Urban

Australia
State of the Environment 2021

Baranyiin baribugu

From yesterday to tomorrow

Yura Ngurrayin bulbulwul

The people of Country are strong.

Dharug/Eora Nation

Australia
State of the Environment 2021

Urban

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Acknowledgement of Country

The authors acknowledge the Traditional Owners of Country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures, and to their Elders both past and present.

Contents

Key findings

Growing populations, resource demand and travel are the main pressures on our urban areas

Population growth, urban density, industry and the associated consumption of resources have a significant influence on the shape, form and function of our urban areas. Most of Australia's 8 major cities are growing at rates faster than many developed cities internationally. As our cities expand and change, so do their impacts. These include increased urban heat, congestion, pollution and waste, as well as growing pressure on our increasingly scarce resources such as water and energy. These impacts expand to the natural environment surrounding our urban areas and the biodiversity, green and blue spaces within them.

Our climate is changing. Average temperatures have become warmer since 1950. We are experiencing more extremely high temperatures, more bushfires and more intense rain events. Sea levels also continue to rise. These factors affect our urban spaces, especially when impacts combine, such as the combined effects of storm surges and sea level rise on our coastal environments.

Furthermore, shocks such as bushfires and the COVID-19 pandemic, together with climate stresses such as drought and lack of water security, have significantly affected our wellbeing, and the resilience and character of our urban environments. Over the past 18 months, our urban environments have experienced several 1-in-100-year shocks and stresses that will have significant impacts for future generations.

The COVID-19 pandemic affected our urban environments in both positive and negative ways

The COVID-19 pandemic was an unforeseen event that has profoundly affected the state of urban environments. The COVID-19 pandemic has highlighted to government, industry and communities the complex and fragile nature of our urban ecosystems, the value of the natural environment for citizen wellbeing and the need to plan for greater urban resilience. The pandemic has significantly reduced international immigration and interstate migration. Combined with lower fertility rates, this will result in the lowest forecast rate of population growth across Australia since World War 1 (Centre for Population 2020).

The pandemic has shifted where we work in our urban areas and how we move around them, and increased our reliance on digital networks. While the pandemic has had some desirable short-term impacts such as improved air quality, increased rates of walking, cycling and flexible working, it is less clear how equitable the changes have been across urban areas and what it means for designing and planning our urban areas in the longer term.

Livability varies between different urban areas and within different parts of our cities and towns

Australia's 18 largest urban areas have higher liveability than smaller urban areas. But smaller urban areas have some advantages – mainly shorter commute times. An analysis of Australia's 18 largest urban areas finds that older, inner-city areas have higher levels of livability when considering factors such as walkability, access to green spaces and services. Conversely, smaller urban areas have shorter commute times yet fewer services and less diversity of employment opportunities.

Livability also varies within urban areas. Urban fringe areas tend to have poorer access to services and longer commute times. Higher socio-economic areas tend to benefit from better tree canopy cover and digital access.

The character of our urban areas continues to shift in response to lifestyle preferences and needs. The proportion of Australians living in higher-density dwellings such as units and townhouses continued to grow, consistent with state and territory targets for greater infill development. However, since the pandemic, our growing appreciation of space and demand for larger homes has led to a move away from apartment living towards more suburban and regional opportunities, supported by greater rates of working from home for some.

Despite this recent shift in lifestyle preferences and needs, the distribution of Australian population growth has been uneven. Most growth has occurred in our major cities while the population of many regional and remote areas has declined. This has challenged assumptions as to where growth could and should occur across Australia, and the extent to which factors such as affordability, urban resilience and environmental sustainability should be considered. This has led the planning profession to call for better data consistency, and agreed employment and population growth assumptions.

A nationwide approach to urban growth and resilience is needed

The resilience and sustainability of our urban environments are being challenged. To effectively respond to these challenges, it will be critical for all 3 levels of government to effectively collaborate and take a holistic, nationwide approach to developing resilient frameworks that do not just sustain our cities, but regenerate them. We must break the nexus between urban growth and poor outcomes. The economic roadmap out of the COVID-19 pandemic and other environmental shocks must therefore dovetail with the shift towards zero carbon and climate-resilient urban environments so that our urban areas can bounce back smarter, greener, cleaner and more equitable.

There have been renewed calls for a more strategic, national approach to urban management. An example is a national population and settlement strategy to improve the timely delivery of urban support services, jobs and infrastructure to meet need and demand. Failure to think holistically is also resulting in the limited consideration of cumulative and longer-term pressures on the environment (e.g. pollution and waste generation).

The largest populations of Indigenous people in Australia live in urban environments. The social and economic disadvantages experienced by Indigenous people and the efforts of successive generations to address these issues are well documented. The ongoing expansion and development of urban areas disproportionally impact Indigenous people's sense of cultural connection and identity through the disruption and destruction of culturally significant places and landscapes.

When planning and managing the urban environment, it is important to recognise the need for a rights-based approach for Indigenous people. We also need greater inclusion, involvement and self-determination for Indigenous people in urban planning, design and environmental management, and in housing diversity to suit their cultural needs. Across Australia, there is still a failure to recognise Indigenous communities in legislation and policy.

Outlook and impacts

Outlook

As our urban environments move into post-pandemic norms, it is expected that population growth rates will return to pre-pandemic levels, as will the associated pressures on our urban environment: consumption, pollution, congestion and waste.

The extent to which positive changes during the pandemic will become embedded in our future lifestyles remains uncertain. How will greater rates of working from home, walking and cycling, e-commerce and digital interactions more permanently change our travel patterns within and between urban areas?

How will our renewed focus on local amenities result in the need to retrofit our neighbourhoods, streets and services for better physical, social and mental health outcomes and create more 'complete' neighbourhoods? How will our greater appreciation of access to green spaces and desire for larger homes translate into demand for more suburban, urban fringe and regional development in the longer term? What does this mean for urban planning and infrastructure strategies that have relied on infill development to optimise capacity?

And can we accelerate a move towards new technology and innovations that support a zero-carbon, circular economy on the back of the economic shocks created by the COVID-19 global pandemic?

Amid these questions, there are many things we do know.

We know that the urban environment is an intricate ecosystem of human-created and natural factors that coexist within urban areas. This means that key drivers and changes in one part of the ecosystem (such as population growth or consumption levels) can have a noticeable impact on another (such as air quality or land available for biodiversity).

We know that shocks and stresses to our urban environments are forecast to continue and indeed increase in frequency and severity. Our progressively hotter global climate will continue to increase urban heat, raise sea levels, increase urban flooding and speed up the loss of native biodiversity. These pressures will result directly and indirectly in increased rates of death, morbidity, illness and infrastructure failure. They will have significant cumulative impacts that can be exacerbated when they occur simultaneously or are coupled with existing trends such as population growth and increasing consumption and generation of waste.

Smart technology has allowed us to engage with urban citizens better and more equitably. The COVID-19 pandemic also accelerated our acceptance and use of online communications. However, these improvements in urban technology are also leading to growing challenges in the equity of digital access as well as challenges associated with cyber security.

We know that urban environments have not meaningfully reflected the custodianship and belonging of Indigenous peoples. They have also not often incorporated the perspectives, values and cultural knowledge of Traditional Owner groups into management structure or actions:

> Aboriginal and Torres Strait Islander peoples are continuing to assert their ongoing presence, connection to and responsibilities

> for their traditional Country. It is inherent in their culture and an integral part of who they are and their wellbeing for present and future generations. The problem is, these realities have barely penetrated the conventional planning systems in Australia. (Wensing 2018)

But we also know there is hope.

To counter the adverse implications of these trends, urban citizens, planners and governments are responding and recognising that our urban environments must change and adapt. There is growing recognition that we must build greater resilience into our urban environments at the same time as reducing the factors that are driving these shocks and stresses – the generation of greenhouse gases and the unsustainable use of our natural resources. This is also recognition that we must move from siloed, service- and sector-based thinking to more collaborative, whole-of-government and place-based outcomes that do not just sustain but regenerate our urban areas and support their communities.

This refocus is creating opportunities to replan our cities. Opportunities include increasing our access to green spaces, urban ecology, jobs and services through more sustainable methods and concepts such as the 5-minute neighbourhood and the 30-minute global city.

To manage urban heat and increase our safety and wellbeing, we will be looking to re-establish more natural environments within our urban environment, empower Indigenous peoples and their knowledge, create new programs of tree planting, reintroduce biodiversity, renaturalise our waterways and use biomaterials to construct our built environment. This must occur concurrent with our reduction in energy consumption and as we reconnect our green and blue urban infrastructure into a quality network for people and urban biodiversity.

Recognition of the intricate urban system and its inherent relationship with nature and citizen wellbeing are driving a renewed appreciation and recognition of Indigenous knowledge that enables us to better understand the unique features of our environment and sympathetically coexist. There has also been increased public interest in, and awareness of, Indigenous connection to Country and the need to care for Country.

