plan;
6) To facilitate the effective implementation of the Local Planning Framework, including the local planning Plan, local planning polices, structure plans, activity centre plans and local development plans; and
7) To seek to achieve greater ecologically sustainable development that balances and integrates –
    a) Preservation of biodiversity and conservation of natural resources;
    b) Facilitation of economic development; and
    c) Maintenance of social, cultural and wellbeing of people and communities; by managing the process and effects of land use and development in a manner that applies the precautionary principle and principle of intergenerational equity.

The LPS 8 is integral to the preservation of trees on residential lots to be developed and will influence the feasibility of new plantings on private land. It's fundamental that the LPS 8 and Greening Plan coordinate to not only avoid/mitigate developmental impacts on the environment and public health but improve them.

2.4.1.4 City Centre Action Plan

The purpose of the Bunbury City Centre Action Plan (CCAP) is to revitalise the City Centre. The vision for the Bunbury City Centre as proposed in the CCAP is that the City Centre:

> Will be regarded as welcoming, accessible, attractive, and full of opportunities.
> Will be renowned as a place to work, live, study, holiday, play and invest in.
> Will represent the heart of Greater Bunbury: healthy, strong, and vibrant.
> Will reveal and celebrate the best of all the South-West has to offer as the regional capital.

The CCAP delivers a strong vision with direct and concise objectives. Greening the City Centre will contribute greatly to the achievement of the CCAPs vision. Focussing innovative greening projects foremost in the City Centre will contribute to the City's uniqueness and progressiveness, paving the way for other areas of the City, or for other local centres to do the same.

2.4.1.5 Tree Management Council Policy and Road Verge Treatment Corporate Guideline

These two policies guide the Council's approach to managing trees and road verges, as well as laying out requirements and guidelines for landowners in the City to manage trees and verges around their property. A review of the Tree Management Council Policy, Road Verge Treatment Corporate Guideline and Significant Tree Register is in progress. It is important to streamline and improve these documents according to best practice and based on the progress of the Greening Plan.

2.4.1.6 Public Open Space and playgrounds Plan

The Public Open Space and Playgrounds Plan is due to be adopted in 2021. This Plan outlines the actions needed to deliver quality open space for the City. It provides a framework that guides the management, provision, use, and future investment in our open space.

2.4.1.7 Significant Tree Register

The City maintains a Significant Tree Register as part of the City of Bunbury Municipal Inventory 2001; however, this document was never endorsed by the Council. Significant Tree Registers are necessary to appropriately record and protect trees that are considered significant to the environment, culture, or heritage of the area. It's important that the Significant Tree Register be reviewed, updated, and endorsed by Council. Significant Tree Registers generally fall under the Council's planning policy and framework. The Register allows members of the public, as well as City staff, to nominate trees that they believe are significant for any number of reasons, including their environmental, scientific, historical/cultural, and aesthetic value.

Significant Tree Registers are usually comprised of several documents. They are usually written into Local Planning Schemes or as a standalone Local Planning Policy, which will outline the nomination and approval process, nomination acceptance criteria, and any special conditions applied to Significant Trees in terms of development and tree maintenance. To accompany this document, it is also important to develop a publicly accessible Register that is updated when trees are accepted into the Register; a clear and accessible nomination form for residents to complete; and community information brochures to clearly explain the process for and value of the Register, as well as describing the responsibilities of the council and the land owner with respect to maintaining trees on the register which are considered of significance to the whole City.

2.4.2 State Legislation and Strategies

The WA Department of Planning, Lands and Heritage (DPLH) has developed the guiding document Better Urban Forest Planning to provide overarching principles and useful guiding examples of urban forest planning for Western Australian local governments. It includes a breakdown of legislation and state Plan documents which are relevant for the development of a greening or urban forest Plan.

The State Planning and Development Act 2005 encourages sustainable land development in WA, including the protection of vegetation and the ecological processes it supports. The State Planning Plan 2050 (State Planning Policy/SPP 1) further promotes open space, urban tree canopy, and health outcomes in development, all of which are improved by robust, extensive greening. Various State Planning Policies (especially SPP 2, 2.8, 3.0, 3.1, and the Draft SPP 7.0) also support these aims in various ways and for different land use types, from supporting "retention of existing vegetation and revegetation in subdivision and development proposals" (SPP 2), to protecting and managing "regionally significant bushland for conservation purposes" (SPP 2.8).

Beyond the requirements within those statutes, various non-legislative strategic documents (like Liveable Neighbourhoods and Perth and Peel @ 3.5M) also encourage greening, and outline strategic goals around liveability, sustainability, and conservation. Each of these goals is supported by improved greening and the protection of existing vegetation, with all the attendant benefits vegetation brings for a community.

2.4.3 United Nations Frameworks

2.4.3.1 United Nations Sustainable Development Goals (SDGs)

As the global population grows, the world's limited resources will be placed under increasing pressure. The United Nations SDGs are a range of goals formulated to guide development around the world and assist policymakers in addressing the interlinked challenges of population growth, from poverty to climate change. They encourage equity and long-term planning. The City of Bunbury SCP addresses a number of these goals, and an Urban Greening Plan will also directly or indirectly relate to some, through the measurable benefits of vegetation for health, climate, and biodiversity, as well as through improved social cohesion. In particular, it will support positive progress for SDGs 3, 10, 11, 13 and 15:

3. Good Health and Wellbeing
10. Reduced Inequalities
11. Sustainable Cities and Communities
13. Climate Action
15. Life on Land

Considering this Plan within the context of international sustainability efforts should provide the City and community with the added motivation of being part of a global movement. Innovation and creativity as part of the Plan and its implementation can make Bunbury a leader in the urban greening space.

2.4.3.2 United Nations Sendai Framework

The United Nations Office for Disaster Risk Reduction's Sendai Framework for Disaster Risk Reduction 2015-2030 is a collection of guiding principles around improving the safety and resilience of communities to natural disasters worldwide. Four main Principles guide this Framework:

1. Priority 1: Understanding disaster risk.
2. Priority 2: Strengthening disaster risk governance to manage disaster risk.
3. Priority 3: Investing in disaster risk reduction for resilience.
4. Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction.

This Greening Plan can help address Priorities 3 and 4 to make the city more robust and resilient when facing natural disasters. Improving vegetation cover and diversity across an urban area provides significant benefits, explored in detail throughout this Plan. A targeted, comprehensive approach to greening will improve the City's resilience to natural disasters, including flooding, severe storms, extreme heat, and drought.

As described in Section 2.2.3 above, the stormwater interception, wind buffering, and soil stability provided by vegetation reduce the likelihood and the consequences of flooding and mitigate the effects of severe storms. As one specific example, good dune vegetation cover stabilises coastline soils, maintaining dune structure in the face of high tides and storms; this not only mitigates coastal flooding, but also reduces coastal erosion, maintaining the robustness of dune systems between seasons. The positive cooling effects of vegetation, explored throughout this Plan, also reduce the severity of extreme heat events relative to areas with less vegetation cover; vegetation also intercepts rainwater that would otherwise evaporate in summer or perhaps become runoff in winter, improving the water cycle, increasing recharge into aquifers, dams, and waterways, and therefore reducing the risk and severity of drought.

Therefore, improving greening through this Plan will improve disaster resilience by reducing the negative effects of disasters, allowing the City to recover faster when they occur. This is increasingly important, as the changing climate of the South-West (see Section 3.1), is likely to result in an increased frequency of climate and weather events of greater intensity over time.

2.5 State of Greening in the City of Bunbury

The City of Bunbury's urban forest includes all trees and other vegetation that occur within public and private lands. It encompasses the mosaic of streets, parks, gardens, understorey, and natural areas including the Kalgulup Regional Park (KRP) and other reserves, ocean and inlet foreshores, creek and drainage banks, native vegetation and the environment that supports the ecosystem services provided by soil and water. The urban forest also supports a range of animals, which rely on a healthy urban forest for their success and survival. The term 'urban canopy' refers to the green cover provided by the canopy of vegetation, defined in this Plan as those plants over three metres in height.

2.5.1 Historical Vegetation Cover

The vegetation of the area now occupied by the City of Bunbury has changed significantly through the region's history. The area has been part of the country of the Wardandi Noongar people for many millennia (Turney et al., 2001). The lifestyle and culture of Noongar people is closely linked to management and custodianship of the land, including its vegetation. Prior to colonisation, the Bunbury area was covered by a diverse range of vegetation types; from the coastal heathland of the dunes, to forests and woodlands of tuart (Eucalyptus gomphocephala), marri (Corymbia calophylla), jarrah (Eucalyptus marginata), moitch/flooded gum (Eucalyptus rudis) and banksias, to low-lying wetlands of melaleucas and other species. Wardandi Noongar people have uses for a range of local species, including marri for medicinal purposes, and many others for food and materials (Consultation).

From first European settlement in 1838, and especially the opening of lots for selection in 1841, native vegetation was cleared for agriculture and housing, and native forests were felled for timber. The logging industry was a significant industry throughout the Nineteenth and Twentieth Centuries, and Bunbury was a major port for the export of timber to other colonies and overseas. Jarrah was a particularly prized timber for its strength, constructive potential, and burn quality. Jarrah was felled in huge quantities, with the early industry operating with little regulation, and no emphasis on sustainability or forest regeneration.

Examples of many of the species and ecosystems that existed pre-colonisation still exist, but these have been altered significantly as the population of the region has grown and industries have expanded. Native ecosystems have become more disturbed and fragmented over time. New development has resulted in a net loss in vegetation cover over time and has meant that existing native vegetation is brought into closer contact with residential and industrial development or becomes surrounded by it. The City's Biodiversity Planning Discussion Paper in 2013 estimated that only around 24% of the native vegetation that originally occurred in the City still exists.

Colonisation has affected the vegetation of Bunbury in other ways than just clearing and development. Planting of introduced species in public and private land has meant the species composition of vegetation in the urban forest has changed over time. Parks, road reserves, verges and gardens often contain a combination of native and introduced species, which have diverse and variable requirements and ecological benefits. Significant introduced tree species include jacaranda (Jacaranda mimosifolia), Norfolk Island pine (Araucaria heterophylla) and olive (Olea europaea).

Particular introduced species also have significant weed potential in the City, including the arum lily (Zantedeschia aethopica), bridal creeper (Asparagus asparagoides), narrow leaf cotton bush (Gomphocarpus fruticosus), and blackberries (Rubus spp.). These species compete with native species and have detrimental effects on their health and the health of other elements of the urban forest, like soil and animals.

The Kalgulup Regional Park Management Plan includes a more comprehensive explanation of the various species of vegetation found in the Bunbury area, as well as the threatened and priority ecological communities in the area. These priority communities include a variety of wetlands and shrublands, banksia-dominated woodlands, and tuart/peppermint woodlands. These communities are found throughout the proposed Kalgulup Regional Park area and throughout the City of Bunbury.

The Plan explains that, of the over 200 plant taxa in the region, twenty-one species are priority native species, and three are threatened: the speargrasses Austrostipa jacobsiana (critically endangered) and Austrostipa bronwenae (endangered), and the tall donkey orchid Diuris drummondii (vulnerable). Management of vegetation in the City needs to consider these priority and threatened species and prioritise their survival and success.

2.5.2 Current Status of Vegetation in the City

2.5.2.1 Vegetation Cover

ArborCarbon's 2020 investigation into the current levels of vegetation cover in the City provided useful insights into the current status of the City's greening, and what approaches should be taken to improve on current levels. Vegetation cover is an important metric, as is canopy cover (vegetation cover of >3 metres in height) because trees greater than 3m in height often provide the most significant benefits (as discussed above), compared to other vegetation types.

Key areas of vegetation on public-owned land in the City include Manea Park and Maidens Reserve. Manea Park and Maidens Reserve are particularly important areas of surviving native vegetation; the Shearwater tuart forest in Maidens is one of the few remnant continuous tracts of tuart forest across the City. Both parks are part of the Kalgulup Regional Park (KRP), which is shown in Figure 3.

The KRP is a collection of interconnected areas of bushland and reserve in the southern part of the City, including Manea and Maidens. According to the Kalgulup Regional Park Management Plan, significant portions of the KRP will be vested in the Conservation and Parks Commission and managed by the Department of Biodiversity, Conservation and Attractions (DBCA). The City is therefore not responsible for the revegetation of the DBCA-managed parts of the KRP. However, opportunities to collaborate with the DBCA to produce the best outcomes possible for the Park should be investigated; even if it is DBCA-managed, a large part of the KRP is still within the City and its greening is still an important consideration.

Levels of vegetation cover excluding the KRP will be reported in this section to most accurately represent urban vegetation cover. However, it's important to note that the KRP makes a significant contribution to vegetation cover in the suburbs of Davenport, Carey Park, College Grove, Usher, Withers and South Bunbury. The areas outside of the KRP may be most important for targeting greening, as they have the most potential for increase; the City's population is also concentrated in these areas.

With the KRP excluded, College Grove, Withers and South Bunbury have the greatest proportion of their area covered by vegetation; when it comes to canopy percentage cover, College Grove, Davenport and Pelican Point top the list. Usher, Bunbury, and Vittoria are the suburbs with the lowest vegetation and canopy cover as a proportion of their area. Figure 2 illustrates the canopy cover percentage in each suburb, with increasing green intensity indicating higher proportional canopy cover.

