Temperature check: Greening Australia's warming cities
Key findings

- The hottest summer days in Brisbane and Melbourne are expected to regularly reach over 40°C by 2060-2080, and up to 50°C in Sydney.

- The urban heat island (UHI) effect is likely to add several degrees on top of this — especially in more vulnerable places.

- Improving the amount of vegetation in cities will help address rising temperatures.

- Greener cities are also good for human health and wellbeing, reduce heat-related deaths, create jobs and help combat climate change by absorbing more carbon dioxide from the air.

- Cities also need to protect their remaining native plants and trees.

- Australia’s national environmental law is allowing the destruction of native trees that could be cooling cities and providing critical habitat for wildlife.

- In the first 17 years that Australia had a national environment law, 20,212 hectares of urban threatened species habitat — that’s 11,400 MCG footy grounds — was destroyed.

- Places most vulnerable to the UHI effect tend to be disadvantaged suburbs with lower levels of vegetation. Better green infrastructure — like native plants and trees — in these areas offers important health and wellbeing outcomes for these communities.

- All levels of government and community must work together to prioritise policies and collaborative programs that promote green infrastructure, water management and cooling solutions to maintain our wellbeing.

- Green infrastructure takes time to establish to maximum effectiveness, so acting early is critical for meeting future needs.

- City data that projects future extreme heat at local scales is only available in Brisbane, Melbourne and Sydney.

- Funding for nationally coordinated research is needed to ensure all population centres understand their levels of risk and can act to protect their communities, economy and urban ecosystems.
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Australia has always been a country with extreme weather events — “A land of droughts and flooding rains”1 — however, these events are becoming more frequent and extreme, with heatwaves of particular concern for our cities. Heatwaves kill more Australians than any other ‘natural’ disaster and these are predicted to get more severe as our climate changes.2

Heatwaves are particularly troublesome in cities, because cities are typically hotter than the surrounding countryside. Australia is the most urbanised nation on earth, with 60% of the population living in cities of one million people or more,3 which places our communities at significant risk of heat-related impacts.

One important way we can cool our cities and reduce the risk and severity of heatwaves, is by revegetating our urban areas. Not only is expanding our urban vegetation good for reducing heat-related deaths, but it can create jobs (helping with COVID-19 economic recovery), provide habitat for our native wildlife, and help address climate change by absorbing more carbon dioxide from the air.

In this report we present evidence that strong action to increase urban vegetation will become imperative in our three largest cities to reduce serious heatwave impacts by 2060–2080, even with strong climate action. Without strong climate action — and continuing business-as-usual — Brisbane, Melbourne and Sydney will regularly experience temperatures above recommended health thresholds. Green infrastructure (like planting native trees and plants) takes time to establish to its maximum effectiveness, so acting early is critical for meeting future needs. This study also finds that local areas more vulnerable to additional city heat are typically more disadvantaged suburbs with lower levels of protective vegetation cover.

In Brisbane, business-as-usual predictions show the city’s hottest summer days will sit between 38.3°C and 41.8°C for 2060–2080.4 In comparison, summer’s hottest days over the last 50 years at the Brisbane Airport station averaged 35°C. While Brisbane is one of Australia’s greenest capital cities with 54% overall vegetation cover,5 on average the city experiences an additional 1°C of temperature due to heat being trapped by the city’s built infrastructure — with some more vulnerable local areas experiencing additional heat of as much as 6.1°C.6

In Melbourne, business-as-usual predictions show the city’s hottest summer days will sit between 42.9°C and 49.4°C for 2060-2080.7 In comparison, summer’s hottest days over the last 50 years at Melbourne’s Olympic Park station averaged 41.9°C. Melbourne is one of Australia’s least green capital cities with 23% overall vegetation cover,3 and the city typically experiences an additional 5.5°C of temperature due to heat being trapped by the city’s built infrastructure — with some more vulnerable local areas experiencing additional heat of as much as 13.5°C.6 Despite advances representing the urban heat island in some Australian climate projections, these street-level hotspots are not yet seen in projections.7
In Sydney, business-as-usual predictions show the city’s hottest summer days will sit between 41.7°C to 50°C for 2060–2080. In comparison, summer’s hottest days over the last 50 years at Sydney’s Observatory Hill station averaged 39.1°C. Sydney is one of Australia’s less green capital cities with 34% overall vegetation cover, and the city typically experiences an additional 5.5°C of temperature due to heat being trapped by the city’s built infrastructure — with some more vulnerable local areas experiencing additional heat of as much as 13.5°C.

Sydney also has more local variation in green infrastructure and additional city heat than Melbourne and Brisbane. Mosman, for example, has moderately high vegetation cover at 43% and experiences on average 2.2°C of additional heat from its built infrastructure, whereas Blacktown, which has only 22% vegetation cover, experiences an additional 5.8°C on average from its built infrastructure.

This ‘heat gap’ between suburbs that have high vegetation cover versus those with lower cover, will continue to disadvantage vulnerable local areas within our cities as temperatures increase towards 2060–2080 predictions. Eliminating this gap and improving green cover across all parts of our cities while taking strong action on climate change, are urgent tasks if Australia’s most populated centres are to protect the health and wellbeing of our communities in the coming decades.
Heatwaves kill more Australians than any other ‘natural’ disaster. These are predicted to get more severe as our climate changes.
Climate change and its impacts in Australia

Our global climate is changing due to carbon dioxide being pumped into the atmosphere from human activities such as the production of electricity, manufacturing and transport.

As carbon dioxide builds up in the atmosphere, it creates a reflective force that keeps the sun’s heat from escaping into space, which increases the earth’s land, sea and air temperatures. Global carbon dioxide concentrations are now higher than at any time in the last 2 million years.\(^9\) Humans have emitted more carbon dioxide in the last 50 years than we did in the 200 years before that.\(^{10}\) This rapid increase is presently warming the globe by 1.7°C, changing the climate system 170 times faster than the last 7,000 years of human history.\(^{11}\)

Though we’ve seen increased efforts from communities, businesses and local governments acting on climate change, Australia remains one of the largest (per person) carbon emitters in the world.\(^{12}\) In the 2020 Climate Change Performance Index, Australia ranked last on climate policy among all 57 countries assessed.\(^{13}\)

Australia’s domestic emissions as of 2020

Australians make up just 0.3% of the world’s population...

...but we burn 1.3% of the world’s greenhouse gases (that’s 3.6x the world average).

We are also the world’s largest supplier of coal.

