

GREENING GREATER BENDIGO

A 50-year vision and 10-year action
plan for a greener Greater Bendigo



Acknowledgement of country

The City of Greater Bendigo is on both Dja Dja Wurrung and Taungurung Country.

We acknowledge and extend our appreciation for the Dja Dja Wurrung and Taungurung Peoples, the Traditional Owners of this land.

We pay our respects to leaders and Elders past, present and emerging for they hold the memories, the traditions, the culture and the hopes of all Dja Dja Wurrung and Taungurung Peoples.

We express our gratitude in the sharing of this land, our sorrow for the personal, spiritual and cultural costs of that sharing and our hope that we may walk forward together in harmony and in the spirit of healing.





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Executive summary

The fifty-year vision of this strategy is justifiably long. The life of a single tree will span several human generations. With good planning and foresight, the trees we plant today will leave an enduring legacy on the landscape of Greater Bendigo and for future generations.

The challenges facing Greater Bendigo's urban forest threaten the health of the natural environment, the health of our residents and the liveability of our City and townships. These challenges are complex and effective strategies to overcome these can only be successfully tackled with ongoing commitment over the long-term.

A ten-year action plan outlines the City's most immediate priorities and commitments to achieve the vision over the short-term and will ensure that the City's resources and paradigms are aligned accordingly. By 2030, we can look back, take stock and reset priorities for the coming decades in response to progress made, emerging challenges, the environmental and political climate and future technological advancements.

Vision

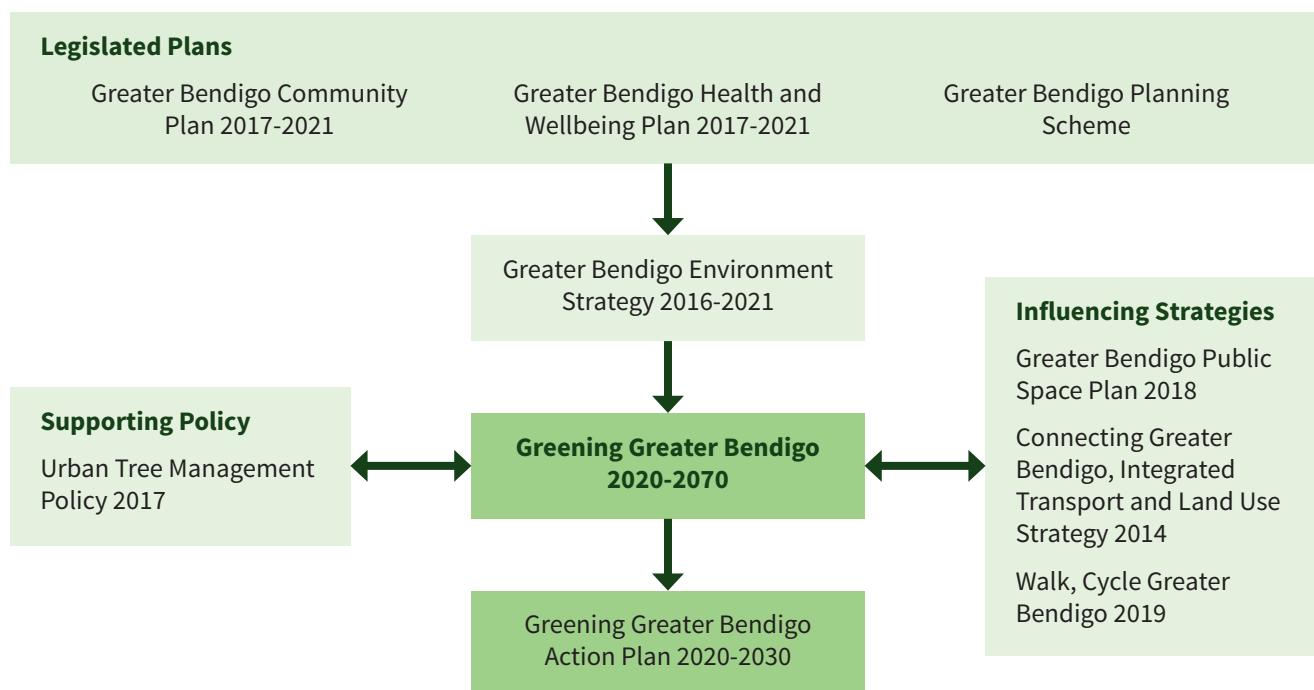
“Greater Bendigo: where the community values mindful development that enhances and conserves our environment, provides well-designed green spaces that promote community wellbeing and is conscious of our future climate.”

Youth Council, November 2019

The vision for Greening Greater Bendigo was written by Greater Bendigo's Youth Council with careful consideration of the community's aspiration and needs for such a strategy.

The vision supports the Council vision to be the world's most liveable community.

Organisational context



One Planet Living Framework

	Health and happiness	Encouraging active, social, meaningful lives to promote good health and wellbeing
	Equity and local economy	Creating safe, equitable places to live and work which support local prosperity and international fair trade
	Culture and community	Nurturing local identity and heritage, empowering communities and promoting a culture of sustainable living
	Land and nature	Protecting and restoring land for the benefit of people and wildlife
	Sustainable water	Using water efficiently, protecting local water resources and reducing flooding and drought
	Local and sustainable food	Promoting sustainable humane farming and healthy diets high in local, seasonal organic food and vegetable protein
	Travel and transport	Reducing the need to travel, encouraging walking, cycling and low carbon transport
	Materials and products	Using materials from sustainable sources and promoting products which help people reduce consumption
	Zero waste	Reducing consumption, re-using and recycling to achieve zero waste and zero pollution
	Zero carbon energy	Making buildings and manufacturing energy efficient and supplying all energy with renewables

The City of Greater Bendigo has adopted the One Planet Living Framework to help us realise our vision to become the world's most liveable community.

We only have one planet, but as a global society we're living as if we have several planets and consuming in ways which cannot be sustained. If everyone in the world lived like we do in Australia we'd need over four planets.

We have never had so much technology but social isolation, loneliness and poor mental health are increasing problems. Global animal populations are in sharp decline threatening our ecosystem and food systems, and human induced climate change is already having devastating consequences.

Greening Greater Bendigo has incorporated the One Planet Living Framework and the 10 One Planet Principles.



What is an urban forest?

An urban forest comprises all trees and vegetation within urban areas as well as the soil and water that supports it. An urban forest is made up of all vegetation in streets, parks, gardens, schools, creek and river verges, wetlands, transport corridors, community gardens, balconies and rooftops.^{1,2}

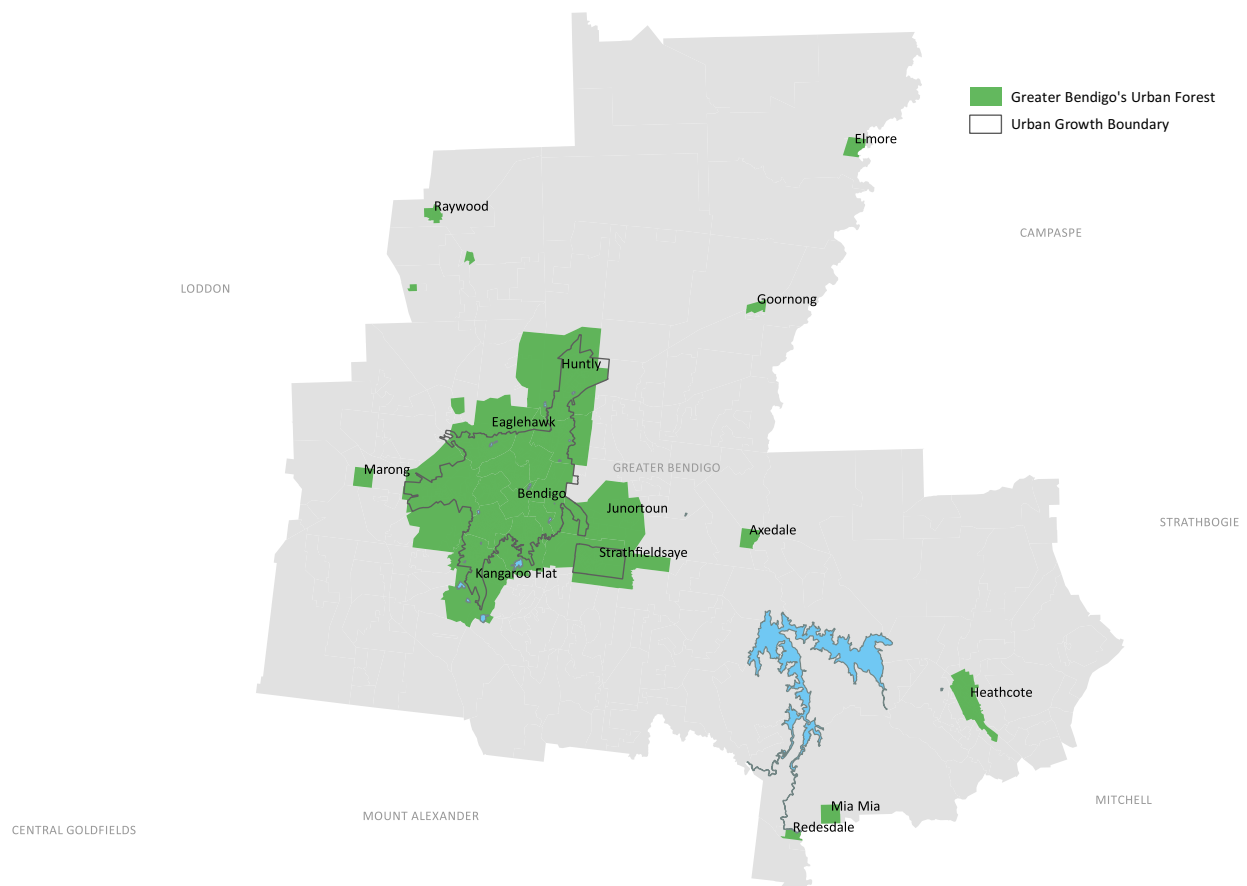
The practice of urban forestry, as distinct from arboriculture and horticulture, considers the collective benefits of the entire

tree population as well as other urban greenery across urban areas and townships. Urban forestry can be described as the science of managing trees and natural ecosystems in and around urban communities to maximise the physiological, sociological, economic, environmental and aesthetic benefits that trees provide society.³

Scope of Greening Greater Bendigo

The primary focus of Greening Greater Bendigo is on Council owned and managed land within urban areas and townships of Greater Bendigo. This includes; park and street trees; road reserves; parks and gardens; active and passive recreational reserves; urban vegetation; natural reserves within urban areas; waterways under City of Greater Bendigo management and; where planning controls can be implemented such as in new developments, overlays and subdivisions.

Under this strategy Council will also advocate for urban forestry on the interface of National and State Parks with urban areas, private properties and reserves and easements within urban areas managed by other agencies - particularly with Vic Roads around township entrances.



Greater Bendigo's Urban Forest.

1. 2020 Vision, How to Grow an Urban Forest

2. City of Melbourne, Urban Forest Strategy 2021-2032

3. Helms, 1998, Dictionary of Forestry Quoted in JC Schwab (Ed), 2009, Planning the Urban Forest

Context: Bendigo's urban forest – past, present and future

The City of Greater Bendigo covers almost 3,000 square kilometres, and along with Bendigo- Victoria's third largest city with a population of over 116,000 people- includes the townships of Axedale, Elmore, Goornong, Heathcote, Marong, Raywood and Redesdale.⁴

The urban area is almost completely encircled by 40,000 hectares of regional, state and national parks as well as many bushland reserves. For this reason, Bendigo is frequently referred to as a 'City in a Forest'. The Box-Ironbark forests around Bendigo are home to more than 200 species of birds, 44 species of mammals, 40 species of reptiles and 12 species of frogs.

Prior to European settlement, the region was covered in a mix of dry forest and woodland. In their original state, these forests would have consisted of open stands of tall, large trees. Nearly all that remains is significantly modified, including changed understory plants and multi-stemmed, more densely spaced trees. Many of the tree species, including red stringy bark, red box and yellow box were considered inferior for timber production and were deliberately removed or selected against in order to promote more desirable timber species such as ironbark, grey box and yellow gum.

A Brief History of Greater Bendigo's Urban Forest

Timeline	Event
Pre- European settlement	Traditional owner land management
1836	Major Mitchell passes through the region
1830s-1840s	Pastoralists arrive
1851	Gold first found at Golden Square; Gold rush – migrants; Clearing and mining; The advent of 'upside-down country'
1854	Township survey and first Sandhurst land sales; Pall Mall first surveyed; First crushing battery set up
1856	First Municipal Council elected
1857	Botanic Gardens established at White Hills
1860s	First parks established; 59 acres of land reserved for a park and George Brown appointed first curator of Rosalind Park; Blue Gums planted in Pall Mall
1871	Sandhurst proclaimed a City
1870s	Development of Rosalind Park including the planting of many shady and 'choice' trees – some of which were supplied by Ferdinand von Mueller from the Melbourne Botanic Gardens
1873	Samuel Gadd appointed as curator of Parks and Gardens
1879	Lake Weeroona opened
1891	Sandhurst renamed Bendigo
1898	Conservatory in Rosalind Park opened
1890s	100 miles of streets and roads in the goldfields planted including Elms, Planes, Blue Gum, Sugar Gum and Ironbark
Early 1900s	Plane trees planted in Pall Mall
1954	Post war development and no mines in operation
1960s-80s	Urbanisation and suburbia; Outdated tree management practices
1990s	Undergrounding of power in central Bendigo and planting of Plane Trees
1994	Council amalgamation
2002	Creation of Greater Bendigo National Park; The rise of the 'City in a Forest' concept
2000s	Millennium drought and water restrictions
2015	Introduction of proactive maintenance cycle for all City managed trees

4. About Greater Bendigo, <https://www.bendigo.vic.gov.au/About/About-Greater-Bendigo>



Bendigo's landscape – a Dja Dja Wurrung Perspective

The Box-Ironbark forests that sit atop the hills surrounding Greater Bendigo provided valuable resources for thousands of generations of Djaara. Sweet drinks were made using nectar from Eucalypts, Banksias, Callistemon and Melaleucas. The incredibly hard wood of Eucalypts served perfect for turning into spears and clubs, while the bark was utilised for shields, canoes, dishes, and roofing on shelters. These high points covered in Box-Ironbark forest also catered as a lookout for the local mob and accommodated for important ceremonial and spiritual practices.

Travelling down the slopes to the flat, open valley, grassed areas that border the Bendigo Creek, where thousands of residential properties are now placed, it would have been easy to see that these areas were intensely managed using fire because of the lack of understory vegetation and large, sparsely spread

Eucalypts - making future property development unobstructed. These open grasslands had an abundance of yellow, purple, white and pink flowers during the spring – but these colourful flowers were most valued by Djaara for their large, nutrient rich, crispy potato-like tubers located in the root system. Tubers were so prized by Djaara that we farmed the land using fire, and subsequently planted Murnong (Yam Daisy) in large crop-like plantings through the use of tools such as a digging-stick.

The trees of the Greater Bendigo Region are one of the most important assets to the Dja Dja Wurrung, whether they are being utilised for their wood, bark or nectar – or for providing some refreshing shade whilst taking a kip by the Bendigo Creek during the harsh Central Victorian summer.

Bendigo's landscape – post 1850

The initial push into Central Victoria by Europeans was by pastoralists in the 1830s and 1840s however the greatest change on the landscape came with the discovery of gold in the early 1850s. This generated an extraordinary period of development, broadscale clearing and urbanisation – the scars of which remain today and what the local Dja Dja Wurrung refer to as 'upside-down country'.

After clearing the forests for mining and associated development, Bendigo's town planners realised that if the City was to be a pleasant place to live some major changes would be needed. Original plans for Bendigo (formerly Sandhurst) and surrounding towns were drafted by Richard Larritt and allowed for wide malls, sweeping terraces, large lots and reserves for parks and gardens, and were later realised as the City was built up.⁵

Street trees were planted for beautification as well as a means of providing shade during the long hot summers. Bendigo's tree planting program begun in the 1860s and was substantially expanded in the 1870s.⁶ By the turn of the nineteenth century, it is claimed that around 100 miles of streets and roads in Bendigo had been planted. The City planted a mix of native and exotic trees with Elms (*Ulmus procera*), Planes (*Platanus x acerifolia*) and number of Eucalypt species making up the majority of plantings. This planting occurred before the arrival of powerlines allowing for complete avenues to persist.

*"Sandhurst, which was a place perfectly hideous in its desolation, probably without a parallel in its bad pre-eminence, has become one of the most attractive and healthful towns in Victoria... its streets are adorned by avenues of lofty trees, whose leafy bounty is the pride of its citizens, if not indeed the people of Victoria"*⁷

Public parks and gardens were also seen as a way of alleviating the unhealthy conditions associated with mining and industry, transforming overworked landscapes and providing spaces where people from different backgrounds and classes could

mix and recreate. Several areas were reserved as public parks and gardens in the 1860s including Rosalind Park, the Botanic Gardens in White Hills and Lake Weeroona. However, they were not developed until the 1870s when a more reliable water supply could be established.

The first major park developed in Bendigo was the Botanic Gardens. This was laid-out with various native and exotic tree species by Ferdinand von Mueller, government botanist and curator of Melbourne's Royal Botanic Gardens. In 1878 William Guilfoyle, the recently appointed director of Melbourne's Royal Botanic Gardens, was commissioned to design Lake Weeroona. Guilfoyle's plans included the planting of 1,600 trees including Bunya Pine, Figs and many species of Pine.

Bendigo enjoys a legacy of impressive, Victorian-era parks and gardens as well as various tree-lined boulevards and wide residential streets which help define the character of many older parts of Bendigo and rural townships.

Photos to the right:

- a. Pall Mall, 1861. The large, dying red gums in Rosalind Park is evidence of the original course of the Bendigo Creek.
- b. Blue Gums outside the Capital Theatre in View Street.
- c. View from Camp Hill looking NE circa 1875
- d. View from Knipes Castle circa 1875
- e. Sandhurst from Camp Hill, James Edwin, 1886⁸

5. Thematic Environmental History, final report, June 2013, Lovell Chen, Adopted by CoGB July 31 2013

6. Inventing Traditions in Goldfields Society: Public Rituals and Townbuilding in Sandhurst, 1867-1885, 198, 200

7. Royal Commission on Conservation of Water - First Report, in *New South Wales Parliamentary Papers*, 1885, p.129

8. Meadows, James Edwin, Sandhurst from Camp Hill, 1886, On long term loan from City of Greater of Bendigo 1995, Bendigo Art Gallery





Bendigo's landscape – the urban forest in the 20th Century until now

By the turn of the twentieth century, the state forests around Bendigo were beginning to be managed in a more systematic way so that a reliable, ongoing supply of timber could be secured and by the late 1920s, state forests in the Bendigo district reportedly covered more than 100,000 acres. At this time also, municipal open spaces were trending away from formally landscaped gardens, to more natural landscapes and bushland reserves were established such as Lake Tom Thumb, Lake Neangar and Spring Gully Creek.

For much of the twentieth century, many of Bendigo's public trees received little to no care and when they did were often 'mutilated' by people with no understanding of proper tree management.

During the 1950s the then Bendigo City Council cut all the trees to a height of 20 feet. After a period of two or more years these trees were further pollarded to reduce their height to 12 feet. In many instances this action ruined the trees leaving them as a solid trunk with excessive regrowth and prone to decay. This practice left a legacy of poorly structured trees of which many remain today. It was reported by the then superintendent of parks and recreation that in 1979 Bendigo City Council had approximately 15,000 trees. 70 per cent required removal

because of the poor management that had taken place in the decades prior.⁹

During the 1970s and 1980s approximately 2,500 street trees were planted annually. It was reported that planting holes were often dug with jackhammers to overcome some of the rockier areas. Many of these 'native style' plantings, popular during this era and planted widely across Melbourne, were not particularly well-suited to Bendigo's relatively harsher climate and many plantings were short-lived.

In 1994 the then City of Bendigo amalgamated with the Borough of Eaglehawk, Rural City of Marong and the Shires of Strathfieldsaye, Huntly and parts of the Shire of Mclvor to become the City of Greater Bendigo.

By the turn of the millennium in excess of 13 kilometres of above-ground powerlines in central Bendigo were put underground enabling the provision of complete tree-lined avenues in the central Bendigo once again. The increase in shade and greenery has not only improved the amenity of the city centre, it has contributed to creating a high-quality public realm and the rise of outdoor dining.