For the purposes of this Plan the City boundary has been divided into three broad categories: Urban, Rural and the KRP (Figure 3). Urban land is defined by a boundary including all residential, commercial, and industrial areas, as well as the associated roads, parks and municipal services, but excluding land zoned as general industry and industrial development. These broad categorisations reflect very different land use types with different purposes and requirements for green space.

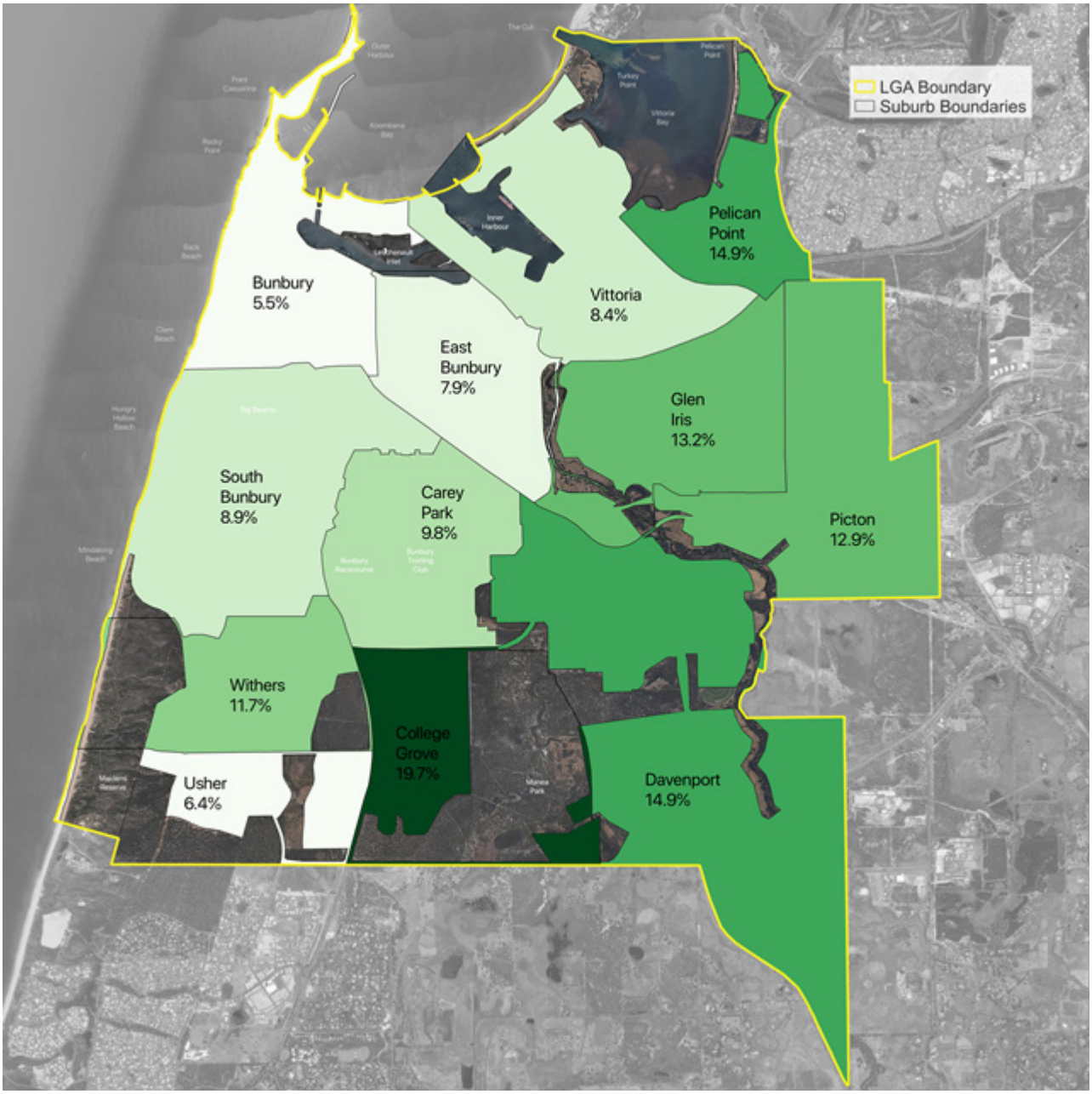


Figure 2: Thematic map showing canopy cover as a percentage of total suburb area, excluding the KRP within suburb boundaries. Darker green indicates a higher relative canopy cover percentage.

Current canopy cover within the Kalgalup Regional Park (KRP) area is 23.28%, compared to 11.32% in Rural areas ;

and only 10.2% total canopy cover in the Urban Area

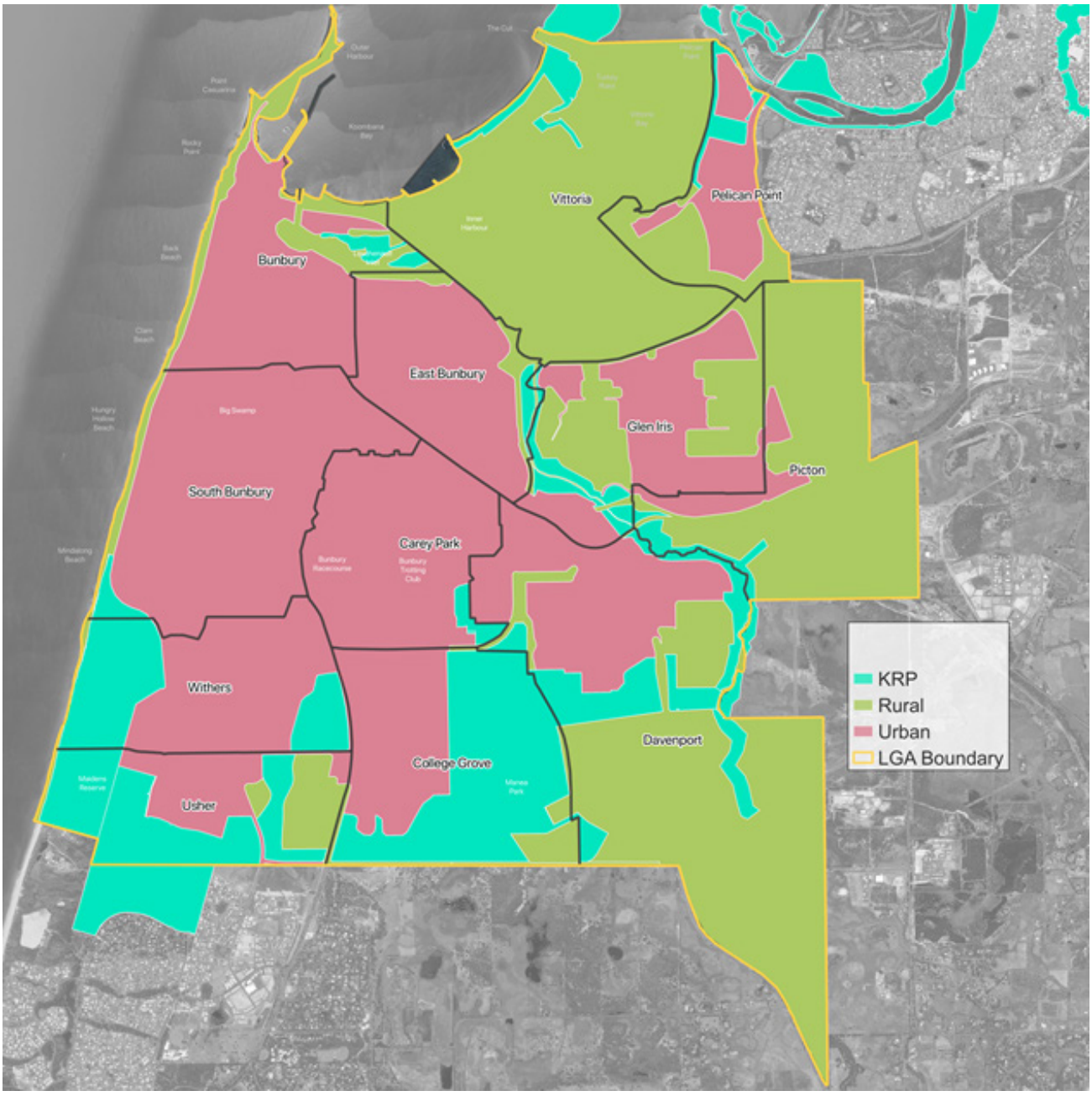


Figure 3: Broad land use categorisations within the City.

This Greening Plan relates primarily to the urban areas of the City, where the values, benefits and challenges of greening are greatest.

Management of the green space within the KRP is governed by the Kalgalup Regional Park Draft Management Plan 2020.

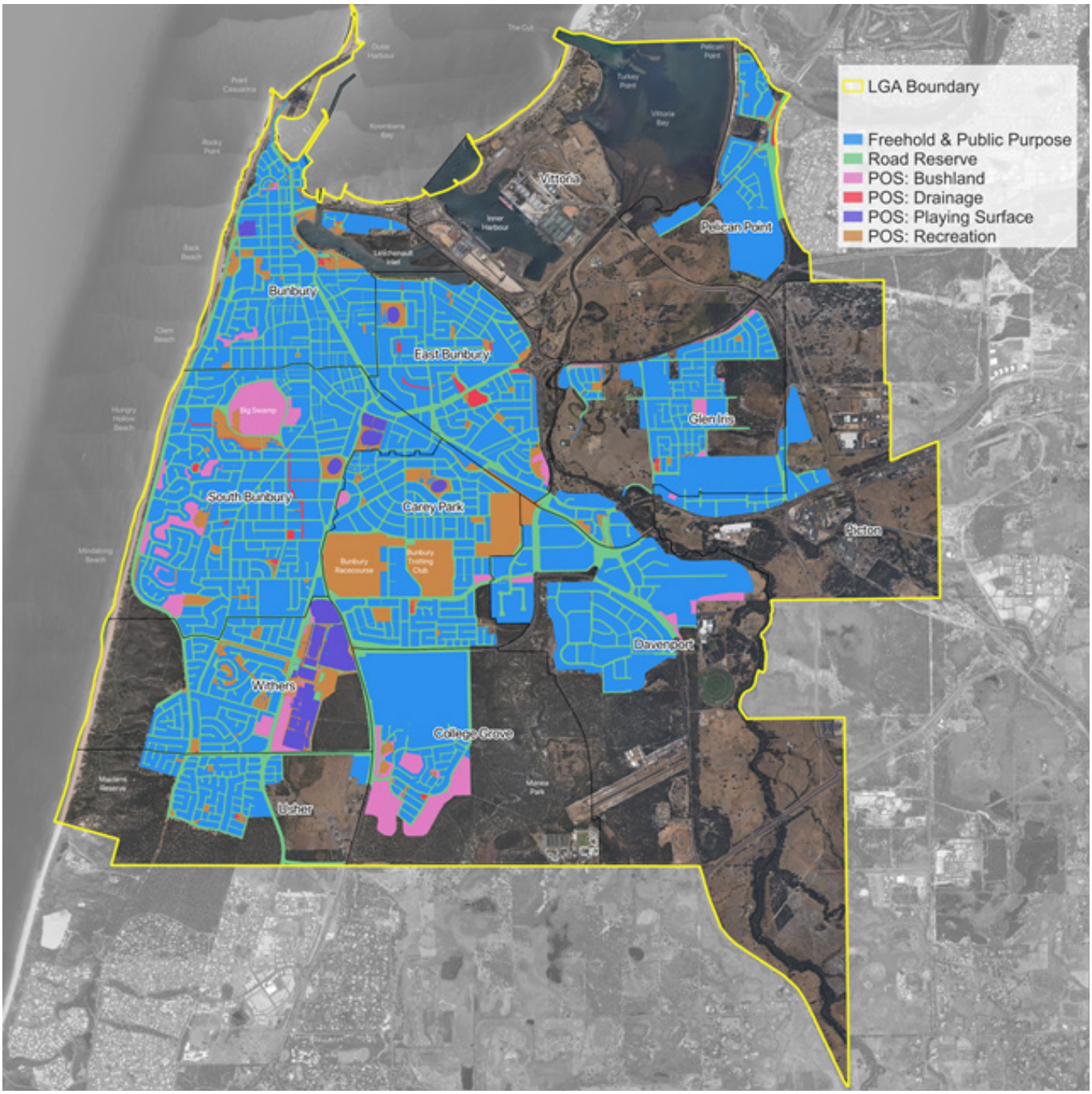


Figure 4: The Urban area of the City of Bunbury sub-divided into Land Use categories.

The urban area was further divided into six categories of use: Bushland, Recreation, Drainage, Playing Surfaces, Road Reserve, and Freehold & Public Purpose, based on usage and internal funding streams (Figure 4).

The first four categories are different categories of POS, and with Road Reserves make up the Council-managed land in the LGA.
The Freehold & Public Purpose category is comprised of residential, commercial, and industrial land, as well as public purpose land like the hospital precinct and schools. Current canopy cover for each of these categories was determined from the 2020 ArborCarbon aerial imagery analysis (Figure 5).

Bushland had the highest proportional canopy cover – 29.02% of land classified as bushland was covered by vegetation more than 3m in height. Land used for recreational purposes had 16.83% proportional canopy cover, as did Drainage areas. Playing surfaces (such as ovals and other sports fields) had the least proportional canopy cover (1.72%), followed by Freehold & Public Purpose land (8.86%).