Source: Based on data provided by RMIT Fact Check.\(^{14}\)
The role of cities

Cities in particular are major contributors to climate change, accounting for approximately two-thirds of domestic carbon dioxide emissions globally.\textsuperscript{15}

Addressing these emissions where they actually occur is an important step in addressing global temperature rise. This makes Australian cities well-positioned to play a leadership role in driving global action on climate change, which is especially important considering the population of our cities will continue to increase. For instance, in both Melbourne and Sydney the population is expected to double by the year 2056.\textsuperscript{16, 17}

Our cities’ carbon emissions have had consequences for Australia and the rest of the world. Australia’s climate has warmed on average by 1.44°C since 1910, with this warming happening even faster from 1950 onwards.\textsuperscript{9}

This may not sound like much of a change, but even a slight shift in overall temperature has significant consequences for our climate. It is already causing a greater amount of extreme weather events, from more intense floods, fires and storms to Australia’s deadliest natural disaster — heatwaves.\textsuperscript{9} To be classed as a heatwave, maximum and minimum temperatures must be unusually hot for at least three consecutive days in comparison to historical conditions at the location.\textsuperscript{18}

Heatwaves have increased in intensity, frequency and duration across Australia over the past century, particularly in recent decades.\textsuperscript{2, 19} With current levels of greenhouse gas emissions, Australia can expect to see further increases in temperatures, with predictions that a global temperature rise of just 1.5 to 2°C may almost double the frequency of heatwaves.\textsuperscript{20}

\textbf{Heatwaves in Australian cities are becoming hotter, longer and more frequent}

\textit{Source: Perkins and Alexander}\textsuperscript{21} comparing heatwaves between 1950–1980 and 1981–2011. Figure adapted from Steffen.\textsuperscript{22}
The urban heat island effect and nature in our cities

This shift in extreme weather has many implications for human health, ecosystems and infrastructure. Although heatwaves occur all over Australia, their impacts are felt particularly strongly in cities, because of a phenomenon known as the urban heat island effect (UHI).

What is the urban heat island effect?

It’s important to note different regions of Australia have different climates. This is true even at a smaller, more local scale. Many of us will have experienced the satisfying change as we journey out of the city and suburbs to enjoy the fresh seaside breeze, or the crisp alpine air. Cities form their own microclimates by interacting with climate processes and influencing the surrounding atmosphere. Typically, the microclimate they form is noticeably hotter than their surroundings, a phenomenon studied since the early 1800s when it was first observed. This additional warmth in metropolitan or urban areas is known as the UHI effect, and occurs in cities all across the globe.

The UHI effect occurs for a number of reasons. The profile of cities, full of skyscrapers and narrow streets, creates canyons in which heat gets trapped. The increased proximity and density of structures that characterise cities also helps heat accumulate. Urban environments are dominated by dense or dark materials — such as concrete, asphalt, steel and glass — that absorb and retain more heat within the city than natural materials. The comparative absence of trees and vegetation means less available moisture to cool the air and fewer instances of shade for us to take refuge under.

Source: Adapted from City of Parramatta material.
Within cities, there is also typically a greater density of people and activities than in rural areas. The energy we consequently burn is released as heat: if there are a lot of people and machines in one area, that’s a lot of extra heat. This waste heat — particularly from our cars, factories and cooling systems — has a two-way relationship with the UHI effect. When temperatures go up, we strive to make ourselves more comfortable and rely on more air-conditioning and refrigeration. This increases electricity usage and creates more waste heat, further contributing to the UHI effect.\textsuperscript{31}

Addressing the UHI effect requires changing the balance of heat being trapped or released in the city. There are several technologies available that can help reduce the UHI effect — e.g., the use of materials with higher reflectance or that are super-cool, cooling systems that involve evaporation and transpiration, devices for solar control and shading, and natural temperature sinks.\textsuperscript{32} One simple and cost-effective method that can have significant impact, however, is increasing the amount of urban vegetation.
Increasing urban vegetation

Increasing urban vegetation, or the creation of green infrastructure, refers to establishing plants such as trees and shrubs within an urban or metropolitan setting. Whereas a city’s built infrastructure includes the networks of roads, buildings and other constructed spaces across the city, green infrastructure is the network of photosynthetic vegetation, including trees, shrubs and other plants in forests, parks, waterways, wetlands and gardens, and on green roofs and walls.

The presence of green infrastructure is a key factor influencing UHI effects. It is one of the simplest ways to reduce the UHI effect. Trees, shrubs and even grass, help reduce the amount of heat in urban areas in different ways such as by absorbing sunlight, releasing water vapour that evaporates and cools the air when they ‘breathe’, and shading surfaces that would otherwise store and release heat.

Urban revegetation takes many forms but usually occurs as open spaces or parks and wetlands, vertical greenery on building facades, or vegetated roofs. Each of these methods involve slightly different benefits and costs, but all can help reduce the UHI effect and cool down our cities.
Trees, shrubs and grass help reduce heat in urban areas by absorbing sunlight and releasing water vapour that evaporates and cools the air when they ‘breathe’.
How heat and ‘greening’ impact Australian city life

The increase in urban heat resulting from lack of urban vegetation and from climate change has multiple impacts.

The most important of these are physical and mental health considerations, infrastructure damage, economic costs and wildlife loss. As one of the most urbanised nations in the world, with 90% of its population living in urban areas, Australians are particularly vulnerable to the UHI effect. Furthermore, a large and growing proportion of our population is made up of older people, who are more impacted by heat. People from low-socioeconomic backgrounds are also disproportionately affected.

The following pages will compare the impacts of the UHI effect and the various benefits of establishing urban green infrastructure on health, infrastructure, the economy and wildlife.
Health

Impact of heat

Extreme heat is a major health hazard that puts strain on the body. It prevents our bodies from managing our internal temperature at its usual healthy 37 degrees. Increased body temperature can cause heavy sweating, clammy skin, dehydration, tiredness, headache, dizziness, nausea, cramps, and a quick, weak pulse. This can lead to heat exhaustion, heat collapse and heat stroke, sometimes proving fatal.

Species case study

A 2014 study in Brisbane, showed that 10°C increase in daily maximum temperature in summer months was associated with a 7.2% increase in hospital admissions on the following day.

Poore mental health

Heat impacts our mood and behaviour, often making us more irritable and susceptible to mental health conditions. An Adelaide study showed that as temperatures climbed above 26.7°C, there was an 10% increase in mental health hospital admissions.

Rakes the risk of death

More Australians die from heatwaves than all other natural disasters combined. The 2014 heatwave caused 228 deaths across Victoria. Under climate change, heatwaves could cause an additional 6,214 deaths by 2050 (or 402 deaths annually) in Victoria alone.