9. Street Trees and their Management – Bendigo, Andrew Taylor in Street Tree Directory, Royal Australian Institute of Parks and Recreation, Victorian Region, 1981, edited by T.E. Arthur and S.D. Martin



The Current State of Urban Tree Management in Greater Bendigo

A proactive works program was introduced for the City's trees in 2015, dividing urban areas and townships into 17 maintenance zones. As part of the program, each City tree is inspected and worked on as required and all obligatory electrical line clearance is undertaken. The introduction of the proactive program resulted in the removal of many large trees with significant defects that had never previously been inspected. Four hundred large dead, dying and dangerous trees were removed in Spring Gully alone.

2019 saw the completion of one rotation of all 17 zones. Given the extensive works and removals that have been undertaken since the introduction of the program, the severity, size and urgency of defects in future cycles is expected to dramatically decrease resulting in a reduced spend on contractors and zones being completed much faster. Although it is anticipated that this will be accompanied by a reduced spend on the proactive cycle, moving forward, the proactive program will need to absorb an additional 25,000 trees that were captured in a recent survey that are under Council management, an increase in the City's tree population of over 25 per cent.

In 2017, an Urban Tree Management Policy was endorsed by Council which providing a framework for an equitable, transparent and consistent approach to the management of the City's trees. The Policy introduced standards for tree protection, management and planting and clearly defined the circumstances under which City trees may (or may not) be removed. According to Parks and Open Space staff, the introduction of the Policy has resulted in a substantial decrease in the number of City trees being removed for civil works and development and as a result of customer requests. The Policy also introduces the Australian Standard for the procurement of landscape trees as well as industry best practice tree planting procedures for all staff, contractors and developers involved in establishing City trees, giving all new City trees the best chance of fulfilling their long-term intended function and avoiding costly interventions at a later date.

Although the City's arboricultural practices have come along way over the past two decades there is still room for improvement. Areas that require greater attention are tree replacement which is not currently keeping pace with the number of tree removals, and tree establishment with disappointing success rates of establishment post the two-year initial maintenance period.



What's Working Well

- Proactive maintenance program
- Introduction of the Urban Tree Management Policy
- Tree inventory and asset management
- Timely completion of reactive requests
- Electrical line clearance

What needs improvement

- Establishment of young trees
- Infrastructure conflicts
- Tree replacement not keeping pace with removals
- Ad hoc tree planting in the absence of guiding strategies and master plans
- 'Significant trees' on private property not protected with statutory controls



Health Check – Bendigo’s current Urban Forest

Bendigo is fortunate to have a legacy of good design and foresight by our forefathers. Wide streets, avenues of elms and planes, quality parks and gardens as well as the establishment of national, regional and state parks have placed Greater Bendigo in good stead to support a unique urban forest. But tree populations are dynamic and are constantly growing and adapting to changes in the environment. On the surface it may appear that Bendigo has a thriving urban forest but how well are we really doing? We must not be complacent and ensure that Greater Bendigo’s urban forest is resilient, robust and replenished to continue to deliver services to the community and the environment both now and into the future.

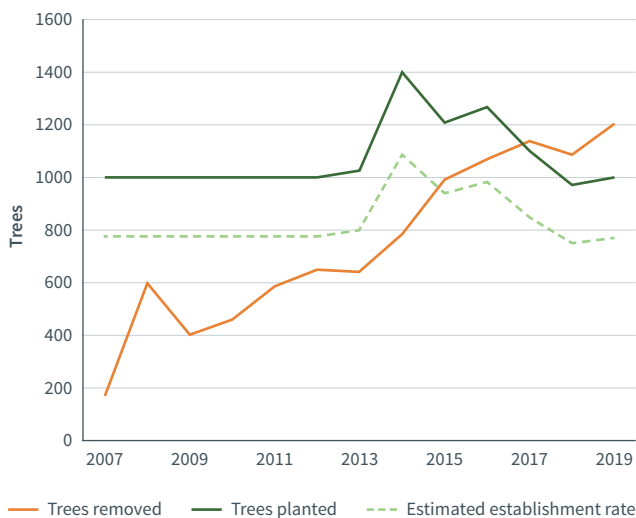
Tree Removals V Planting

Since 2007 the number of removals of City managed trees has steadily been increasing and now averages 1,200 trees per year. Over that same period, the City’s tree planting program has remained static and resulted in the planting of between 1,000-1,100 trees annually. The City is now removing more park and street trees than it is planting.

These numbers are conservative as the tree removal figures do not consider trees that have been removed that were not on the City’s database, trees removed as part of the proactive maintenance program nor trees removed for development, works or through storm events.

The numbers also assume that all trees that were planted survived, yet this is not the case. Losses of newly planted trees are as high as 30 per cent in some instances further exacerbating this deficit.

Tree Planting vs Removal

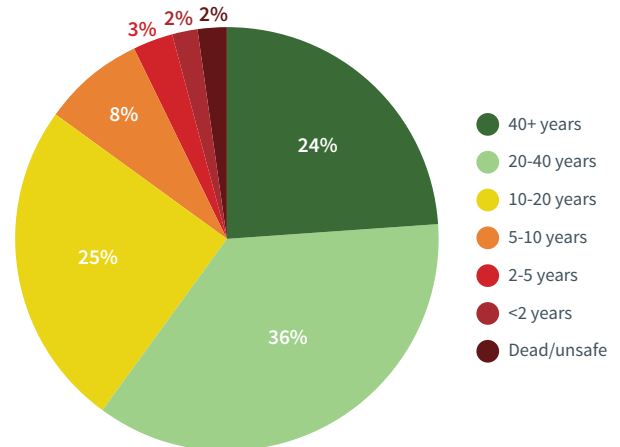


Since 2007, the rate of tree removals by the City Greater Bendigo has steadily increased and this trend is forecast to continue. Tree planting is not keeping pace with the rate of removals and this trend will need to be reversed in order to increase tree cover over the long-term and meet the targets of Greening Greater Bendigo.

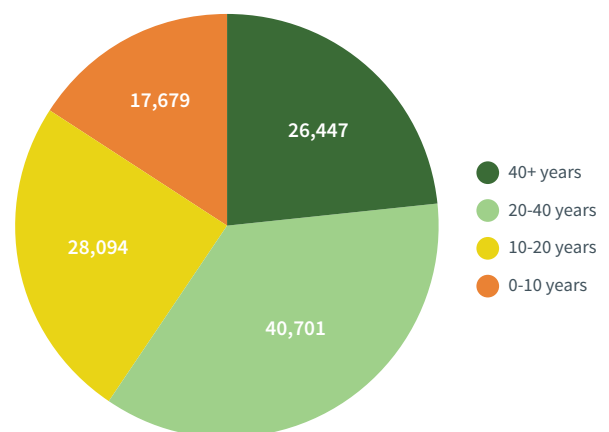
Projected Tree Losses

Greater Bendigo can expect to lose 15 per cent of all Council managed trees by 2030 to natural attrition alone. This translates to approximately 18,000 trees that will have to be replaced and significant investment over the next decade just to maintain existing tree numbers. This forecast does not include trees that are removed for other reasons such as for works or development or from storm damage. This figure also does not include the estimated 25,000 trees that have been lost since the previous tree inventory was completed in 2006, many of which have not been replaced.

Useful Life Expectancy



Estimated Tree Loss By Decade



The useful life expectancy of Council managed trees in urban Bendigo according to the recently updated tree inventory. By 2030 the City can expect to lose 15 per cent of all trees to natural attrition.

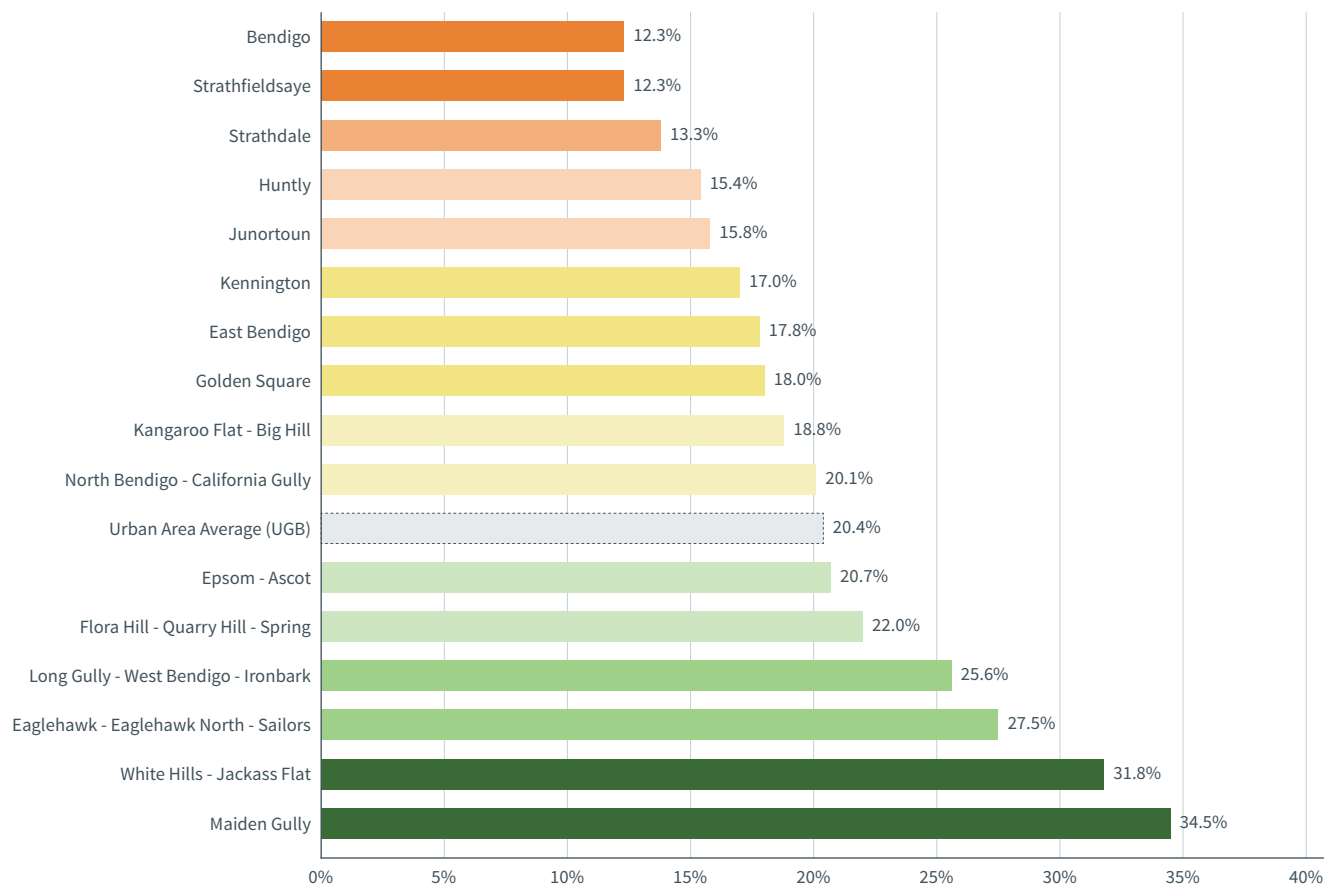
Urban Tree Canopy Cover

Tree cover is an important way of measuring the extent of an urban forest. A single large tree can shade a larger area than several smaller ones, so percentage cover is a greater indication of tree cover than counting individual trees.

The current extent of tree cover within Bendigo's urban growth boundary is 20.4 per cent.

Tree cover across urban Bendigo is uneven. Some precincts have much greater cover than average and others much less.

Tree Canopy Cover 2019



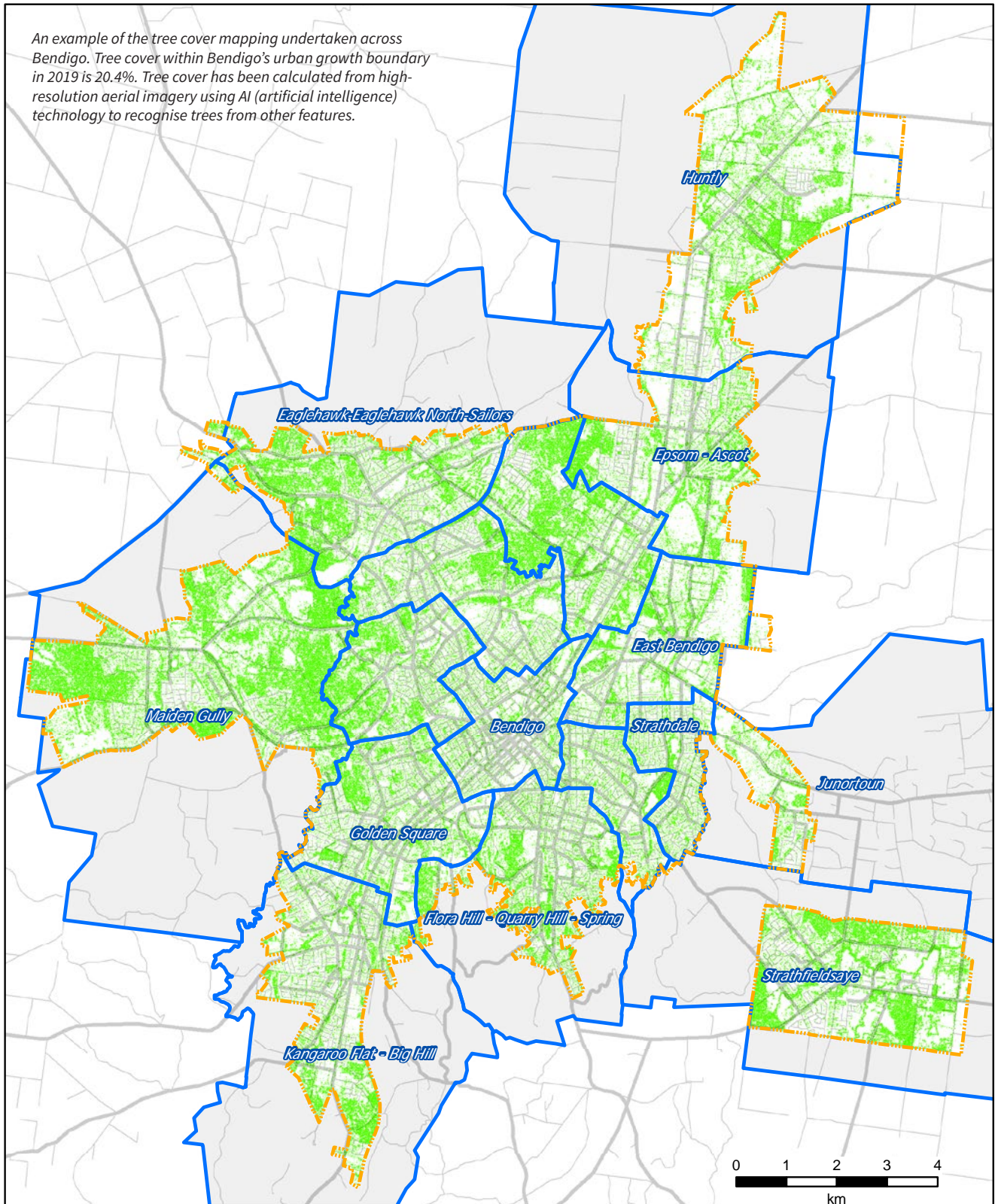
This graph shows the net tree cover of urban areas within the urban growth boundary in 2019.

It should be noted that only the tree cover within Bendigo's urban growth boundary has been mapped. For some of the outer areas like Huntly, Junortoun, Eaglehawk and Maiden Gully, only a portion of the precinct falls within the urban growth boundary. This explains why the percentage tree cover calculation shown is so low in some areas that are otherwise associated with being leafy or in proximity to naturally forested crown land.

Tree cover within the urban growth boundary is of particular interest as this is where the bulk of the community carry out their daily lives and where the benefits of Greening Greater Bendigo will be realised. The directions of this strategy will also be applied to other areas, including townships, of Greater Bendigo.



An example of the tree cover mapping undertaken across Bendigo. Tree cover within Bendigo's urban growth boundary in 2019 is 20.4%. Tree cover has been calculated from high-resolution aerial imagery using AI (artificial intelligence) technology to recognise trees from other features.



Legend

- Urban Growth Boundary
- Precincts Boundary
- Tree Cover 2019

Note: Scope of analysis is the precincts within the UGB



The same technology to map tree cover has been applied to map cover change over time. This is an important metric as it helps to determine trends in tree loss and the best policy mechanisms to reverse those trends. Arial images dating back to 2012 have been analysed for tree losses and gains. Since 2012 there has been a cumulative loss of tree cover as a well as individual trees across the urban area. This is consistent across all precincts and across all land tenures.

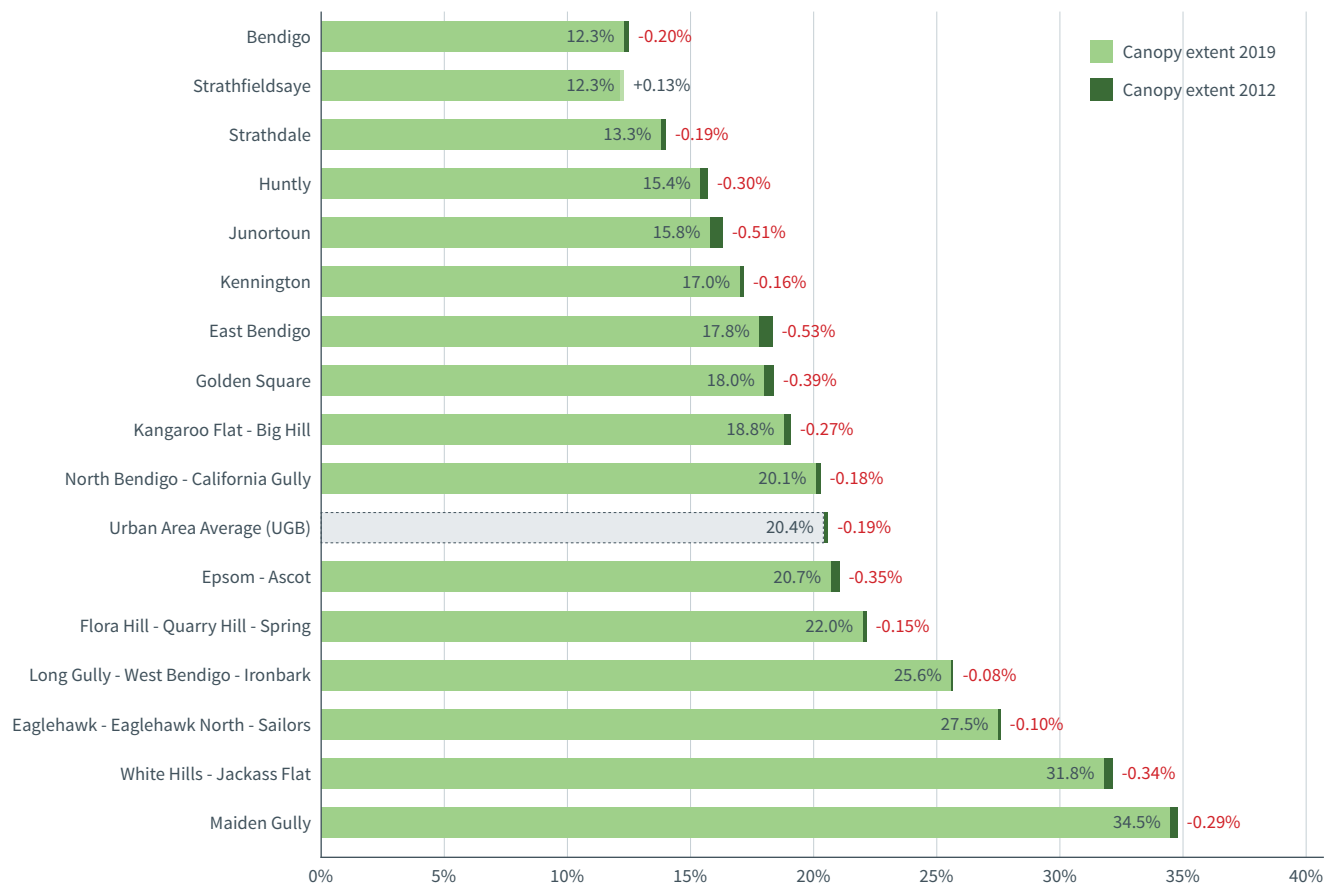


This map shows the current tree canopy extent for central Bendigo in green and tree loss since 2012 in red.

Land Tenure	Tree Cover 2012	Tree Cover 2019	Change
Urban Bendigo Average	20.59%	20.39%	-0.19%
Class 1 – Council managed land and streetscapes	21.48%	21.24%	-0.24%
Class 2 – Other public land	34.04%	33.97%	-0.07%
Class 3 – Private land	16.58%	16.36%	-0.21%



Tree Canopy Cover 2019



Tree loss within Bendigo's urban growth boundary is greatest in areas experiencing urban growth and development. There have been some increases in tree cover since 2012 as existing trees continue to grow and newly planted trees have become established. Overall however, there has been a decrease in tree cover. This trend must be reversed if the vision of Greening Greater Bendigo is to be realised.