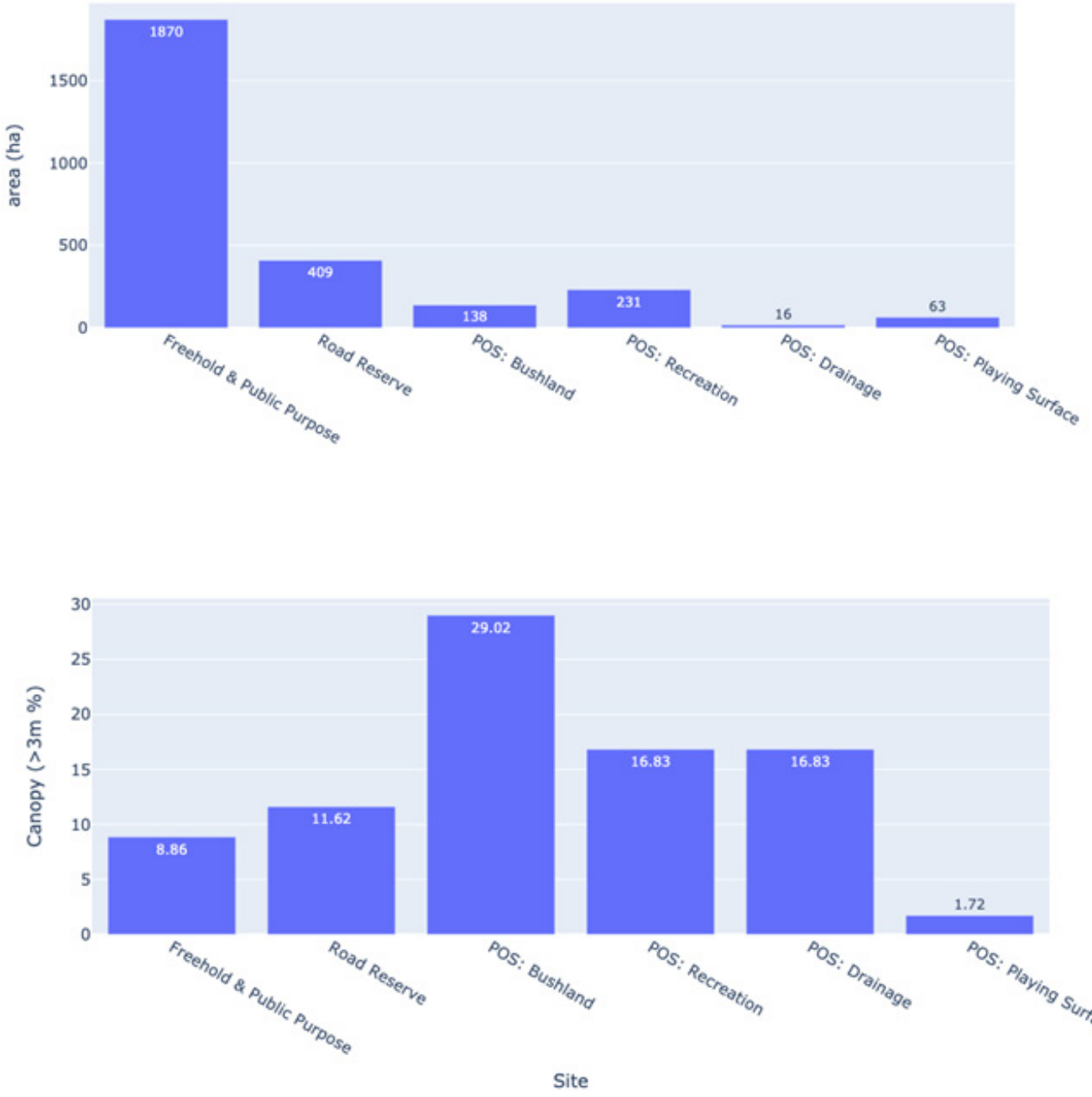


Figure 5: Area (ha) and proportional canopy cover (%) of urban land use categories.

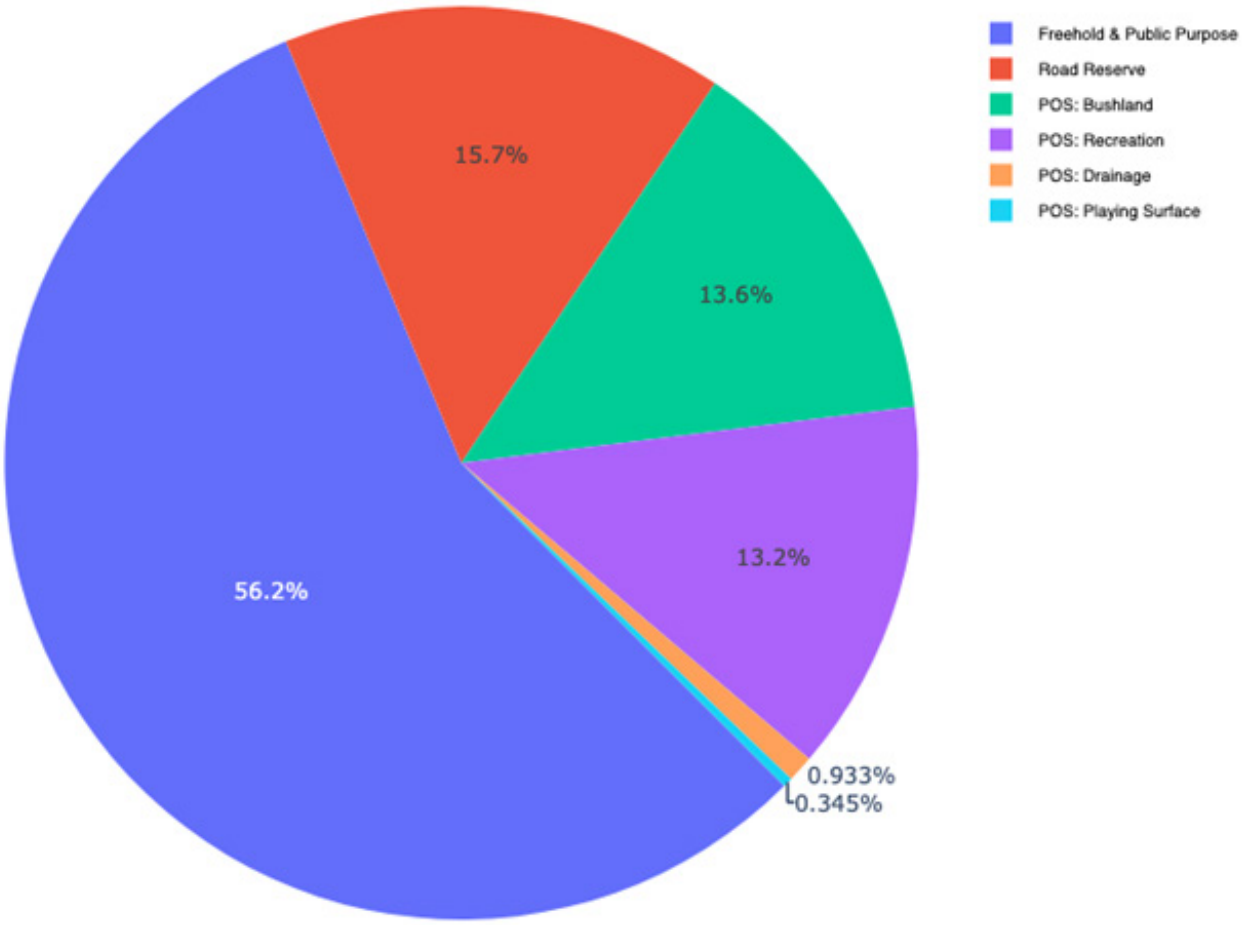


Figure 6: Contribution of each land use category to total canopy cover in the City of Bunbury.

Bushland had the highest proportional canopy cover,
the majority of canopy in the urban area was on:
Freehold & Public Purpose land (56.2%)
Road Reserves contributed 15.7%,
Bushland contributed 13.6%,
Recreation contributed 13.2%.
Playing Surfaces and Drainage land contributed less than 1%
(Figure 6).

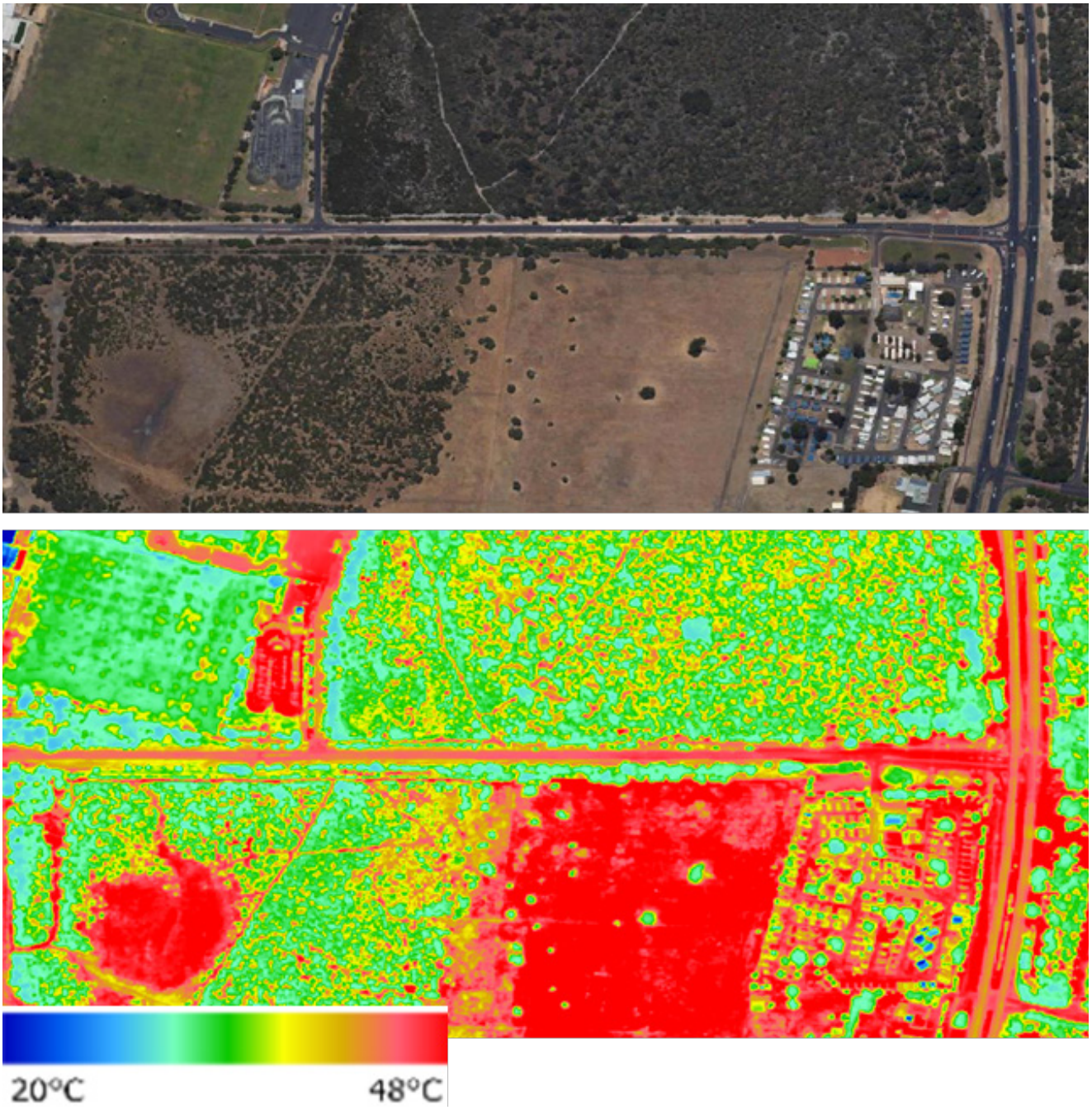


Figure 7: ArborCarbon high-resolution imagery compared to thermal imagery showing land surface temperatures around Washington Avenue in Usher. Note that bare soil, dry grass, buildings, and roads are significantly hotter than vegetation.

For Bunbury, urban hot spots are a significant issue in areas with lower levels of canopy cover.

The residential areas of Usher, and parts of Carey Park are examples of urban hot spots.