Harder on disadvantaged populations

Health problems arising from heat are not equally distributed across the population. Heat is particularly problematic for those in low socioeconomic circumstances with reduced access to healthcare, the elderly and others reliant on public infrastructure.

Benefits of vegetation

There is growing evidence that urban vegetation is crucial in mitigating rising heat stress and protecting us from the harshest effects of heatwaves, consequently improving human health and extending life spans.

Encourages exercise

More green spaces like parks and gardens encourage people to get out and exercise, helping to reduce obesity and improve general health and wellbeing.

Fosters community

Green spaces often act as neighbourhood meeting points, connecting communities and bringing people together.

Improves mental health

There is a certain ‘emotional warmth’ brought by the presence of wildlife in an urban environment that works to promote positive mindsets, reduce stress and lift overall wellbeing. Australians experiencing just 30 minutes of any outdoor green space each day are less likely to experience depression.

Lowers burden on hospitals

Leafy urban suburbs can reduce projected daily hospital admission rates for dehydration and heatstroke by 15% and 30%, respectively.

Reduces heat-related deaths

Urban vegetation can reduce average maximum peak daily temperatures by up to 1.8°C and night-time temperatures by up to 2.3°C. A 0.1°C reduction in peak daily temperature has been found to lower death rates by an average of 3%. Temperature reductions are most significant at night, due to the reduced amount of heat stored in city surfaces through the day that is then released at night.
**Infrastructure**

**Impact of heat**

*All infrastructure faces additional and costly repair and maintenance work as a direct result of heat stress.*

*Reduction of infrastructure lifespan over the long term is likely as higher temperatures increase the heat stress on buildings, roads and railway lines.*

**Disrupts electricity supplies**

Extreme temperatures and severe weather put our electricity grid at risk of extended disruption. Higher electricity demand during summer also puts additional stress on electrical generation, capacity and efficiency, which can lead to significant blackouts.

**Damages public transport systems**

Heatwaves can expand rail lines, buckle tracks and cause power outages. In 2009 there were up to 250,000 services cancelled on Melbourne’s railways as a direct result of heatwaves. Like many services, public transport is highly dependent on telecommunications and electricity supply, both of which are threatened by increasing heat stress.

**Interrupts internet provision**

Internet provision in general is at serious risk from excess heat putting strain on physical assets such as cabling and data centres. For example, 111 of Australia’s largest data centres are in the CBD’s of our capital cities and are vulnerable to heat through disruption of electricity required for general function and cooling. During Perth’s third hottest day on record in 2015 (44.4°C), iiNet services collapsed due to failure of both the main and backup air-conditioning systems.

**Benefits of vegetation**

*Greenery reduces general heat stress on our infrastructure, while offering important co-benefits for stormwater management.*

**Protects roads and pavements**

Shady trees can protect asphalt pavements, roads, and other transit infrastructure from degrading under heat stress. Annual operations and maintenance costs such as crack sealing and surface replacement are reduced as a result. This can represent an accompanying financial benefit of up to $1.6m for a 500m urban street lined by 100 trees.

**Improves building lifespans**

Greening strategies are desirable risk-reduction investments due to the benefits to human settlements, energy and water infrastructure, and other amenities. Longer roof lifespans, reduced cooling loads, less maintenance lower heating system needs, and a cutback in stormwater strain are all reasons for increasing urban vegetation.

**Protects stormwater systems and reduces requirements**

Green infrastructure slows and reduces immediate stormwater loads that infrastructure receives. It reduces strain on the drainage systems by reducing flow speeds and volume and so reduces the average annual damage to infrastructure. The reduced capacity requirements also help realise cost savings of 50% or more. New York City reports their trees reduce runoff at a value of USD$4.6m annually.
Economy

Impact of heat

In 2013–2014 alone, heat stress cost our economy approximately $7.9 billion. These costs increase exponentially with the severity of the heatwaves, making climate change a critical economic issue.

Reduces worker productivity

Excessive heat directly impacts the productivity and health of both indoor and outdoor workers, with disruptions to services such as public transport, internet and electricity also reducing productivity. Heat causes outdoor workers’ capacity to significantly decrease, leading to greater absenteeism. Indoor workers report loss of judgement, reduced patience and lower cognitive function. Heat stress caused productivity loss of between $724 and $868 per worker, per summer. This can be as high as $1,602 across Western Australia and $3,678 in the Northern Territory.

Increases health-related costs

Many of the costlier impacts of the UHI effect are those on human health. As mentioned, heat-related mental ill health, morbidity and mortality are typically higher under a UHI effect, and this has a high cost. In addition to direct heat stress, the concurrence of higher emissions of air pollutants and lower water quality is also a costly health burden.

Benefits of vegetation

Trees and urban landscapes provide far more value economically and ecologically than they use, with a cost-benefit ratio of 1 to 6 in favour of urban trees and landscapes.

Creates jobs

Urban planting programs can deliver a strategic response in supporting Australia’s Covid-19 economic recovery. Recently, the Australian Conservation Foundation estimated that a $2.4 billion investment in landscape management and restoration will ‘create 24,000 jobs in the sector in the first year of operation’. Employment for qualified people in the labour market for horticulture and arboriculture is expected to continue growing until mid 2023.

Adds value to homes

Residential homes can reap a wide range of rewards from increasing vegetation. In Melbourne, properties in tree-lined streets are valued roughly 30% higher than those in streets without trees, while in Sydney, a 10% increase in the abundance of street trees could increase property values by an average of $50,000.
Temperature check: Greening Australia’s warming cities.

**Economy continued**

Impact of heat

**Adds to infrastructure costs**
Updating or increasing the resilience of infrastructure after extreme heat events is difficult because of scale, disturbance and cost. More specifically, the Environment and Communications Resource Committee reported in 2018 that local government areas faced with repairing and updating conventional infrastructure against climate change are challenged by inadequate resources and limited finances.65

**Escalates antisocial behaviour**
Collective crime such as riots and assaults tend to increase with heat. These anti-social behaviours have direct and indirect costs to society, including financial loss due to personal injury and property damage, and the public funding of crime prevention, policing, courts and correctional facilities.76

Benefits of vegetation

**Reduces energy costs**
Shading buildings in summer reduces the need for air-conditioning and, in turn, reduces energy costs. Similarly, green facades and green roofs offer an additional insulating layer to a building, and in sub-tropical Queensland, for example, could lead to a 11.7% energy saving.89 In a residential context, Blacktown City Council, Sydney, investigated one street and found residents could reduce their average yearly household electricity bill by $249 over time.76