Indigenous knowledge has been embraced in many major cities and larger regional centres. Here, improved appreciation and understanding of the traditional culture of the area, informed by Traditional Owners and custodians or by Indigenous residents, has resulted in design of place, space and built form that is mindful of the needs and 'voice' of Country and its custodians. Indeed, there is a burgeoning cultural shift in thinking, demonstrated by inclusive planning legislation, policy development and processes. Similarly, academic institutions have taken on board the demand for Indigenous content within their curriculum for environmental and planning qualifications. However, many attempts to 'incorporate' Indigenous knowledge fail to empower Indigenous peoples, communities and aspirations. Our rush to incorporate, 'celebrate' and include must not reinscribe harmful extractive modes of engagement that have been highly damaging.

The unveiling of a building in central Melbourne that claimed to celebrate Aboriginal presence but without the meaningful involvement of Indigenous community members is an example of the problem of celebrating Indigenous peoples and culture in a way that provides little benefit to them or their communities:

> When the enormous drapes that had been covering a new building in central Melbourne were thrown off in early 2015,

> an extraordinary sight was revealed: a colossal image of a face staring down the city's civic spine. This moment of unveiling marked a fascinating moment for Indigenous–settler relations in Australia, but especially urban, densely settled Melbourne. For the face is that of William Barak, ancestor and leader of the Wurundjeri people, whose Country was stolen and remade into what we now know as Melbourne. That an early land rights champion is represented in the built form at such a pivotal location in the city that dispossessed his people offers an opportunity to consider the forms of violence, appropriation and misrepresentation that are perpetually constitutive of settler–colonial cities. (Porter et al. 2019)

The implementation of Indigenous knowledge and values as a means to improve our collective knowledge of and caring for Country responsibilities must happen in tandem with empowering Indigenous peoples and communities to lead (Cumpston 2020c).

Cultural mapping projects are increasingly being used in Australia, and particularly within urban areas, to inform biodiversity actions and land-use planning, and to forefront Indigenous knowledge, ongoing custodianship, and cultural, historical and contact stories. Cultural mapping is far more than just naming sites of cultural significance. It is a means through which Indigenous ways of seeing and doing are empowered to underpin a living record of the landscape alive with law, language, ethics, activity, traditional practices and culture (Jackson et al. 2018). An example of the value and richness of cultural mapping projects can be seen in Gnarla Boodja Mili Mili (Our Country on Paper), created by the WA Department of Local Government, Sport and Cultural Industries Aboriginal History team, working together with Noongar-Whadjuk Traditional Custodians. The initiative documents the traditional names of Noongar places throughout the Perth metropolitan area and is designed to assert the continuation of the deep cultural and spiritual connection of Noongar people, their continuing role as custodians of the Perth region and their continued belonging to their ancestral Country (DLGSCI 2021).

A more collaborative and coordinated approach to planning our urban areas at the national level will help to focus growth in areas that are resilient, redirecting it from areas that are environmentally sensitive and resource strained. Using materials that are more sustainable will result in healthier buildings for citizens and our urban biodiversity. The application of new technologies, ancient knowledge systems and smart cities will allow us to better monitor our activities and adapt our approaches. Empowering Indigenous communities to lead, and embracing traditional knowledge of our ecosystems and climates, will allow us to better understand and manage the challenges our cities face in the future.

Looking forward, the aim will be to break the correlation between growth and its impact. That is, bigger does not have to be worse. Rather we must care for the natural and urban environment so that it can care for us.

The ultimate aim is a more sustainable coexistence between the built and natural environments in our urban areas. As we grow, we need to contain our environmental impact and actively regenerate, restore and bring nature back into our villages, towns and cities. As a result, the urban planning profession has called for greater collaboration and a shared national strategy for how and where our urban environments will change and how to best manage the outcomes.

Impacts

Impacts on livability

The combined built and natural components of the urban environment form the foundations of our standard of livability. As our urban areas grow and expand, this standard will decline without a collective and concerted effort to build better, greener and more resilient urban environments. This will become increasingly important given that 43% of projected urban growth across Australia will occur within Australia's 2 largest urban areas (Greater Sydney and Greater Melbourne).

Renewed efforts to redesign our neighbourhoods to have better access to jobs, retail and community services will reduce the need to travel and increase access to opportunities, making our urban areas more equitable and livable. At the same time, greater community awareness and investment in urban green and blue spaces will enhance community connection, and human and animal wellbeing.

While the impacts of climate change will grow over the next 5 years, a new focus on designing and planning our built environment will help to reduce the impact of urban growth and potentially help to address existing urban risks.

Climate change and extreme events disproportionately impact Indigenous communities, as these pressures will continue to contribute to declining employment, health and wellbeing, which are already tenuous. In a recent submission from the National Aboriginal Community Controlled Health Organisation (NACCHO) to the Senate Inquiry into the Australian Government's response to the drought, NACCHO identified housing as an area of great importance in mitigating the effects of drought and climate change, stating that (NACCHO 2020):

> Better housing for Aboriginal and Torres Strait Islander people remains a critical issue. Housing issues are amplified in extreme weather. It is vital that state and territory governments, with leadership and assistance from the federal government, play a greater role in developing, administering and enforcing design standards for housing - to not only meet household needs and predicted drought and other climate change conditions, but to allow for heightened flexible and locally responsive housing design approaches.
>
> A number of recommendations we have previously made to the federal government are particularly pertinent in light of the impacts of drought and climate change in general:
>
> - Expand the funding and timeframe of the current National Partnership on Remote Housing to match at least that of the former National Partnership Agreement on Remote Indigenous Housing.
> - Establish and fund a program that supports healthy living environments in urban, regional, rural and remote Aboriginal and Torres Strait Islander communities, similar to the Fixing Houses for Better Health program. This must ensure that rigorous data collection and program evaluation structures are developed and built in, to provide the federal government with information to enable analysis of how housing improvements impact on health indicators.
> - Update and promote the National Indigenous Housing Guide (FaCSIA 2007), which is a best-practice resource for the design, construction and maintenance of housing for Aboriginal and Torres Strait Islander peoples.

Impacts on resource availability and security

Urban areas will continue to affect the availability and reliability of our water and energy resources as populations grow and the impacts of climate change increase. These impacts need several approaches to be managed, starting with managing levels of demand for resources. Then, more sustainable built environments must be built by choosing suitable building materials and using big data to manage the efficiency of operations. At the same time, we must be more conscious of how we think of and use water and energy. We also need to rethink and redesign how resources that are traditionally considered to be 'waste' are redeployed.

Increasingly, other countries will not accept waste from Australia. Current landfill and waste strategies have unacceptable impacts on our land through soil and water pollution. Illegally dumped waste also has a significant impact on land through its direct effect on soils, biota and habitats. In the future, this could be partly mitigated by moving to a circular economy, eliminating single-use plastics, and preventing microplastics and other persistent agricultural and industrial toxins permeating water supplies and food chains.

In this way, a more sustainable, resilient and circular ecosystem can be created.

Impacts on greenspaces and bluespaces

While pressures relating to urban growth and associated pollution and waste generation will continue, growing recognition of the value of our urban greenspaces and bluespaces will help to reduce the degree to which our urban biodiversity will be affected. Increased expenditure and resources directed to creating and protecting green links and corridors within urban areas will help wildlife and the habitats to connect and survive. A better understanding of how to manage important ecological systems through Indigenous knowledge systems will also allow for a more careful and effective means of balancing our impact on the urban environment and protecting urban biodiversity.

For example, Indigenous communities and their ability to participate in, and pass on, cultural practices are significantly affected if water is considered to be simply a resource. Reframing the discussion to consider water as a living entity – recognising its spiritual and cultural value as well as that of a commodity – can help to restore balance to river ecosystems in urban areas.

This can create:

- structural elements that respect unique cultural landscapes and inform spatial structure of land use and infrastructure
- restored and protected landscapes underpinned by a wider strategy for integrated land use, water management and cultural connection
- connected spaces in riparian corridors that provide ecological protection and enhancement, as well as regionally significant networks of public access, active transport, recreation and cultural uses
- a lasting, valued and managed asset which supports community participation, custodianship and connection to Country.

Impacts on wellbeing

A new focus on designing our urban areas to be more walkable, green, proximate to services and jobs, and resilient to extreme weather events including heat will enhance the wellbeing of urban citizens. Consistent cross-jurisdictional methods to measure

and benchmark wellbeing will also assist in guiding urban policies to continuously improve outcomes and keep the wellbeing of our urban citizens and biodiversity at the forefront of urban planning and development.

The United Nations Sustainable Development Goals (SDGs) (UN 2021) are also important to consider in all aspects of managing our environment. The Australian Government has committed to the SDGs:

> Australia has long recognised the role of sustainable development in ensuring the wellbeing of the Country and its people. Government legislation, regulation and policy already drives us towards many of the environmental, social and economic outcomes enshrined in the SDGs. As approaches and circumstances evolve, the SDGs provide a framework through which governments, businesses, organisations and individuals can conceive of a problem or objective and devise collective action through partnership to drive progress. (UN 2021)

Impacts on Indigenous wellbeing

At the beginning of European colonisation, our urban environments were created by the newcomers as safe places for people to meet, live, work and be protected from the effects of the Australian environment. This was often at the exclusion of Indigenous people, who were pushed to the edges of these 'settlements', and consequently the knowledge systems that had sustained Country for many thousands of years were suppressed.