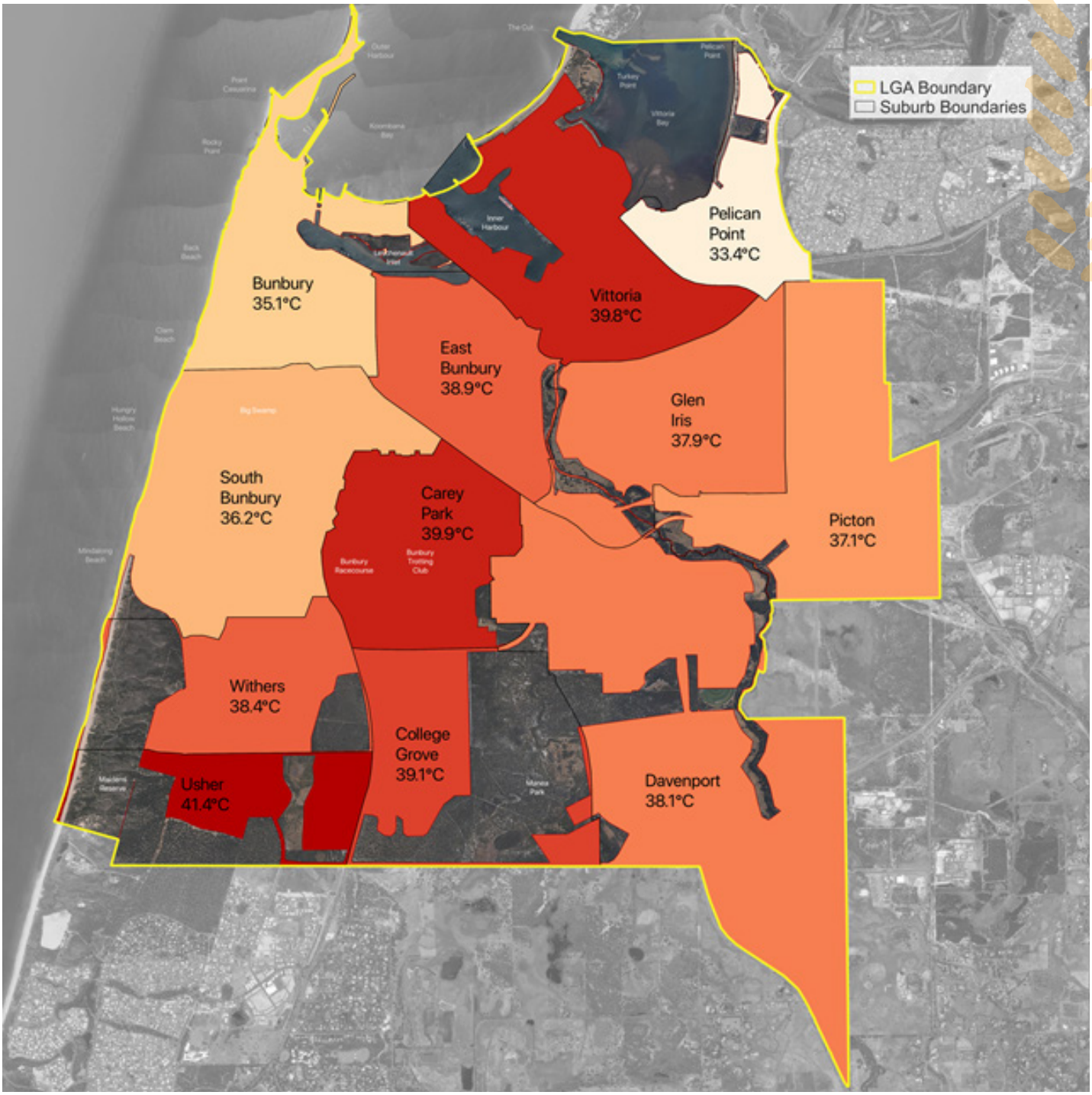


Figure 8: Average land surface temperature for each suburb of the City of Bunbury excluding area of the KRP. Surface temperatures range from 33.4 to 41.4°C. Areas of open water were excluded from the analysis.

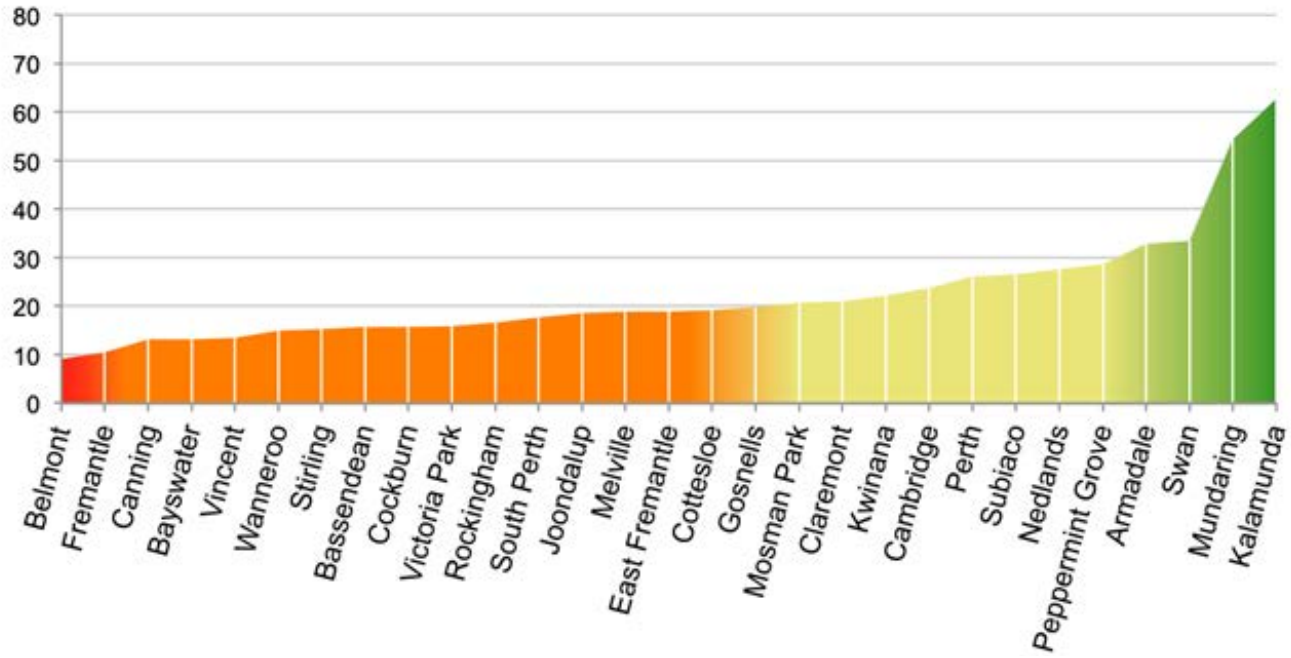


Figure 9: Canopy cover levels of various WA LGAs, as assessed using i-Tree. Source: Jacobs et al. 2014.

The City's vegetation and/or canopy cover percentages has been compared with other Local Government Areas (LGAs) around the country to determine targets, and what canopy levels have been achieved by other councils.

A 2014 study considered canopy cover across a range of LGAs in Australia (i-Tree, Jacobs et al. 2014). WA has a median of approximately 20% canopy cover (Figure 9).

Comparatively, the City has lower-than-average canopy cover at 13.7%.

2.6 Community Engagement

Engagement of the community is considered critical to the success of any Urban Greening Plan. The amount a LGA can achieve in improving green spaces is limited by the available budget as well as the area of land managed by the council. Therefore, it is important to engage the passion and resources of the local community. To do this, residents, businesses, and community groups must understand the benefits of urban greening and actively engage in greening goals.

The community was engaged in several ways during development of this Plan. It was important to determine how well the community understood a variety of greening concepts, as well as understand how supportive the community would be of further greening. Engagement came in the form of consultation with local Wardandi Elders, as well as through an online survey and comments portal. Over 500 users engaged with the online portal, with 233 comments and 71 survey responses.
Further in-person engagement was limited due to COVID-19 restrictions.

2.6.1 Consultation with Elders

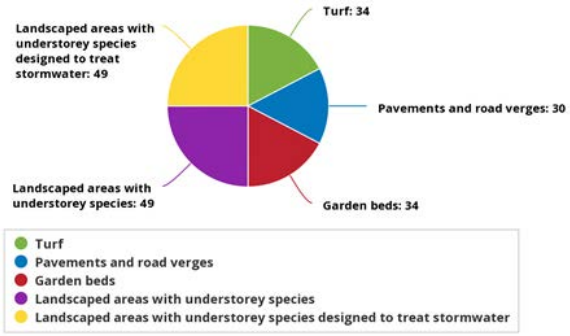
Initial consultation with local Wardandi elders provided useful guidance around priorities and focus points from their perspectives. They highlighted species and individual trees that hold important cultural significance and suggested several greening approaches that they thought should be prioritised. A key focus was species selection; elders suggested that "peppermint trees (Wonil), paperbark and Balga bushes (grass trees) all grow well in these areas", but that they needed to be planted selectively. For example, "the Balga bushes planted near the back beach have eroded and struggle to survive...probably because they are being burned by the saltwater."

Management of culturally significant vegetation was another priority for elders. They emphasised that "the WA Christmas tree or Mudja is a culturally significant tree" and gave an example of particularly significant specimens. Other species, like banksias and quandong, were suggested for planting as suitable species with cultural significance, as was "Marri...the medicine tree".

These insights from a key, knowledgeable group of stakeholders, are uniquely useful in the development of this Greening Plan. They can help guide the goals and strategies that underpin the City's approach to future greening.

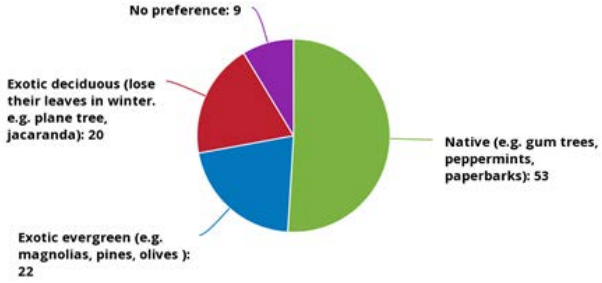
Q14. In recreational areas, do you prefer tree planted in:

69 answers



Q12. What types of tree do you prefer?

66 answers



Community understanding of many of the urban greening focus concepts was high. Many respondents had strong levels of awareness about the benefits of trees, related to shade, cooling, and habitat.

97% of respondents wanted more trees planted in the City Centre, 97% also wanted more trees planted in their suburb.

2.6.2 Online Engagement- Comments

Residents of the City of Bunbury also had the opportunity to make comments on an interactive map of the City. Comments were geographically referenced, so locals could make specific suggestions about greening priorities in their area. Comments could also be 'upvoted' or 'downvoted', providing a coarse but interesting indication of community sentiment. Some of the most 'upvoted' comments included:

"We need local shrubs and trees providing shade, beauty and habitat for our fauna and birds"
"Native trees planted on either side of highway with flowering native shrubs would balance the ecosystem and create an impressive statement for Bunbury"

Comments were analysed for particular words to determine the themes of each comment. Several themes occurred regularly; some of these are summarised in a table below. The themes relate to a range of concepts, benefits, and practices around urban forests. Some of them, like 'Native', related to people's preferences for the type of vegetation they'd like to see prioritised. Others, like 'Habitat/ecology', 'Aesthetics', and 'Shade' related to the benefits of vegetation and trees. Comments around benefits were often linked to ideas about where to plant vegetation, or where good examples of existing vegetation existed, and why the resident thought vegetation in those places was a good idea.
Other themes related to 'Management' of vegetation, including 'Watering' and vegetation around 'Buildings'. Some comments on these management themes were critical of current vegetation management and encouraged improved practices in the planting and maintenance of trees and other greenery.

Theme	Number of comments	Percentage of comments
Native	58	24.9
Habitat/ecology	53	22.7
Aesthetics	53	22.7
Shade	33	14.2
Recreation	33	14.2
Garden	29	12.4
Wind	17	7.3
Weeds and pests	11	4.7
Health	10	4.3
Erosion	8	3.4
Heat and cooling	7	3
Watering	7	3
Management	7	3
Climate change and air quality	7	3
Deciduous	6	2.6
Buildings	5	2.1
Value	5	2.1
Drainage and runoff	4	1.7

Table 1: Summary analysis of the major themes respondents raised in comments using the online survey platform.

Bunbury residents are aware of the benefits of greening, and are passionate about improving greening in the City. Engaging community will ensure actions reccomended in this plan are supported and successful

3 Key Issues

3.1 Climate change

The changing climate is a key concern for people, organisations, and governments worldwide. Compared to the 1986-2005 climate, by current projections, temperatures may rise by up to 5oC by the end of the century in southern Australia (CSIRO, climatechangeinaustralia.gov.au). Under an intermediate scenario (where atmospheric greenhouse gas concentration rises slowly and becomes stable mid-century), temperature rise is projected to be around 1.2-2.1oC.

Winter rainfall across the South-West of WA is projected to decrease by around 15% by 2030, and up to 30% by 2090. Despite this overall decline, extreme rainfall events are projected to increase significantly, leading to increased flooding and erosion risk. Mean sea level has also been rising and is predicted to continue to do so, increasing coastal erosion.

These effects are all likely to have a significant impact on the City of Bunbury and its human, plant and animal inhabitants. Increasing temperatures will lead to adverse health effects, reduced quality of life for residents, and increased consumption of energy and costs associated with cooling. Higher temperatures will also likely lead to increased demand for water for irrigation and consumption. Coupled with reduced rainfall, this increased demand will place significant pressure on Bunbury's water infrastructure.

Extreme rainfall events, sea-level rise, and coastal erosion are likely to increase the incidence and intensity of flooding events in Bunbury. Bunbury, along with other towns in the South-West, has been labelled by some climate scientists as extremely vulnerable to these events (Climate Commission, 2011). Low-lying areas of the City, especially those parts that were once marshland, or along the coast or edge of the estuary, are particularly vulnerable to flooding.

As discussed in Section 2.2, vegetation, particularly trees, has numerous benefits for addressing the causes and effects of climate change, including through carbon capture and storage, temperature regulation, soil structure to reduce erosion, and many others. A targeted and comprehensive Greening Plan will support the City's commitment to climate change adaptation, indicated by adoption of the WA Local Government Declaration on Climate Change.