**Boosts tourism**
Greener spaces will increase tourism potential and residential development, attracting more people to live, work and visit in our cities.88 In the UK, business premises have discovered consumers are willing to travel further, visit more often and spend more in precincts with extensive green infrastructure. Meanwhile, retail and office buildings sporting green infrastructure can enjoy a 7% increase to their average rental rate.80
Wildlife

Impact of heat

Australian capital cities are home to many different plants and animals. Unfortunately, the lives and habitats of this wildlife are at risk with increasing urbanisation and rising heat limiting the areas where they live and leading to higher extinction rates.90

Contracts and degrades habitat

With a 1°C increase in temperature, 79% of wildlife in south eastern Australia are likely to contract their range and many types of wildlife would attempt to move to other areas, if possible, to find better climates.91 With a 3°C rise in temperature, 57% of our wildlife is predicted to lose 90–100% of their current suitable range.91

Increases heat stress and deaths

Both plants and animals can become stressed and die due to excessive heat. Higher soil and air temperatures and lower moisture levels harm many plants, although to different levels.92 Similar to heat’s effect on humans, other animals’ capacity to manage their internal temperatures is reduced by excessive heat and can lead to heat stress and death. For example, flying foxes are affected by heat stress when temperatures are above 38°C, with deaths occurring above 42°C.93

Reduces reproductive success

Extreme temperatures can reduce egg and embryo survival and change development patterns for a range of wildlife.43, 94

Promotes disease

Competition for space and resources (e.g., water) among wildlife in urban areas can lead to more interactions that increase the spread of disease, with stressed animals likely to be more vulnerable to infection.95 Some diseases and their carriers are also more likely to thrive through warmer winters.95

Benefits of vegetation

Urban vegetation is crucial in the conservation of native wildlife,96 creating healthy thriving cities and neighbourhoods.

Provides wildlife habitat

Green spaces can form corridors for wildlife, reconnecting habitat and attracting native birds and insects. This can provide crucial protection for threatened wildlife such as flying foxes.97

Supports healthy home gardens

Urban vegetation provides important habitat for pollinators,98 which benefits private and community gardens. These gardens also form part of urban green infrastructure with reinforcing benefits.

Connects humans with nature

By providing habitat to wildlife, green infrastructure supports a range of hobbies and interests — from hiking to photography and birdwatching. Being among nature has a range of physical and mental benefits as discussed earlier, however it also increases the value visitors place on nature more broadly.99 People tend to feel nature is more important when they get to experience it. This, in turn, helps encourage additional green infrastructure protection and development.
Pollution and carbon emissions

Impact of heat

Carbon emissions and rising temperatures feed each other, as the combination of heat and urbanisation leads to increased cooling requirements and carbon-based electricity usage and emissions, while rising carbon emissions results in increased heat. Switching to renewable energy sources can help break this cycle.

Higher carbon emissions

As the temperature becomes warmer, more people retreat inside, and air-conditioner use increases. This raises electricity consumption and consequently releases more carbon dioxide into the atmosphere, further contributing to the warming effect.

Increased pollution

The extreme heat and stagnant air during a heatwave also increases the amount of ozone pollution and particulate pollution. In the city, this pollution becomes trapped in street canyons, exacerbating its impacts. The health implications of this are enormous — air pollution is linked to conditions such as asthma, lung cancer, heart problems, emphysema, bronchitis and other respiratory diseases. In Australia urban air pollution causes approximately 3,000 deaths in Australia each year, which costs around $11-24 billion per year.

Worse for disadvantaged communities

An analysis of Australian postcodes from the Australian Conservation Foundation showed air pollution is felt most in lower socioeconomic communities, adding to the heavily unequal distribution of heat impacts.

Benefits of vegetation

Urban vegetation is crucial in the conservation of native wildlife, creating healthy thriving cities and neighbourhoods.

Reduces carbon emissions

Vegetation acts as a carbon sink, converting carbon dioxide to oxygen through the process of photosynthesis. This reduces the amount of carbon dioxide in the atmosphere, helping to mitigate the impacts of climate change. A study in the US for example, showed that greening can reduce building carbon emissions by 5–20%.

Cleaner air

Trees can absorb and intercept particulate matter through their leaves, removing it from the air. An assessment in the US found street trees and other greenery could reduce particulate pollution by up to 60%, consequently decreasing the risks of respiratory diseases.

Leadership opportunity

By implementing policies on greening our cities, Australian governments can help increase the liveability of our cities, reduce our carbon footprint and benefit the communities they lead.
How are our capital cities performing?

Local governments and communities face both immediate and longer-term challenges in managing urban heat and promoting green infrastructure.

Each local government area (LGA) has a unique mix of geography, climate, development, community and policy characteristics that collectively influence the amount of green infrastructure present and the heat effects experienced.

Understanding the current levels of green infrastructure and the current experiences of urban heat islands in the LGAs of Australia’s capital cities provides a snapshot of the cumulative outcomes of policies to date, and the baseline for policies into the future.

Green infrastructure and the UHI effect

Australia’s capital cities (based on local government areas with at least 50% urban land use) show highly variable levels of green infrastructure that isn’t dictated by population densities. Areas with low numbers of people living close together (population density) don’t necessarily have high levels of green infrastructure as this can indicate more industrial uses.

For instance, let’s compare Sydney’s Liverpool City and Northern Beaches LGAs. People in Liverpool in Western Sydney live further apart (744 people per km²) than those living in the Northern Beaches (1,076 people per km²), but the Northern Beaches area has higher levels of vegetation (63% of the area has vegetation cover) compared to Liverpool (33%). Liverpool experiences much higher UHI effect (4.1°C extra heat) than the Northern Beaches (1.1°C).

Hobart and Brisbane have the highest levels of vegetation cover of Australia’s capital cities, while Melbourne, Perth and Adelaide have the least. However, the amount of green infrastructure in our capital cities is generally declining, based on a comparison of 2013, 2016 and 2020 data.5 While the percentages of loss may appear small, over large cities like Brisbane, Melbourne and Sydney, it can mean substantial areas of reduced vegetation (e.g. 0.8% of area lost in Sydney equates to 12.2 km² or approximately 570 AFL football fields). Hobart is the only city that showed more vegetation in 2020 than in 2013.5

The capital cities’ most vegetated LGAs include:

- The City of Mitcham for Adelaide — 50% vegetation cover
- The City of Palmerston for Darwin — 35%
- The City of Manningham for Melbourne — 41%
- The City of Kwinana for Perth — 35%
- Sydney’s Northern Beaches — 63%

A comparison of levels of green infrastructure and the UHI effect across capital city LGAs clearly shows the heat reduction effects of vegetation.