The occupation of this 'new' landscape was undertaken within the paradigm of European understanding of land use, seasons and ecological systems based on the Northern Hemisphere experience. Over time, however, there has been increased understanding of the need for a Southern Hemisphere approach to environmental management, which incorporates the appreciation and application of Indigenous knowledge and its value in understanding and caring for Country:

> In terms of urban areas in Australia, it is important to understand that there is no place in Australia whether urban or remote, that is not on Aboriginal or Torres Strait Islander Country. There is no place in Australia that does not have one or several Traditional Custodian groups whose communities hold many, many millennia of knowledge embedded within that specific Country. Today in Australia, around one-third of Indigenous Australians live in major cities and satellite urban areas (ABS 2018a). And yet, urban areas are often not understood as 'Country' – that is, places of cultural significance, active custodianship and belonging to Indigenous peoples.
>
> Many of the histories of Australia's First Peoples have been erased by the ongoing march of colonisation, which continues to do damage when Australia's Indigenous peoples' stories and culture are subsumed, often denied, not seen, and actively silenced. Across Australia there is very little acknowledgment in urban areas of the connection these places have and have had to Indigenous peoples over thousands of generations.
>
> We are very much still here. And yet, if we look around Australia's urban areas there is very little that attests Indigenous presence, custodianship, our deep knowledge of Country, our voices, our histories and belonging. Our culture is often represented as fixed and stagnant, negating our efficacy and capacity to continuously adapt and innovate: foundational to our longevity as the oldest living culture on Earth.
>
> We are a powerful people. Our knowledges, held and transmitted through our communities and our cultural practice,

> remain strong. The efficacy of our holistic approaches to systems of management are not lost. Our interactions with Country, both today and over time, are highly valuable in all aspects of environmental management, whether urban or remote. These knowledges and practices are undoubtedly a key part of the arsenal of scientific knowledge we need to empower in meeting the environmental challenges we together face.
>
> Together we must continue working to dismantle barriers and heal the psychological damage that colonisation and its continued circumstance inflicts on us all.
>
> Many, many Indigenous people live in an urban circumstance in Australia today and it is vital for our wellbeing, and the wellbeing of Country, that we see ourselves and our culture in our urban environments. Most especially, for the health of Country and for all Australian peoples, it is imperative that we are empowered to meaningfully partner with decision-makers to bring our knowledge and aspirations into mainstream systems of planning and management. While we are diverse, there are some aspects of our cultures as the Indigenous peoples of Australia that are overarching – the understanding that Country is our Mother, a living relative who must be cared for and actively loved, sits at the core of all of our interactions. We have so much 'skin in the game', it is prescient to expand and empower our involvement in management of Country, both in urban areas and across Australia.
>
> By Zena Cumpston (Barkandji), from Cumpston (2020d) and Mata et al. (2020)

The ability to adapt, central to the longevity of Indigenous cultures in Australia, can be evidenced in the strong continuation of culture central to the lives of Indigenous peoples in urban areas, despite the many barriers to connecting to Country within the built environment (Peters & Andersen 2013, Page et al. 2021). The cohesive and culturally resilient circumstance of urban Indigenous peoples is also shown by the strong and long history of community-led services that have been central to the lives and wellbeing of urban Indigenous peoples, such as health and legal services. During the COVID-19 crisis, community-led health services in particular have shown their efficacy in strongly advocating and caring for Indigenous communities (Follent et al. 2021) Resourcing of Indigenous-led services and dedicated gathering places is integral to the health and wellbeing of diverse Indigenous communities in urban areas, self-determination, respect of culture, sustainability and strong governance (Kingsley et al. 2021).

However, the 'invisibility' of Indigenous peoples in urban environments is still evident in the paucity of available data that can be used to measure Indigenous peoples' wellbeing, experiences and circumstance within urban contexts. It must also be understood that urban Indigenous communities are melting pots of many Indigenous communities and identities. This includes Traditional Owners, but also those who may not have ancestral belonging, but have deep multigenerational connections to place through family and community connections over time.

The need for more research and understanding of Indigenous peoples living in urban areas is elucidated in the 2016 research paper 'Indigenous in the city: urban Indigenous populations in local and global contexts':

> Urbanisation has been a historical reality for a number of Indigenous groups, including Aboriginal and Torres Strait Islander people in Australia. Yet the perception remains that large proportions of world's Indigenous peoples live in rural and remote areas. Both the UN and global Indigenous organisations

have raised concerns over the danger of conflating Indigenous identity with rural connections, as it risks ignoring the reality of large urban Indigenous populations. The stereotype also carries with it certain notions about the validity of urban Indigenous identities.

For urban Indigenous peoples, this misconception of discord between cities and Indigenous communities often has negative policy implications of service misdirection. It also plays out in the challenge of 'Indigenous invisibility'. Here, governments often struggle to recognise Indigenous urban communities due to 'abstract and non-geographically clustered nature of the community' (Langeveldt & Smallacombe 2010). Yet arguably this also stems from the persistent assumption about 'real' Indigenous peoples living only in rural regions. This has significant ramifications for funding allocation and service mainstreaming. It is critical, then, that researchers and policymakers move to deepen their understanding of urban Indigenous populations' (Brand et al. 2016:4).

Assessment Wellbeing related to the urban environment

2021

Somewhat adequate confidence

Based on social and economic indicators, most urban residents experience a high level of wellbeing in relation to their environment, especially compared with international examples,. However, this varies with location and socio-economic circumstances. Climate change may affect the wellbeing of urban residents directly by increasing the impacts of heatwaves, and of storms for coastal cities.

Related to United Nations Sustainable Development Goal targets 3.9, 6.1, 7.1, 11.7

Assessment Livability

2021

Medium confidence

The livability of Australia's largest cities is increasing with improving access to urban services, and a broader choice of jobs and housing.

Livability continues to be good in smaller urban areas that impact the environment less. However, citizens in these areas have poorer access to jobs, services and facilities.

Assessment Resource availability and security

2021

High confidence

Larger urban areas place more strain on demand for water and energy and resources while increasing overall consumption. Despite some efficiency gains, all urban areas are facing resource security challenges, particularly in areas of high population growth and greater vulnerability to climate change.

Environment

Population and buildings

Australia's urban environment varies in size – from global cities to small remote settlements. It incorporates components constructed by humans, such as buildings and public places and the infrastructure that supports them such as transport, water and energy networks. Importantly, Australia's urban environment also has natural elements, including rivers, creeks, coastlines, the sky and subterranean aspects, parks, green links and bushlands, together with the flora and fauna within them.

The Australian Bureau of Statistics (ABS) defines several urban environments:

- Urban localities are centres with populations of more than 200 people.
- Urban areas have populations of more than 1,000 people.
- Significant urban areas have populations of 10,000 people.
- Major urban areas (cities) have populations of more than 100,000 people.

Based on these definitions, there are more than 1,853 urban environments in Australia. For pragmatic reasons and because of data availability, this chapter focuses largely on the 8 capital cities and, where possible, the 18 cities with more than 100,000 people, including the capital cities. Smaller urban areas have been explored as case studies or examples of the pressures on the environment or management approaches. This chapter also considers smaller, more-remote urban areas that may have fewer than 200 people. Many of these are home to Indigenous peoples.

Population

Australia's population is increasingly concentrated in our cities. As of 30 June 2020, Australia's population exceeded 25.6 million people, with more than 76% living in major cities (population of more than 100,000) (Table 1). The major cities grew by 3.1 million (+20%) between 2010 and 2020, accounting for 84% of the country's total population growth over the decade.

By comparison, growth in inner regional areas between 2010 and 2020 was 501,399 people (+12.4%), representing 13.7% of Australia's total population growth. During the same period, there was negative growth in Australia's remote and very remote areas (–5.8%; Table 2). This decade-long trend changed in 2019–20, with a modest population increase in remote and very remote areas (+0.2 and +0.1%, respectively).

Melbourne experienced the most significant actual growth of all capital cities between 2010 and 2020, increasing by 1,003,723 people or 25%, together with the greatest proportional change in Australia. In 2019–20 alone, the greatest proportional growth in population at the capital city level was in Brisbane (1.9%), followed by Perth (1.8%) and Melbourne (1.5%).

At a state and territory level, there were various notable population changes by suburb between 2006 and 2016 (ABS 2017):

- Australian Capital Territory – Areas in the northern outskirts of Canberra experienced the most significant population increases. These included Harrison (+7,100 people), Bonner (+6,900), Franklin (+6,500), Casey (+5,900) and Crace (+4,500).