Furthermore, as with other urban areas worldwide, the City of Bunbury is facing rising temperatures, which are exacerbated by the prevalence of non-vegetated areas in the urban area, as described in Section 2.3.

3.2 Development pressures

Residential, commercial, and industrial development has historically caused significant loss of green space and trees. Development continues to be an issue for retention and expansion of canopy due to development of greenfield sites as well as urban infill development for provision of new housing and services to support a growing population.

The retention of existing trees during development and allowing adequate space for tree establishment in development plans are common challenges for local governments across WA.

As is the case for urban or suburban areas across the country, convincing developers to retain significant trees and plant new ones can be difficult, as it is often easier and more cost-effective in the short-term to simply remove all trees from a block. All the benefits of greening described above suggest that this is a short-term perspective to have; apart from the many environmental, social and health benefits provided by greening, trees also increase property values.

The City can have a positive effect on how trees are prioritised during development. They can do this by both encouraging property owners and developers to understand the positive benefits to property values by retaining and planting trees.

3.3 Fire risk

Fire is a major concern for councils and residents in regional or rural areas. The risk of bushfire is a significant issue; climate change also means that bushfire frequency and severity are increasing. Therefore, greening the City in a way that minimises potential fire risks, is a key priority.

Several State and Federal Government guidelines exist for planning in bushfire-prone areas (Department of Planning, Lands and Heritage 2017). These set out guidelines for Bushfire Hazard and Attack Levels (BHL and BAL). BHL describes the potential intensity of a bushfire in the area around a property, based on the surrounding vegetation and topography; BAL estimates the vulnerability of a building to a fire if it were to occur. These measures determine whether planning approvals will be given to a development. The BHL and BAL levels, as determined by a qualified assessor, influence whether development will be approved, and under what conditions. Certain levels of BHL or BAL require developers and property owners to have a bushfire management plan (BMP), and to develop buildings to certain standards.
The Department of Fire and Emergency Services (DFES), also has recommendations for buildings and assets of critical infrastructure to be surrounded by a Building Protection Zone (BPZ). This is an area around a building or asset that meets a range of requirements, such as keeping shrubs a minimum of three times their height away from the building; keeping the fuel load in the BPZ to less than 2 tonnes per hectare; and pruning trees so that no branches come within 2 metres of a building, among many other requirements.

There is a possibility that increasing vegetation and canopy cover will increase the fuel load around some properties or developments or increase the proximity of properties to connected areas of bushland. For example, the City's Bush Fire Response Plan identifies some specific bushfire risk areas like Maidens Reserve and Manea Park; extending the urban forest near these may increase the risk of any fire spreading from those sites to residential areas. The same goes for many of the Bushfire Prone Areas identified by DFES around the City. This heightened risk level may then force the owner or developer of undeveloped land to create or reconsider a BMP, or contravene BPZ recommendations for existing buildings, placing more onerous development or management requirements upon them. It may also increase the area of the City that is classified as Bushfire Prone. This could be a genuine concern for residents of the City wishing to develop or extend their existing properties.

Bushfires are a major threat to lives and homes and increasing risk would be an undesirable outcome. This Greening Plan will encourage increasing canopy in ways that will minimise any increase in fire risk or severity. However, increased vegetation in Australia often does mean unavoidably increased summer fuel loads. Therefore, management of vegetation to reduce risk is another priority for the City and for residents. Increased canopy and vegetation cover with minimised fire risk increase is possible; however, it will require sustained management of vegetation and careful planning.

Airborne remote sensing datasets used to locate and measure vegetation and canopy cover can be used to locate and measure growth of vegetation that requires removal. These datasets can also be utilised to ensure excess vegetation is not removed beyond the BPZ, unnecessarily impacting the City's canopy cover.

3.4 Conflict of trees with services and engineering

Occasionally, trees come into conflict with infrastructure and engineering, including powerlines, underground power and water infrastructure, and paths and roads. Branches can impact powerlines through growth or limb/tree failure, and roots can damage pipes or wires underground or above-ground. This can be avoided, however, through careful planning, robust design, accurate monitoring, and effective procedures around maintenance.

For example, the threat of branches to powerlines can be managed by selecting smaller species for planting under powerlines, and by maintaining a regular, targeted pruning program. Remote sensing methods already utilised for accurately measuring the City's vegetation cover and condition can be used to identify vegetation encroaching on utilities or provide early warning of unhealthy trees that may prematurely fall. In dense urban development, the available soil volume for tree roots becomes a key constraint to tree establishment. Following modern design principles, it is possible to safely accommodate trees within dense urban settings.

However, this cannot be done on an ad-hoc basis. The space, in terms of above ground crown expansion and rooting volume, must be designed into the infrastructure project at the planning phase.

3.5 Diseases and Pests

Diseases are a significant challenge for those who manage vegetation. With changing climatic conditions and movement of people, plants and animals across borders, the distribution and intensity of threats to plant health are changing.

Disease-causing pathogens threaten the health and survival of some of Bunbury's most iconic species. This is especially the case for species affected by a changing climate, as these are likely to already be weakened. Phytophthora oomycetes, including P. cinnamomi and the more recently described P. multivora, are plant pathogens that threaten a wide range of species, including tuarts, jarrah, peppermints, and Norfolk Island pines, each of which is an important species within Bunbury ecosystems and part of Bunbury's cultural identity. Botryosphaeria, Armillaria, and Omphalotus fungi are other key threats to these and other species. These pathogens can cause mild to severe stress, necrosis and eventual death of a broad range of tree genera and species. Once these pathogens become established, treatment can be complex and difficult as many spread via root-to-root contact or with infested soil and plant tissue; therefore, containment and prevention of these diseases is a more effective approach to disease management.

Norfolk Island pines (Araucaria heterophylla) are a notable introduced species in the City. These tall trees are found throughout the City but are especially common and visible along the coast. The decline of Norfolk Island pines has been documented in several locations in Australia and New Zealand. In the Town of Cottesloe, a combination of Phytophthora and Botryosphaeria pathogens, and changing rainfall and temperature patterns, have been attributed to causing rapid decline and death of Norfolk Island pines (ArborCarbon 2020c). Similar symptoms have been observed as far south as Esperance, meaning that Bunbury's Norfolk Island pines are also at significant risk. Similar challenges face the iconic tuart, with climate pressures exacerbating the effects of disease. Death of these trees is extremely concerning for numerous reasons, from the ecological detriment of losing mature tuarts, to the safety risks posed by large dead trees which can drop limbs.

There are also growing threats of diseases that have not yet reached Bunbury that are likely to cause widespread illness or death. One disease of concern is myrtle rust, caused by Austropuccinia psidii. This fungal disease is wreaking havoc on the east coast of Australia, and affects hundreds of native Australian species, including many commonly planted varieties in the City like bottlebrush, red flowering gum, marri, and peppermints.

Insect pests are a key threat also, for both native and introduced plant species. These include aphids, borers, scales, and nematodes. These can alone affect plant health or compound the effects of diseases and other health issues. One example is the red gum lerp psyllid (Glycaspis brimblecombei), which affects a range of WA eucalypts, especially moitch/ flooded gum.

To address the risk of disease and pests, the City should adopt a multi-faceted approach. Firstly, disease awareness training and hygiene protocols should be conducted for City employees and volunteers who interact with vegetation or soils. These protocols can include the identification of exclusion zones to mitigate the spread of a disease, and requirements around cleaning and disinfecting equipment, shoes, and vehicles. Another recommended approach is to develop diversity targets for planting and maintenance of vegetation. Ensuring a high diversity of species across the City and in local areas will mean a diversity in plant susceptibility, thereby increasing resilience and reducing the chances of widespread damage or death events. Further to this, species selection should consider resistance to key diseases, as well as resilience to climate change, as extreme weather stress can exacerbate the effects of, and susceptibility to, disease.

These management requirements could be combined into a comprehensive pathogen management plan, outlining protocols as well as City-specific risk factors and management goals. The City of Joondalup have a pathogen management plan which gives risk and priority rankings for a range of diseases to each park and natural area in the City (City of Joondalup 2017). The City of Joondalup has utilised airborne remote sensing methods for monitoring spatial and temporal changes in vegetation condition and setting of Key Performance Indicators (KPI's) for condition of natural areas utilising objective, quantitative remote-sensing derived metrics rather than traditional subjective and qualitative measures (ArborCarbon 2018, 2019a). This has enabled a targeted approach to disease monitoring and management with improved outcomes. Such methods have also been used by the City of Melbourne to monitor the condition of more than 40,000 trees across the City (ArborCarbon 2019b, 2020b, 2021).

3.6 Weeds

Weeds are another threat to the health and resilience of the City's vegetation. Invasive plant species like those mentioned in Section 2.5.1 interrupt and threaten native ecosystems or planted native or exotic species that are part of the City's green landscape. They compete with other plants for space and resources and can affect their health and establishment. Rapid-establishing, fast-growing and highly fertile species like cotton bush (Gomphocarpus fruticosus) can take over an area and choke out other species, or even act as a host or vector for disease spread to other hosts. Weeds can also seriously threaten agricultural crops and leave producers with no choice but to use increasing rates of herbicides to maintain productivity, which can have negative downstream ecological or health effects.

Weeds can be tackled directly, through weeding or spraying programs; however, as with diseases, containment and hygiene are the most effective approaches to reducing the effects and spread of weeds. Hygiene protocols around the safe movement of soil and cleaning of equipment are also useful in the case of weeds, as are widespread monitoring, education, and awareness campaigns. The City should work closely with the Department of Primary Industries and Regional Development and other stakeholder groups to raise awareness among residents through access to information about weed management for their properties and facilitate the reporting of weeds.

High-resolution airborne remote sensing data, such as that used to measure the baseline vegetation cover across the City in 2020, has been used successfully to identify weed infestations in areas outside of Bunbury. The City should explore how this data can be used to locate and monitor weed infestations and measure the efficacy of management actions.

3.7 Coastal habitats

Bunbury's beaches and coastal attractions are popular and world-class. Maintaining the amenity of coastal parts of the City should be a priority, and this means the requirements for coastal greening must be carefully considered. Plants must be selected for salt and wind tolerance, as well as their suitability for sandy soils. In dune systems, many trees are unlikely to survive; therefore, hardy shrubs and groundcover plants, especially coastal natives, are more suitable. Some hardy tree species, like the Moonah (Melaleuca lanceolata), may survive in harsh conditions, if their establishment is supported by good management.

In areas protected from wind, some native trees are suitable. These include wonil (Agonis flexuosa), some South-West eucalypts like marri (Corymbia calophylla) and Hamelin Bay Mallee (Eucalyptus calcicole), and some banksias, like Bull Banksia (Banksia grandis). The South-West Catchments Council has a 'Coastal Gardens Booklet', which is useful for private landowners, but also contains species suggestions that are relevant for the City when planning plantings.

As mentioned above, climate change is likely to increase the severity of storm events and lead to rising sea levels. This sea level rise may threaten the health and survival of coastal vegetation. However, having well-planned and maintained coastal vegetation will also increase the resilience of dunes and coastal land to storms and sea level rise, by providing structure to the soil of these areas and reducing erosion.

Coastal habitats can be delineated using geospatial methods and airborne remote sensing data collected in 2020 analysed to provide a baseline measure of vegetation cover and condition across these habitats. Gaps available for planting can be identified within this data, and targets/KPI's established for cover and condition of the vegetation based on objective and quantitative data.

4 Opportunities

4.1 Noongar cultural values

Aboriginal people have lived in the Bunbury area for tens of thousands of years. The local Wardandi Noongar people are the Traditional Owners and continue to live their culture in the region. The Gnaala Karla Boodja Indigenous Land Use Agreement (ILUA) includes Bunbury and is part of the South-West Native Title Settlement. A Noongar corporation representing this ILUA will be conclusively registered in 2021. It is important to note that not all Noongar people support the establishment of the ILUA in its current form.

Noongar culture is entwined with natural vegetation and landscapes. The six Noongar seasons are closely linked to the life cycles of plants and animals, and movement and food practices are determined by the natural flowering, seeding and growth of vegetation. Noongar management of the land has an ancient and continuing history; vegetation management practices were built from deep knowledge, and maintained the productivity of ecosystems for people, animals, and plants.

Section 2.6.1 includes parts of the consultation conducted with local Wardandi elders for this Greening Plan. As can be seen, Wardandi people have a deep, continuing connection to the vegetation and landscapes of the Bunbury area. Vibrant ecosystems are a priority for these elders, and particular species are culturally significant, for a range of practical, medicinal, and spiritual reasons. These species include marri (Corymbia calophylla), which is used for medicinal and other purposes; Moojar (Nuytsia floribunda), which has deep spiritual significance as a kind of resting place for the souls of people on their way to their final resting place across the ocean; Balga (Xanthorrhoea preissii), used for its gum, flower spike and for the nutritious grubs it harbours; as well as quandong (Santalum acuminatum) and various banksias. Elders made several suggestions about placement of vegetation as well.
Embracing the Aboriginal knowledge and cultural history of the City within the Greening Plan could make a significant contribution to the City's existing cultural heritage goals as described in the Local Planning Plan (2018) and link the long Aboriginal history of the area to the present day.