In the 2018–2019 summer, for example, Adelaide’s City of Mitcham (with 50% green infrastructure)5 experienced UHI effects of 4.0°C extra heat107 in comparison with the nearby Port Adelaide Enfield, which has 11% green infrastructure5 and experienced Adelaide’s highest UHI effect of 7.9°C.107

During that same summer, Melbourne’s City of Manningham (with 41% green infrastructure)5 experienced UHI effect of 4.9°C107 in comparison with the nearby Greater Dandenong, which has 14% green infrastructure5 and experienced Melbourne’s highest UHI effect of 6.6°C.107

The presence of green infrastructure is also in part related to a community’s level of socioeconomic advantage and disadvantage, with more disadvantaged areas likely to have slightly lower levels of vegetation cover than more advantaged neighbourhoods.5,108

More green infrastructure tends to mean lower urban heat island effect

Source: Devereux and Caccetta 2019107; Hurley et al. 2020.5
Green infrastructure and native wildlife

Australia’s capital cities are home to a variety of threatened native plants and animals. Sydney has the richest mix of such wildlife, as it is home to 124 different types of threatened wildlife (69 animals and 55 plants). Brisbane and Melbourne follow with 97 and 94 known types of threatened wildlife, respectively.99

The destruction of green infrastructure that provides habitat to wildlife is playing a significant role in worsening Australia’s extinction crisis. Australia’s national environment law — the Environmental Protection and Biodiversity Conservation Act 1999 — has failed to protect our wildlife and also puts our cities at increasing heat and health risk.

In the first 17 years of the operation of this law, at least 20,212 hectares of urban habitat for threatened wildlife was destroyed.109 This is an area equivalent to more than 11,400 MCG football grounds. The independent review of this law, finalised in January 2021, found the law to be “ineffective and inefficient, and reform is long overdue.”110 It proposed substantial changes and a clear pathway to improve the law and its implementation, including realigning its focus and improving its governance, enforcement and monitoring. Implementing these changes is critical to the ongoing protection of our cities’ remaining wildlife.

Source: Ives et al. 2016.99

Australian cities are home to many different threatened species

In the first 17 years of Australia’s national environment law, at least **20,212 hectares of urban habitat for threatened wildlife was destroyed.**
Green infrastructure and carbon emissions

Australia’s capital cities (based on LGAs with at least 50% urban land use) show highly variable carbon emissions that aren’t dictated by population densities. Areas with low numbers of people living close together (population density) don’t necessarily have lower levels of carbon emissions as this can indicate that more industry is present.

There is no clear relationship between carbon emissions and green infrastructure at the LGA level. However, when aggregated across a city, emissions tend to be somewhat higher in cities with lower levels of vegetation and lower when more green infrastructure is present. This green infrastructure also then helps capture some of those emissions for added benefit.

Climate change projections for capital city heat

Climate change is expected to increase the amount of heat experienced by people living in our cities. By understanding these predictions and what they mean for our communities, we can determine how much urban planting efforts could help protect our communities and ecosystems from the cumulative effects of climate change and the UHI effect.

Coping with heat

Due to the varying features and diverse communities of our cities, the health-related responses of the populations of each city are slightly different. Heat-related health impacts (including deaths) worsen when daily temperature limits are exceeded, and these thresholds vary by city. The health data available for each city varies, so different thresholds have been calculated. For some cities, health data was most linked with daily minimum temperature, for other cities it was the daily mean or the maximum temperature.\textsuperscript{113}

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<th>City</th>
<th>Temperature thresholds for heat-related health impacts (including deaths)</th>
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<td>-</td>
<td>28°C</td>
<td>44°C</td>
</tr>
<tr>
<td>Perth</td>
<td>-</td>
<td>-</td>
<td>43°C</td>
</tr>
<tr>
<td>Sydney</td>
<td>-</td>
<td>-</td>
<td>38°C</td>
</tr>
</tbody>
</table>

Green infrastructure takes time to establish to maximum effectiveness, so acting early is critical for meeting future needs.
Predicted future climate

Climate change is increasing global temperatures, and the UHI effect will further exacerbate this for Australia’s cities. Some climate projections, such as the Victorian Climate Projections, are already advanced enough to show slightly warmer temperatures in the city than surrounding areas. However, they are not fine-grained enough to show the sometimes substantial suburb-to-suburb differences. UHI effect estimates are, therefore, generally taken to be in addition to future estimates of warming in this report unless otherwise noted.

Understanding what our future climate is likely to be is critical for being prepared and acting to protect our communities and environment.

Many of our capital cities don’t have adequate climate change prediction data that can be used to analyse LGAs, so this section focuses on those that do — Brisbane, Melbourne and Sydney. Data at this scale is particularly helpful for examining differences in risk across larger cities and, therefore, where efforts should be strengthened. Comparison information for the summer of 2019–2020 is used here as context as “2019 was the warmest and driest year on record for Australia as a whole.”

Understanding our future climate is critical for being prepared, and for protecting our communities and environment.
Brisbane

Climate modelling shows Brisbane is likely to be substantially hotter from 2060–2080 than it has been in recent decades, especially if climate change action is not prioritised.

The business-as-usual predictions for 2060–2080 show that if no additional climate action is taken, Brisbane’s hottest summer days will sit between 38.3°C and 41.8°C, based on a range of climate model estimates. This is in comparison with summer’s hottest days over the last 50 years which averaged 35°C. These extreme temperatures are already being seen, however, with Brisbane’s warmest day in the 2019–2020 summer reaching 41.2°C.

Looking at the more typical days, without additional climate action, Brisbane’s average summer temperatures will range from 31.3°C to 33.8°C throughout 2060–2080, with around 137 average days over 30°C each year and around 14 average days over 35°C each year. This is considerably hotter than the long-term average of 30.0°C and the average for the 2019–2020 summer, which was 30.9°C.

Even with significant climate change action, the effect of existing carbon emissions will result in average summer temperatures in Brisbane of between 30.2°C and 31.8°C, with the hottest summer days reaching from 37.8°C to 41.1°C.

Brisbane City’s current average UHI effect is 1°C, while some local areas within the city can experience a UHI effect of as much as 6.1°C, which will further exacerbate these extreme temperatures. With 54% overall green infrastructure cover, Brisbane is one of Australia’s greenest capital cities, however there is potential to increase greening, which would be particularly beneficial in locations with higher UHI effect.

Brisbane’s hottest summer days will sit between 38.3°C and 41.8°C in 2060-2080 if climate action isn’t taken

Source: Queensland Future Climate Dataset.
Melbourne

Under current levels of climate action, by 2060–2080 Melbourne’s hottest days will typically be over 40°C. While the city’s hottest summer days in average years will sit between 39.2°C and 43.9°C, based on a range of climate model estimates, its hottest days will range from 42.9°C to 49.4°C. This is in comparison with summer’s hottest days over the last 50 years which averaged 41.9°C. Recent summers show these extreme temperatures have already started, with the hottest day in the summer of 2019–2020 reaching 45.2°C.