The trend of increasing urbanisation and population growth not only threatens human health and well-being, it places considerable pressure on natural environments and systems, with potentially devastating consequences for biodiversity.¹⁰ Biodiversity in our cities is increasingly being threatened by changed microclimates, habitat simplification and fragmentation and the introduction of pest plants and animals.¹¹ Yet urban areas are an important refuge for native and threatened species with an estimated thirty percent of all threatened Australian plant and animal species found in cities.¹²

The retention and enhancement of natural spaces and managed public spaces for conservation are among the best means available for countering human impacts on natural areas and conserving urban biodiversity.

Strategies to increase tree cover across urban areas and townships of Greater Bendigo will include retaining existing vegetation in areas of relatively high existing cover and ramping up tree planting efforts in areas that have lower tree cover.

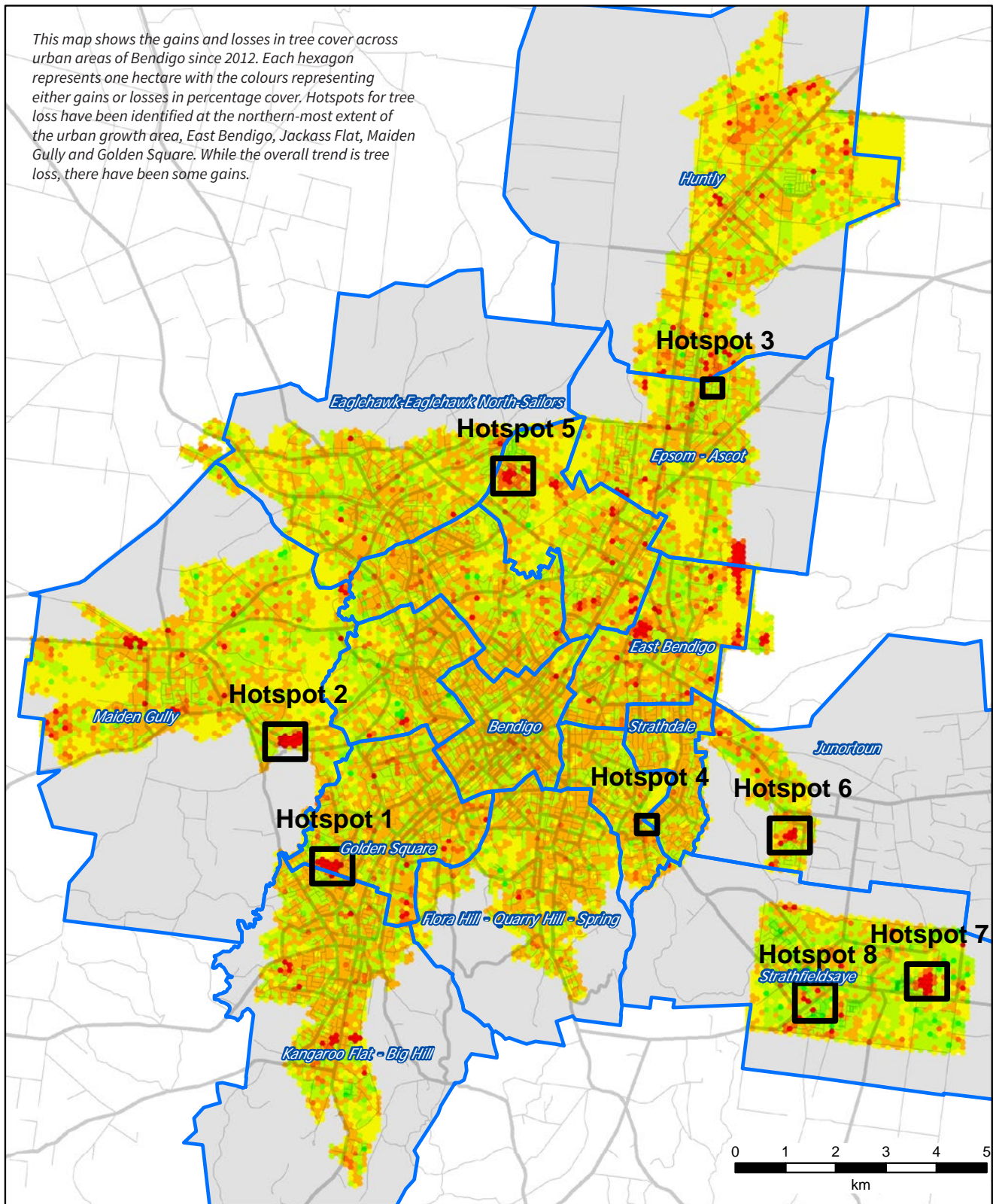
10. FAO, 2019, The State of the World's Biodiversity for Food and Agriculture

11. Threlfall, C.G., et al, 2017, Increasing biodiversity in urban green spaces through simple vegetation interventions. J Appl Ecol, 54: 1874-1883. doi:10.1111/1365-2664.12876

12. Ives et al, 2016, Cities are hotspots for threatened species, Global Eco. Biogeogr., 25: 117-126. doi: 10.1111/geb.12404

Tree canopy cover change hot spots

This map shows the gains and losses in tree cover across urban areas of Bendigo since 2012. Each hexagon represents one hectare with the colours representing either gains or losses in percentage cover. Hotspots for tree loss have been identified at the northern-most extent of the urban growth area, East Bendigo, Jackass Flat, Maiden Gully and Golden Square. While the overall trend is tree loss, there have been some gains.



Legend

Urban Growth Boundary	< -5.0	-2.5 - -0.1	0.0 - 2.5	5.0 >
Precincts Boundary	-5.0 - -2.5	-0.1 - 0.0	2.5 - 5.0	

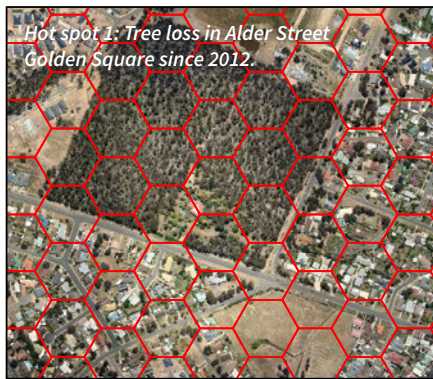
Tree Ledger data aggregated to 1ha hexagons.
Percent of foliage to change per hectare

Note: Scope of analysis is the precincts within the UGB

Data extracted from Bendigo Tree ledger copyright PlayerPiano Analytics 2020
a4_tenure_full_extent.mxd



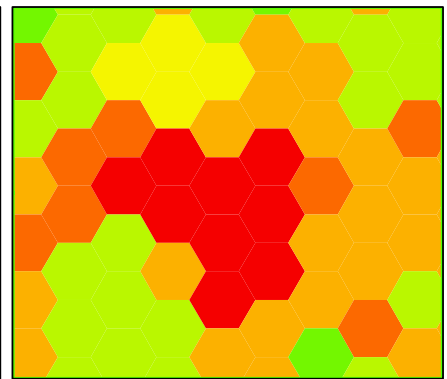
Canopy cover loss



Hot spot 1: tree cover 2012 imagery



Hot spot 1: tree cover 2019 imagery



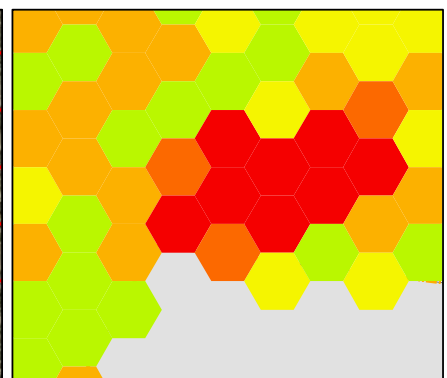
Hot spot 1 Tree Ledger aggregated change analysis



Hot spot 2: tree cover 2012 imagery



Hot spot 2: tree cover 2019 imagery



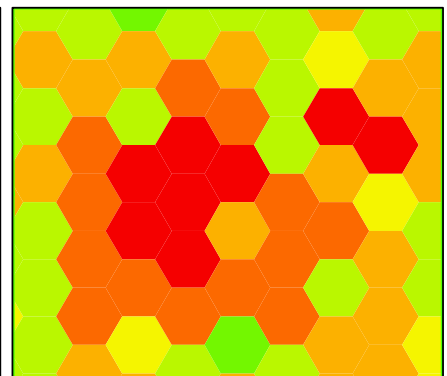
Hot spot 2 Tree Ledger aggregated change analysis



Hot spot 3: tree cover 2012 imagery



Hot spot 3: tree cover 2019 imagery



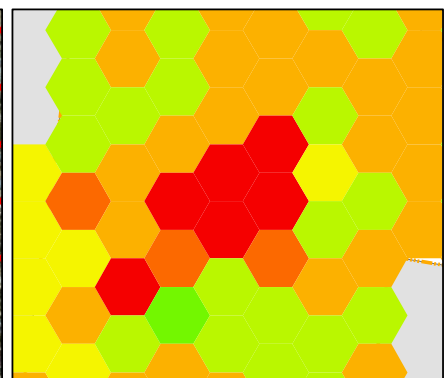
Hot spot 3 Tree Ledger aggregated change analysis



Hot spot 4: tree cover 2012 imagery

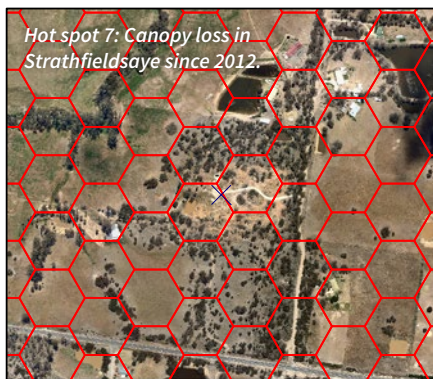


Hot spot 4: tree cover 2019 imagery

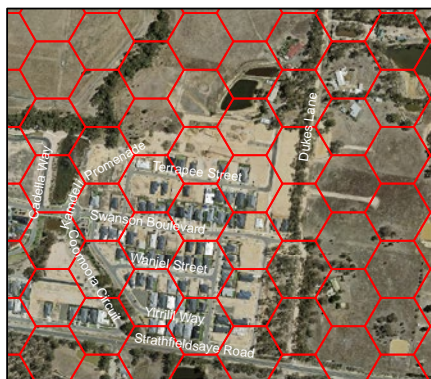


Hot spot 4 Tree Ledger aggregated change analysis

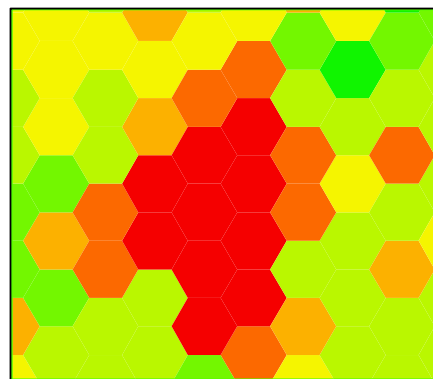




Hot spot 7: tree cover 2012 imagery



Hot spot 7: tree cover 2019 imagery

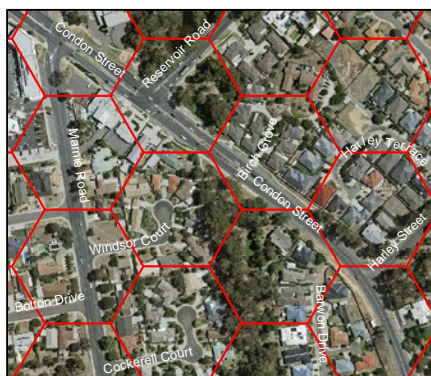


Hot spot 7 Tree Ledger aggregated change analysis

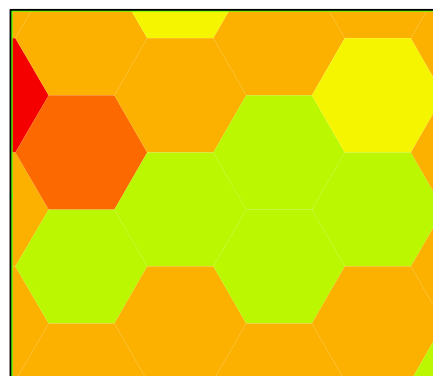
Canopy cover gain



Hot spot 5: tree cover 2012 imagery



Hot spot 5: tree cover 2019 imagery



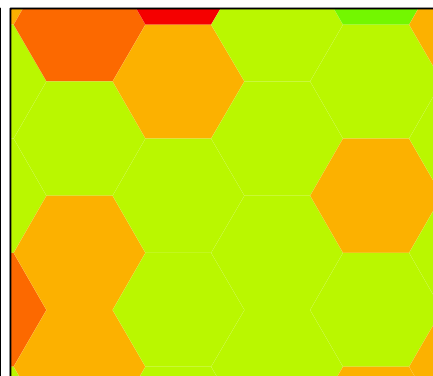
Hot spot 5 Tree Ledger aggregated change analysis



Hot spot 6: tree cover 2012 imagery



Hot spot 6: tree cover 2019 imagery



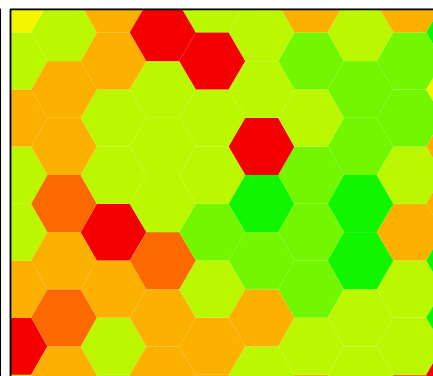
Hot spot 6 Tree Ledger aggregated change analysis



Hot spot 8: tree cover 2012 imagery



Hot spot 8: tree cover 2019 imagery



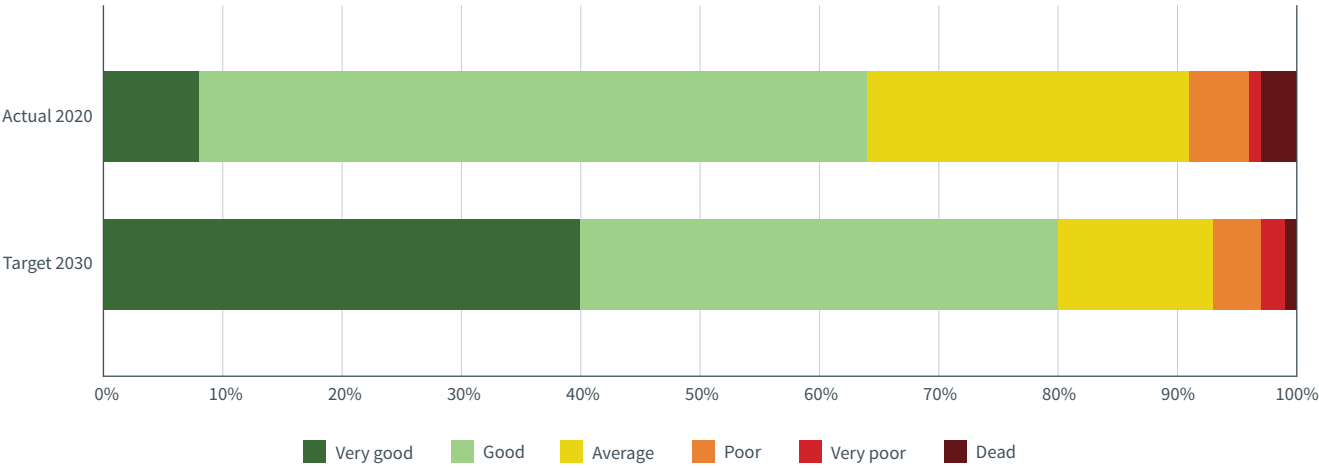
Hot spot 8 Tree Ledger aggregated change analysis



Tree Health

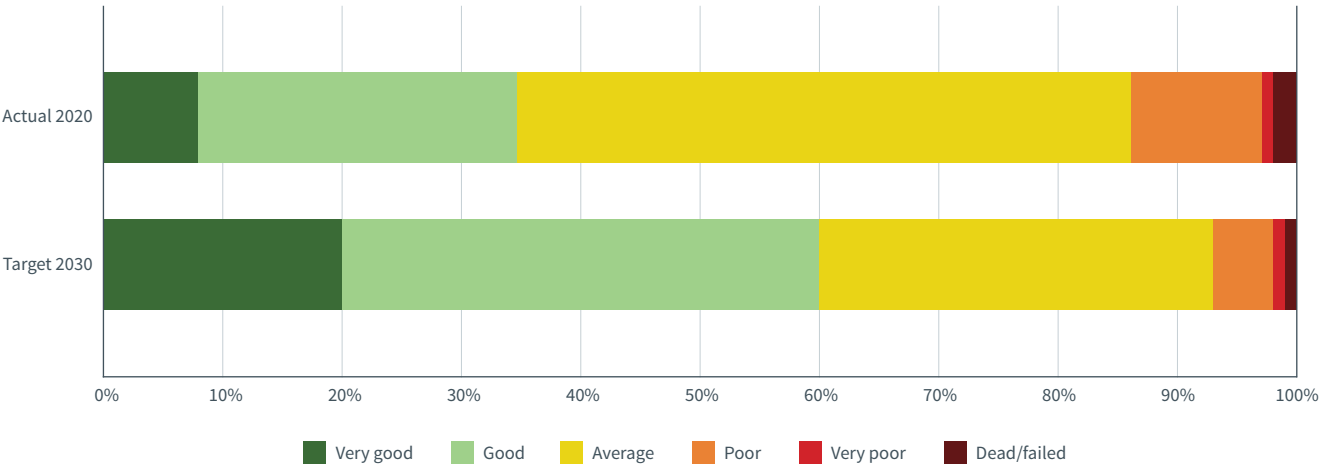
To maximise the benefits we derive from urban trees it is imperative that we ensure that Greater Bendigo's trees are healthy. Healthy trees are less likely to succumb to pest and diseases, drop deadwood or branches and can better withstand heat and drought. Healthy and structurally sound trees have a greater longevity in the landscape and mean we need to remove and replace trees less frequently. By improving the growing conditions for urban trees we can increase their health allowing us to reap the rewards and enjoy a landscape that is more visually appealing.

Tree Health



The health of Greater Bendigo's urban tree population in 2020. Only 64% of City trees are in good or very good health. By 2030 we aim to increase this figure to 80%.

Tree Structure

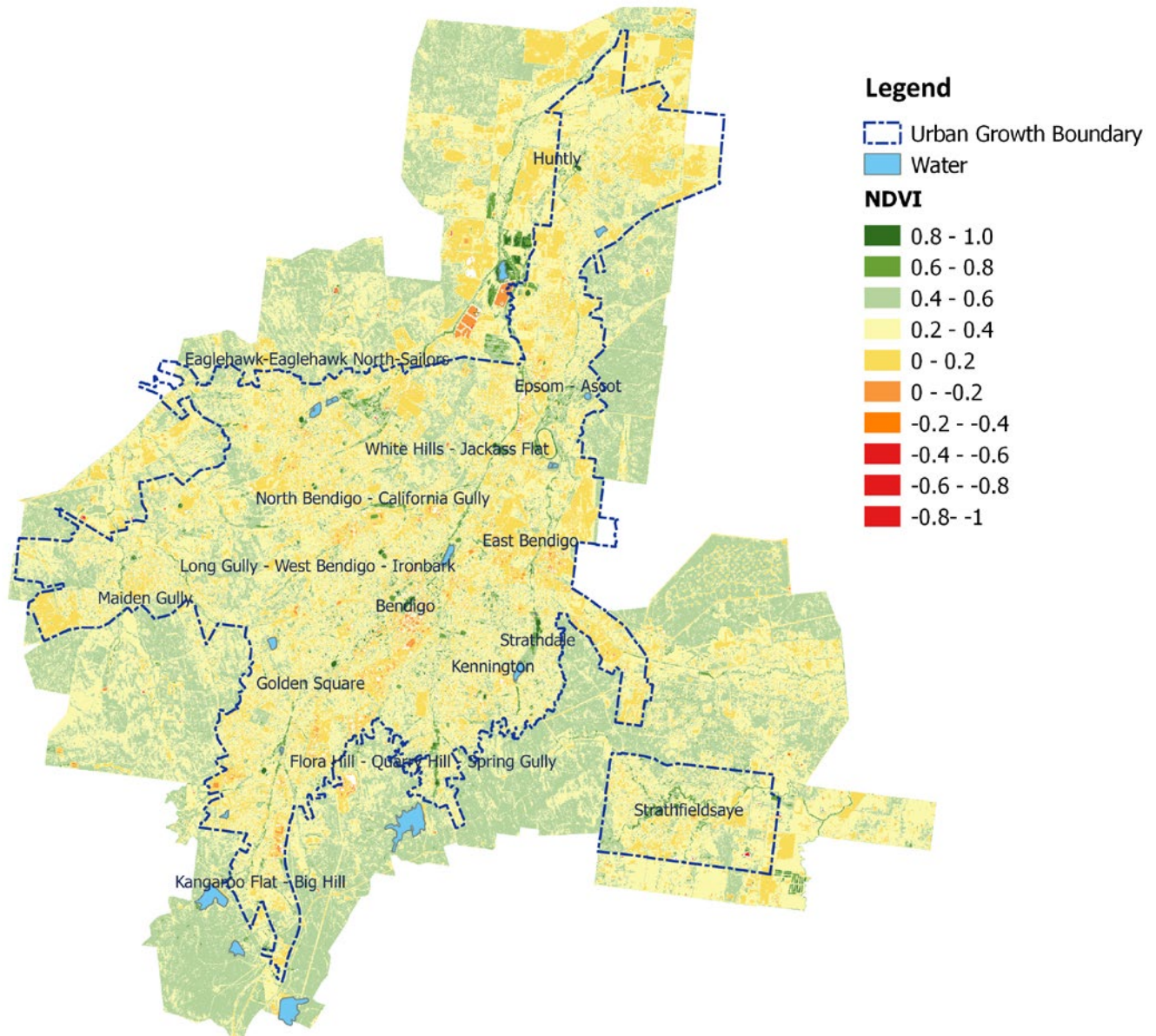


The structure of Greater Bendigo's urban tree population in 2020. Unfortunately, Bendigo has a legacy of poorly structured trees as a result of past pruning practices. As these older, poorly structured trees are removed and are replace with quality young trees, the overall structure of Bendigo's trees will improve.