European-derived vegetation management practices are, in many ways, unsuited to the climate, species and landscapes of Australia. The significant clearing, diversion of waterways, and fire mitigation that has occurred in the Bunbury area since colonisation has often disrupted natural cycles and interfered with the Noongar cultural practices related to land management. For a comprehensive and transformative Greening Plan to be successful, Noongar voices should be prioritised, to ensure that unique Aboriginal cultural knowledge guides the implementation of this Plan.

4.2 City Centre Action Plan

The Bunbury City Centre Action Plan outlines the City's aims of enriching Bunbury's sense of place, increasing greenery in the City Centre, and establishing a shopfront/façade improvement scheme.

This Greening Plan will support the City's City Centre Action Plan. It will guide significant progress towards the second Pillar, 'A Colourful City Centre', especially Objective 5:

"To transform the City Centre into a network of interesting, attractive streets and laneways that excites and contributes to promoting a shaded, green and healthier environment."

The Action Plan intersects with several of the goals and targets of this Plan. As described above in detail, the benefits of vegetation are numerous, and have a significant influence on the amenity and cultural identity of a place. This is particularly important for the City Centre to function as an attractive, vibrant centrepiece for the City, encouraging commerce and tourism, as well as longer-term immigration to the City from other parts of the state, country and world.

There is significant opportunity for improved greening in the City Centre, from better integration of street trees to innovative and creative projects. Examples of these projects could include:

Central median strips on City Centre streets to provide added areas for greening.

Rooftop gardens on appropriate buildings to innovatively maximise potential greening area.

Shade trellising, particularly in places (like concrete paths) where planting trees is difficult. This might involve planting climbing/spreading plants on or between existing infrastructure like lighting or signage or erecting attractive structures for these plants to grow on and around.

Green walls are a similar type of initiative, involving the greening of exterior walls. This can be achieved by installing hanging or attached pots to walls or attaching trellises. Greenery can then grow along the surfaces of buildings, increasing their attractiveness and improving their heat mitigation, reducing the UHIE.

Stormwater tree pits on City Centre streets to assist with stormwater management and shading/greening. These can act as a point of difference for the City Centre compared to the suburban shopping centres and precincts further afield in the City and surrounding Shires. There are various other innovative possibilities for the City Centre, including rooftop gardens and greening for particular buildings.

Many of these types of initiatives directly address the City Centre Action Plan's goals as outlined above. They also have the potential to be trialled or first implemented in the Centre, and then expanded to other commercial areas, shopping centres or larger residential developments across the City. The City of Melbourne is a leader in this space and should be used as a resource for development of future initiatives. Serious consideration must be given though to the engineering, species selection and water requirements as the climate in Perth is less favourable for growth of rooftop vegetation than cooler and more humid environments such as Melbourne.

4.3 Integration with Council Works Programs

Traditionally, standard local government engineering and infrastructure works are often in direct competition with "Green Infrastructure" such as trees and other vegetation. Vegetation is often considered a cosmetic addition and engineering teams do not typically have the knowledge to successfully accommodate the requirements of trees and vegetation. The result is that the spaces set aside for trees and vegetation are often inadequate and fail to reach their full potential, or vegetation causes damage to the hard assets and require removal. However, this does not have to be the case. If "Green Infrastructure" was considered a green asset on equal footing to grey assets such as buildings and pavements, it would require substantially greater funding for design, implementation, and ongoing maintenance. This would result in more attractive urban spaces, and in the City Centre would lead to increased utilisation by residents, and increased revenue for local businesses. Most importantly, integrated design of green and grey assets would reduce conflict between them, improve the ongoing health of urban trees, and reduced costs for maintenance and removal.

The City can develop guidelines and specifications for the best ways to incorporate greening into Council building construction, park upgrades, road maintenance, stormwater infrastructure upgrades and other works. These could include minimum vegetation or canopy cover levels for Council works, and design guidelines for the successful incorporation of trees and vegetation into typical council works projects providing examples of successful implementation for future expansion.

4.4 Engagement with Developers and Property Owners

Significant opportunities exist for collaborating with developers to encourage positive development practices that prioritise greening and reduce canopy loss over time. A key opportunity exists to encourage builders and property owners, perhaps with financial incentives and accelerated approvals, to protect and expand vegetation within private property boundaries. There could be long-term financial benefits to this approach because the City would avoid the significant compounding costs of losing the ecosystem service benefits the established vegetation provides. Having to plant new vegetation and then maintain it to offset the loss of established trees is likely to be more expensive than providing subsidies.

Given trees on street frontages are owned and managed by council, it is important to ensure these trees are protected, and one of the most effective measures is through policy and tree bonds. Tree bonds are payments made by the developer to maintain the health of existing trees on verges; this bond is returned if the developer protects the tree for a defined period (i.e. 12 months), but is forfeited if the tree is damaged or declines in health, to cover the costs of re-establishment and lost amenity. This requires the ongoing monitoring of tree condition, and this can be achieved in an objective manner using the airborne remote sensing data already acquired by the city, combined with field validation. The City of Vincent is one WA local government which has implemented tree bonds.

Engagement with developers can also take the form of education and information sessions whereby the City informs developers and property owners about the manifold benefits of greening. The significant economic benefits in terms of increased property value and improved amenity would hopefully encourage more protection of existing vegetation and/or prioritisation of greening in building design. These sessions could be voluntary, or mandatory for any individual or company planning to develop property in the City.

4.5 Active lifestyles

The vegetated landscape of the City has a significant impact on the recreational and transport tendencies of residents. Having cool, attractive vegetated areas across the City is likely to encourage residents to walk and cycle in the City as part of their leisure habits and/or daily commute. The City can help encourage an active lifestyle and close engagement with and connection to vegetated areas by integrating active infrastructure with greening. Alongside the City's Cycling Plan, new walk and cycle trails can be integrated with significant parks and reserves, existing ones can have their associated vegetation improved, and new plantings can be targeted to maximise shade and amenity for key commuting times in the morning and afternoon, especially for summer. These actions will help ensure that greening the City will have the maximum positive benefits for residents, encouraging pride in the City's green spaces, and community buy-in to the aims of the Greening Plan.

An innovative approach to encouraging residents to realise the benefits of greenspace during physical activity, and to utilise it, is to provide community members easy access to data, information and maps. For example, software applications that can be loaded on mobile phones to identify the greenest, coolest and/or healthiest routes and locations to commute and undertake physical activity. Such an application would ingest geospatial data on shade quantity (e.g. UV exposure), surface temperatures, vegetation cover and air quality (i.e. particulate matter PM2.5) and enable the user to plan their route based on these parameters.

4.6 Establishing connections

To maximise the possible benefits of greening and achieve the best 'bang for its buck', the City should consider how connections can be made between existing natural assets. Areas of natural vegetation are scattered throughout the City and linking these through planting vegetation between them can have several benefits in terms of biodiversity outcomes and improving community engagement with these assets.

Linking areas of vegetation through connections of unbroken greenery, especially canopy, creates 'wildlife corridors', allowing animals to travel between otherwise fragmented areas of habitat. For example, planting trees along a road between two parks or reserves will allow endangered possums to travel through the canopy between those areas. This expands the accessible habitat for the possums and reduces the need for them to make risky journeys across roads or through properties. Tree species selection can also improve biodiversity outcomes. Planting trees that provide food for animal species (such as almonds, coastal blackbutts, banksias and tuarts for cockatoos) improves their access to food, supporting population stability and reducing conflict with humans.

Linking areas of vegetation can also create a greater sense of connectivity with natural areas throughout the residential parts of the City. Having connected lines of vegetation or canopy between significant reserves may increase utilisation of these sites by a wider range of residents, as travel to these sites is healthier and more aesthetically pleasing, for the reasons explained in previous sections. Improving the equality and attractiveness of access to beautiful natural spaces across the City will hopefully strengthen the sense of pride and identity that these places contribute to the City. Existing geospatial datasets from recently acquired airborne remote sensing imagery can be utilised to locate areas for planting to establish such connections.

4.7 Water Sensitive Urban Design and Recovery

Water Sensitive Urban Design (WSUD) is a land planning and engineering design approach integrating the water cycle in urban areas including groundwater, stormwater and wastewater management and supply, with urban design to reduce environmental degradation and improve recreational and aesthetic appeal. It stresses the inclusion of innovative elements to improve water relations in the urban environment and surrounds. These elements can include landscaped bioretention systems to filter pollutants from stormwater runoff before it enters waterways; extensively vegetated constructed wetlands or swales/living streams, which mimic the characteristics of natural wetlands or streams; infiltration basins and soakwells; permeable paving; and rainwater storage and reuse systems. These elements seek to manage water to reduce uncontrolled runoff in urban and suburban areas, reducing the potential for flow of pollutants into waterways, conserving water for human use/landscaping and providing habitat for animals. Recent investigations, via heat mapping in the City shows that the incorporation of trees within WSUD structures greatly assists with reducing heat levels in the immediate area. This provides evidence that multiple benefits can be achieved, where water management and canopy cover are combined.

The City is expanding its stormwater management program to reduce flooding and improve water quality. As part of this program, there are key benefits associated with incorporating trees and other specialised vegetation. The stormwater also helps to irrigate this vegetation, reduce the need for new irrigation from finite existing water sources. The incorporation of vegetation also assists with improving the water quality within the stormwater system and stabilising the critical infrastructure. Furthermore, it provides landscaping and cooling within the urban fabric. These systems can be used within large parks but also provide an excellent opportunity for street trees, even within the CBD as has already been undertaken on key streets within the City.

Flood-prone areas within the City provide an excellent opportunity for greening. Where the risk to houses and other infrastructure from flooding is too high, land has been set aside for parks and drainage. Within these areas, trees and other appropriate vegetation can be incorporated into natural and landscaped wetlands, waterways, and public parks. Through detailed design, these flood-prone areas can form key green areas through the City, allowing for passive recreation and aesthetic outcomes for residents, while also achieving the dual aims of greening and flood management.

4.8 Water Sources

Aqwest is the WA government owned entity providing drinking water from the Yarragadee Aquifer to 17,000 properties in the City of Bunbury and surrounding area. On 2 September 2020 Water Minister Dave Kelly announced a $11.9 million investment to construct a major new water resource recovery facility to supply water to irrigate public open spaces and for use on major infrastructure projects, alleviating the need to use high quality potable water. Aqwest will be the provider of this non-potable water. This will present a key opportunity for the City to ensure that the water is used strategically to water not only POS, but also irrigate newly planted trees and vegetation and ensure their healthy establishment and survival. This will be essential if the City is to reach the targets listed in this Plan whilst reducing the use of potable water in a drying climate. The current proposal is to deliver the non-potable water to the major parks within the City via new, dedicated pipelines. The groundwater currently being used for oval irrigation can then be diverted to irrigate other parks and landscaping within the City. In the current drying climate, with no likely new groundwater allocation being available to the City, this new water source will provide the ability to increase the overall irrigation to new key greening projects.

Another option for increasing the effective available irrigation for greening in the City is planting vegetation where it can be directly irrigated by stormwater off roads, roofs, and other structures. This water source can provide the majority of water for vegetation when the system is well designed, and the appropriate vegetation is used. Suitable vegetation would include native vegetation adapted to cycles of wetting and drying. By using this direct runoff stormwater as a new water source, vegetation can also be planted in areas where traditional irrigation sources may not be present, are at capacity or are not economical to install.

4.9 New medium density R-code

The Department of Lands, Planning and Housing have produced draft updates to the codes that regulate residential development. One of the Code's objectives is "2B: To support tree retention and re-establishment of the urban tree canopy." These draft updated R-Codes may influence how vegetation is affected by development and may provide opportunities for the City to encourage better greening practices in new developments, and to encourage WSUD.

These draft codes include several requirements related to gardens, trees, and deep soil area. Every dwelling must include at least one small tree (2-6 m canopy diameter at maturity) and 20% landscaped deep soil area. These requirements mandate the establishment of canopy, or at least mandate the retention of soil volume and space to accommodate future canopy growth within private developments, which is a positive step for encouraging the improvement of the urban forest. The Code also encourages the retention of existing trees: if a significant tree is retained onsite, the minimum deep soil area is reduced to 15%. This encourages developers to retain mature trees.

Opportunities therefore exist for the City to guide the application of this Code for developers and people building a home. The City could provide tree, shrub, and groundcover planting suggestions around species selection and placement, and encourage people and developers to retain significant trees. The City can also take advantage of the vegetation-friendly objectives of the goals to further encourage developers to establish vegetation, both on-site and along verges and street setback areas.

5 Vision

To nurture and grow a resilient, healthy, and **diverse urban forest** that will contribute to the health and **wellbeing of the community** and create a liveable city for **future generations.**

5.1 Plan

To develop a robust framework with clear goals and specific targets identified, delivered through a prioritised action plan over the next 20 years.

5.2 Goals

Achieving the City's Vision will require a holistic and targeted approach to greening the City over the next 20 years. These Goals are to:

PROTECT

Manage the City's existing urban forest through a coordinated planning and maintenance approach to minimise potential future adverse impacts to existing vegetation.

CONNECT

Connect, educate, and partner with our community, business, and private landowners to inspire care of and connection with the urban forest.

ENHANCE

Increase canopy cover through a targeted Urban Forest Precinct planning programme to harness the economic, social, and ecological benefits of trees and urban greening.