Melbourne’s ‘typical’ summer temperatures are also predicted to rise considerably, averaging between 26.5°C and 29.7°C without substantial climate action. This is in comparison with the average temperatures of the 2019–2020 summer, which ranged between 22.6°C and 27.0°C across Melbourne.

This might not sound too hot, however Melbourne should expect around 48 average days to reach over 30°C each year, with 17 average days over 35°C and 3 average days over 40°C. Even with strong climate action, the existing carbon emissions are expected to push average summer temperatures to between 25.9°C and 27.8°C in 2060–2080 and the hottest days to between 42.1°C and 47.7°C.

Source: VCP2019 dataset.
Melbourne’s current average UHI effect adds an extra 5.5°C and some local areas within the city can experience a UHI effect of as much as 13.5°C, which will further exacerbate these extreme temperatures. Existing UHI effect representation built into the climate models may already include 1-2°C of this UHI effect in parts of inner Melbourne. With 23% overall green infrastructure cover, Melbourne is one of Australia’s least green capital cities. Increasing vegetation cover will be particularly critical in locations with higher UHI effect.

Predicted maximum summer temperatures across Melbourne’s LGAs do not vary considerably under business-as-usual climate models for 2060–2080. The maximum hottest summer days in Casey were the coolest across the city at 47°C, compared with the highest hottest days predicted for Maribyrnong and Brimbank, both reaching 49.4°C. Maribyrnong currently has 9% green infrastructure cover and an average UHI effect of 5.9°C, however some places can reach up to UHI effect of 10.5°C. Brimbank has 13% green cover with an average UHI effect adding 6.6°C across the LGA and maximum UHI effect in some areas of 13.5°C.

Predicted average summer temperatures in Melbourne are relatively consistent across the city. The hottest average summer temperatures are predicted for Manningham at 29.7°C and Banyule at 29.4°C. These areas have somewhat higher levels of green infrastructure that likely helped prevent their hottest days from reaching the same levels as Maribyrnong and Brimbank. Manningham has 41% vegetation cover, while Banyule has 36%. 

Right. Tree planting Photo. Annette Ruzicka / MAPgroup.
Predictions for Sydney are similarly hotter for 2060–2080. With no substantial climate action, maximum summer temperatures will typically range from 38.7°C to 43.1°C with the hottest days each year sitting between 41.7°C to 50°C, based on a range of model estimates. This is in comparison to summer’s hottest days over the last 50 years which averaged 39.1°C. In 2019, the warmest day in Sydney was 41.3°C.

Average summer temperatures are also expected to rise, ranging from 27.3°C and 31.3°C with no substantial climate action. In comparison, Sydney’s long-term historical summer average temperature is 25.7°C and the 2019 summer average is 27.3°C. Sydney can also expect around 56 of its average days to reach over 30°C each year by 2060–2080, with around 15 average days over 35°C and 2 average days over 40°C.

No comparison data was available to estimate Sydney’s conditions should strong climate action be undertaken.

Comparing predictions across Sydney’s LGAs shows slight variability in temperatures across the city. Looking at the hottest days, Mosman and North Sydney have the highest predicted peak at 50°C. The lowest peak in hot days, was predicted for Burwood at 47.9°C. Average temperatures showed slightly different peaks, with Blacktown having the highest mean summer temperature of 31.3°C.

Mosman and North Sydney have moderate levels of vegetation (43% and 34%, respectively), which keeps their average temperatures somewhat lower than other LGAs. The UHI effect adds an average extra 2.2°C in Mosman (maximum UHI effect of 6.2°C in some areas), and 2.8°C in North Sydney (maximum UHI effect of 7.2°C), which is some of the lowest UHI effects across Sydney. In contrast, Blacktown has 22% vegetation cover, and an average UHI effect of 5.8°C, however some locations can experience UHI effects of 16.3°C. Blacktown’s peak hottest temperature is predicted to be 48.5°C, which makes it one of the hotter LGAs in Sydney in terms of average and maximum temperatures.

Source: NARCLIM dataset.
The heat gap

Comparing these predicted temperature changes with recommended health-related temperature thresholds for our capital cities, highlights significant concerns for the future of our communities. Without strong climate action, Brisbane, Melbourne and Sydney will regularly experience temperatures above the recommended thresholds. With strong climate action, existing emissions will still raise temperatures in these cities to above threshold levels, although to a lesser extent. With the added effect of the UHI, areas within these cities will be at considerable risk unless action is taken. Green infrastructure takes time to establish to its maximum effectiveness, so acting early is critical for meeting future needs.

By 2060-2080 health-related temperature thresholds will be regularly exceeded in Brisbane, Melbourne and Sydney

<table>
<thead>
<tr>
<th>City</th>
<th>Business-as-usual</th>
<th>With strong climate action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean temperature</td>
<td>Maximum temperature</td>
</tr>
<tr>
<td>Brisbane</td>
<td>Regularly exceeds threshold</td>
<td>Regularly exceeds threshold</td>
</tr>
<tr>
<td>Melbourne</td>
<td>Consistently exceeds threshold</td>
<td>Regularly exceeds threshold</td>
</tr>
<tr>
<td>Sydney</td>
<td>No threshold determined</td>
<td>Regularly exceeds threshold</td>
</tr>
</tbody>
</table>

*Source: NARCLIM dataset.*
Revegetating urban areas at high risk from heatwaves is an effective way to cool cities, save lives and improve quality of life, as well as create jobs. Several Australian cities have recognised the importance of green infrastructure and are actively working towards greening their urban areas. While 69% of Australia’s urban areas have seen a long-term decline in green cover, 62% have seen increases in the last four years.  

**Current initiatives**  
There are many local initiatives paving the way in greening our Australian cities, and collaborative strategies are being introduced in some areas to improve alignment and coordination of these efforts (see Appendix A for examples). These initiatives take a range of forms and include nature strategies, water sensitive design approaches, and general ‘greening’ strategies. Many of these recognise the importance of green infrastructure for addressing the UHI effect, and the various other benefits already discussed in this report.

While these initiatives show a lot of promise, overall Australian cities still seem to be lagging behind many of our international counterparts when it comes to establishing green infrastructure. It’s important that we learn from the lessons of previous and existing Australian initiatives and build on their work.