Normalised difference vegetation index

The normalised difference vegetation index (NDVI) is an indicator that can be used to analyse the presence, density and health of land surface cover. It uses remote sensing technology to assess whether the target area being observed contains live green vegetation or not and is a measure of the photosynthetic capacity of the land surface cover. It is essentially a measure of 'greenness' with values ranging from -1 to +1. Higher values are associated with greater density and greenness of the plant canopy. NDVI decreases as vegetation becomes increasingly water stressed, diseased or dies. Bare soil and snow values are close to zero, while water bodies have negative values. Vegetation NDVI in Australia typically ranges from 0.1 up to 0.7.



NDVI of urban Bendigo over the summer of 2018/19. Prepared by Office of Other Spaces Pty Ltd, 2019. This image is a composite of 9 satellite images taken over Bendigo from December 2018 to February 2019. Note the higher NDVI values within the urban area are where water is most abundant - either along the creeks and water courses or where irrigation is actively being provided such as in major parks and gardens and recreation grounds dotted across Bendigo.



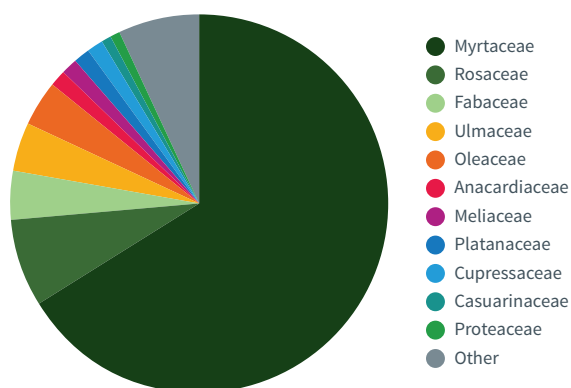
Tree diversity

Much like finance, spreading your investment across different asset classes helps to reduce the exposure of the urban forest to any one risk. Dependence on very few tree species within an urban forest is risky as the population is more vulnerable to threats from pests, pathogens and climatic changes. This risk is demonstrated in overseas examples of the decimation of whole forests from pests and pathogens including Chestnut Blight and Emerald Ash Borer in North America and Dutch Elm Disease in Europe, responsible for eliminating Elms from much of the northern hemisphere.

Again, having a mix of age classes helps to build resilience in the tree population. Reliance on any one age class will mean that a large percentage of the urban forest will age, decline and require replacement at the same time.

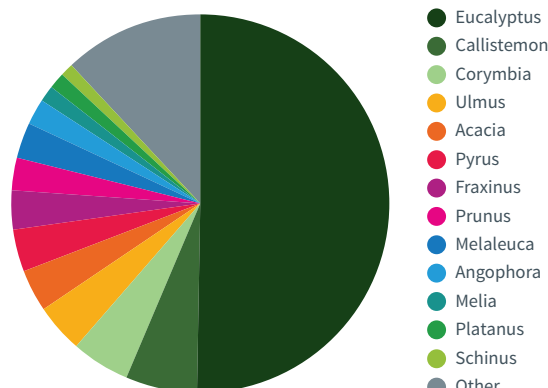
A mix of tree species, genetic diversity and age classes helps to build a more resilient, robust urban forest that can better tolerate and adapt to emerging threats in the environment.

Plant Family Diversity



The diversity in plant families of Bendigo's tree population according to the recently updated tree inventory. 67% of Bendigo's urban trees are in the Myrtaceae family highlighting the vulnerability of the City's trees to pathogens such as Myrtle Rust which target plants from this family. Myrtle Rust became established in Victoria in 2011.

Tree Genus Diversity



Eucalypts make up half of all trees within Bendigo's urban growth boundary.

The 20 Most Represented Tree Species in Urban Bendigo

Tree Species	Number of trees	Percentage of total tree population
<i>Eucalyptus microcarpa</i> - Grey Box	12,527	11.1%
<i>Eucalyptus camaldulensis</i> - River Red Gum	9,875	8.7%
<i>Eucalyptus leucoxylon</i> - Yellow Gum	8,196	7.3%
<i>Eucalyptus tricarpa</i> - Red Ironbark	6,429	5.7%
<i>Eucalyptus melliodora</i> - Yellow Box	5,338	4.7%
<i>Eucalyptus sideroxylon</i> - Mugga Ironbark	3,675	3.3%
<i>Pyrus calleryana</i> - Callery Pear	3,281	2.9%
<i>Callistemon viminalis</i> - Weeping Bottle Brush	3,098	2.7%
<i>Ulmus procera</i> - English Elm	2,773	2.5%
<i>Eucalyptus polyanthemus</i> - Red Box	2,689	2.4%
<i>Corymbia maculata</i> - Spotted Gum	2,553	2.3%
<i>Angophora costata</i> - Sydney Apple Gum	2,262	2.0%
<i>Callistemon 'Kings Park Special'</i> - Crimson Bottle Brush	1,741	1.5%
<i>Prunus cerasifera 'Nigra'</i> - Purple Cherry Plum	1,721	1.5%
<i>Corymbia citriodora</i> - Lemon Scented Gum	1,532	1.4%
<i>Ulmus parvifolia</i> - Chinese Elm	1,513	1.3%
<i>Melia azedarach</i> - White Cedar	1,502	1.3%
<i>Platanus x acerifolia</i> - Plane Tree	1,417	1.3%
<i>Eucalyptus scoparia</i> - Wallangarra Gum	1,285	1.1%
<i>Fraxinus raywoodii</i> - Claret Ash	1,209	1.1%

The Importance of Tree Species Diversity

Whilst the removal of overhead powerlines from central Bendigo twenty years ago enabled the planting of many street trees that have left a positive mark on the city, many of the trees planted were London Planes (*Platanus x acerifolia*). This species is susceptible to several fungal pathogens, extreme heat and Sycamore Lace Bug which has recently emerged in Australia from North America. The dependence on London Planes in the middle of Bendigo presents a risk. In several decades from now, the trees, all roughly the same age, will likely senesce and require replacement at the same time. Furthermore, this species is associated with inducing allergies and hay fever. The fine leaf hairs are renowned for making people cough and wheeze, especially in late spring. For these reasons there is merit in introducing a greater variety of tree species in central Bendigo when there is opportunity to do so.

Mitchell Street, Bendigo. Pin Oaks were planted in the median between Pall Mall and Queen Street in Spring 2019. The loss of the Plane trees that were previously planted presented an opportunity to introduce a different species into central Bendigo.

A balancing act. Crusoe Road in Kangaroo Flat with English Elms down one side and River Red Gums on the other.



Tree Species Origin

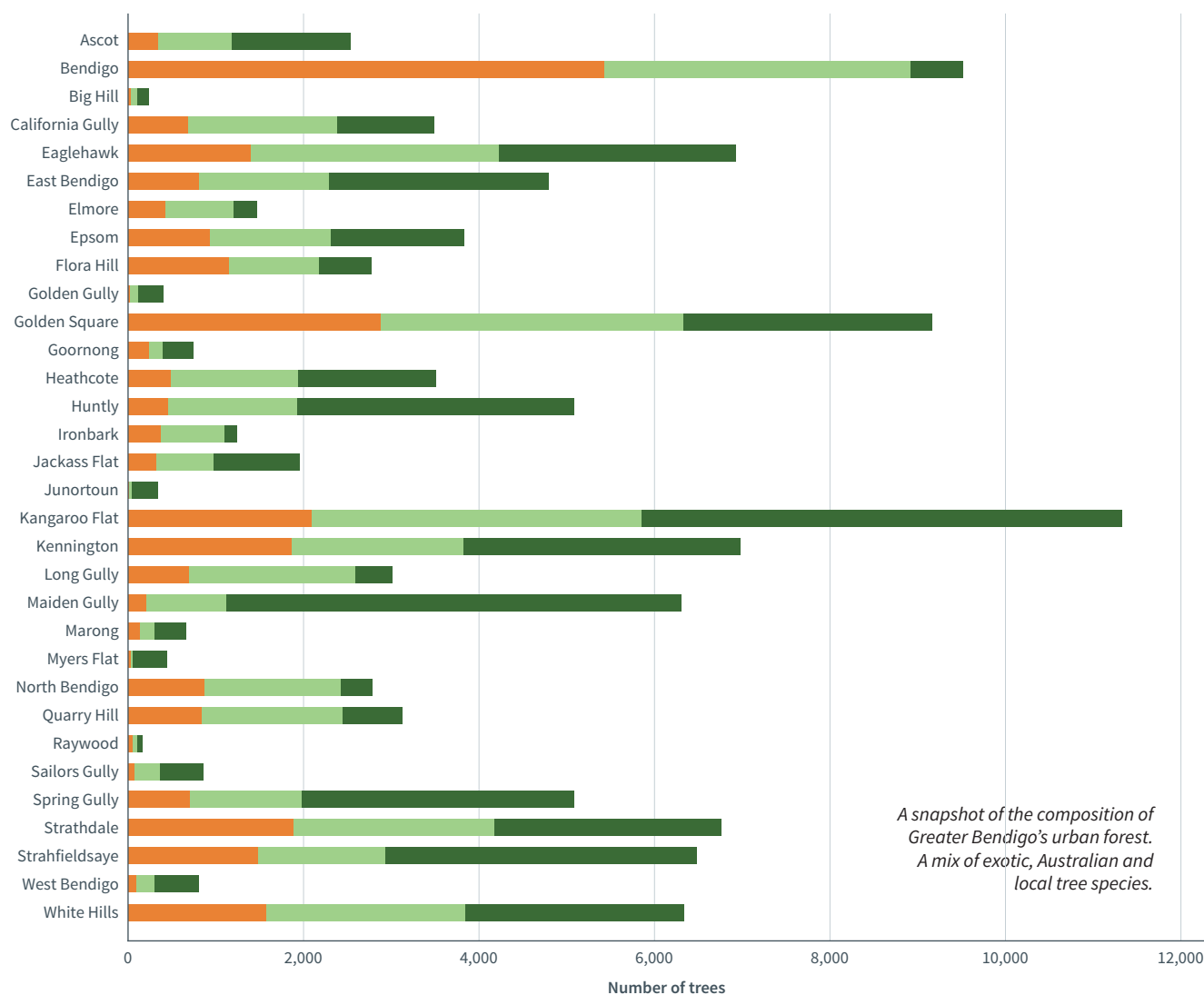
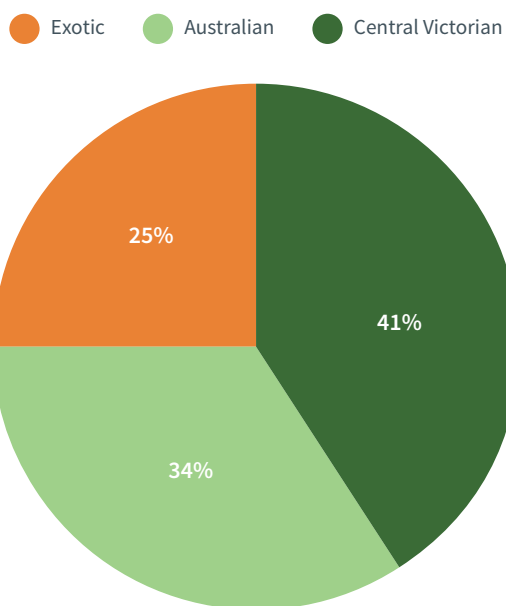
The trees that make up Bendigo's urban forest are a fairly even spread of locally indigenous, Australian and exotic species.

Locally indigenous tree species make up 41 per cent of all trees in Bendigo, and the five most represented species are Central Victorian eucalypts.

Exotic tree species which include the elms and planes of central Bendigo and our more European style parks and gardens make up 25 per cent of the tree population. The remaining third of trees are Australian species, with their origins outside of Central Victoria.

This even mix of native and exotic species remains constant across all urban areas and townships with the notable exceptions being central Bendigo, with a larger proportion of exotic species, a legacy from the past century. Maiden Gully, Spring Gully, Ascot and Junortoun in contrast have a much greater representation of Australian native and locally indigenous trees.

Striking the right balance in tree species composition for particular locations will be an essential part of the Greening Greater Bendigo precinct plans, the development of which is an action of this strategy.

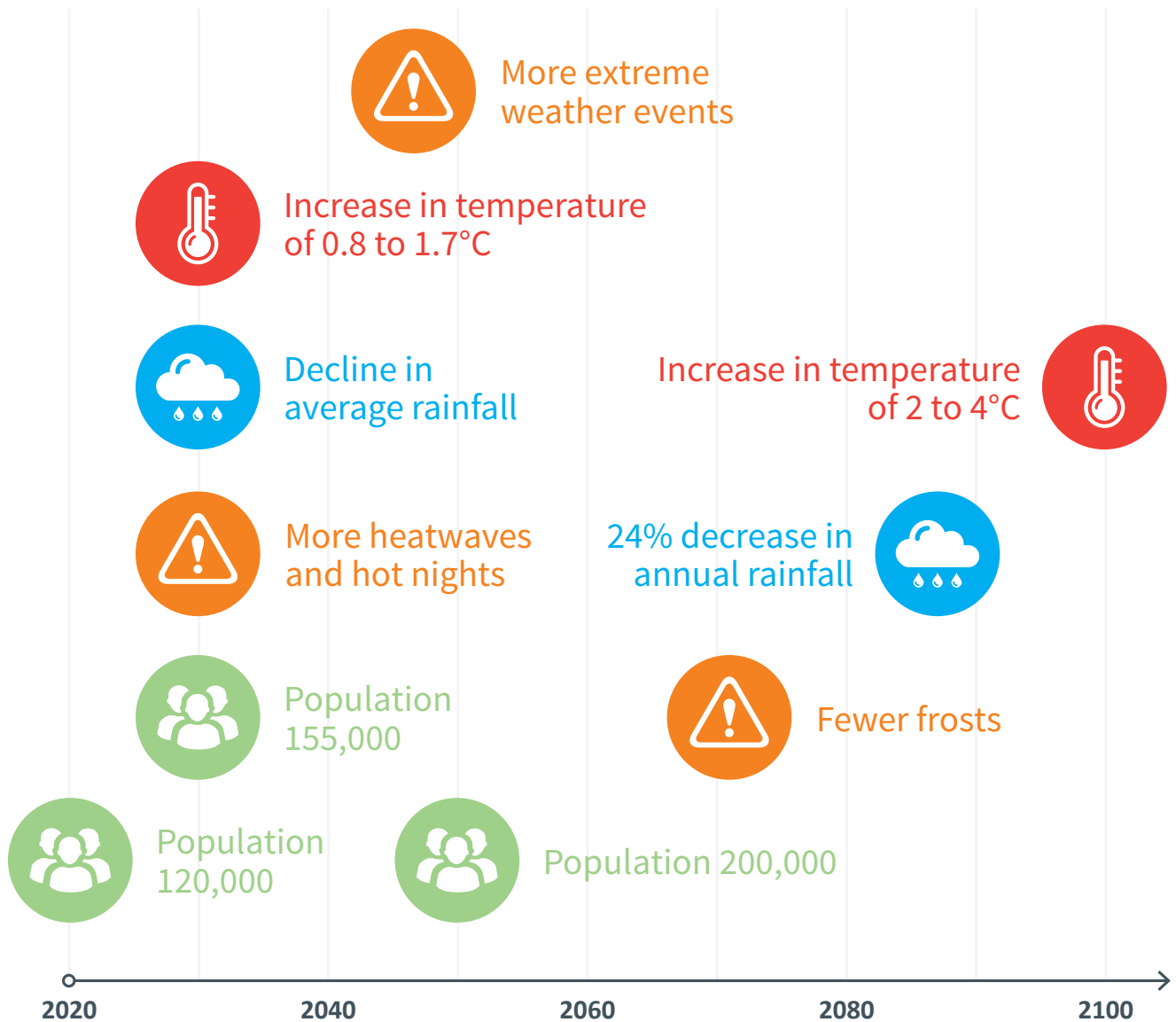


A snapshot of the composition of Greater Bendigo's urban forest. A mix of exotic, Australian and local tree species.



Future challenges and the case for change

Many of the trees we enjoy in Bendigo today were planted at the turn of the last century and have shaded successive generations of residents and visitors under their branches. Over the next fifty years, Bendigo's population is set to double. As we grow, our climate will become increasingly hotter and drier, putting greater importance and strain on the urban forest. The trees we plant today will become the shade trees over the coming decades for future generations, and they must withstand the many climatic, environmental, economic and social challenges.



Climate

Greater Bendigo's climate is temperate to semi-arid and characterised by hot, dry summers and relatively cooler, wetter winters. The southern and more elevated parts of the municipality normally experience cooler weather with relatively higher rainfall, whereas the north-western areas are more prone to the warming and drying influences from inland Australia.

Bendigo's long-term average annual rainfall is 510mm. Median annual rainfall in Redesdale and Heathcote is around 570mm whilst Elmore and Raywood receive considerably less with an average of 450mm and 431mm per annum respectively.

The current climate is challenging enough for tree establishment. Compared to Melbourne, Bendigo experiences an average of 150mm less rainfall, 32 fewer rainy days, 62 more sunny days and 34 more frosts annually.¹³ Rainfall is becoming increasingly unpredictable and infrequent impacting on the timing of the City's annual tree planting program. In the past, tree planting typically occurred from autumn until mid-spring however warmer and drier autumn and spring conditions have narrowed the window for planting to the winter months only. Bendigo's average annual rainfall between 2012 and 2018 has been well below the long-term average at 417mm.

Climate projections for the region towards the end of this century and over the life of this document predict increased

temperatures, more frequent and extreme heatwaves, less rainfall and more intense storm events.¹⁴ The IPCC¹⁵ warns that climate change will amplify existing risks and create new risks for natural and human systems.

Modelling by the CSIRO suggests that, by the end of the century, Bendigo could experience 16 more days of extreme heat up from 4 currently and an increase in heatwave events.¹⁶ Hotter, drier conditions will result in a greater number of heat related illnesses and deaths, an increase in bushfire weather and a greater demand on energy for air-conditioning.