MONITOR

Undertake ongoing monitoring and evaluation of the urban forest to measure success and adapt to future challenges.

5.3 Development of Targets

Canopy cover and canopy cover potential vary depending on land use type; as a result, the Council area was divided into broad land use categories to determine targets.

As discussed in Section 2.5.2, freehold land is the greatest contributor to canopy cover in the City containing 50% of the total canopy area. However, while the City can encourage and support residents to plant and retain trees and other vegetation on their properties, it has little direct control over greening on most freehold land. As such, the burden for greening is on the remaining areas of public land throughout the City.

For the purposes of this Plan the council-managed outdoor area was categorised into five major groupings. These were: Bushland, Drainage areas, Playing Surfaces, Recreation areas, and Road Reserves (Figure 12). By far the largest land area is the Road Reserves, which includes major highway easements, plus council-managed connector roads, medians, and street verges in residential areas, but excluding state government (Main Roads) roads which predominantly fall outside of the urban area.

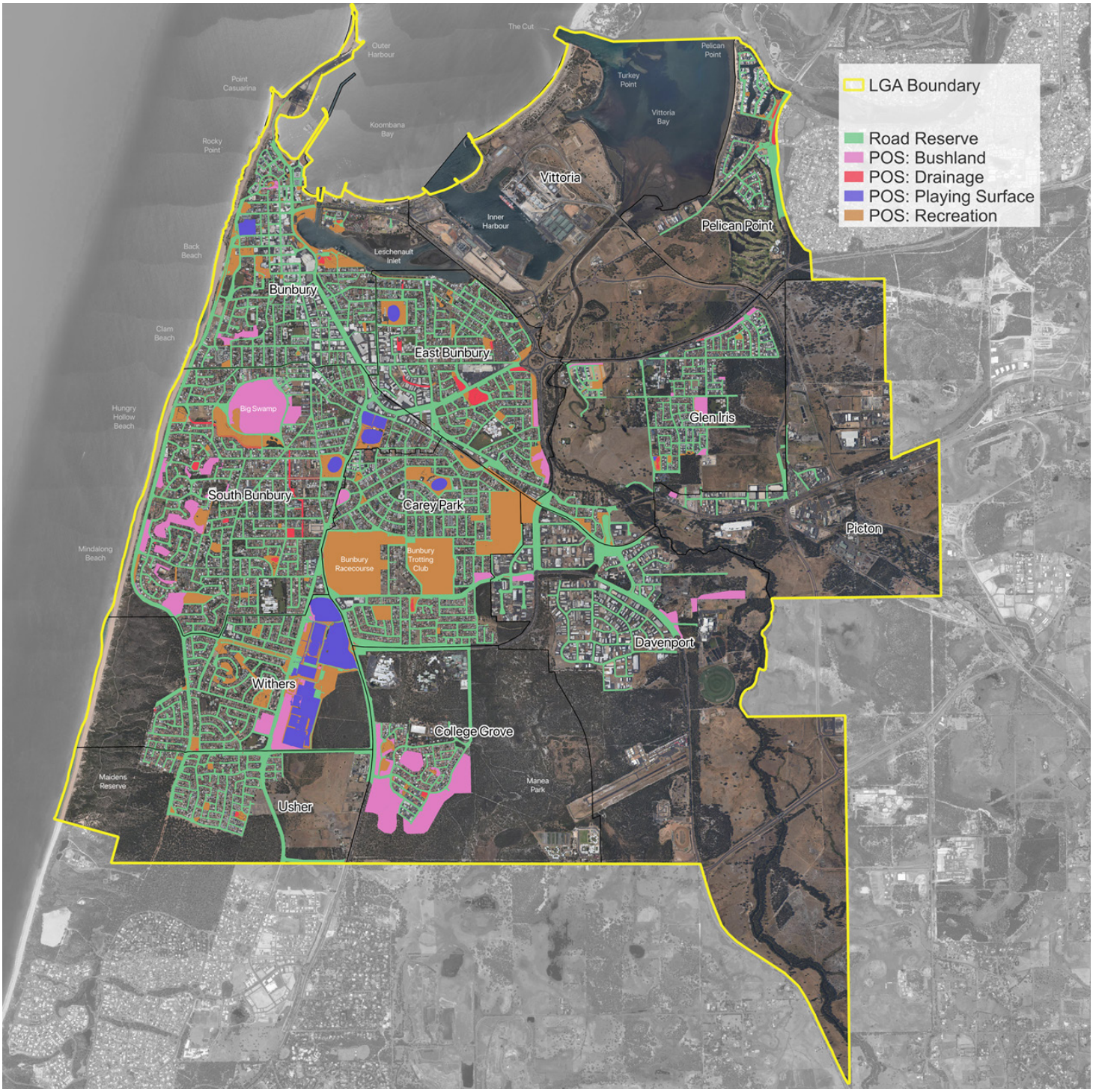


Figure 12: The City of Bunbury boundary highlighting the major Council-managed land use categories defined in this Plan. Bushland, Drainage areas, Playing Surfaces, Recreation areas and Road Reserves.

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These categories have variable levels of canopy cover and different total areas across the City (Table 3). Furthermore, each of the identified land use categories has a different capacity to support additional greening based on the other land use requirements. For example, Road Reserves may have lower initial canopy cover than Bushland, and therefore greater potential to increase canopy cover. Conversely, Playing Surfaces are required to be virtually free of vegetation other than turf; therefore, these areas were not considered in setting targets for the Greening Plan. However, most Playing Surfaces are surrounded by areas of Recreation; these sportsground surrounds are areas that can be targeted for greening.

Road Reserves and Recreation were identified as the categories with the two greatest opportunities for increasing greening on public land. Road Reserves occupy a large area, over 657 ha, and currently have low canopy cover relative to other land use categories. Road reserves also typically have few uses that conflict with vegetation, except for traffic visibility, vehicle clearance, and competition from power lines. Road Reserves are also one of the first features of the City that are seen by people travelling to or passing through the City, therefore they have great potential to make a large impact on visitors in their perception of place and to encourage people to spend more time within the City.

5.3.1 Canopy Potential Estimates – council land

For establishing meaningful and achievable canopy area targets, the potential canopy cover within Council-managed land was investigated. Visual and quantitative examples of different land use types were provided with varying proportional canopy cover. Data for canopy cover area was derived from the ArborCarbon-produced 2020 dataset and street level views were derived from Google Street View. These examples were reviewed by council staff and a desired level of canopy cover for each area was discussed.

For the Drainage and Recreation areas, a Canopy Potential Estimate equal to the median of all parcels was set: 17.8% for recreation reserves, and 11.1% for drainage areas. Integration of the vegetation to achieve stormwater management outcomes including water quality should be reviewed as part of this canopy cover increase.

For Road Reserves, separate Canopy Potential Estimates were considered for residential verges and larger managed medians and road reserves. For the larger managed medians and road reserves the target canopy cover is based on raising road reserves to the 75-percentile level (20.9 % canopy cover). This was considered an ambitious aspiration, but not unobtainable because of the current low canopy coverage in these areas.

For residential verges a Canopy Potential Estimate was set to have one street tree for each land title. This was calculated using the City's street tree audit database and aligning each tree with the closest land parcel in the cadastre. Using this method, we calculated that this would require an additional 9,147 trees.

For Bushland parcels, a Canopy Potential Estimate was suggested to be that which is present in a typical healthy bushland site. To calculate this, a range of typical patches within the KRP were selected and the mean canopy cover was calculated to be 47%.

When considering targets, it is also important to consider the projected change in canopy cover over time based on current policy settings. The current annual budget available for tree planting and establishment is $155,000 with additional ongoing operating costs of $18,700 (Table 7). This allows for an increase in canopy along the lines of the 'Business as Usual' scenario outlined in Table 7. On the other hand, projected population growth over the coming 20-year period will inevitably result in loss of canopy area within freehold land to accommodate the expanding population. Based on the DPLH revised WA Tomorrow population estimates for Western Australia (2020) and using the Band-C projections estimate, the population of Bunbury is set to increase by 1860 people, from 32,780 to 34,640 by 2031. Recent analysis of the potential housing capacity

allowed under the LPS8 identified that 40% of potential dwellings were within greenfield development sites. The remaining 60% were from urban infill and development of mixed-use sites. Following these assumptions, the projected canopy loss by 2031 from residential freehold land is 3.38 ha.

Table 3 below illustrates Canopy Potential Estimates for each public land use type, for the duration of the Plan (20 years). These were determined using the levels for each City-managed land use type discussed above.

The land use categories Playing Surface and Freehold are not predicted to change, nor do they have a high opportunity to increase canopy; therefore, Canopy Potential Estimates for these categories are the same (no change). This is not to say that no effort would be required to meet these estimate levels, and pressures from development in these areas may result in unexpected loss of vegetation which will need to be compensated if future targets are to be achieved.
Road Reserves have been recognised as one of the biggest opportunities for increasing canopy cover. The Canopy Potential Estimate for Road Reserves is 13.5%, reflecting an increase of 36.39 ha of canopy.

Table 3: City of Bunbury 'Urban area' canopy cover potential estimate.

	Current Canopy		Canopy Potential Estimate			
	area (ha)	Canopy (ha)	Canopy(%)	Canopy (ha)	Canopy Change (ha)	Canopy(%)
Bushland	138.0	40.0	29.0	50.0	10.0	36.3
Drainage	16.0	2.7	16.8	3.2	0.5	20.1
Playing Surface	63.0	1.1	1.7	1.1	0.0	1.7
Recreation	231.0	38.9	16.8	46.4	7.5	20.1
Road Reserve	661.0	52.6	8.0	89.0	36.4	13.5
Freehold & Public Purpose	1870.0	165.7	8.9	162.3	-3.4	8.7
Total - Urban	**2979.0**	**302.8**	**10.2**	**353.8**	**51.0**	**11.9**

Rural land and the KRP were included to summarise the predictions for the entire LGA (Table 4). There is no major anticipated change in canopy predicted for the KRP and Rural areas, therefore their Canopy Potential Estimate has remained unchanged. In view of this, the Canopy Potential Estimate canopy cover is 11.9%, reflecting an increase of 54.4 ha (all from the Urban area), minus 3.4 ha from Freehold & Public Purpose, reflecting an overall change of 51 ha.

Table 4: Total City of Bunbury canopy cover targets.

	Current Canopy		Canopy Potential Estimate			
	area (ha)	Canopy (ha)	Canopy(%)	Canopy (ha)	Canopy Change (ha)	Canopy(%)
Urban	2979.0	302.8	10.2	353.8	51.0	11.9
KRP	**1095.2**	**254.9**	**23.3**	**254.9**	**0.0**	**23.3**
Rural	2611.8	295.8	11.3	295.8	0.0	11.3
LGA Total	**6686.0**	**853.5**	**12.8**	**904.5**	**51.0**	**13.5**

5.3.2 Planting Priorities

Expanding the City's vegetation cover should also be done with an awareness of how current cover varies between the City's suburbs and where opportunities exist to plant to increase canopy cover, whilst achieving the greatest impact on the liveability of suburbs. Section 2.5.2 outlines canopy cover in each suburb.
Areas with lower current canopy cover (like Bunbury and South Bunbury) may have greater total potential for canopy increase than those areas with high canopy cover (like College Grove and Davenport). Furthermore, to maximise the social, health and economic benefits of vegetation across the City, equity of canopy cover and access to green space should be an important goal, along with mitigation of the UHIE. Suburbs with low existing canopy cover are therefore priority areas.

The built-up areas of Usher, Withers and Carey Park (excluding the KRP) are low in canopy cover and are urban hotspots (see Section 2.5.2). These are examples of key areas that initial plantings could focus on, as guided by Forest Precinct Plans once developed (see Section 6.1.1). There are particular thermal hotspots in these suburbs, and areas of POS with particularly low canopy cover; the City can use the airborne data captured by ArborCarbon to help guide specific decision-making.

5.4 Targets

The City has determined two different canopy cover targets for the urban area of the City for the 20-year period covered by this Plan.

To come up with these targets, a detailed consideration of the calculations above was conducted.

From this, the options for increasing canopy cover were considered, and the 10% and 20% target levels decided on.

Note that these targets guide plantings for a 20-year period; the 10% and 20% targets refer to increases in canopy that will be achieved once all trees planted in that period approach maturity, not achieved straight away at the end of the 20 years.

A key target of a 10% increase in canopy cover

An aspirational target of a 20% increase in canopy cover

5.5 Costings and Funding

5.5.1 Costings

5.5.1.1 Bushland

Several assumptions were made regarding the costs associated with re-vegetation. The planted cost per tube stock can be accurately estimated from historic accounts; however, it is more difficult to translate this into area of bushland and canopy area successfully established, particularly as only a fraction of the plants established are trees. The purpose and value of bushland revegetation extends beyond those benefits provided by tree canopy alone, which is a greater focus in other urban areas. We assume that approximately 4 tube stock are planted per square metre at establishment, and the outcome of a successful revegetation planting is to achieve a canopy cover similar to an average existing bushland within the City of 47%. This factors in average attrition rate, as not all 4 plants per meter are required to achieve the expected canopy density. Using these numbers, we calculate a per ha cost of $222,000 per ha planted and $472,340 per ha of canopy cover.