Table 1 Share of population across Australia's 18 major cities, 2021

City	Population	Fraction of total (%)
Melbourne	4,969,305	19.3
Sydney	4,966,806	19.3
Brisbane	2,475,680	9.6
Perth	2,083,645	8.1
Adelaide	1,357,504	5.3
Gold Coast – Tweed Heads	709,495	2.8
Newcastle–Maitland	498,015	1.9
Canberra–Queanbeyan	464,995	1.8
Sunshine Coast	348,343	1.4
Wollongong	309,345	1.2
Geelong	282,412	1.1
Hobart	219,071	0.9
Townsville	183,322	0.7
Cairns	155,340	0.6
Toowoomba	139,526	0.5
Darwin	133,268	0.5
Ballarat	109,533	0.4
Bendigo	102,499	0.4
Total (major cities)	**19,508,104**	**75.8**
Total (Australia)	**25,697,298**	**100.0**

Source: Based on ABS (2021c)

Table 2 Estimated resident population by remoteness, 2010–19

Remoteness area	Population 2010		Population 2015		Population 2020		Change 2019–20		Change 2010–20	
	People	%	People	%	People	%	People	%	People	%
Major cities of Australia	15,501,847	70.4	16,981,989	71.3	18,586,095	72.3	265,606	1.4	3,084,248	19.9
Inner regional Australia	4,055,452	18.4	4,296,474	18.0	4,556,851	17.7	57,268	1.3	501,399	12.4
Outer regional Australia	1,968,332	8.9	2,035,718	8.5	2,062,597	8.0	7,826	0.4	94,265	4.8
Remote Australia	299,163	1.4	297,686	1.2	291,190	1.1	678	0.2	–7,973	–2.7
Very remote Australia	206,956	0.9	204,128	0.9	200,565	0.8	175	0.1	–6,391	–3.1
Total Australia	**22,031,750**	**100.0**	**23,815,995**	**100.0**	**25,697,298**	**100.0**	**331,553**	**1.3**	**3,665,548**	**16.6**

Source: Based on ABS (2021c)

- New South Wales – More than 75% of New South Wales' population growth occurred in Greater Sydney, which also reached a milestone of 5 million residents in 2016. Areas with the greatest growth were Parklea – Kellyville Ridge, located in Greater Sydney's north-west growth centres (+22,200 people), and the inner-city area of Waterloo–Beaconsfield (+17,800 people).
- Northern Territory – Darwin's population increased almost 7 times faster than the rest of the Northern Territory (+4.4%), and Darwin was the fastest-growing capital city in Australia in proportional terms (+29%) over the decade. The most significant population increase (+5,500 people) occurred in the Rosebery–Bellamack area of Palmerston.
- Queensland – 3 of the 5 largest-growing areas in Queensland during the period were located outside of Brisbane, including Upper Coomera – Willow Vale (+17,400) on the Gold Coast and Deeragun (+14,200) in the outer suburbs of Townsville. The biggest population growth (+22,000 people) occurred in the North Lakes – Mango Hill area north of Brisbane.
- South Australia – Mawson Lakes – Globe Derby Park in Adelaide's north experienced the largest population growth in the state (+8,400 people). This was followed by Munno Para West – Angle Vale (+7,900), the southern areas of Seaford (+6,800) and Aldinga (+5,700).
- Tasmania – The largest growth in Tasmania was in Margate–Snug (+1,900 people), followed by Kingston–Huntingfield (+1,700); both are south of the Hobart central business district (CBD).
- Victoria – 5 of the 10 largest-growing areas in Australia between 2006 and 2016 were in Melbourne. These were the outer western suburb of Tarneit (+28,800 people), inner-city Melbourne (+26,200) and the outer suburbs of Cranbourne East (+22,600), Truganina (+21,800) and Doreen (+19,200).
- Western Australia – Baldivis, in Perth's outer south, was the largest-growing area in Western Australia in the decade to 2016 (+27,400 people). Other areas to experience notable growth were Ellenbrook in Perth's north-east (+23,600) and Forrestdale – Harrisdale – Piara Waters (+18,800) in the south-east.

A significant proportion of Indigenous people live in urban areas. In 2016, there were 798,400 Indigenous people in Australia, representing 3.3% of the total population; 37.4% of Indigenous people live in capital and other major cities. The largest urban Indigenous population in Australia is in the Blacktown local government area in Western Sydney. Seventy-five per cent of Australia's Indigenous population live in New South Wales, Queensland and Western Australia combined, with the largest Indigenous population in New South Wales. The Indigenous population increased by 19% during 2011–16. It should be noted that demographic trends for Indigenous communities can be markedly different from those for wider Australia. For example, ABS data from 2016 shows that just 5% of the Indigenous community were aged 65 years and over, compared with 16% of the non-Indigenous population (AIHW 2018).

Population concentration

While Australia is a highly urbanised country, it has comparatively low levels of overall population concentration by international standards. In 2020, Australia's population concentration was 3.3 people per square kilometre (people/km^2), increasing from 2.9 people/km^2 in 2011. By way of comparison, Japan had 347 people/km^2 in 2020, the United Kingdom had 281 people/km^2, and the United States had 36 people/km^2.

The concentration of population varies across Australia's states and territories. The Australian Capital Territory is the smallest and most urbanised territory and has the highest population concentration (181 people/km^2) as of 2019. Urban densities then reduce significantly to Victoria as the second-most densely populated state or territory at 29 people/km^2. Western Australia had the lowest ratio – just 1 person/km^2 as of 2019.

Cities and suburbs

The urban concentration by capital city and suburb shows similar variability. In 2019, Greater Sydney and Greater Melbourne had the highest population densities of all Australian capital cities. Densities within these cities also varied – pockets of higher density were generally within inner-city and CBD areas compared with lower, more dispersed greenfield development on the city fringes (Table 3).

Table 3 Population density (people per square kilometre) and change in Australia's most densely populated suburbs, 2011–19

State	Capital city	Suburbs and area	June 2011	June 2016	June 2019	Increase 2011–16 (%)	Increase 2016–19 (%)	Increase 2011–19 (%)
NSW	Greater Sydney	Pyrmont–Ultimo	13,500	15,700	16,600	16.3	5.7	23.0
		Potts Point Woolloomooloo	13,500	15,800	16,800	17.0	6.3	24.4
		Darlinghurst	12,800	14,200	15,100	10.9	6.3	18.0
Qld	Greater Brisbane	New Farm	5,900	6,300	6,700	6.8	6.3	13.6
		Kangaroo Point	5,800	6,600	7,400	13.8	12.1	27.6
		Fortitude Valley	4,618	4,980	7,100	7.8	42.6	53.7
Vic	Greater Melbourne	Inner-city Melbourne	9,200	17,500	21,900	90.2	25.1	138.0
		Carlton	8,400	11,300	13,600	34.5	20.4	61.9

NSW = New South Wales; Qld = Queensland; Vic = Victoria
Source: Amended as per ABS (2021c)

Between 2011 and 2019, there was an apparent trend towards increasing population density in Australia's most established inner urban areas of Brisbane (e.g. New Farm), Melbourne (e.g. Carlton) and Greater Sydney (e.g. Potts Point). The increasing population density of Australia's densest suburbs between 2011 and 2019 (Table 3) is likely to reflect changing lifestyle preferences and interests, as many Australians sought to downsize or live closer to a greater mix of entertainment and retail activities as well as their place of work.

These activities are supported by the critical mass offered by a denser and growing inner-city population, and enabled by local and state government plans and strategies for urban regeneration and intensification (see Management approaches). These plans seek to optimise existing services and infrastructure, bringing citizens closer to jobs and services to reduce the need to travel and the associated adverse impacts to lifestyles and the environment such as traffic congestion.

Yet at the same time, governments have also supported new greenfield developments, offering larger and more affordable homes on the outskirts of urban areas (see Management approaches).

Rural and remote areas

Despite the population growth in Australia's major cities, populations in rural and remote urban areas across all Australian states and territories are declining. Infrastructure Australia contends that the trend of declining rural and remote population reflects changes to regional and rural economies as industries decline, the environment changes and personal preferences shift, including the move of young people to larger towns and cities to seek job opportunities.

Infrastructure Australia has identified service provision as a factor influencing population movements. For example, in New South Wales, a 'hub-and-spoke' service delivery model is galvanising a shift towards regional centres as 'service centres' across the state (Infrastructure Australia 2019). Access to employment is also important in explaining localised increases in remote populations, which may reflect the growth in some remotely located industries such as mining.

Built form and development

The structure and form of buildings within our urban environment affects how we experience the urban environment, how we socially interact and our overall wellbeing. Given that most of our built form and development activity relate to housing (56% of all development) (ABS 2021a), the changing character, scale and density of housing significantly influences the character of Australia's urban environments.

As of 2020, Australia had an estimated 10,558,000 dwellings. The 2016 Census provides the latest breakdown by type: 73% of existing dwellings in Australia are detached dwellings and 13% are apartments (ABS 2020c).

While the number of dwellings (including houses, townhouses and apartments) developed each year fluctuates with market trends, the overall number produced has increased over the past 20 years from 146,500 dwellings per year to more than 201,000, with 2018 seeing the peak at close to 218,000. Over the same period, the proportion of housing developed by the public sector has declined from 2% to 1% (noting a peak of 7% across Australia in 2011, which likely represents a counter-cyclical government response to the fall in housing starts by the private sector).

Since 2002, the number of detached dwellings developed each year across Australia has remained relatively constant (between

95,000 and 105,000). Thus, growth in the overall number of dwellings has been because of a significant shift towards more medium (semidetached) and higher-density (apartment) forms of development.