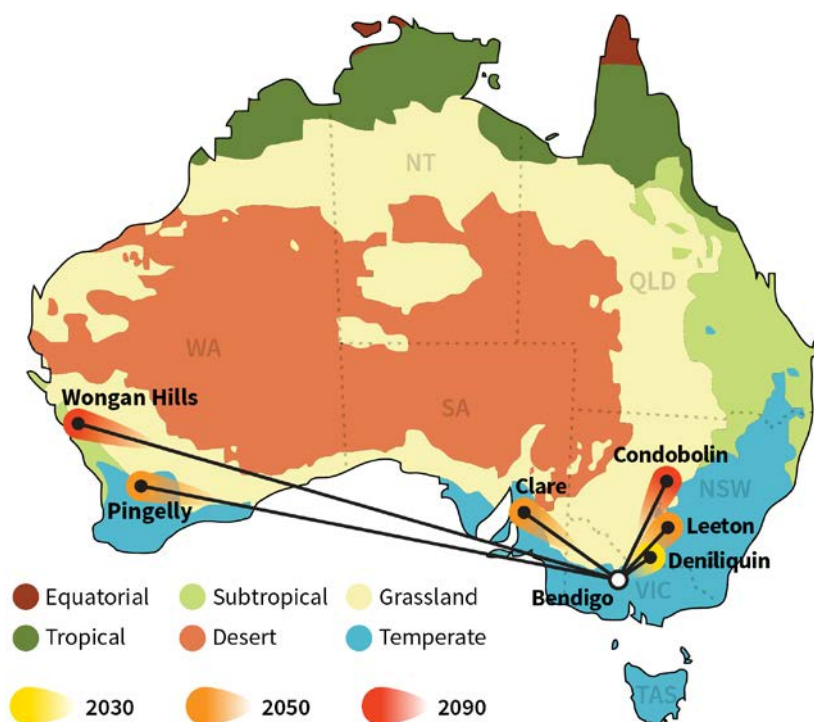
Although mean annual rainfall is predicted to decline, with the greatest decline experienced over spring, incidents of heavy rainfall and storm events are predicted to increase. This will put greater strain on ageing drainage infrastructure and place many low-lying areas at risk of flooding.¹⁷

The climate is changing at a rate faster than that of wildlife and ecosystems to adapt. Many species that presently grace our City are increasingly vulnerable in a warmer and drier Bendigo. Conditions predicted under climate change may also extend the geographical range of many pests and disease and further threaten Bendigo's landscapes.

Climate Analogues

A climate analogue is a matched location which is currently experiencing the climatic conditions that are predicted for the location of interest under climate change. Over the life of Greening Greater Bendigo and the next generation of urban trees, Bendigo will become increasingly warmer and drier.

Over this time, Bendigo's climate is predicted to become more like that currently experienced in arid inland areas of western New South Wales and Western Australia.¹⁸



13. Bureau of Meteorology, 2019, Weather and climate data Commonwealth of Australia, <http://www.bom.gov.au/climate/>

14. Clarke JM, G. M. T. M. R. V. & H. C., 2019. Loddon Campaspe Climate Projections 2019, Melbourne Australia: CSIRO

15. Reisinger et al. 2014, Australasia. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Intergovernmental Panel on Climate Change; 2014

16. CSIRO and Bureau of Meteorology 2015, Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia

17. Rogers, B.C., Gunn, A., Church, E., Hammer, K., and Lindsay, J., 2018. Vision and Transition Strategy for a Water Sensitive Bendigo. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities

18. Climate Change in Australia – Projections for Australia's NRM Regions, www.climatechangeinaustralia.gov.au, last updated 28 June 2019



Urbanisation and Extreme Heat

As the population expands so too does the prevalence of buildings, roads and impervious surfaces such as asphalt and concrete that trap and emit heat from the sun. During hot weather urban areas can be several degrees warmer than that of the rural surrounds due to the trapping of this heat resulting in the phenomenon called the Urban Heat Island (UHI).¹⁹ The UHI can intensify extreme heat events and in turn, can have deleterious effects on human health.²⁰ Over a period of successive hot days, overnight temperatures do not drop sufficiently to allow people to rest and recover and those that are vulnerable to heat - the elderly, the very young, those with pre-existing chronic health conditions and those that are socioeconomically disadvantaged- are most at risk.^{21,22,23}



Increasing development in Golden Square. In many instances the loss of trees to development has exacerbated urban heat with several studies finding an association between land surface temperature and land cover changes with an increased risk of heat related illness.

Extreme heat events are associated with marked short-term increases in mortality world-wide, putting great pressure on emergency departments and health systems.²⁴ The Melbourne heatwave in 2009 leading up to the events of Black Saturday included three consecutive days above 43°C and resulted in a 62 per cent increase in mortality from the five previous years.²⁵ This study revealed a twelve per cent rise in all hospital admissions, a 46 per cent increase in ambulance callouts and a 280 per cent increase in cardiac arrest cases over this period compared to the same period the previous year. This culminated in 374 excess deaths – an increase of 77 per cent from the same period in 2008. Another study attributed heatwave events in Sydney in 1994 and Brisbane in 2004 as being associated with 100 and 75 excess deaths respectively.²⁶

For Bendigo, there is an increase in mortality when the minimum daily temperature is 22°C or warmer (5%) and when the daily maximum temperature is greater than 40°C (8%). There is a

significant increase in mortality (18%) when the mean daily temperature is 32°C or greater.¹⁹ Heat related mortality is immediate and typically peaks either on the day of extreme heat or the day following. Heat events in Bendigo tend to be longer and hotter than those experienced in Melbourne and other Victorian districts yet the impact of these events at the local scale is relatively unclear and the spatial variability of these impacts is unknown.

Due to the combined effects of shading and evapotranspiration, trees have the potential to cool urban microclimates and mitigate urban heat, reduce thermal discomfort and help to create comfortable outdoor spaces for people. Recent studies in inner Melbourne have attributed street trees to reductions in daytime summer air temperatures by between 1.5°C²⁷ and 4°C²⁸.

Thermal photographs of Bendigo streets demonstrate not only the cooling effect that shade trees have on the microclimate but also highlight the heat that is trapped in the built environment.

19, 27. Coutts et al, 2016; 'Temperature and human thermal comfort effects of street trees across three contrasting street canyon environments', *Theoretical and Applied Climatology*, 124(1), 55-68

20. Loughner et al. 2012, 'Roles of Urban Tree Canopy and Buildings in Urban Heat Island Effects: Parameterization and Preliminary Results', *Journal of Applied Meteorology and Climatology*, 51(10), 1775-1793

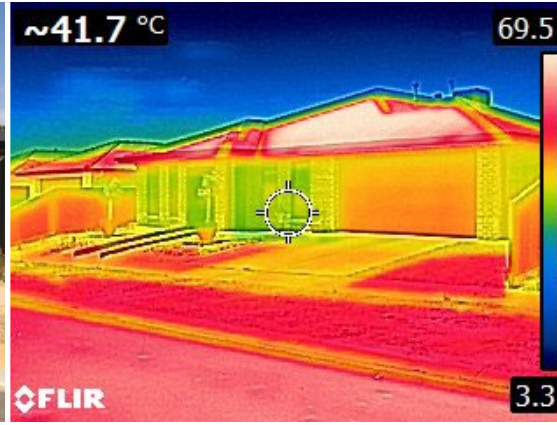
21. Parsons, K. 2009, 'Maintaining health, comfort and productivity in heat waves', *Global Health Action*, 2, 39-45

22, 25. DHS, 2009, January 2009 Heatwave in Victoria: An Assessment of Health Impacts, Melbourne, Australia: Victorian Government Department of Human Services

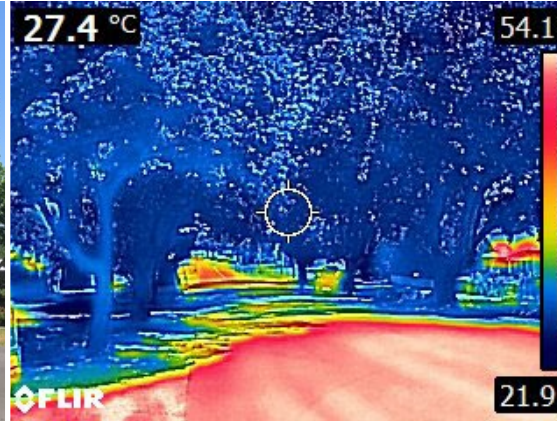
23, 26. Bi, P. et al, 2011, 'The Effects of Extreme Heat on Human Mortality and Morbidity in Australia: Implications for Public Health', *Asia-Pacific Journal of Public Health*, 23(2), 27S-36S

24. Loughnan et al, 2010, A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities, National Climate Change Adaptation Research Facility, Gold Coast, 128 pp.

28. Sanusi, R., Johnstone, D., May, P. and Livesley, S. J. (2016) 'Street Orientation and Side of the Street Greatly Influence the Microclimatic Benefits Street Trees Can Provide in Summer', *Journal of Environmental Quality*, 45(1), 167-174



Huntly, 16 January 2019, 2.45pm. Ambient temperature 43 degrees.



Hallam Street Flora Hill, 14 November 2017, midday. 30 degrees.



Mark Street, Bendigo, 16 January 2019, 3.45pm. 43.6 degrees.



Mias Way, Epsom 3pm, 14 November 2017. 32 degrees.



Heat Vulnerability

As the temperature rises, the human body must work harder to cool itself and maintain a healthy temperature. Extreme heat can affect everyone although some members of the community are at greater risk of heat related illnesses due to a range of social, economic and environmental factors. These include the elderly, young children, those with existing medical conditions and those with limited adaptive capacity to respond to heat. Across many Australian cities there is a strong correlation between 'hot spots' and poor socio-economic circumstance. In contrast,

areas with lower temperatures are more likely to be associated with greater tree cover and affluence.²⁹ Bendigo is no exception. Inappropriate city planning without mitigating urban heat and considering equality may unintentionally expose many members of the community to an unacceptable level of harm.

Identifying where the most vulnerable community members are is a great first step in identifying where shade is needed most.

Case Study – Cool It!

In 2018 the City of Greater Bendigo together with the Central Victorian Greenhouse Alliance and partner councils undertook a project to identify where areas of social vulnerability and heat exposure overlap. The 'Cool It!' project identified the most urgent areas for cooling interventions based on social vulnerability and amount of vegetation to impermeable surface cover. These areas included nine distinct areas in Kangaroo Flat, Golden Square, White Hills, California Gully, Long Gully and Eaglehawk, North Bendigo and Heathcote for cooling interventions such as tree planting. This information was used to inform what streets were planted as part of the 2019 tree planting program.



Carpenter Street and surrounding streets in Kangaroo Flat were identified for tree planting in the 2018 Cool It! report. Street trees were planted in these streets as part of the 2019 annual tree planting program.

29. Amati, M. et al. (2017) *Where should all the trees go? Investigating the impact of tree canopy cover on socio-economic status and wellbeing in LGA's* prepared for Horticulture Innovation Australia Limited by the Centre for Urban Research, RMIT University.

Back Creek Trail, Flora Hill

Participating in outdoor physical activity during hot weather has also been recognised as a risk for heat-related illness with adverse implications for travel behaviour. This is particularly true for pedestrians and cyclists, who are more exposed to prevailing weather conditions. Trees were planted for shade along the Back Creek trail in winter 2019.

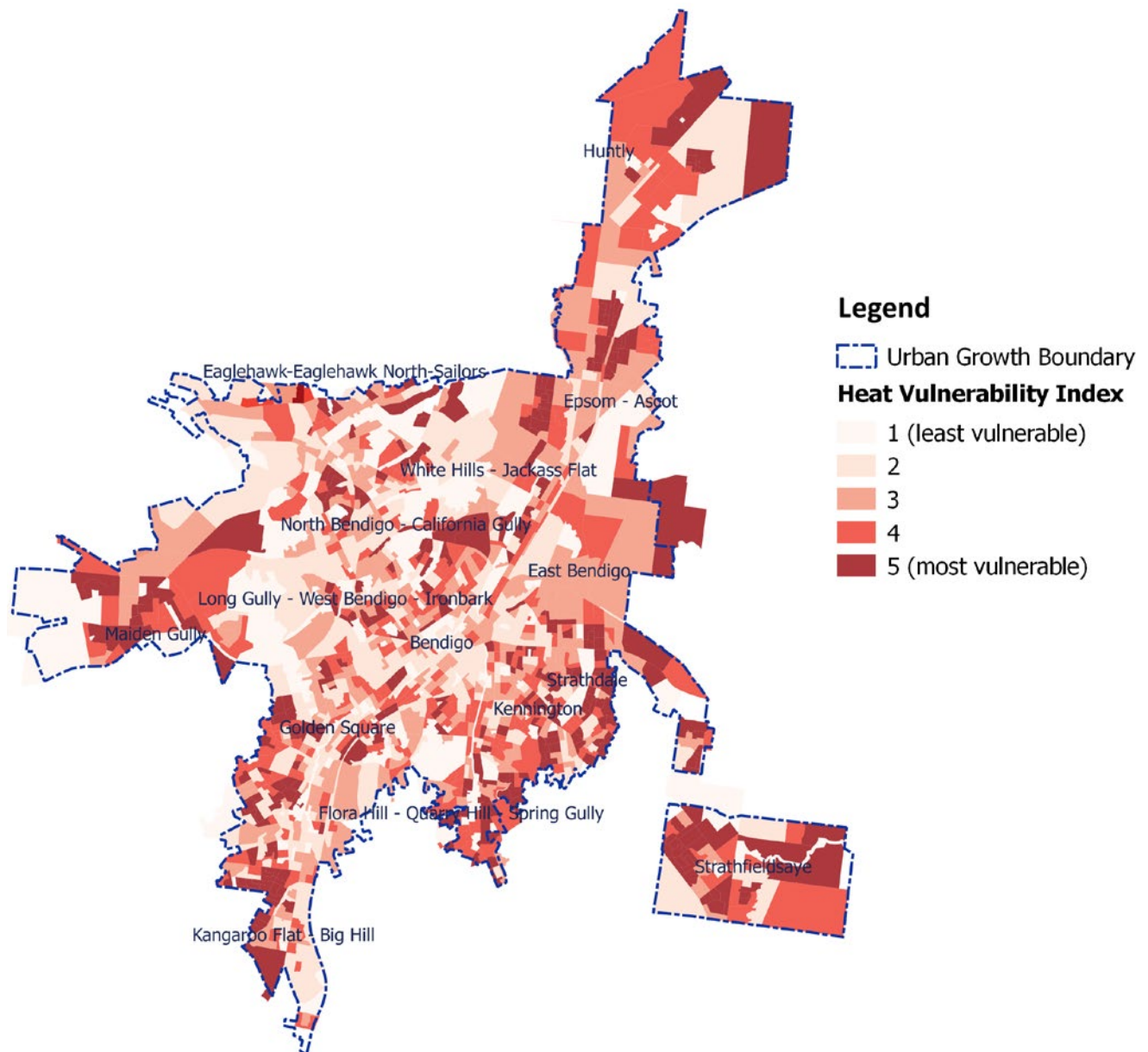


Back Creek Trail, Havelin St East, Flora Hill, 1pm, 14 Nov 2017. 30 degrees.



Heat Vulnerability and Shade Mapping

In collaboration with RMIT's School of Geospatial Sciences the City of Greater Bendigo has developed a heat vulnerability index for the municipality. The index combines a vast mix of socio-economic data, land surface information, satellite imagery and thermal comfort mapping to identify Bendigo's most vulnerable residents to extreme heat. Metrics that inform the index include tree density, population density, percentage of elderly and young persons, percentage of residents for whom English is a second language, adaptive capacity and exposure to heat.



Heat Vulnerability Index of urban areas of Bendigo. Heat vulnerability has been measured down to the mesh block level. A Mesh Block is the smallest spatial unit tracked in the Australian census and contain between 30 to 60 dwellings.

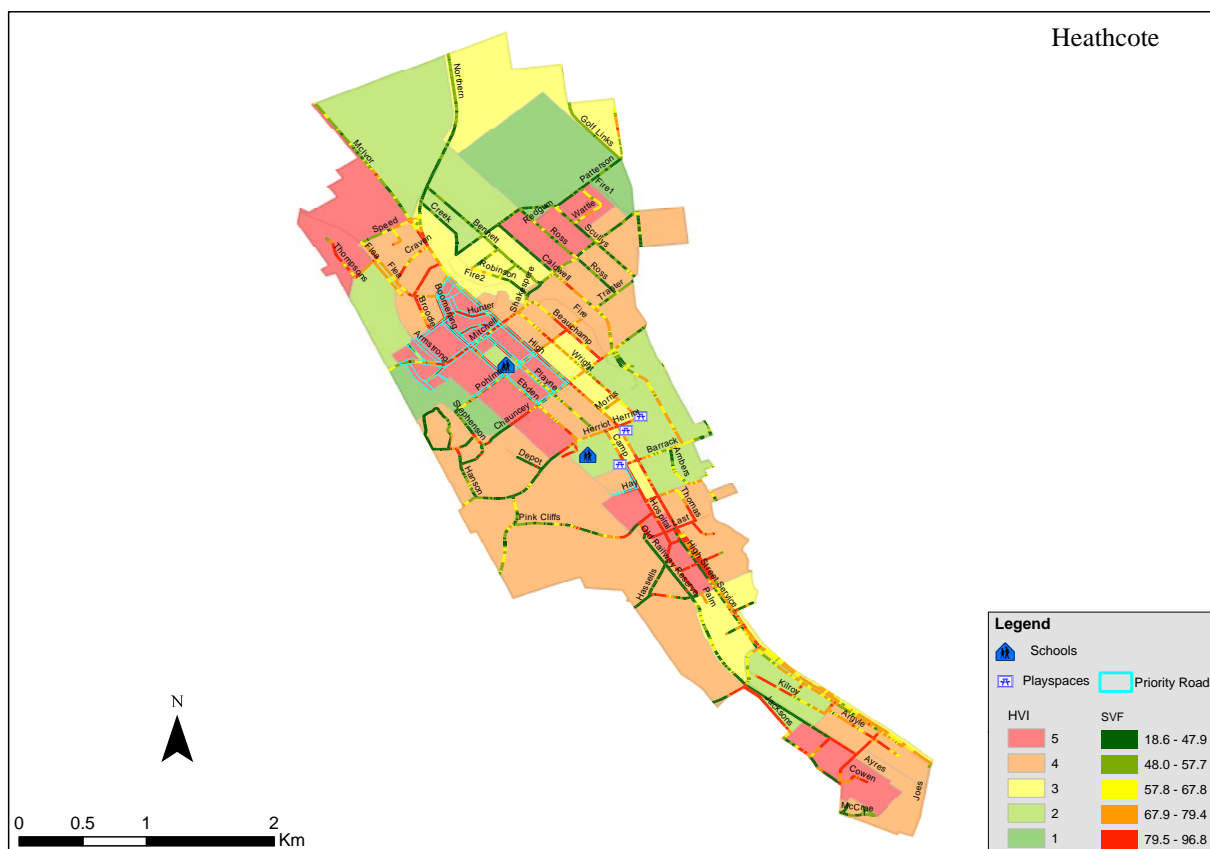
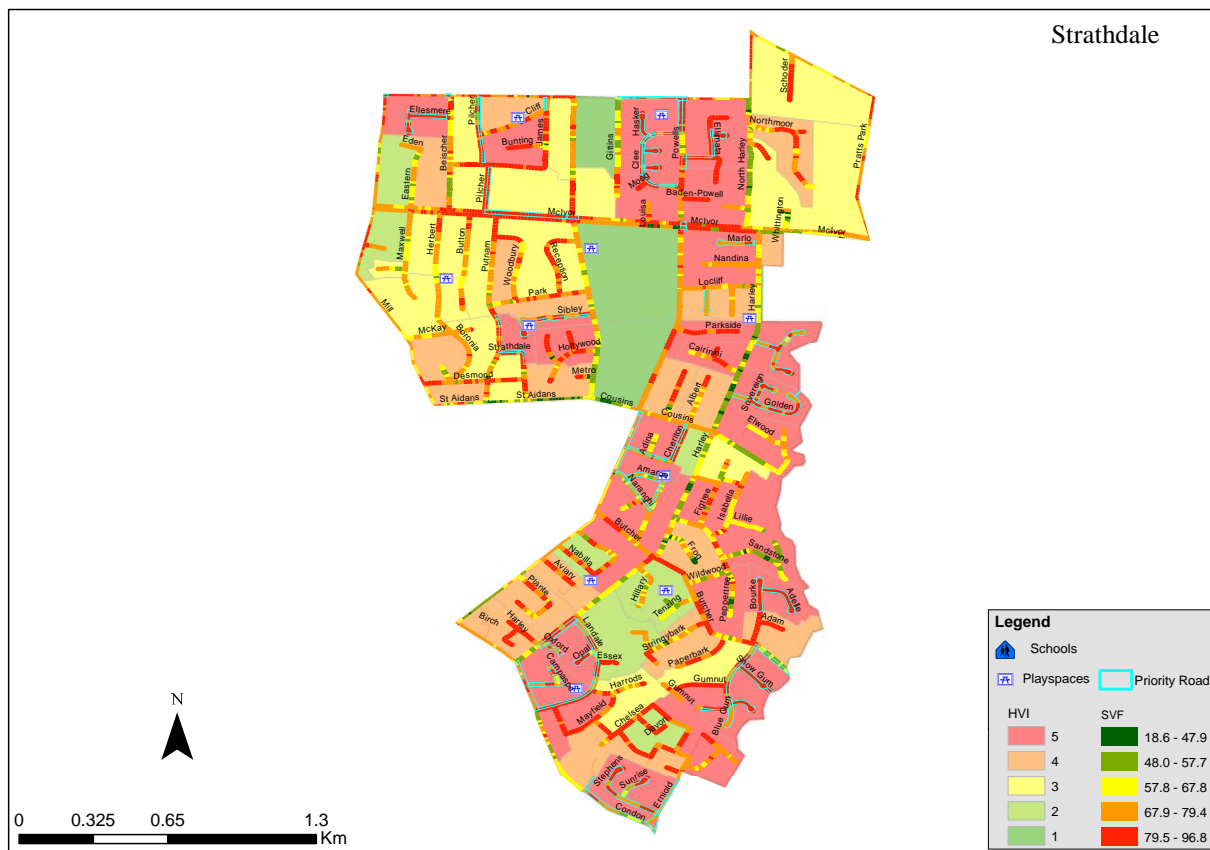
Step two of this project was to map the extent of shade available at streetscape level at 10 meter intervals across Greater Bendigo's road network. This was achieved by using 'Machine Learning' to calculate the amount of shade cast by trees from freely available Google Street View images.