*Right.* Community engagement events for Cool Streets© Schofields. *Photo.* Matthew Duchesn
Case study: Lessons learnt from the City of Vincent

Prior to European settlement, the City of Vincent in Perth featured a series of interconnected wetlands that drained into the Swan River, but clearing and development have since seen the loss of almost all of its native vegetation and wetlands.

With active planting and wetland redevelopment programs, areas such as Smith’s Lake have been revitalised into more natural ecosystems with benefits for wildlife and water quality.

The City of Vincent’s first Greening Plan commenced in 2014 and aimed to expand and enhance tree coverage and wildlife habitat on both private and public land. A review of progress towards that plan was conducted in 2018 and found that though efforts on public land were effective, they were insufficient against the private land losses. For example, tree canopy on public increased from 19.9% in 2009 to 21.5% in 2014, however tree canopy on private land decreased from 7.4% in 2009 to 6.8% in 2014. This meant the overall tree cover increased by only 0.2% despite planting over 300 trees per year on public land.

The loss of trees on private land remains a key issue for Vincent but is somewhat outside council’s control. In its new Greening Plan 2018–2023, objectives for public and private land have been simplified and strategies refined to take into consideration several important, practical factors that can be barriers to success, ranging from competing land uses to data collection and analysis issues.

Education and development policy provisions are important strategies in the new private land objectives, with a separate community-focused objective for increasing community-level involvement on the issue.

**KEY POINT:** Increasing our urban vegetation is a complex issue that is influenced by competing goals and priorities across a community. It requires community involvement and support to succeed – including private individuals and businesses, community groups and government.
Learning from the past

Research and past greening projects provide a range of insights that can help build successful future programs. These learnings include both strategic advice and practical principles that can be used to inform community approaches to increasing urban vegetation cover. Strategic advice includes aspects such as leadership, knowledge-sharing and collaboration.

Some examples include guides such as How to grow an urban forest: A ten-step guide to help councils save money, time and share practical knowledge,120 strategies like the Roadmap for green roofs, walls and facades in Australia’s urban landscapes 2020–2030,118 journal articles such as Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes,121 and resources on the websites of research groups such as the Clean Air and Landscapes Hub122 and the Cooperative Research Centre for Water Sensitive Cities.123

In contrast, practical principles offer guidance that underpin green infrastructure design and management. Some examples include guides like Trees for a cool city; Guidelines for optimised tree placement,124 The Sustainable urban forest: A step-by-step approach,125 journal articles such as Sustainable urban green infrastructure strategies for compact cities in developing and developed economies,126 and local plans such as the City of Rockingham’s Greening Plan 2017.127

Good decision-making requires access to reliable and appropriate data, and leadership in needed in this area. Issues with inconsistent datasets (e.g., heat-related health113 and infrastructure65 data and thresholds), data at scales not suitable for LGA level analyses (e.g., no climate projections downscaled to suburb scale for several cities), and lack of available data (e.g., the nature and quality of urban biodiversity109) reduces the effectiveness of decision-making at all levels. UHI effects are not consistent within or across LGAs6 and urban green infrastructure designs need to be tailored and prioritised for optimal effectiveness.121

Diverse stakeholders must be involved in the planning and implementation of programs and policies. This process will help to address urban heat and ensure effective outcomes that address a community’s nature and needs. This will also help achieve community ownership and support,128 and address any stakeholder concerns about potential adverse impacts due to poor design.129 Stakeholder involvement is particularly important where private land is a significant part of cities’ green infrastructure.127 Coordination of these efforts is also critical for efficient use of resources and to ensure connectedness of designs (e.g., water movement)130 across the landscape.

With many countries’ economies substantially affected by COVID-19 and their governments developing policies to stimulate economic recovery, experts have been calling for such stimulus to focus on climate change mitigation.131-133 Urban planting offers an important avenue for carbon capture, and reducing carbon emissions from energy use, as well as offering employment opportunities. It is a valuable choice for inclusion in economic stimulus packages.

Another mechanism to support the integration of greening into national planning and programs is raising the profile of green infrastructure alongside that of built infrastructure. Infrastructure Australia provides advice to the Australian government regarding priorities for investment in transport, energy, communications and water infrastructure that has a material impact on national productivity.134 The inclusion of green infrastructure in this mandate, due to its importance for the health and wellbeing of Australia’s businesses, workforces, general community and other built infrastructure, would support important research and investment.
As with any infrastructure project, there are technical, social, and political complexities that must be taken into consideration for urban green infrastructure projects to succeed. These include:

• Landscape scale issues such as competing land uses, competition for space, planting location selections with respect to other infrastructure, plant selection for local environmental conditions and for health implications such as asthma, changing environmental conditions, water limitations, and the lifecycle of trees, and the availability of suitable data and analysis methods to inform design decisions.¹¹⁹, ¹²⁷, ¹³⁵

• Project implementation challenges such as the selection and availability of appropriate trees, availability of water such as through alignment with stormwater management, project timing and coordination of resources.¹¹⁹, ¹²⁴, ¹²⁷

• Public perceptions challenges, with community members sometimes worried about the potential for trees to fall, resulting in human injury or damage to homes, footpaths, plumbing and roads.¹²⁹

Ultimately, the goal of mitigating additional heat stress will require action from a range of different stakeholders. Everyone from individuals to governments can play a part in greening Australia’s cities. National and state leadership is critical to ensure local efforts are well-informed, supported by policy at all levels, coordinated and sufficiently resourced. Translating the diverse learnings from past research and projects into practical ways forward, provides guidance for individuals, businesses, communities and governments who wish to increase green infrastructure in their city.

**As a community**

• Join a local group who is revegetating your suburb or advocating for more parks and native vegetation — or start one yourself.

• Plant vegetation around your home (on roofs, living walls, gardens, patios, nature strips or wherever you can) and in your community.

• Use native plants wherever possible so that they are better suited to the local environment and more likely to survive and thrive in shifting conditions.

• Explore your suburb and record what you see with citizen science programs like iNaturalist.

• Be a champion for green homes and natural places spaces in your area.

• Spend time in nature to remind yourself of its importance.

**As a business**

• Retain green infrastructure wherever possible.

• Install green roofs and living walls.

• Encourage employees to attend community planting days and other urban planting initiatives.

**As local governments**

• Tell your success stories.

• Prioritise green infrastructure in planning, policies and programs, including maximising the retention of vegetation under development requirements.

• Implement water sensitive urban design projects to integrate stormwater management and urban vegetation projects to support ongoing plant watering needs, mitigate flooding and reduce stormwater system requirements.

• Work with state government data providers to ensure appropriate scale data is available to support local decision-making.

• Regularly review and evaluate progress and share learnings and knowledge with communities and other agencies to collectively adapt and improve approaches, especially for impact on private land.