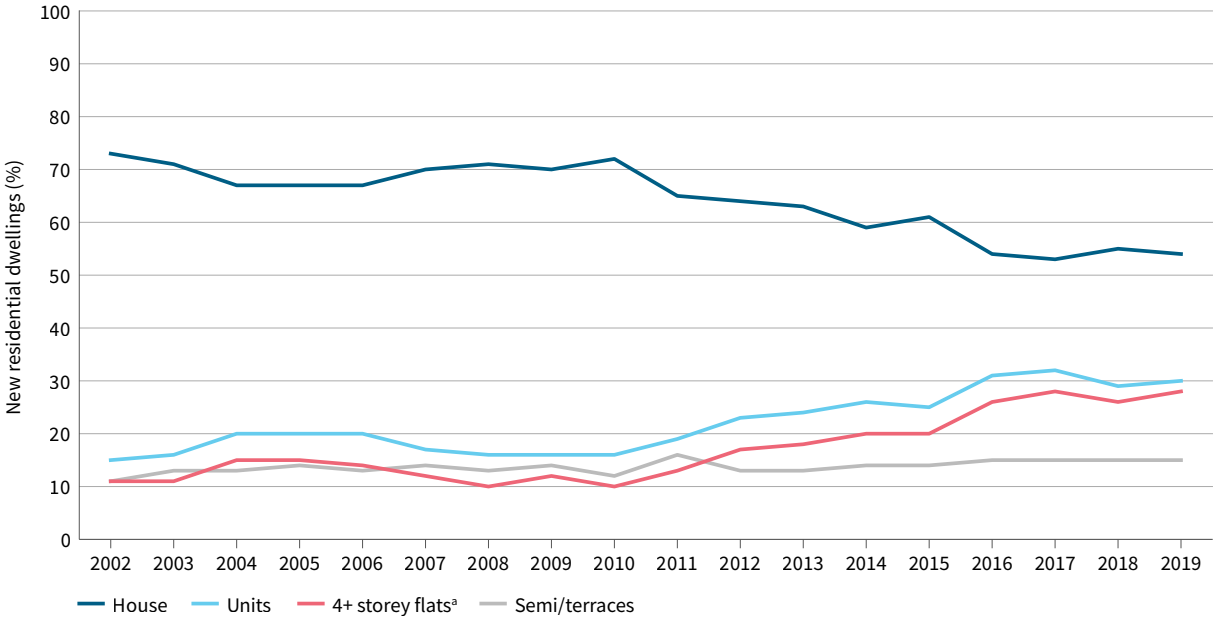
As a proportion of the total housing market, between 2002 and 2019 the production of semidetached dwellings increased from 11% to 15% of total supply, and apartments increased from 15% to 29%. By contrast, the proportion of detached dwellings built across Australia declined from 73% to 54% over the same period (Figure 1).

Of note has been the increase in the proportion of apartments constructed in buildings of more than 4 storeys (from 11% to 28%). These taller buildings, combined with the growing trend towards more medium-density supply, are creating a significant shift in the character of many of our inner-city and middle-ring urban areas, and therefore of how we live.

Despite constant housing growth over the past 2 decades, in 2019 and 2020 overall housing construction dropped to 131,790 dwellings, representing an 38% decline in the 2-year period. The greatest proportional declines occurred in the semidetached and apartment markets (–12 and –18%, respectively; Table 4). This significant change is likely to be due to 2 factors – the ending of a significant housing construction boom, and the impacts of the COVID-19 pandemic (Evans et al. 2020, KPMG Economics 2021, Verdouw et al. 2021) (see COVID-19 pandemic) on market preferences and thereby the feasibility and supply of medium and high-density development.

Housing supply, and the type of housing developed varies notably by state, territory and city:

- Australian Capital Territory – The Australian Capital Territory is an urban environment traditionally dominated by detached dwellings. Up to 2014, it supplied an average of 1,200 new dwellings per year, reaching a peak in 2014 of 1,516 dwellings. Since 2014, however, the type of dwellings developed has shifted, with a significant increase in



a 4+ storey flats are a subset of units, not an independent category.
Source: Adapted from ABS (2021b)

Figure 1 Australian new residential dwellings by type as a proportion of the total, 2002–19

Table 4 New residential dwellings in Australia by type, 2019–20

Year	Houses	Total units	Semidetached/ terraces total	Total residential
2019	108,631	60,841	29,766	199,238
2020	103,841	49,604	26,297	179,743
Change 2019–20 (no.)	–4,790	–11,237	–3,469	–19,495
Proportional change (%)	–4	–18	–12	–10[a]

a Refers to apartments, units, semidetached and town house dwellings. Excludes 'other' category.
Source: Adjusted from ABS (2021b)

apartment dwellings resulting in a new average of 4,400 dwellings per year, peaking in 2019 at 5,327 new dwellings. As of 2019, 28% of this supply was detached dwellings and 57% was apartments; in total, 72% was higher- and medium-density housing (including semidetached and terrace dwellings and apartments). These changes are significantly altering the character of urban development in the Australian Capital Territory.

- New South Wales – On average, New South Wales has developed 25,000–30,000 dwellings per year since 2010. However, in 2018, supply increased substantially, reaching a record high of 72,913 new dwellings. Detached dwellings as a proportion of the whole have continuously declined, with a notable shift occurring in 2016 when most developments were units, terraces, townhouses and semidetached dwellings (57% of total supply, up from 34% in 2010). The proportions have remained stable since then – as of 2019, 43% of supply was detached dwellings and 57% was higher- and medium-density housing (including terraces, semidetached dwellings and townhouses).
- Northern Territory – An average of 1,000 dwellings per year were developed before 2016, with supply decreasing to around 600 per year in 2018. This is a notable contrast to the boom experienced in NSW. The ratio of detached dwellings has continuously increased from 44% in 2015 of all dwellings to 84% in 2018.
- Queensland – On average, Queensland developed 30,000 dwellings per year from 2008 to 2015, jumping significantly to 46,106 in 2017 and dropping back to 35,265 in 2019. The number of detached houses remained at double that of apartments until mid-2017, then increased so that by 2019 3 times as many houses as units were being constructed.
- South Australia – On average, South Australia has developed 10,000 new dwellings per year since 2004. Detached homes have out-developed medium- and high-density dwellings at a ratio of about 4 to 1.
- Tasmania – On average, Tasmania has developed around 2,500 new dwellings per year since 2004, and there has been consistently more new detached houses (85% on average) than any other type of dwelling.
- Victoria – On average, housing supply has been strong in Victoria, at 49,000 dwellings

per year from 2009 to 2014, reaching a peak of 64,610 new dwellings in 2019. Detached dwellings accounted for three-quarters of new construction until 2014, when apartment and medium-density housing supply increased and accounted for half of new construction. From 2016, detached dwellings were most common, at a ratio of 1.5 to 1 compared to other forms.

- Western Australia – From a consistent supply of approximately 20,000 dwellings per year up to 2014, supply jumped to a peak of 31,154 in 2015, then dropped to 17,000 per year between 2017 and 2019. This drop reflects an adjustment in the market after the increased supply in 2015, together with broader economic changes such as the decline in the mining industry. Detached dwellings are consistently developed 3.5 times more often than other forms combined.

Size of dwelling

Australian homes are among the largest in the world (CommSec 2020), and the average size increased between 2008 and 2018, from 234 m^2 to 248 m^2 (+6%) (ABS 2019a). However, the number of occupants within an Australian home on average remained relatively constant over the decade, at 2.6 persons per dwelling (ABS 2019a).

These findings vary by Australian capital city (Table 5). Greater Sydney and Perth both experienced a notable reduction in dwelling size between 2008 and 2018 (–10% and –9%, respectively). This likely reflects the trend towards greater inner-city development as well as responses to housing affordability in these cities.

Notwithstanding the decline in average home size in Greater Sydney – from 280 m^2 in 2005–06 to 252 m^2 in 2019–20 – homes in Greater Sydney continued to be larger than the average across all Australian capital cities of 248 m^2. In all other capital cities, the trend towards larger homes continued, with the most significant growth in dwelling size occurring in Greater Brisbane (+18%) and Greater Melbourne (+10%).

While dwelling size across Australia remained relatively consistent on average, block sizes decreased from 2005–06 to 2019–20 (ABS 2020b). The combined average lot size for

Table 5 Average floor area of new houses, Australian capital cities, 2005–06 to 2019–20

Greater capital city statistical area	2005–06 (m^2)	2019–20 (m^2)	2005–06 to 2019–20 change (m^2)	2005–06 to 2019–20 change (%)
Greater Sydney	280	252	–28	–10
Greater Melbourne	230	253	23	10
Greater Brisbane	209	246	37	18
Greater Adelaide	208	223	15	7
Greater Perth	243	222	–21	–9
Australian capital cities	234	248	14	6

m^2 = square metre
Source: ABS (2020b)

dwellings approved within the 5 largest greater capital cities (Adelaide, Brisbane, Melbourne, Sydney and Perth) fell from 602 m^2 in 2005–06 to 467 m^2 in 2019–20.

Because of the increasing ratio of building area to land area on lots, the space for trees, plants and outdoor recreation at both the front and rear of dwellings has declined. This change in urban form is not only changing the physical form and character of existing and greenfield neighbourhoods, but the ability to manage heat, improve walkability and thereby the livability or our urban environments. It is also reducing the extent of urban biodiversity by decreasing tree canopy cover and garden space (Garrard et al. 2015). Research has found that private sector residential development in the past 20 years has less tree cover than in previous decades (Saunders et al. 2020).