For each of the images, the percentage of sky was calculated to give an indication of sky view factor (SVF), or shade, for each street. The greater the SVF, the less shady the street.

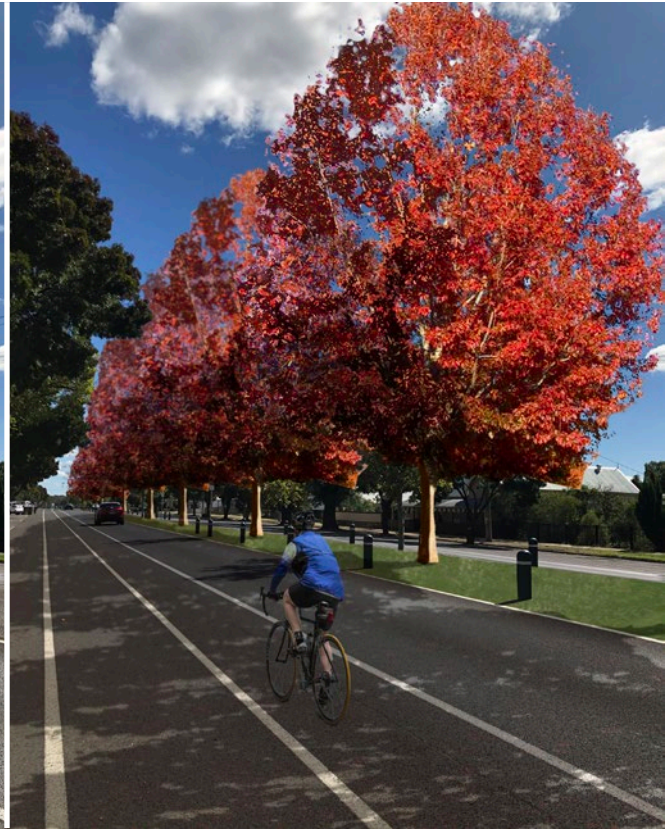
The final step was to combine the heat vulnerability index with the shade map to highlight the streets across the municipality that have the greatest need for street trees. These streets are where lack of shade from trees and heat vulnerability intersect and the priority streetscapes for each of Bendigo's urban areas and precincts have been highlighted. This information will form the basis of a ten-year tree planting program.





Street tree planting priorities for Strathdale and Heathcote based on heat vulnerability (HVI) and shade (SVF). Priority streets have been highlighted for each precinct and township.





High Street Heathcote, with its vast expanse of asphalt and poor performing median trees, has been identified as a priority street for street tree improvements. Here is an artist's impression of what High Street could look like.

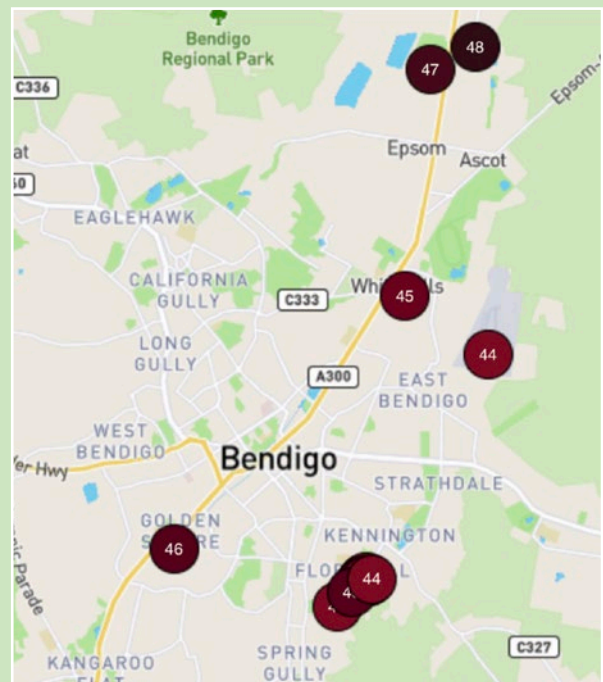
Case Study – Clever Weather

Together with La Trobe University's Technology Innovation Lab, the City of Greater Bendigo have installed up to 100 individual weather sensors in landmark locations and backyards across Bendigo.

The sensors capture accurate temperature and humidity readings and transmit these to Bendigo's Internet of Things (IoT) network. There are frequently areas of the city that are 2 to 3 degrees warmer than others which has important implications for the way people are exposed to extreme temperatures.

The sensor network will allow residents to get a much more accurate temperature reading in their local area. It will also help the City make important decisions on how to best manage urban heat such as where to plant trees.

The image on the right shows a 4-degree difference in temperature between the official BoM reading at the airport and some locations in the city's north during a day of extreme heat on January 25, 2019.



Human Health and Wellbeing

An increasing amount of research is finding many positive impacts of urban green space on the health and wellbeing of the community.

Access to green space has been found to improve mental wellbeing with studies showing relationships between greenery and reduced rates of depression, anxiety and faster hospital recovery times.

As well as reducing heat related illness, canopy trees help to reduce people's exposure to harmful ultra-violet rays. Shade alone can reduce exposure to UV radiation by as much as 75 per cent.³⁰

Proximity to greenspace helps to encourage people to get outside and be more active with many flow-on health benefits. This is of particular interest to Greater Bendigo with the region experiencing rates of obesity and chronic diseases such as diabetes far higher than the state average.³¹ Furthermore, Bendigo has one of Victoria's highest rates of car ownership and a strong correlation exists between low density sprawling suburbs, low levels of physical activity and poor health outcomes. Creating healthy green spaces to support healthy lifestyles and active transport options is essential for improving community health and wellbeing outcomes.

Strategies to increase tree cover and improve public open space are an effective and economical way of providing both human health and environmental benefits.

Public Health and Wellbeing Planning

Municipal Health and Wellbeing Plans are required to consider the focus areas and priorities of the Victorian Public Health and Wellbeing Plan 2019–2023. Relevant priorities from the Victorian Public Health and Wellbeing Plan 2019–2023³² include:

- Tackling climate change and its impact on health
- Increasing active living
- Improving mental wellbeing

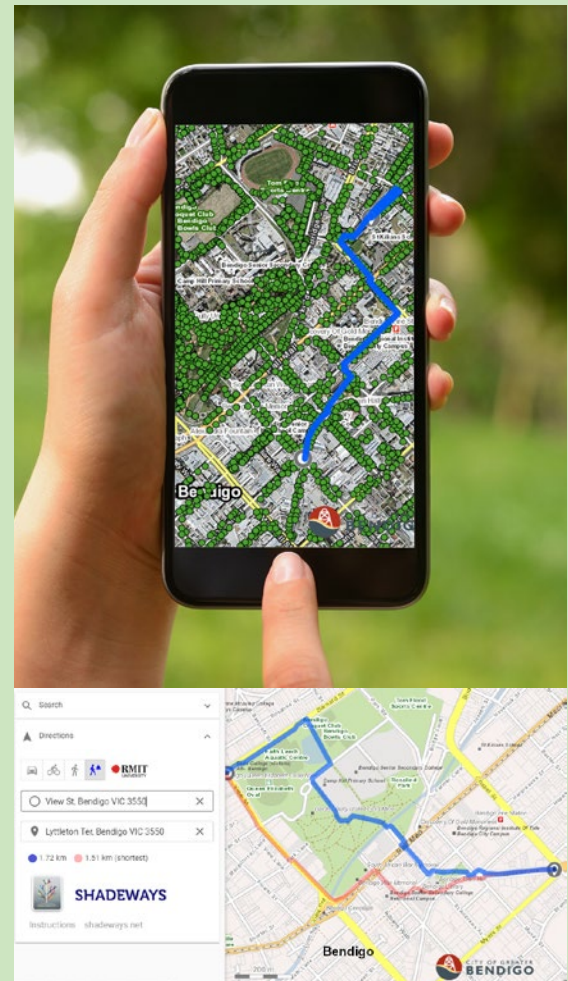
The Greater Bendigo Health and Wellbeing Plan 2017–2021 aims to promote environmental sustainability and resilience to a changing climate and facilitate supportive built and natural environments. Like Greening Greater Bendigo, the plan focuses on socio-economic disadvantage and climate change impact on vulnerable communities.

Case Study – Shadeways

In partnership with RMIT's Centre for Urban Research, Latrobe University and Spatial Vision, the City of Greater Bendigo was successful in attracting funding through the federal government's Smart Cities and Suburbs Program to demonstrate how urban heat can vary at the small scale and what impact this has on walking and cycling behaviour in Bendigo.

The Shadeways platform is an interactive map similar to Google Maps which enables users to find the coolest, shadiest route to navigate around Bendigo by foot or on bike.

Shadeways uses a variety of data sets including tree cover, surface material, land use and transport layers to create a thermal comfort model that determines the ideal route for optimal shade and thermal comfort.

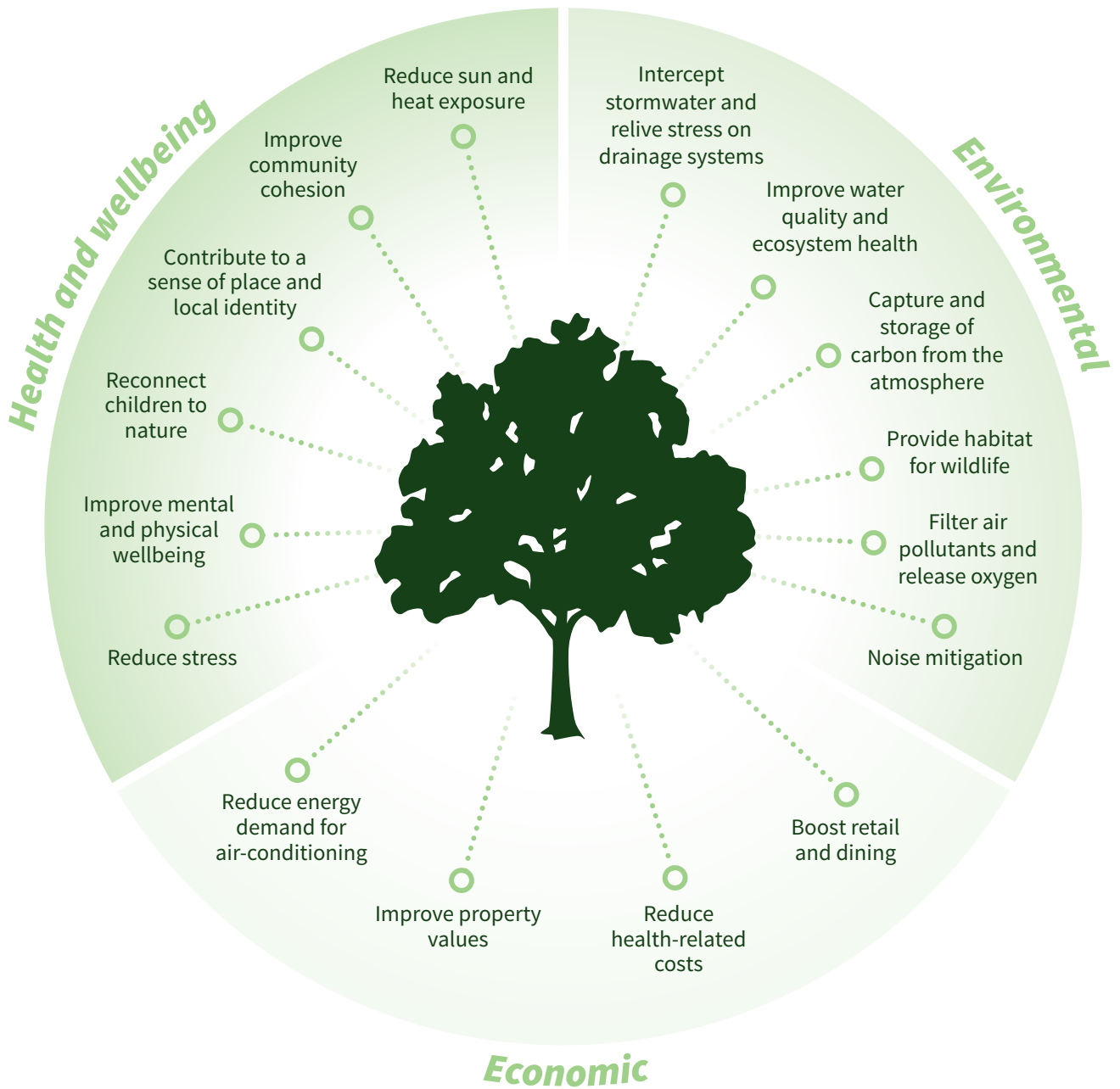


30. Parsons, K. (2009) 'Maintaining health, comfort and productivity in heat waves', *Global Health Action*, 2, 39–45.

31. Healthy Heart of Victoria, <https://www.bendigo.vic.gov.au/Services/Community-and-Care/Healthy-Heart-of-Victoria>

32. Victorian public health and wellbeing plan 2019–2023, <https://www2.health.vic.gov.au/about/health-strategies/public-health-wellbeing-plan>

Critical Urban Infrastructure – the many benefits of urban trees



Economic justification for improving Greater Bendigo's Urban Forest

Trees and other natural features in cities can help regulate water quality, water quantity, and the timing of water flow. They can help clean and cool the air, and reduce harmful air pollutants. They add beauty to our streets, enhance citizens' lives, and significantly increase property values. These many benefits provided by the urban forest can be translated into dollar terms to build a compelling case for investment in green infrastructure.

A US study estimated that for every \$1 spent on tree planting and maintenance there is a return of \$8.36 (\$US5.82) in benefits.³³ These benefits, often called ecosystem services, include:

Amenity Value

The City of Greater Bendigo introduced an amenity tree value for assessing the monetary value of Bendigo's urban trees. The Bendigo Amenity Tree Value formula has since been used to attract compensation for City trees lost to development. Using this formula, the total amenity value for Bendigo's City trees is estimated to be worth \$1.4 billion.

Reducing energy costs

Major energy savings come from shading buildings during summer and reducing the reliance on air-conditioning. Increasing tree cover over a house by ten percent has been attributed to an estimated \$50-\$90 in power savings per year.³⁴

Health benefits

The benefits of greenspace on human health and wellbeing have previously been touched on however it is difficult to pin a dollar value on the total avoided health related costs. In an effort to quantify how much more investment in trees would be required to realise greater potential health benefits, the Nature Conservancy estimates that there is an under-investment of approximately \$11.50 (\$US 8) per person annually.³⁵

Storing and sequestering Carbon

Trees capture and store carbon in their biomass and therefore have a role to play in reducing atmospheric carbon. It is estimated that the average street tree in Bendigo contains just under a tonne of carbon. Multiply that figure across the City's tree population and that equals 120 million kilograms of carbon.

Increasing Property Values

Tree-lined streets have been proven to increase property prices by up to around 30 per cent than those in treeless streets.³⁶

33. McPherson, E.G., N. van Doorn, and J. de Goede, The State of California's Street Trees. 2015, Pacific Southwest Research Station, U.S. Forest Service: Davis, CA

34. Parsons et al 1998, The shady side of solar protection, Queensland Cancer Fund Laboratories

35. The Nature Conservancy, 2017, Funding trees for health - Finance and policy to enable tree planting for public health

36. Sander et al. 2010, the value of urban tree cover a hedonic property price model in Ramsay and Dakota, USA. Ecological Economics 69(8), 1646-4656



Constraints for the urban forest

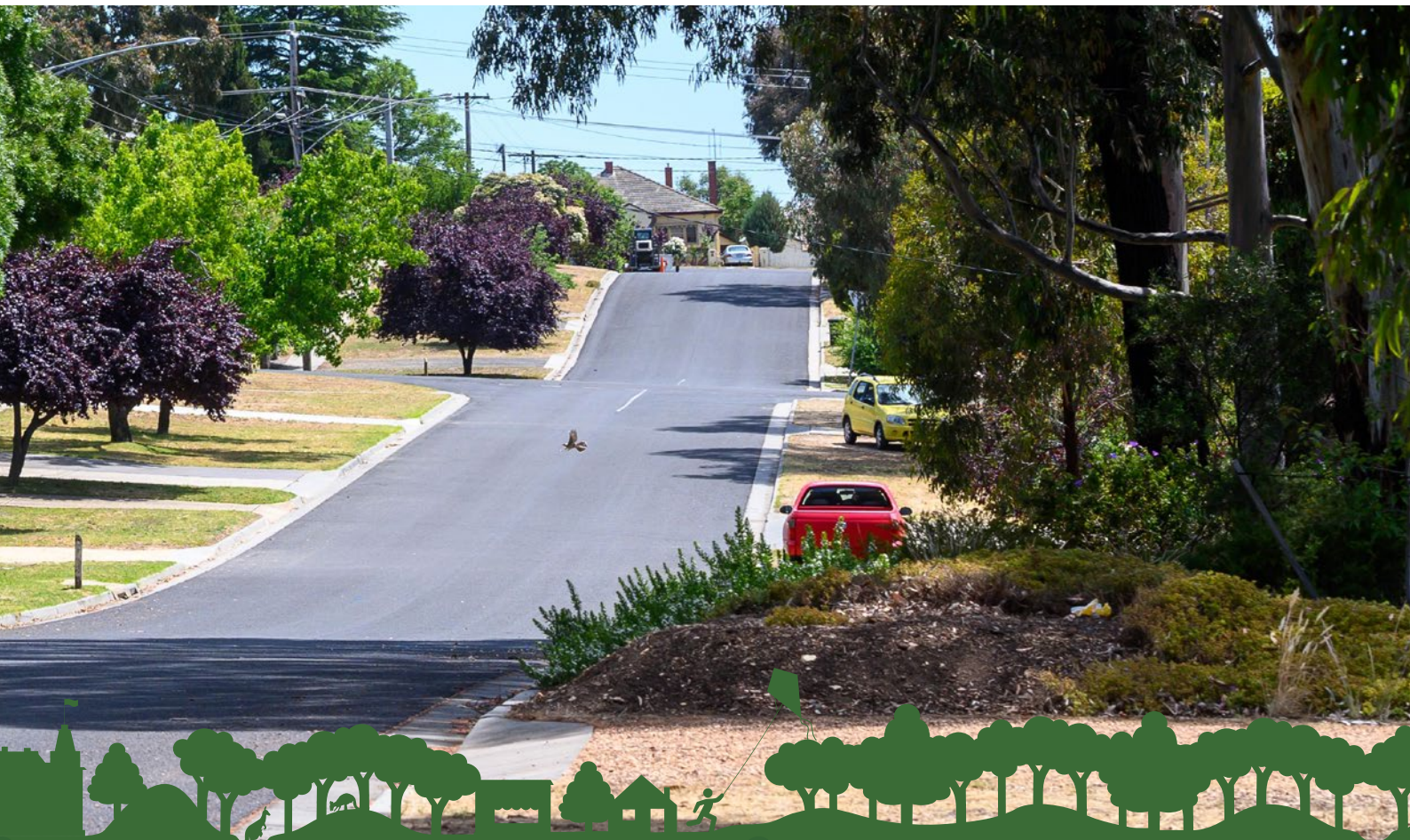
Unlike trees in open parks and forests, urban trees must overcome many challenges if they are to survive and thrive.

Below-ground space for tree roots is compromised by extensive road and path networks and underground utilities including gas, water, sewer and telecommunications. Soils are often compacted, contaminated and covered by impermeable surfaces making it harder for trees to access water, air and nutrients required for growth.

Above-ground, trees in the built environment must contend with electrical lines, clearance requirements for transport and urban structures such as verandas, awnings, poles and signage.

Furthermore, community perceptions to trees can be challenging for tree managers as they are frequently seen as messy, causing nuisance, increasing fire risk or not in line with individuals' aesthetic preferences.