• Collaborate and coordinate with communities and other governments to optimise access to resources and knowledge.

• Strive to reach net zero greenhouse gas emissions by 2035.¹³⁶
As state or territory governments

- Prioritise green infrastructure across cities in policies and programs, including the retention of vegetation.
- Promote water sensitive urban design principles that link stormwater management and urban vegetation projects for more efficient and effective impact.
- Implement national data standards to ensure appropriate scale data is available to support decision-making within and between urban areas, including monitoring and projections of urban heat, green infrastructure and heat-related health, infrastructure, economy, biodiversity and carbon emission statistics.
- Regularly review and evaluate progress and share learnings and knowledge with communities and other agencies to collectively adapt and improve approaches.
- Collaborate with communities and other governments to optimise access to resources and knowledge.
- Strive to reach net zero greenhouse gas emissions by 2035.\(^{136}\)
- Protect existing critical habitats and ecosystems in cities.

The Australian government

- Develop a national green infrastructure strategy and prioritise green infrastructure across cities.
- Protect existing critical habitats and ecosystems in cities.
- Facilitate the development of national data standards for monitoring and projections of urban heat, green infrastructure and heat-related health, infrastructure, economy, biodiversity and carbon emission statistics.
- Establish a new generation of strong national environment laws and institutions to protect our threatened wildlife and the habitat they need to survive in cities and around the country.
- Strive to reach net zero greenhouse gas emissions by 2035.\(^{136}\)
- Continue to support research on urban green infrastructure and urban heat island effects under a changing climate, through initiatives such as the Cooperative Research Centre for Water Sensitive Urban Design, sharing new knowledge with communities and other agencies to support ongoing improvements to approaches.
- Collaborate with communities and other governments to optimise access to resources and knowledge, and to ensure research and policy facilitate ongoing improvements.
The way **forward**

It is clear our warming climate will only exacerbate the effects of urban heat islands in Australia. Greening these urban areas offers substantial capacity to help keep our cities liveable while reducing greenhouse gases and supporting our wildlife and economy.

Despite the many projects instigated across our cities, green infrastructure levels remain low in many areas. With rising heat and populations, our communities and quality of life are at increasing risk that requires effective and coordinated action. There are a range of factors to consider when deciding how best to green our cities, so it is critical that communities come together to agree on the collective way forward and ensure these programs succeed.

This report has provided an overview of current progress in protecting Australian cities from rising temperatures, and summarises climate change predictions that highlight the critical importance of urgent action. Green infrastructure takes time to reach its full potential, so now is the critical time to act.
References


8. ARC Centre of Excellence for Climate System Science 2012, NSW and ACT Regional Climate Model (NARClIM) project dataset, Available from: http://www.climdir.org/node/16/overlay-context=node/17


22. Steffen, W 2015, Quantifying the Impact of Climate change on extreme heat in Australia.


Temperature check: Greening Australia’s warming cities.


Appendix A —  
Greening our cities program examples

There are many local initiatives paving the way in greening our Australian cities, and collaborative strategies are being introduced in some areas to improve alignment and coordination of these efforts. Below are some examples of these across each of our capital cities.

Adelaide:
- Green Adelaide\textsuperscript{137} — A state government-led suite of priorities for managing the urban environment, focusing on parks, water and wildlife sensitive urban design, education, and management of pest species.

Brisbane:
- Greener Suburbs Program\textsuperscript{138} — A local government initiative for street tree planting aimed at improving amenity and wildlife habitat rather than targeting the UHI.

Canberra:
- Canberra’s Living Infrastructure Plan\textsuperscript{139} — The ACT Government’s plan for the city’s landscapes and ecosystems with specific focus on addressing the impacts of climate change, urban growth and aging environments on health, amenity, wildlife and urban heat.

Darwin:
- Heat mitigation, liveability and tropical design project\textsuperscript{140} — Research by CSIRO, commencing in 2021, which aims to identify ways to make Darwin a cooler, more comfortable place to live.

Hobart:
- The City of Hobart Street Tree Strategy\textsuperscript{141} — A local government strategy to value, expand and manage green infrastructure along the city’s streets, and includes discussion on the importance of street trees for addressing the UHI.

Melbourne:
- Living Melbourne Strategy\textsuperscript{142} — This collaboration across Melbourne’s local governments aims to protect, restore and connect species habitat, and includes discussion of the role of greening in addressing the UHI.
- Greening the West’s Strategic Plan 2020–2025\textsuperscript{143} for Melbourne’s western suburbs — A strategy developed collaboratively by Melbourne’s western local governments and Victorian government partners, with goals focused on a range of issue areas including health and social wellbeing, and the extent, function and quality of green space.
Perth:  
- Waterwise Perth Action Plan[^144] — A state led initiative for the Perth and Peel regions that aims to better manage the urban water cycle for healthy and attractive green spaces and secure urban water, especially under a changing climate.
- Individual local government plans, such as the City of Vincent’s Greening Plan 2018–2023[^179], the City of Rockingham’s Greening Plan 2017[^127]; and the Greening Fremantle Strategy 2020.[^145]

Sydney:  
- Western Sydney’s Turn Down the Heat Strategy and Action Plan[^146] — A WSROC plan to reduce the effects of urban heat on local communities by aligning existing local greening and water projects for more collaborative and effective action at household, precinct and regional levels.
- Sydney’s Greening our City[^147] Premier’s Priority — An initiative supported by eight NSW government departments to support their staff and programs to help expand urban vegetation, including the 5 million trees program.

Nationally:  
- The Australian government’s 20 million trees[^148] program — This program aims to establish green corridors and urban forests, with activities across urban, peri-urban and regional areas of Australia for biodiversity outcomes (not specifically heat mitigation).
- Greening Australia’s Nature in Cities[^149] program — A national, non-profit initiative promoting greener, more liveable cities through local projects such as ‘Cooling the Schools’ in Greater Sydney.
- The Cool Streets[^150] initiative — A community-led decision-making approach to improve environmental outcomes for streets, including urban planting projects in Sydney’s Blacktown and Hobson’s Bay.

[^144]:  [Waterwise Perth Action Plan](#)
[^145]:  [Greening Fremantle Strategy 2020](#)
[^146]:  [Western Sydney’s Turn Down the Heat Strategy and Action Plan](#)
[^147]:  [Sydney’s Greening our City](#)
[^148]:  [The Australian government’s 20 million trees](#)
[^149]:  [Greening Australia’s Nature in Cities](#)
[^150]:  [The Cool Streets](#)
Addressing the rising temperatures in our cities is critical for their ongoing liveability.