People per dwelling

Occupancy rates for Australian homes range from an average of 2.7 people and 3.2 bedrooms per home in capital cities, to 2.4 people per home in regional areas (the remaining parts of the relevant state or territory, minus the capital city). The most recent data – from 2017–18 – found that Greater Darwin had the highest average occupancy rate of 2.9 people per dwelling, whereas urban areas in South Australia (excluding the Greater Adelaide area) had the lowest occupancy rate of 2.2 people per dwelling (Table 6).

Indigenous built environment

While the built environment in Australia rarely reflects Indigenous peoples and their cultures, belonging, histories or knowledges, there have been some small steps towards building a more just relationship between the urban planning profession and the rights and interests of Indigenous peoples (Parris et al. 2020). This includes the ways in which Indigenous peoples are engaged to participate in housing and building design, to better meet their living and cultural needs. In the book *Indigenous place: contemporary buildings, landmarks and places of significance in south-east Australia and beyond,* the authors assert:

> Meanwhile, purpose-built structures and what might even be described as 'modern Aboriginal architectural forms' have been designed and built in other more regional and especially remote areas. The colonial tendency is to obliterate any trace of Indigeneity in the city, while continuing to celebrate 'our' Aboriginal heritage in the outback/on the frontier. Indeed, the way in which Aboriginal people and culture is viewed by, and the extent to which Aboriginal society has been reconciled with, mainstream Australian settler society can be measured in the nation's geography and architecture alone. The return or reinsertion of Aboriginal places into metropolitan centres may well be the best measure of how far along the road to reconciliation we have come. (Pieris et al. 2014:95)

Darug academic and archaeologist Maddison Miller elucidates the importance of recognising and empowering Indigenous perspectives in the built environment:

> Cities can give back to Indigenous peoples in a number of different ways. The way in which we plan our cities and the way in which we consider our cities can reflect Aboriginal thought and Aboriginal knowledge and Aboriginal principles for caring for Country. If we consider all of the parts of Country, and all of the parts that are important to Aboriginal peoples, we can create better communities. Ones that consider waterways and animal pathways, ones that consider our sacred sites, ones that consider the way in which resources are used and protected and nourish back to the Earth. (Barrow et al. 2020)

In the Queensland Parliament, a planning statute has been passed that asserts

Table 6 Dwelling occupancy rate by capital city and other areas, 2017–18

Capital city or area	Mean number of persons in household	Mean number of bedrooms in dwelling
Australian Capital Territory	2.6	3.2
Greater Sydney	2.8	3.1
Rest of New South Wales	2.4	3.2
Greater Brisbane	2.7	3.3
Rest of Queensland	2.4	3.2
Greater Adelaide	2.5	3.0
Rest of South Australia	2.2	3.1
Greater Hobart	2.3	3.0
Rest of Tasmania	2.4	3.0
Greater Melbourne	2.7	3.1
Rest of Victoria	2.3	3.1
Greater Perth	2.7	3.4
Rest of Western Australia	2.4	3.4
Greater Darwin	2.9	3.1
Rest of Northern Territory	n/a	n/a
Total capital cities	**2.7**	**3.2**
Total rest of states or territories	**2.4**	**3.2**

n/a = data not available
Source: ABS (2019c)

Indigenous knowledge, culture and tradition are integral to advancing the purpose of the Planning Act 2016 (Qld). This provision opens pathways for Indigenous peoples to be meaningfully involved in land-use planning projects from the outset, as opposed to being involved merely as a 'tick-a-box' towards the end of processes. It also does not depend on the existence of native title, or heritage listings or a site of significance being registered, nor does it involve land grants or any transfer of titles. In another small but significant gain, the Planning Institute of Australia recently effected changes to its policies of educational accreditation to ensure Indigenous knowledges are recognised as a foundational Supporting Knowledge Area as a part of attaining Australian qualifications in planning (Wensing 2018).

Indigenous housing design preference

Housing is central to many of the Closing the Gap goals. It has direct flow-on effects in many areas, including physical and mental health, susceptibility to infectious diseases, emotional stress, health in infancy, early childhood education, and employment (Habibis et al. 2018). Studies have shown that, when community housing is improved, the incidence of hospital admissions are as much as 40% lower than in communities that do not receive improved services (NSW Department of Health 2010).

Case study Government Architect New South Wales – Connecting with Country

The NSW Government is exploring how to plan and design projects in the built environment that are informed by Indigenous connections with Country. The Government Architect NSW has developed the *Connecting with Country* draft framework for understanding the value of Indigenous knowledge in the design and planning of places. The framework has been informed by the experiences and knowledges of Indigenous people who work on and are from Countries in and around the Sydney Basin (GA NSW 2021). The project is being led by Yugembir man Dillon Kombumerri in close collaboration with Traditional Custodians and knowledge holders. Dillon says, 'There is a tendency to see Aboriginal places as distinct from non-Aboriginal places without acknowledging we are always on Country wherever we are. We need to better understand that post-contact heritage is generated from a shared history between 2 cultures even though each culture is distinct' (email correspondence 29 July 2021).

The *Connecting with Country* framework reflects on the meaning of Country and the interconnections between culture, identity and community. The framework puts forward a 'Country-centred' model in which natural systems – including people, animals, plants and resources – are integrated in a network of relationships through Country (GA NSW 2020a:17). It then offers strategies for connecting with Country and a guide for implementation. It also includes case studies on significant projects in architecture (e.g. Casino Aboriginal Medical Service), interior design (e.g. Koorie Heritage Trust) and public art (e.g. Barrangal Dyara) (KPAP 2021).

Overall, the project has 3 long-term strategic goals (GA NSW 2021:8); they are to:

- reduce the impacts of natural events such as fire, drought and flooding through sustainable land and water use practices
- value and respect Aboriginal cultural knowledge with Indigenous peoples co-leading design and development of all NSW infrastructure projects
- ensure Country is cared for appropriately, and sensitive sites are protected by Aboriginal people having access to their homelands to continue their cultural practices.

The *Connecting with Country* framework is intended for community, local government, government agencies, industry and developers. The draft framework will be tested and piloted over 12 months, with further input and guidance sought from Aboriginal communities across New South Wales.

Some initiatives recognise the relationship between housing and health outcomes of Indigenous people and communities, such as the 10-year Remote Indigenous Building and Refurbishment Program in 2008–18. But attempts to address Indigenous community needs for housing have been hampered by a lack of enforceable guidelines and by expedited rollouts that have failed to use high-quality materials and design processes that actively and meaningfully engage community (ANAO 2011, Wong 2018).

For many decades, Indigenous people have been subject to housing availability and design that does not meet basic needs or cultural needs, or suit their family composition. One way that Indigenous communities have sought to rectify this issue is through a more involved and collaborative design process (Saha et al. 2019). Indigenous people are seeking housing design that is more in tune with kinship and intergenerational living, provides better amenity for facilities such as kitchen and bathrooms, and allows for common living and outdoor areas to facilitate large family gatherings and events. Also favoured are designs for sturdier kitchen and bathroom facilities that consider family influxes during times of funerals and cultural celebrations and gatherings (Long et al. 2007:55, Page et al. 2021).

The United Nations Sustainable Development Goals (SDGs) highlight the problematic deficiencies in Australia in terms of compliance with international frameworks and in servicing the rights of Indigenous people through meeting housing needs (UN 2021). This is especially evident in SDG 6 (clean water and sanitation) and SGD 11 (sustainable cities and communities).

The 2018 Australian Government report on the implementation of the SDGs in Australia noted some of the disproportionate challenges faced by Indigenous communities:

> Remote communities, many of which are Aboriginal and Torres Strait Islander communities, may lack reliable energy supply, telecommunications, clean water and wastewater services, and adequate road access. Low population densities in some areas result in higher per capita costs for some goods and services. Disadvantage also occurs in urban areas. High housing costs contribute to the rate of homelessness in Australia, with disadvantaged groups particularly affected. (DFAT 2018)

However, the same report revealed that there were no specific programs to work towards meeting the SDGs that relate to housing for Indigenous communities, except for the Closing the Gap initiative, which incorporates some housing targets. The lack of specific targeted undertakings in Indigenous housing is part of a failing to recognise and act on SDG 1 (no poverty), SDG 3 (good health and wellbeing) and SDG 10 (reduced inequality) (DFAT 2018).

Case study The Koorie Energy Efficiency Project

The Koorie Energy Efficiency Project (KEEP) (Bedggood et al. 2016, Bedggood et al. 2017), funded by the Australian Government Department of Industry, Innovation and Science's Low Income Energy Efficiency Program, provides some insight into the many barriers Indigenous people (as with other vulnerable groups) face in achieving energy efficiency in their homes. Based on data collected from 867 Indigenous households across Victoria (2013–15), the KEEP report states (Bedggood et al. 2016):

> Initial analysis reveals that Aboriginal households invariably live in homes that are older than 20 years and were not structurally energy-efficient. Participants were mostly tenants and lived in dwellings with higher than average occupancy levels, had limited window coverings and insulation and relied heavily on gas for heating in the winter. Many struggled to pay their utility bills and were stressed due to their financial situation.