As urban development increases and vegetation on private land diminishes, greater importance and pressure is placed on the public realm to provide healthy trees and green spaces for people.



Urban trees and bushfire

Street trees across the urban area commonly occur in nature strips bordered by a road and footpath and, by themselves, are generally not considered a fire hazard. Clean trunks, separation between the ground and tree canopy, lack of understorey vegetation, spacing between individual trees and the distance of trees to houses that is typical of most street tree plantings is not a configuration that promotes fire spread. The main fire threat in urban areas is likely to come from ember attack from as far as several kilometres away.

Well-placed vegetation and large, canopy trees have been shown in some instances to help protect property from fire by;

- Trapping embers
- Absorbing radiant heat
- Reducing wind speed therefore reducing the speed and spread of the fire



A typical layout of street trees in urban areas. Separation between individual trees and houses, clean trunks and absence of understorey vegetation help to reduce fire risk.

Much of Bendigo's urban area is surrounded by forest therefore there is always a chance of fire impacting homes which could be direct flame, radiant heat and/or ember attack depending on the location and the fire event.

Under certain conditions, all vegetation will burn and residents in areas of high bushfire risk need to be aware of their environment and the risks they face during the fire season. Residents are encouraged to refer to the CFA website for details www.cfa.vic.gov.au/plan-prepare/landscaping

The City of Greater Bendigo is obligated under the Electricity Safety Act 1998 to maintain vegetation clear from electrical wires and conductors and must submit an annual Electrical Line Clearance Management Plan. The plan outlines how the City will manage its trees in areas of high and low bushfire risk.

Community Priorities

A period of extensive community engagement took place in spring 2018 to identify the community's aspirations for Greening Greater Bendigo.

There was a great response with over 1,000 people attending community meetings, participating in the online interactive survey, stopping by one of the listening posts or writing private submissions.

There were several consistent themes that emerged throughout this process.

What people want to see more of;

- More trees for shade and cooling
- Enhance greening to enhance the aesthetic and character of local areas
- Enhance habitat and biodiversity in urban areas

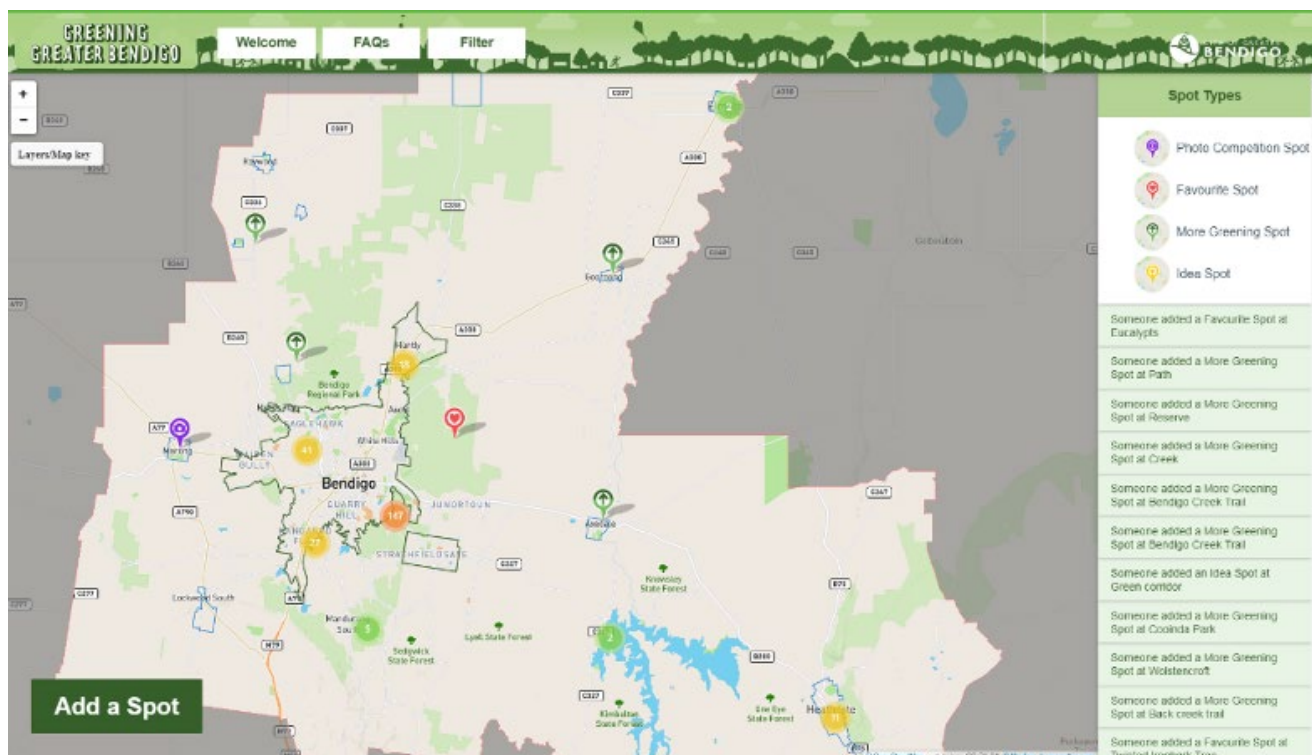
What people do not want to see more of in the future;

- Devastating loss of vegetation for new developments
- 'Don't cut down the trees in the first place' – retain and protect existing trees in urban areas
- Roads, paths and expanses of paved areas lacking shade
- Fewer Plane trees, especially in central Bendigo
- House block with very little greenery

The information gathered throughout this process has been used to shape the long-term vision of Greening Greater Bendigo as well as the priorities for the ten-year action plan.



Number of CrowdSpot visitors	407
Number of CrowdSpot interactions	355
Number of people who signed up to mailing list	79
Number of private submissions	8
Number of community meetings we consulted at	11
Number of listening posts held	12
Number of Facebook posts about the consultation opportunities	28
Total number of Facebook engagements	1,776
Number of updates distributed through mailing list	3
Number of internal unit meetings	6
Number of entries to photographic competition	34



An example of the interactive, online survey used for engaging with the community. Participants were able to use the CrowdSpot map to post their suggestions and ideas.



Targets – What are we aiming for?

1. Increase tree cover across urban areas and townships of Greater Bendigo

- a. 25% tree cover across urban Bendigo by 2030
- b. 35% tree cover across urban Bendigo by 2050
- c. 45% tree cover across urban Bendigo by 2070

2. Improve the health of Bendigo's urban forest

By 2030 we will achieve:

- a. An establishment rate for all newly planted trees of at least 95%

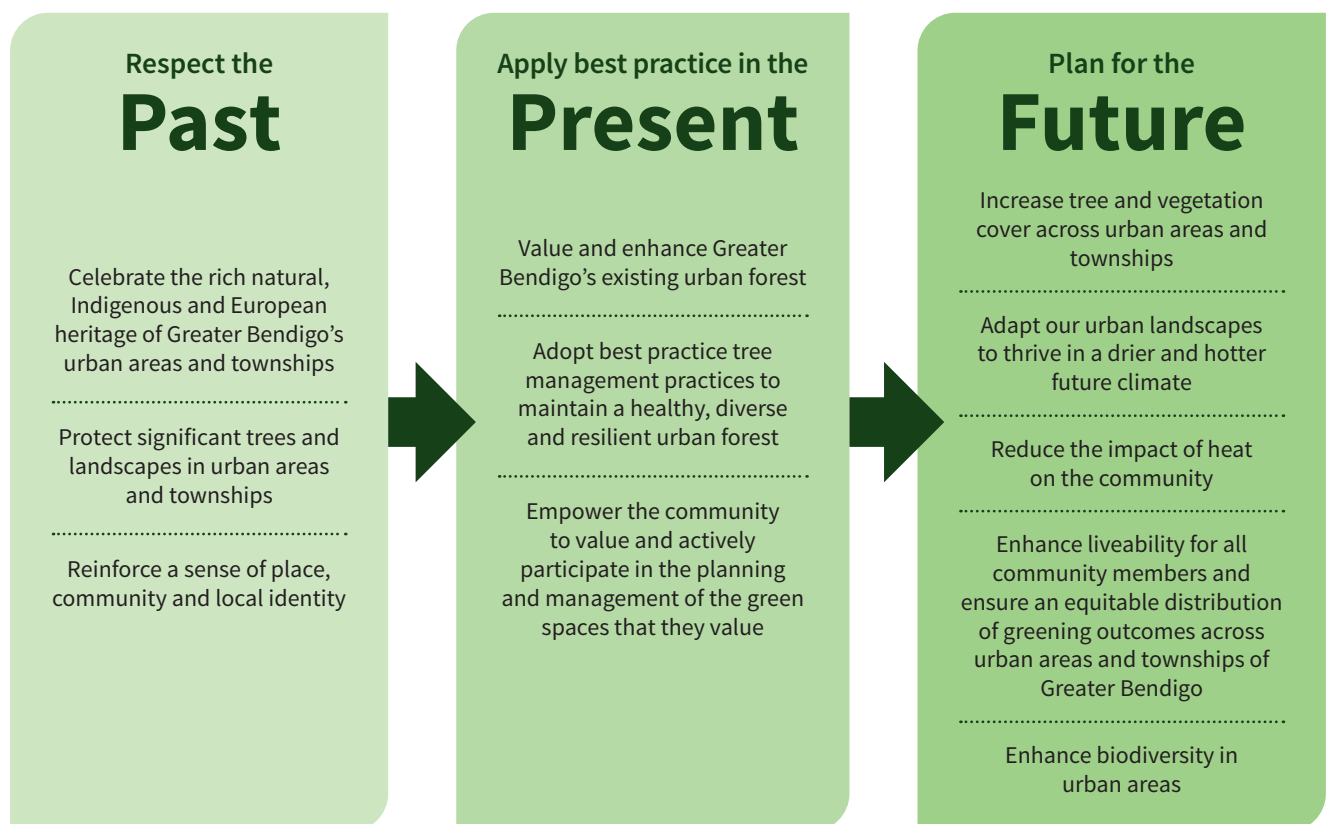
At any one time there will be:

- b. No more than the 10% of the total tree population with a useful life expectancy of less than ten years; and
- c. 80% of the total tree population will be healthy

3. The community will have a greater understanding of the importance of the urban forest and engage in its stewardship

How will we get there?

Greening Greater Bendigo Principles



What might Bendigo look like at 2070?

2020



2070



2020



2070



2020



2070



Greening Greater Bendigo Action Plan 2020–2030

Greening Greater Bendigo is the first urban forest strategy for Greater Bendigo. The 10-year action plan addresses the most immediate priorities and actions to achieve the vision over the short-term and puts the foundations in place to begin to reverse the trend of tree loss from urban areas and align the City's resources and procedures accordingly.

Following extensive community and staff engagement, the numerous actions for Greening Greater Bendigo have been grouped into five strategies and assigned priorities and timeframes for action. Each strategy, in no particular order, responds to the most pertinent drivers identified for Greening Greater Bendigo.

Of all the actions, there are three that have been listed as priority actions based on their importance to the successful delivery of this strategy.

Priority Actions

1. Develop and deliver a ten-year tree planting program to increase tree cover and replace projected tree losses (Action 1.1)
2. Develop Greening Greater Bendigo precinct plans for each urban precinct and township to guide local tree planting and green infrastructure investment (Action 4.1)
3. Undertake a review of the mechanisms available to protect significant trees and landscapes and implement recommended controls (Action 4.2)

Strategies

1. Maintain liveability in a changing climate

Ensure that there is plentiful healthy green infrastructure to support community health and wellbeing in a changing climate.

2. Connect the community to nature

Increase the community's connection to and appreciation of nature, support outdoor activity and foster community stewardship of the landscapes they value.

3. Integrate green and grey infrastructure

Embrace innovative civil infrastructure design solutions that support healthy urban vegetation and reduce urban temperatures whilst reducing maintenance requirements over the long-term.

4. Celebrate the identity and enhance the aesthetic of Greater Bendigo's urban areas and townships

Enhance the aesthetic of Bendigo's urban areas and townships through appropriate planning and tree planting that reinforces a sense of place, celebrates the area's diverse heritage and ensures that valued trees and green spaces can be enjoyed by future generations.

5. Increase biodiversity in urban areas

Ensure green infrastructure contributes to the protection and enhancement of biodiversity in urban areas.



1. Maintain liveability in a changing climate

Ensure that there is plentiful healthy green infrastructure to support community health and wellbeing in a changing climate.



Measures of Success

- Increase tree canopy cover from 20.4% at present to 25% by 2030.
- Number of priority streets based on local heat vulnerability and shade indexing planted
- All trees removed have been replaced
- 80% of the urban tree population is healthy by 2030
- 60% of all trees will have good structure by 2030
- Improved age and species diversity achieved

Actions	Priority	Resource Demand	Lead Unit	Partners
1.1. Prepare and implement a ten-year program to increase tree canopy cover across urban areas and townships informed by; <ul style="list-style-type: none">• Local heat vulnerability indexing• Lack of existing tree cover• Projected tree losses and the need for succession planting• Greater Bendigo Public Space Plan (2019)• Walk Cycle Greater Bendigo infrastructure hierarchy (2019)• Related strategies and master plans• Community priorities.	High	Significant	P&OS	RSD A&HL



Actions	Priority	Resource Demand	Lead Unit	Partners
1.2. Integrate Greening Greater Bendigo principles into the planning and delivery of all future City funded infrastructure and open space projects <ul style="list-style-type: none"> i. Ensure that all future reviews of existing master plans, structure plans, management plans and proposed developments for major parklands and public open spaces incorporate the principles of Greening Greater Bendigo ii. Consider a budget allocation for trees, landscape, greening and associated maintenance in conjunction with all future City funded capital and renewal infrastructure and open space projects iii. Refer to actions 3.1 and 3.2 	High	Low	P&OS	E A&HL RSD
1.3. Recognise green infrastructure as an essential service and explore nature-based solutions as part of the City's response to climate adaptation and mitigation <ul style="list-style-type: none"> i. Take a long-term asset management approach to managing the City's urban tree population ii. Allocate appropriate funding to ensure that the City's tree population is renewed in line with the Urban Tree Management Policy and tree (asset) management plans iii. Include greenhouse gas emissions from urban landscapes and tree management activities in Council's annual One Planet Living Report iv. Investigate approaches such as 'Triple Bottom Line' to incorporate ecosystem service provision from green infrastructure (e.g. water quality, energy savings, carbon storage) across the City's reporting framework 	Medium	Low	RSD	P&OS FS HGB
1.4. Demonstrate best practice urban tree management <ul style="list-style-type: none"> i. Implement and periodically review Council's Urban Tree Management Policy (2017) ii. Replace all City trees that are removed to ensure there is no net loss of public trees from urban areas and townships iii. Integrate the timely upkeep of Council's tree data inventory into the City's proactive tree management program iv. Ensure the specifications of relevant contracts align with the objectives of Greening Greater Bendigo and the Urban Tree Management Policy v. Ensure that all new tree assets handed over from new developments are incorporated into the City's asset database and proactive tree management program vi. Implement a formative pruning program for all young trees to promote good branch structure and correct emerging defects 	High	Medium 1 FTE – Tree Establishment Officer	P&OS	SP



Actions	Priority	Resource Demand	Lead Unit	Partners
1.5. Improve the health, longevity and climate preparedness of Bendigo's future tree population <ul style="list-style-type: none"> i. Promote greater species diversity within the City's tree population ii. Support research in to growing climate appropriate species for Greater Bendigo in a warmer, drier climate iii. Establish living labs for the trial of climate matched species for Bendigo and use the proposed Arboretum at the Bendigo Botanic Gardens for research and conservation (as per 5.2.8. of the Bendigo Botanic Gardens Master Plan) iv. Mitigate tree stress through regular mulching, irrigation and other horticultural treatments especially over the summer months v. Investigate an additional year of maintenance for newly planted trees to increase the success rate of tree establishment vi. Work with Coliban Water to identify water for supplementary irrigation in times of drought and water shortages vii. Remove hard surfaces around trees where possible and replace with porous surfaces to enhance water capture and root growth viii. Monitor, treat and assess emerging threats to the urban forest from pests and pathogens 	Ongoing	High	P&OS	E W
1.6. Develop a local planning policy to provide a local response for subdivision design to increase tree canopy and vegetation cover in urban areas, consider WSUD treatments as standard practice, minimise the effects of urban heat and to create healthy and sustainable neighbourhoods	High	Low	P&OS	SP HGB



2. Connect the community to nature

Increase the community's connection to and appreciation of nature, support outdoor activity and foster community stewardship of the landscapes they value.



Measures of Success

- Greater community stewardship of the landscapes they value demonstrated by;
 - an increased number of community members involved in community planting days;
 - number of community groups involved in ongoing management of public spaces; and
 - an increase in customer requests for street tree planting.
- Partner with Dja Dja Wurrung to implement Greening Greater Bendigo and Dhelkunya Dja – Dja Dja Wurrung Country Plan 2014-2034
- Number of play-spaces with provision of natural shade
- Number of kilometres of new tree planting along walking and cycling trails



Actions	Priority	Resource Demand	Lead Unit	Partners
2.1. Enable, support and empower the community to actively participate in the planning and management of the green spaces that they value <ul style="list-style-type: none"> i. Maximise and coordinate Council resources across related service units ii. Support local networks and build partnerships to improve regional greening outcomes iii. Expand Council's support of community planting days iv. Encourage other public land managers (i.e. cemeteries, schools, crown land) to undertake projects towards the wider vision v. Ensure that 3.1.2. of the Greater Bendigo Public Space Plan is developed to support community-based public space initiatives and overcome barriers to allow for greater community involvement in the management of public open space vi. Explore incentives to encourage the protection and enhancement of significant trees and native vegetation on private property vii. Explore the feasibility of establishing a local Intrepid Landcare program or similar for engaging youth in urban environmental initiatives viii. Update the City's Nature Strip Policy (2006) to include the City's position on nature strip edible planting and urban agriculture (<i>also action 3.3. Greater Food Systems Strategy 2020-2030</i>) 	Medium	Medium Organisational capacity for staffing of greater environmental education and outreach	P&OS	RSD A&HL CP HGB
2.2. Educate the wider community on the benefits of urban vegetation and improve 'urban forest literacy' <ul style="list-style-type: none"> i. Develop interpretive, communications and educational tools for better access and dissemination of information throughout the community ii. Discourage the use of non-living landscape treatments such as artificial turf and tan bark, particularly in darker colours iii. Promote the use of permeable pavements for passive irrigation and maximising deep soil areas for planting trees in the private realm and provide education to developers and the community in this area iv. Review the booklet '<i>Indigenous Plants of Bendigo: a Gardener's Guide to Growing Local Plants</i>' and '<i>Smart Gardens for a Dry Climate</i>' and include Greening Greater Bendigo principles in the new editions 	Medium	Low	P&OS	RSD CP C
2.3. Create well-designed public spaces to foster a sense of place and to enable people to connect with nature <ul style="list-style-type: none"> i. Actively increase natural shade and opportunities of nature-based play in the City's play spaces and early learning centres ii. Provide opportunities for nature-based play, exploration and reflection in public open space iii. Support active transport by providing natural shade along walking and cycling trails iv. Provide natural shade to City amenities, street furniture and facilities 	Medium	Medium	P&OS	A&HL RSD E PS CW
2.4. Increase involvement by Traditional Owners in the decision making and management of public spaces and explore opportunities to re-introduce cultural practices into the urban landscape	Ongoing	Low	P&OS	RSD CP A&HL
2.5. Implement ongoing engagement and partnerships <ul style="list-style-type: none"> i. Ensure equitable and transparent implementation of the strategy and continue to seek guidance from the Sustainable Environment Advisory Committee and Public Spaces Committee i. Investigate the establishment of new regional partnerships and alliances to advocate for improved greening outcomes for Victorian regional Cities and towns 	High	Low	P&OS	RSD A&HL BT



3. Integrate green and grey infrastructure

Embrace innovative civil infrastructure design solutions that support healthy urban vegetation and reduce urban temperatures whilst reducing maintenance requirements over the long-term.

Side entry pits along High Street capture stormwater from the kerb for uptake by the trees.