Table 5: Typical Bushland revegetation costings

	Bushland establishment cost
Tubestock planted per m2	4
planted cost per tube	5.55
Cost per planted ha	$ 222,000.00
Final average canopy density	47%
Cost per ha Canopy	**$ 472,340.43**

5.5.1.2 Street and park trees

Street tree establishment costs were again taken from historic accounts from the City. This was then translated into a cost per hectare of canopy cover based on an average mature canopy size and an estimated survival rate of 75% over 20 years. The average canopy size was calculated separately for trees and parks throughout the City. Street trees are on average smaller than those in parks due to constraints around powerlines, rooting volume, as well as irrigation and other management which typically assist tree vigour in parkland area compared with streets and residential verges. As a result, the cost per hectare is greater for street trees than park trees. One important factor which is not considered is the effect of tree species. All tree species are roughly the same cost to purchase and establish. However, larger tree species will provide a much greater area of canopy (and therefore shade and other benefits) per unit of cost. Large trees are not suitable for all areas, but they should be prioritised where space permits.

Table 6: Summary costings for Road Reserve tree establishment.

	Park trees	Street trees
Average canopy size after 20 years (m2)	37.5	28.8
Survival rate (20 year)	0.75	0.75
Cost per tree	$403.09	$403.09
cost per ha canopy	**$143,320.89**	**$186,615.74**

5.5.2 Budget Estimations

Business as Usual (BaU) targets are based on projected canopy changes and current levels of funding for street tree establishment and bushland revegetation. Using the summary cost estimations above, estimations of required budget to meet both the Key and Aspirational targets were calculated. The proportional contribution of each land use type (based on Table 3 calculations) was used to calculate the contribution of each land use type, and multiplied by the costs of bushland revegetation, park tree canopy plantings and street tree plantings to determine the annual capital investment required. Recreation and Drainage were combined to determine a shared contribution, as both used park tree costings in calculations. Then the annual ongoing operating expenses were calculated using the proportion used by the City for Business as Usual ($18,700 vs $155,000).

Table 7: Calculation of required investment for different target canopy increase levels.

Scenario	Business As Usual	Key Target	Aspirational Target
Canopy Increase (%)	4.4%	10%	20%
Total Canopy (ha)	316.2	332.20	363.36
Total Canopy (%)	10.61	11.15	12.2
Bushland canopy increase contribution (ha)	2.45	6.19	11.75
Road reserve canopy increase contribution (ha)	8.91	22.51	42.76
Recreation and Drainage canopy increase contribution (ha)	1.96	4.96	9.42
Capital Investment per year	$155,000.00	$391,768.96	$744,022.39
Ongoing Operating Expenses per year	$18,700.00	$47,265.03	$89,762.70

5.5.2.1 Achieving Aspirations

Both the key and aspirational targets will require an increase in Council funding. Complementary funding sources to support each target are also found in Section 5.5.3. The aspirational 20% target is also above the Canopy Potential Estimate from Table 3. If the City were to attempt to achieve this target on Council-managed land alone, it would need funding of more than $700,000 per year, to achieve canopy levels well above the already high Canopy Potential Estimate. Rather than attempting to do this across the Council-managed area of public land, the City could instead aim for this target by actively encouraging planting across private freehold and public purpose land. Encouraging residents, businesses, and industry to green freehold land can be done in a range of ways, explored in Sections 2.6.4, 4.4 and elsewhere in this Plan. Encouraging community plantings across residential, commercial, and industrial land would offset the losses from infill and greenfields developments and increase canopy levels outside Council-managed land.

5.5.3 Funding

State Government Funding

Lotterywest and Healthway have aligned their grant-awarding Plan to maximise community support.
Under the Lotterywest and Healthway Community Investment Framework the City of Bunbury is eligible to apply for funds to support research projects that:

- Address WA social, cultural, medical, economic, geographic, health and environmental issues
- Inform policy or practice
- Result in learning that can be transferred into practice
- Bring researchers, practitioners, policy makers and consumers together
- Have findings which will be broadly distributed and accessible; and
- Are not part of an academic qualification

This presents an opportunity for the City of Bunbury to seek funding to directly support some of the research gaps that exist in Western Australia. Potential examples of such topics include:

- Screening of tree species for drought and heat tolerance in a changing climate.
- Determining the impact of street design and tree selection on mitigation of urban heat.
- Determining the relationship between human health and proximity and abundance of urban green infrastructure using remote sensing methods.
- Screening of trees and trialling of treatments for managing tree health disorders.
- Trialling real-time smart sensors for monitoring soil moisture, tree water use and temperature for targeted watering.

Funding for water management projects is also available from time to time. This represents an opportunity to achieve canopy cover plantings within stormwater management assets.

The Australian Research Council (ARC) Linkage Program is currently open, and the City of Bunbury is eligible to apply in partnership with researchers, business, industry, community organisations, and other publicly funded research agencies. The Linkage Projects grant opportunity supports projects which initiate or develop long-term strategic research alliances to apply advanced knowledge to problems or acquire new knowledge, and as a basis for securing commercial and other benefits of research. The project would be led by a University and a cash and/or in-kind contribution would be required from the City of Bunbury with funding of $50,000 to $300,000 available per year for two to five years.

The National Health and Medical Research Council (NHMRC) is the Australian Government's primary health and medical research funding agency. There is a wide range of funding schemes available, and these are open at different times with different levels of funding. Lead organisations would be medical institutes and universities with the City of Bunbury partnering. Some of the relevant schemes that are currently open include:

- Ideas Grant Scheme – funds innovative and creative research and may be funded in conjunction with other organisations. These grants offer opportunities to researchers whose work is particularly relevant to the priorities and research interests of the partner organisations.

- Partnership Projects – provides funding and support to create new opportunities for researchers and policymakers to work together to define research questions, undertake research, interpret the findings, and implement the findings into policy and practices.

- Development Grants – provides financial support to individual researchers and/or research teams to undertake health and medical research at the proof-of-concept stage that specifically drives towards a commercial outcome. The developed product, process, procedure, or service, if applied, would result in improved health care, disease prevention or provide health cost savings.

A great deal of research on the connection between urban forests, green infrastructure, urban design, and human health has been conducted overseas or along the east coast of Australia. There is a need for similar research to be conducted within WA.

Private Sector

Voluntary Planning Agreements made between council and land developers may provide for either or both funds and space to be directed towards community facilities such as trees. Policy options could be explored to mandate new tree establishment during the design and approval of new developments, to offset the direct costs to council associated with achieving the Greening targets. Large organisations that reside within the City could be invited to invest in greening initiatives presenting an opportunity to provide the community with many of the benefits provided from increasing green space as detailed in this Plan. Health Care and Social Assistance employs more people in the City of Bunbury that any other industry. This presents an opportunity to align the objectives of the City's Greening Plan with those of some of the private healthcare providers.

The City of Bunbury could also establish a 'Greening Fund' using the City of Melbourne's 'Urban Forest Fund' as a model. The City seeks corporate organisations, charities and NGO's to help deliver projects, with greening project funds matched dollar for dollar by the City. Each project must meet a range of criteria to be eligible for funding and located on land owned by the applicant. Funds range from between $25,000 and $500,000. Projects are prioritised for areas with low canopy cover or public accessibility, located in Urban Heat Island hotspots, and must contribute to community health and well-being, and use innovative approaches that support further research. All these criteria align with these actions within this Plan.

6 Implementation and Monitoring

6.1 Action Plan

Short term	1-2 years
Medium term	3-5 years
Long term	5-10 years
Ongoing	

Goal		Action	Timeframe
Goal 1 - Protect			
	1.1	Undertake a detailed survey and inventory of all existing street, park, and reserve trees throughout the City, to further establish the current condition of the Urban Forest and assist in the development of Urban Forest Precinct plans.	Short term
	1.2	Investigate, review and develop local policies and guidelines that appropriately support the protection and enhancement of existing urban forest.	Medium term
	1.3	Review and update the City's Tree Management Policy and Road Verge Treatment Corporate Guideline to align with the vision, goals and objectives of this Plan.	Medium term
	1.4	Develop an integrated Weed, Pest and Disease Management Plan with a focus on appropriate hygiene practices for staff and contractors.	Long term
Goal 2 - Enhance			
	2.1	Develop Urban Forest Precinct Plans for each suburb within the City and the CBD, that identify opportunities for greening initiatives across all of the five reserve categories, outlined in the Plan.	Short term
	2.2	Undertake a review of the City's existing capacity for the implementation phase of this Plan, with a view to increasing FTE resources, if deemed necessary to successfully implement the key actions of the Plan and better manage the City's Urban Forest, into the future.	Short term
	2.3	Develop planting specifications in line with industry best-practice standards for use by the City, developers and contractors when implementing greening initiatives.	Medium term
	2.4	Ensure the Plan is adequately funded through annual capital and operating budget allocations to deliver the Plan's key goal of a 10% increase in canopy cover over 20 years.	Ongoing
	2.5	Continue to deliver annual planting programs and other greening and urban forest restoration initiatives.	Ongoing
Goal 3 - Connect			
	3.1	Develop a detailed community engagement framework that clearly identifies how the City will engage with the community throughout the implementation of the Plan and the development of Urban Forest Precinct Plans.	Short term
	3.2	Investigate opportunities to partner with the community, private sector, developers and other agencies to support the ongoing implementation of the Plan.	Ongoing

3.3	Develop a list of suitable tree and understorey species for use by the City, community and developers to implement greening initiatives in conjunction with the preparation of Urban Forest Precinct Plans.	Short term
3.4	Develop a range of educational material targeted at the general community and developers to promote the importance of protecting and enhancing the City's Urban Forest.	Long term
3.5	Conduct regular community planting days to involve and engage with the community and seek feedback on the ongoing implementation of the Plan.	Ongoing
3.6	Investigate opportunities to access funding through grants and other external funding sources to support the ongoing implementation of the Plan.	Medium term

Goal 4 - Monitor

4.1	Undertake airborne imagery acquisition at regular intervals throughout the implementation of the Plan, to track progress towards achieving the Plan's key target of a 10% increase in canopy cover over 20 years.	Long term
4.2	Update the City's street, park and reserve tree inventory on a regular basis, to monitor the condition of the City's Urban Forest, identifying potential issues and guiding future planting priorities.	Ongoing
4.3	Develop and implement an internal auditing tool to monitor the success of annual planting programs and other greening initiatives.	Medium term
4.4	Regularly review planting specifications and standards to ensure they are in line with current industry best-practice standards and trends.	Ongoing
4.5	Regularly seek feedback from the community on the implementation of the Plan to ensure it is meeting their needs and expectations.	Ongoing
4.6	Undertake a detailed review of the Plan at the 10 year point, to monitor the City's progress towards its key target and ensure the plan remains relevant	Long term

6.1.1 Urban Forest Precinct Plans

A number of actions in the Action Plan above involve the development of Urban Forest Precinct Plans for each suburb in the City. These plans will examine greening in each suburb in close detail, identifying specific opportunities for planting programs. These plans will guide planting, monitoring and management of vegetation across the five reserve categories in this Plan, for each precinct . The plans will be a key part of delivering the vision, goals and key targets of the Plan over the next twenty years. The Precinct Plan key focus areas will include:

- Setting a clear vision for the precinct with a focus on protecting and enhancing the urban forest.
- Providing a detailed inventory and analysis of existing urban forest within each precinct.
- Determining the existing character and historical patterns of tree planting and landscape design within the precinct.
- Providing a clear a community engagement process to discover community values.
- Developing a species list for each precinct that balances ecological restoration principles with amenity planting requirements.
- Identifying where masterplans and/or reserve management plans are required for parks and reserves within the precinct.
- Identifying and setting priorities for planting across the five reserve categories in the Plan.

Forest Precinct Plans will be developed for each suburb in the City, as well as for the CBD.

7 Conclusion

As this Plan outlines, urban forests are clearly essential for the liveability of any City. Trees and other vegetation provide significant economic, social, health, visual and aesthetic benefits, through the provision of ecosystem services including air and water filtration, shade, habitat, oxygen production, temperature regulation, carbon sequestration and nutrient cycling. However, urban forests around the world are under threat. To remain sustainable and liveable into the future, the City of Bunbury is prioritising its greening.

With an average canopy cover level of 13.7% across the City, Bunbury has lower canopy cover than many Western Australian Local Government Areas and is below a measured median of approximately 20% across Perth LGAs.

The in-depth analysis of current canopy levels across the City in this Plan, as well as analysis of potential future canopy levels by land use type, has resulted in two suggested canopy targets for the City's urban area over the next 20 years:

1. A key target of a 10% increase in canopy cover over the 20 years.
2. An aspirational target of a 20% increase in canopy cover over the 20 years

This Plan will guide the City's greening policies and activities, to protect the existing urban forest, and expand and improve it to ensure it will be resilient and sufficient to provide the benefits necessary for a liveable and sustainable city into the future.

To achieve the goals and targets of the Plan, the City will undertake a range of Actions to protect, enhance, connect, and monitor the urban forest. A key part of this will be the development of a series of Urban Forest Precinct Plans for each suburb in the City. These plans will examine greening in each suburb in close detail, identifying specific opportunities for planting programs. These plans will guide planting, monitoring and management of vegetation across the five reserve categories in this Plan, for each precinct.

Through these Forest Precinct Plans and the actions in the Action Plan, the City will aim to become a leader in urban forest management, protecting and expanding the urban forest that is such an important part of Bunbury.

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