The fact that most Indigenous respondents were tenants (86% compared with 25% in the non-Indigenous population) means that they cannot make structural change (retrofits or insulation) or engage with new technologies (such as solar panels) that deliver energy efficiency. With insulation being one of the most important aspects in the energy efficiency of homes, it is alarming that 36% of Indigenous households reported having none.

The data collected showed that Indigenous households in Victoria live in suboptimal thermal conditions, which pose significant health risks to all family members. Overwhelmingly, Aboriginal tenants in Victoria are living in old draughty homes that have had little to no upkeep from landlords. Their financial situation is often further eroded because their appliances, including heaters, are energy-hungry, resulting in large energy bills that are difficult to pay. The KEEP data showed that energy-related disadvantage for Aboriginal peoples is complex, and given the rising costs of gas (55% of Aboriginal households reported gas as the most common heating source) tenants will be under increasing financial strain if the price of gas continues to rise.

The KEEP report (Bedggood et al. 2016) put forward several recommendations, including:

- the need to consider factors beyond energy consumption when assessing energy efficiency – such as energy-related disadvantage and the resulting stress and discomfort
- the need to design and undertake programs within Aboriginal communities and with high-level Aboriginal community involvement
- ensuring homes are well-insulated as a priority in reducing disadvantage
- the need for regulations and incentives to encourage landlords (private and public, and including Aboriginal housing) to improve their properties with retrofits, especially insulation
- providing Aboriginal households with support and guidance in negotiating with energy providers, and encouraging energy providers to employ Aboriginal representatives
- providing tips and advice to Aboriginal households that are easily transferrable between different properties, and providing efficient appliances that are movable.

Indigenous occupancy rates

Household occupancy rates for Indigenous people in Australia are markedly different from broader Australian society. Inadequate income and a lack of affordable housing options result in overcrowding and increased risk of homelessness. This is particularly true in rural and remote communities. Overcrowding in Indigenous communities is a well-documented phenomenon – as of 30 June 2017, 4% of public rental housing, 4% of community housing and 24% of state-owned and managed Indigenous housing was considered to be overcrowded (NSW Department of Health 2010:6).

The problems of overcrowding must not be understated. Living in overcrowded housing increases the likelihood of many health problems, from ear and eye infections and bloodborne viruses to mental health issues. The impact of deteriorating housing on occupants, and the lack of air-conditioning and heating, is made more severe where there is overcrowding and an inability to maintain hygiene (Hall et al. 2020).

The COVID-19 pandemic in Australia has further exacerbated the widespread challenges faced by Indigenous communities in relation to housing (Higgins 2021). Overcrowding has been a major cause of the spread of COVID-19 among, for example, western New South Wales Indigenous communities (Poulson 2021). Remote learning, another circumstance of the COVID-19 pandemic, is also more challenging for those in overcrowded housing. Indigenous communities are greatly disadvantaged in coping with the demands of COVID-19 conditions because of poor access to housing that meets fundamental health requirements (e.g. overcrowding and scarcity of housing make quarantine impossible). Their remote learning opportunities are also greatly impeded due to reduced access to technology such as computers and the internet – 1 in 4 Indigenous households have no internet

access (Hunter & Radoll 2020, Sonnemann & Goss 2020, WVA & ALNF 2021).

The effects of climate change are likely to necessitate some occupants, especially the aged, disabled and chronically ill, spending more time within their house, which can increase the psychosocial stress and risk of infectious disease transmission (Memmott et al. 2012:12).

However, it must be understood that cultural obligations such as kinship rules, immersive sociality and the cultural traits of sharing and mobility are also factors that affect occupancy rates. Culturally, Indigenous people do not fit into non-Indigenous models and expectations of 'proper' modes of occupation where the typical 3-bedroom home is the 'norm'. Mainstream housing models and expectations fail to serve or recognise foundational ongoing cultural obligations of Indigenous people – these accepted norms are fundamentally incongruent with the Indigenous world-view and cultural circumstances (Memmott et al. 2012).

This reminds us that social justice is not always best achieved through equality, but instead through recognition and respect of the differing circumstance and needs of groups (Memmott et al. 2012:162).

Leading experts in the field of Indigenous housing have made several recommendations in relation to negative impacts of occupancy rates (Memmott et al. 2012:171):

- Government policy on house crowding should include recognition of combined density and stress models and culture-specific factors.
- Indigenous cultural practices and values should be considered in all evaluations. Local department of housing offices should take advantage of Indigenous staff's cultural knowledge when assessing and implementing strategies and management.
- Concessions should be made regarding maximum wage limits of those renting public housing, because some houses act as 'community hub households'.
- New construction should ensure there are adequate large houses (5 and 6 bedroom) in Indigenous neighbourhoods and cities, with sufficient repair and maintenance support.
- Culturally based rules for sleeping group behaviours should be adequately supported.
- Good-practice models of culturally appropriate service delivery and emergency accommodation should be identified and used.
- More housing stock should be developed, especially in Indigenous population centres, as supply has not met Australian Government assessments of need since assessments began in the 1970s.

Commercial and industrial development

Although most development activity occurs in the residential sector, there is also notable development activity in nonresidential areas. On average, there have been 56,500 nonresidential building approvals per year across Australia over the past decade, with a slight increase from 2016 to 2019.

In 2020, however, Australia saw a 10% decline in nonresidential development, with the greatest fall in the commercial sector (including retail and offices). In contrast, industrial development saw an increase of 10%, showing a shift in priorities in the property-development sector with the growing recognition of the importance of onshoring capabilities and industrial supply chains. Despite this positive shift, industrial approvals were still less than 50% of commercial approvals in 2020.

In the past decade, the proportion of nonresidential development per state has remained stable, with Victoria averaging 29% of all nonresidential development, New South Wales 25% and Queensland 20%. This highlights how most (74% on average) of the investment in this type of development occurs in these 3 states.

There are various mechanisms across Australia through which Indigenous people can claim and acquire land (see the Land and Indigenous chapters). Many Indigenous communities may have large land holdings, but little capacity to navigate planning systems that often create legislative and policy barriers to the economic realisation of Indigenous community–driven commercial developments. This lack of connection and alignment between these various pieces of legislation and policy approaches, coupled with a lack of financial capacity, undermines attempts by Indigenous people to achieve self-determination. It also largely excludes their involvement in the ongoing expansion and development of the urban environment.

Livability

Australia is one of the most urbanised countries in the world – more than 96% of the Australian population (around 24.5 million) live in urban areas and 68% live within the greater metropolitan areas of Australia's 8 capital cities. Consequently, the livability of the urban environment significantly affects the lives of most Australians. Fortunately, Australian cities are consistently ranked some of the most livable in the world (Economist Intelligence Unit 2018), although this varies by city or urban area, and by location within cities.

The concept of 'livability' is a subjective and multifaceted concept without a standard definition. For the purposes of this chapter, it is defined as the life quality and satisfaction of people and communities. This includes health, living standards, community and social cohesion, security and safety, freedom, rights, recognition and self-determination, cultural and spiritual fulfilment of people, and their connection to Country and nature.

Consistent with this definition, the Australian Urban Observatory (AUO) identifies a livable community as one that is safe, socially cohesive, inclusive and environmentally sustainable. Highly livable areas provide affordable housing that is well serviced by public transport, walking and cycling infrastructure. They have good access to employment, education, shops and services, public open spaces, and social, cultural and recreational facilities.

Little research into Indigenous people's livability markers has been conducted. However, there is a wealth of evidence for disproportionate outcomes for Indigenous people in many of the areas that define livability, such as health, living standards, community and social cohesion, security and safety, freedom, rights, recognition and self-determination, and cultural and spiritual fulfilment (ABS 2018b, PM&C 2020).

The ongoing circumstance of colonisation also makes explorations of livability for Indigenous people problematic when viewed through the same lens as livability for non-Indigenous people. Several of the widely used 'markers' for livability suppose a level of self-determination, home ownership, employment and mobility, for example, that do not fit well with the lived experience of many urban Indigenous people and, more widely, many sectors of society that are marginalised (Arundel et al. 2017).

The livability of our urban environments is an important determinant of our wellbeing. As is the case with livability, there is no universally accepted measure of wellbeing. One approach

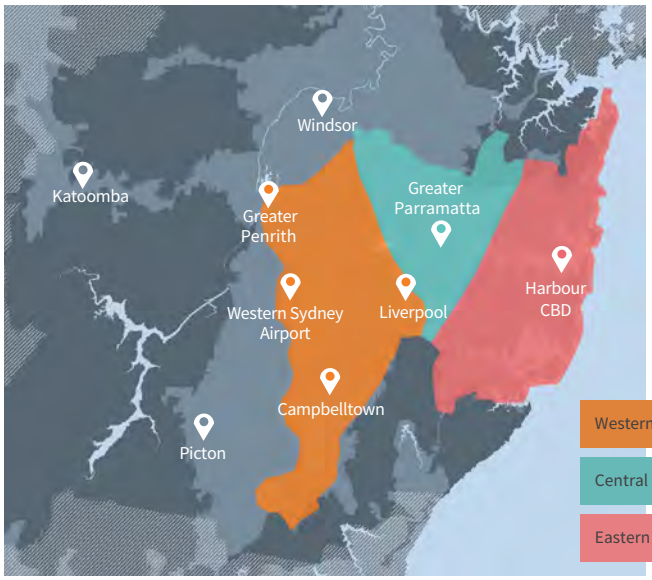
considers 8 factors (personal security, lifestyle, health care, crime, work–life balance and access to green space) to rank the livability of major urban areas internationally (Knight Frank 2020). On this basis, European cities dominate the highest ranks of overall livability with Oslo first and Zurich and Helsinki tied for second, whereas Sydney ranks 7th and Melbourne 11th. Looking at the access to open space component of this overall score, Sydney ranks 3rd after Oslo and Singapore.