Measures of Success

- Green Infrastructure Design Guidelines have been developed
- Internal work areas are up-skilled to deliver best-practice green infrastructure outcomes in new subdivisions
- Emergence of passive WSUD treatments in the public realm
- Number of trees protected from development or refused removal
- Area of pavement removed and replaced by porous materials
- Reduction in tree related insurance claims

Actions	Priority	Resource Demand	Lead Unit	Partners
3.1. Engender an internal culture and establish processes that promote green infrastructure i. Encourage more integrated urban design and planning across disciplines and work areas ii. Integrate Greening Greater Bendigo principles into the design rationale for all new infrastructure projects and seek to retrofit other areas wherever possible iii. Consider targets for tree cover, greening and Environmentally Sustainable Design in all new Council managed and funded infrastructure and open space projects iv. Establish an internal officer-level public space working group or similar that reports to the Public Spaces Committee to ensure a place-based approach to the delivery of projects in the public realm v. Create an internal working group to assess, design and maintain new green infrastructure and water sensitive urban design (WSUD) initiatives vi. Promote and publicise successful examples of WSUD and green infrastructure projects to enhance their uptake vii. Support holistic planning and urban design approaches including 'Complete Streets', 'Healthy Active by Design', 'Health in all Policies' and 'Food Sensitive Planning and Urban Design' initiatives viii. Refer to 1.2	High	Low	P&OS	A&HL E W RSD SP FS PMO HGB
3.2. Develop nature-based solutions to reduce existing and future stresses on City infrastructure caused by vegetation and climate extremes i. Develop a program for resolving existing tree and infrastructure conflicts in central Bendigo consistent with the principles of the Bendigo City Centre Plan and Greening Greater Bendigo ii. Develop Green Infrastructure Design Guidelines with standard design approaches for: - Water sensitive urban design - Tree pits and passive street tree irrigation - Permeable pavements - Maximising soil volumes available to trees in urban areas - Car park design - Road verges (<i>Refer to 2.3.4 of the Greater Bendigo Public Space Plan and 1.2. of Walk Cycle Greater Bendigo which also recommends the development of design standards for the public realm</i>) iii. Educate and support internal staff in the adopted of the above guidelines to ensure they are widely accepted and promoted iv. Review the Infrastructure Design Manual to incorporate the Green Infrastructure Design Guidelines, maintenance requirements for WSUD infrastructure and to allow for sufficient room to plant canopy trees in new developments v. Embrace and seek out new innovative WSUD technologies to passively irrigate urban vegetation and continue to improve their application in Greater Bendigo vi. Minimise the provision of hard surfaces in public open spaces and where hard surfaces are provided, break these up with vegetation and encourage the use of porous and lightly coloured surfaces vii. Develop a local planning policy and advocate for changes to clause 52.06 Car Parking of the Particular Provisions of the planning scheme to ensure climate responsive landscape design in new car parks to reduce the impact of the urban heat island, incorporate WSUD and support the provision of canopy trees	High	Medium	P&OS	E W RSD A&HL SP



Actions	Priority	Resource Demand	Lead Unit	Partners
3.3. Prioritise nature strips for nature <ul style="list-style-type: none"> i. Review the City's Nature Strip Policy (2006) to incorporate Greening Greater Bendigo principles and to mitigate urban heat in the public realm (refer also to action 2.1.viii) ii. Advocate for changes to the Infrastructure Design Manual to consolidate essential services in the public realm and ensure that road verges in new subdivisions are wide enough to support canopy trees iii. Develop internal practices to ensure particular provision 56.09-1 of the planning scheme is applied to prioritise shared trenching and the consolidation of utilities to enable the planting of canopy trees in new subdivisions iv. Reduce conflicts between trees and service infrastructure, maintenance costs of vegetation clearance and increase tree cover by engaging service authorities at the concept and planning permit stage of new developments and retrofit or consolidate existing assets when there is opportunity to do so 	High	Low	P&OS	E SP
3.4. Strengthen the City's capacity to respond to, provide design advice and enforce tree protection requirements <ul style="list-style-type: none"> i. Update standard permit conditions for the protection of City trees in line with the City's Urban Tree Management Policy ii. Investigate opportunities to include the Urban Tree Management Policy and <i>AS4970 Protection of trees on development sites</i> as background documents in the planning scheme and the infrastructure design manual with policy guidance to support satisfactory tree and vegetation protection iii. Provide education and guidance for builders and developers to retain and protect existing trees in new developments iv. Develop a process for responding to planning referrals directed to the Parks and Open Space unit v. Develop a process for tree removal and reinstatement as part of work within road reserve permit applications vi. Develop a process for administering the Amenity Tree Value charge 	High	1FTE – Planning and Protection Arborist	P&OS	SP E





4. Celebrate the identity and enhance the aesthetic of Greater Bendigo's urban areas and townships

Enhance the aesthetic of Bendigo's urban areas and townships through appropriate planning and tree planting that reinforces a sense of place, celebrates the area's diverse heritage and ensures that valued trees and green spaces can be enjoyed by future generations.



Measures of Success

- Delivery of Greening Greater Bendigo Precinct Plans
- Adoption of statutory controls for the protection of significant indigenous and non-indigenous vegetation on private land in urban areas and townships.



Actions	Priority	Resource Demand	Lead Unit	Partners
4.1. Develop Greening Greater Bendigo Precinct Plans for each urban area and township to guide local green infrastructure priorities, canopy cover targets and design guidelines that are responsive to local area needs, conditions, neighbourhood character and community preferences <ul style="list-style-type: none"> i. Ensure an incremental increase to natural shade from tree cover in Greater Bendigo's urban areas and townships ii. Apply the concept of a city-wide mix of European and native tree plantings and maintain a balance of indigenous, native and exotic trees iii. Select the most appropriate species for a location considering local conditions, constraints, climate and neighbourhood character iv. Reinforce a sense of place, community and local identity v. Include Greening Greater Bendigo principles in the review and development of all future structure plans and local area plans vi. Commit to increasing the diversity of tree species within urban precincts and townships with no further plantings of avenues of London Plane trees within central Bendigo vii. Enhance biodiversity in urban areas and townships. Refer to Action 5.2. viii. Review the Entrances and Boulevards Study 1994 and ensure that Greening Greater Bendigo principles are integrated in the development of any new design framework. <i>(Also 2.1.2 of Greater Bendigo Public Space Plan)</i> 	High	Medium	P&OS	RSD A&HL SP
4.2. Protect significant indigenous and non-indigenous vegetation on private land in urban areas and townships of Greater Bendigo <ul style="list-style-type: none"> i. Undertake the strategic work required to define and identify significant indigenous and non-indigenous vegetation on private land in urban areas and townships and recommend the best statutory mechanism by which to protect it ii. Implement the statutory control recommended in 4.2.i. 	High	High	P&OS	SP RSD
4.3. Celebrate the natural, Indigenous and European heritage of Greater Bendigo's public spaces in urban areas and townships <ul style="list-style-type: none"> i. Recognise, respect and allow for Indigenous connection to country through public space and urban tree management and work with Dja Dja Wurrung to implement Greening Greater Bendigo and Dhelkunya Dja – Dja Dja Wurrung Country Plan 2014-2034 ii. Raise the profile of the uniqueness of Bendigo being a 'City in a forest' and investigate Bendigo becoming a National Park City 	Ongoing	Medium	P&OS	CP RSD
4.4. Develop a criteria and process for how revenue generated from City tree removals in the Amenity Tree Reserve is spent ensuring that green infrastructure is replaced in proximity to where it was removed	High	Low	P&OS	FS
4.5. City in a forest <p>Refer to Greater Bendigo Public Space Plan – Implementation Framework section 2.2 City in Forest for associated actions regarding;</p> <ul style="list-style-type: none"> • Options for creating a forested edge and buffer as part of future structure plans • Changes to the Development at the Urban-Interface Policy • Design and development of forest entry points and type of interventions in locations along the forest-urban interface. 				



5. Increase biodiversity in urban areas

Raise the importance of the role biodiversity plays in maintaining urban systems resilient to the shocks and stresses associated with climate change and protect and increase biodiversity in urban areas.



Measures of Success

- Preparation of a biodiversity strategy

Actions	Priority	Resource Demand	Lead Unit	Partners
5.1. Ensure that a biodiversity management policy for Greater Bendigo is developed that sets principles, standards and conditions for the creation and management of conservation spaces, biolinks and for retaining and promoting biodiversity in public spaces (as per 3.3.1. <i>Greater Bendigo Public Space Plan</i>) with the view to inform the development of a biodiversity strategy	Medium	High	RSD	P&OS

Actions	Priority	Resource Demand	Lead Unit	Partners
5.2. Integrate biodiversity and urban ecology values into the planning, design and management of public open spaces including through the development and review of all future open space master plans and the Greening Greater Bendigo precinct plans	Ongoing	Medium	P&OS	RSD SP A&HL E
<ul style="list-style-type: none"> i. Create more natural plantings in urban areas with the inclusion of understory ii. Protect and enhance existing habitats in urban areas iii. Provide habitat through the retention of hollow-baring dead trees where practical while ensuring public safety iv. Increase ecological connectivity and the sense of a forest-like tree canopy across the urban area v. Celebrate Bendigo's Box-Ironbark forests and reinforce the City's forested backdrop vi. Increase the diversity of trees and other plants to provide habitat and a sequence of food sources for indigenous fauna and to promote healthy ecosystems vii. Develop a training program for internal staff related to biodiversity awareness viii. Utilise urban creeks and gullies to create green corridors for urban cooling and biodiversity outcomes. <i>(Refer also to 3.3.2 of the Greater Bendigo Public Space Plan)</i> ix. Create a plan of recovery and improvement of urban creeks and gullies and provide budget for maintenance and retrofitting 				
5.3. Encourage, educate and empower the community to enhance biodiversity in the public and private realm	Medium-Low	Low	P&OS	RSD
<ul style="list-style-type: none"> i. Introduce a Gardens for Wildlife Program – urban environments supporting local plants and animals ii. Explore and support opportunities for 'Citizen Science' to acquire and monitor local biodiversity information iii. Promote the Greater Bendigo Bushcare Incentive Program - a rate relief program for Trust for Nature covenanted land iv. Investigate incentives for community groups to preserve and enhance local bushland v. Promote awareness and education around Greater Bendigo's existing significant plant and animal populations including the Grey Headed Flying Fox colony in Rosalind Park vi. Actively support local land-based community events including 'Spring in the Bendigo Bush' vii. investigate incentives to support renters and landlords to undertake greening initiatives in tenanted properties. viii. Refer to 2.1. 				



Priorities and Timeframes

Priority	Timeframe for action
High	1-2 years
Medium	3-5 years
Lower	5-10 years
Ongoing	Ongoing

Actions have been assigned priority based on a high-level, criteria-based assessment from the following criteria;

- Benefit to community/communities with socio-economic disadvantage (equity of investment)
- Potential to positively impact community health
- Potential to positively impact overall liveability of the city
- Importance as prerequisite to on-ground delivery and/or other initiatives
- Potential to improve government services to the community
- Ease of implementation

Resource Demand

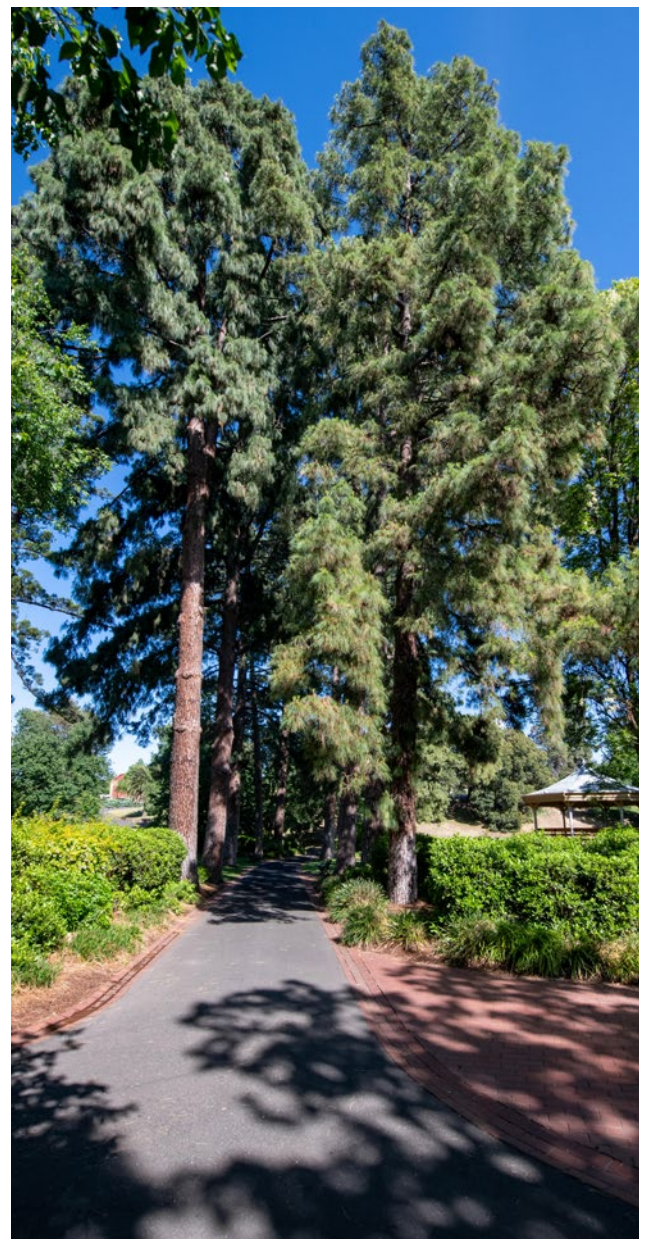
This information is provided provisionally as an indicator of the relative complexity and cost of each action. For costs the following categories are used:

Resource demand	Rough cost estimate
Low	<\$100,000
Medium	\$100,000 to \$500,000
High	\$500,000 to \$1,000,000
Significant	\$1,000,000+
FTE	(full time equivalent)

It should be noted that the above cost indicators are not cost estimates.

Abbreviations

City of Greater Bendigo Service Units	Abbreviation
Active and Healthy Lifestyles	A&HL
Business Services	BS
Business Transformation	BT
Communications	C
Community Partnerships	CP
Community Wellbeing	CW
Engineering	E
Financial Strategy	FS
Healthy Greater Bendigo	HGB
Parks and Open Space	P&OS
Project Management Office	PMO
Property Services	PS
Regional Sustainable Development	RSD
Resource Recovery and Education	RR&E
Statutory Planning	SP
Works	W



Implementation framework

Realising the vision for Greening Greater Bendigo requires long-term commitment from Council, City staff and the wider Greater Bendigo community. It requires effective planning, management and design at all levels and across multiple disciplines. The vision of Greening Greater Bendigo must be well-understood by all to deliver both the most immediate and long-term goals of the strategy and accompanying action plan.

Funding and Resources

The successful implementation of Greening Greater Bendigo should not rely solely on any one funding stream or work unit to deliver. The delivery of the Greening Greater Bendigo action plan will require significant investment over the next decade and beyond and, in a period of rate-capping and slow economic growth, there will no doubt be challenges in securing sufficient resources. It is essential that Greening Greater Bendigo principles are integrated into the way that the City plans for and manages its assets and the public realm. It has therefore been a focus of the action plan to integrate targets for tree cover and green infrastructure into all new Council managed and funded open space projects. Project costs can be more easily justified when benefits of green infrastructure and a more holistic approach to urban design are considered. For example, when a footpath

is built the City is not just investing in the civil infrastructure itself. Tree planting along the path creates a more pleasant environment and encourages more people to walk and cycle.

Creating a greener Greater Bendigo is something the City does not need to tackle alone. Increasing vegetation cover in urban areas will only be achieved through the adoption of Greening Greater Bendigo principles on private land, by residents in their own backyards, in new developments and on other land such as schools and cemeteries that are not directly managed by the City. It has also been a focus of the action plan to foster community stewardship over the green spaces they value and empower them to act.

Monitoring, Reporting and Evaluation

Frequent monitoring and evaluation are essential components in the successful delivery of Greening Greater Bendigo and accompanying action plan. It ensures that key actions and performance indicators can be tracked, appropriate adjustments made and demonstrates accountability to stakeholders and the community. Targets and actions have been considered so that success can be readily measured and reported on.

Methodologies for quantifying the extent and condition of the urban forest are emerging and improving rapidly. These include the use of machine learning, artificial intelligence, smart technology and other remote sensing technologies. Such technologies are likely to make data collection increasingly more accessible, frequent and cost-effective.

Methods for valuing the ecosystem services that trees provide are also being refined. Models such as i-Tree Eco exist that help urban foresters quantify the benefits of urban trees such as pollution removal, carbon sequestration and energy saving benefits. Better understanding the role of the urban forest in delivering these benefits will play an increasing role in Council's response to addressing climate change.

The Greening Greater Bendigo action plan is nimble enough to be able to embrace new technologies as they emerge without being locked into any one methodology.

The table below shows the strategy's key measurables and suggests how these may best be monitored and reported on over the life of this document.

Measure	Benchmark	Target	Suggested Method	Reporting Frequency
Tree Cover	20.4%	25% by 2030 35% by 2050 45% by 2070	Machine learning technology from aerial imagery	The continual use of purposely developed AI technology and freely available aerial imagery at intervals of no-more than 5 years.
Tree Health	64% of all trees in 2020 are in good or very good health	80% of all trees will be in good or very good health by 2030.	Tree inventory	Update tree inventory as part of the proactive tree management cycle (every 4th year)



Measure	Benchmark	Target	Suggested Method	Reporting Frequency
Useful Life Expectancy	15% of all trees have a ULE of less than 10 years	No more than the 10% of the total tree population will have a ULE of less than ten years by 2030.	Tree inventory	Update tree inventory as part of the proactive tree management cycle (every 4th year)
Tree Structure	35% of all trees have good or very good structure	60% of all trees will have good or very good structure.	Tree inventory	Update tree inventory as part of the proactive tree management cycle (every 4th year)
Urban Forest Health	Summer 2018/19 capture	Achieve an incremental increase in the condition of the urban forest.	NDVI from satellite imagery	A cost-effective measurement that can be undertaken seasonally or annually over the summer months.
Diversity	2020 tree inventory	Achieve an incremental increase in genus and species diversity as trees are removed, replaced and planted.	Tree inventory	Update tree inventory as part of the proactive tree management cycle (every 4th year)
Reduce urban heat	N/A	Plant trees in the most exposed and heat vulnerable streets.	Priority streets have already been identified. Continue to update the GSV and HVI model as new street level data becomes available.	Report on the number of trees and streets planted out annually.
Customer service requests for new trees	300 per year	Achieve an increase over time.	Number of service request types in the City's customer request system.	Annually
Community participation in community planting days	~120 per event	Achieve an increase over time.	Number of registrations for community run events	Annually

Acronyms

GSV	Google Street View
HVI	Heat Vulnerability Index
NDVI	Normalised Difference Vegetation Index
SVF	Sky View Factor
UHI	Urban Heat Island
WSUD	Water Sensitive Urban Design



Glossary

Adaptive capacity – The capacity to respond to environmental changes in order to continue to thrive. In the context of climate change, adaptive capacity depends on the inter-relationship of social, political, economic, technological and institutional factors.

Artificial Intelligence (AI) – The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

City Tree – For the purpose of this strategy a City tree is defined as a tree in an urban area or township that is actively managed by the City of Greater Bendigo.

Ecosystem Service – Ecosystem services are the many and varied benefits that humans freely gain from the natural environment and from properly-functioning ecosystems. Such services include shade, energy savings, water filtration, carbon sequestration and pollution abatement.

Green Infrastructure – Describes the network of natural landscape assets which underpin the social-cultural, economic and environmental functionality of urban areas and townships.

Grey Infrastructure – Refers to man-made, constructed assets such as roads, paths, drainage infrastructure, utilities, factories and car parks.

Machine Learning – The study of computer algorithms that improve automatically through experience. Machine learning algorithms build a mathematical model based on sample data in order to make predictions or decisions without being explicitly programmed to do so. It is seen as a subset of artificial intelligence.

Pollarding – A pruning technique by which trees are headed and then reheaded on an annual basis. Pollarding is a resource intensive practice. Pollarding older trees often result in unattractive trees more subject to decay.

Senesce – Deteriorate with age.

Urban Forest – The sum all trees and other vegetation within urban areas as well as the soil and water that supports it. An urban forest is made up of all vegetation in streets, parks, gardens, campuses, creek and river verges, wetlands, transport corridors, community gardens, balconies and rooftops.

Urban Heat Island – An urban heat island is an urban area or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities. The temperature difference is usually larger at night than during the day and is most apparent when winds are weak.

WSUD – Water Sensitive Urban Design is a land planning and engineering design approach which integrates the urban water cycle, including stormwater, groundwater and wastewater management and water supply, into urban design to minimise environmental degradation and to make use of this valuable resource.

“An Iconic Specimen – The loss of mature trees (of our various indigenous local species) from across the landscape has profound implications for the way we think about what our local trees mean and represent. Such specimens hold enormous value. A strong vision with good planning to replant trees (the right species in the right places) will provide a profound legacy for future generations. The sooner we start in a coordinated, strategic and meaningful way – the more productive an outcome can be achieved.”

-Bendigo Field Naturalists Club