The AUO applies 13 measures to assess the livability of Australia's 21 largest urban areas. Its most recent scorecard concluded that, although Australian cities are livable, the degree varies. It found that older, more established inner-city areas were generally more livable than the fringe areas of many urban areas because of their better access to public transport, employment opportunities and services.

Case study Drawing it all together

The complexity of our urban ecosystem means that environmental pressures and built form characteristics combine to influence the livability and wellbeing of our urban environments. For example, urban heat is influenced by the extent of green canopy cover. Collectively, these factors influence the safety and desirability of an urban environment and thereby the degree to which it is considered walkable. The extent to which people walk in an area, as opposed to use other forms of travel, in turn affects community health.

The Greater Sydney Commission is drawing together data from across Greater Sydney to understand how a combination of urban factors affects livability indicators such as walkability and access to open space. It finds that, in areas with lower tree canopy cover and higher temperatures, walking as a percentage of all trips is often lower. The Greater Sydney Commission is tracking and monitoring these factors in its annual Pulse of Greater Sydney report to better understand how effective the implementation of management approaches is across the city (see case study: Measuring what matters).



	Average annual days over 35°C	Existing urban areas tree canopy (2011)	Walking trips as a percentage of all trips (2017–18)
Western	3 days	32%	64%
Central	11 days	17%	15%
Eastern	21 days	16%	10%

Sources: Map from City of Sydney (2021); data from Greater Sydney Commission (2019)

Figure 2 Sydney walkability

Access to jobs, food, services and digital connectivity

Urban accessibility relates to the proximity of citizens to a variety of employment, food and community services, and the ability to travel to them in a safe and cost-effective way. As stated by Arundel et al. (2017), a more-accessible urban environment provides a range of wellbeing and environmental benefits by:

- reducing the need for and duration of commuting, which reduces stress levels and increases the amount of time that can be spent each day doing recreational activities
- reducing the cost of private vehicle use and increasing the opportunities for incidental exercise such as walking
- reducing the environmental implications of traffic congestion and vehicle emissions
- improving opportunities for obtaining fresh food, which supports healthy eating and reduces the potential for obesity and chronic diseases such as type 2 diabetes, coronary heart disease and some cancers (NSW Health 2017)
- improving health, education, early childhood community development, culture, sport and recreation services, all of which promote physical and mental wellbeing
- improving social equity via digital connections, which support educational attainment, information availability and employment opportunities.

Improving access to these services can be achieved in our urban areas by urban densification, which increases the number of people who live close to existing work opportunities, food and services. Alternatively, work, food and services can be brought closer to people through the development of local neighbourhoods and community centres and through urban decentralisation (see Management approaches).

Jobs

The AUO measured access to employment as the percentage of employees living and working within the same statistical area (Table 7). This measure is often referred to as job containment. On this basis, the AUO found that smaller urban areas such as Mackay, Toowoomba and Townsville scored most favourably in terms of commute times and access to jobs.

While job containment is a common method of assessment, it fails to consider the number of jobs, and the type or diversity of employment opportunities provided. For example, commute times may be longer in larger urban areas, but the number and diversity of employment opportunity career and income opportunities are likely to be far greater. For example, in one study, Ballarat had 100% job access and Melbourne had less than 50% access, yet the average Melbourne resident can access 950,000 jobs within 30 minutes, compared to just 45,000 for Ballarat residents (BITRE 2020b).

Based on job containment measures alone, Australia's larger urban areas scored significantly lower than the smaller urban areas – the AUO ranked Perth and Sydney equal 14th, Melbourne 16th, Brisbane 17th and Adelaide 18th. It should also be recognised that these assessments do not factor in recent changes to how we work in response to the COVID-19 pandemic – that, is the increasing rates of working from home and the associated livability benefits and challenges (see COVID-19 pandemic).

Food

To calculate access to food, the AUO measured the average distance to any type of supermarket from individual dwellings using a pedestrian accessible road network (see Public transport; Table 7). It found that Launceston ranked the highest of the 21 largest urban areas in Australia, followed by Canberra and Sydney. However, similar to the jobs measure, this measure fails to consider the quality of the supermarket and its provision of a diversity of fresh foods.

For some disadvantaged groups, access to food is about more than the distance to a supermarket. For example, 'One-fifth of Aboriginal people living in urban areas are food insecure, meaning they don't always know where the next meal is coming from' (Miller et al. 2018). Low income, combined with high costs and limited availability of fresh food, can reduce food security even in urban areas.

Recent research suggests that food insecurity for many Indigenous communities in both urban and remote communities has been further challenged by the COVID-19 pandemic:

> Based on our own lived experiences and anecdotal community feedback, we are hearing that food insecurity has increased for some Aboriginal people in response to COVID-19. People are fearful of going into large shopping centres – fearful of catching COVID-19. In some rural and remote areas, local shops are pushing up their prices, and people are left with no choice but to buy cheaper (and often less healthy) options to feed their families. Increase in government payments has resulted in the one and only shop in community providing food jamming their prices up. The price of food and water is beyond compare when you are paying $10 for a loaf of bread. (Follent et al. 2021)

Services

The AUO measured access to 16 different social services and forms of community infrastructure in various urban areas (Table 7). It found that larger urban areas had the best access to services – Sydney and Melbourne were ranked highest, followed by

Table 7 Selected Australian Urban Observatory livability indicators for Australia's 21 largest urban areas, 2018

Urban area	Access to jobs (proportion of people living and working in the same statistical area, and ranking)	Access to food (metres to nearest destination, and ranking)	Access to social infrastructure (number of destinations)
Adelaide	27% (18)	1,116 (3)	6
Albury–Wodonga	69% (7)	1,648 (17)	6
Ballarat	87% (4)	1,470 (12)	5
Bendigo	85% (5)	2,154 (20)	5
Brisbane	28% (17)	1,403 (9)	6
Cairns	68% (8)	1,578 (14)	4
Canberra	30% (15)	1,058 (2)	5
Darwin	43% (12)	1,419 (10)	5
Gold Coast – Tweed Heads	37% (13)	1,601 (15)	4
Geelong	69% (7)	1,390 (8)	6
Hobart	45% (11)	1,819 (18)	5
Launceston	84% (6)	1,039 (1)	5
Mackay	88% (3)	1,161 (4)	4
Melbourne	29% (16)	1,173 (6)	7
Newcastle–Maitland	52% (9)	1,628 (16)	5
Perth	31% (14)	1,279 (7)	5
Sunshine Coast	48% (10)	1,456 (11)	4
Sydney	31% (14)	1,164 (5)	7
Toowoomba	89% (2)	2,159 (21)	5
Townsville	94% (1)	1,919 (19)	4
Wollongong	48% (10)	1,526 (13)	6

Source: Adapted from AUO (2018)

Adelaide. This conclusion is likely to reflect the population size of these urban areas and their ability to support a greater number and range of social services than regional urban environments.

Digital connectivity

The reliability of digital connections is increasingly recognised to be a critical form of urban infrastructure, given the role it plays in providing information, and educational and employment opportunities. Digital connections are in turn influencing the shape of our urban environments by changing our need to travel.

The number and range of services provided by communications media continues to evolve because of new technologies, including wireless broadband networks, mobile network extensions for 3G and 4G (and now 5G) mobile services, and the convergence of networks, devices and services. This has resulted in a significant take-up of mobile phones and broadband internet over the past 10 years, and a decline in the number of subscribers to the older technologies of dial-up internet and fixed phones. As of 2018–19, there were 27.5 million mobile internet subscriptions compared with only 7.8 million for fixed phone (BITRE 2020c).

The importance of digital infrastructure has been highlighted during the COVID-19 pandemic. The number of people working and learning at home has significantly increased, including a remarkable estimated increase of 1,000% (Holloway et al. 2020) in the proportion of employees working from home. However, it should be noted that the increase in working from home has been better suited to some jobs (e.g. professional and knowledge jobs) than others (e.g. retail, manufacturing, education and frontline health). As the latter jobs are predominantly taken by lower-income and female workers, this shift has produced inequity in working opportunities. The pandemic has also brought to light inequities in digital access, affecting mostly low-income households. For example, 2.5 million people in Australia still have no internet access (Holloway et al. 2020).

There are common clusters within Australia's capital cities where people tend to work from home. Rates of working from home tend to be higher closer to inner-city areas and major centres, with these areas often correlating with higher socio-economic suburbs (Holloway et al. 2020).

Travel

Ease of travel and access to a variety of goods, services, employment and education opportunities is a key factor in urban livability and, in turn, wellbeing. As our population grows and urban environments expand, the number of kilometres (km) we travel each year similarly continues to grow (see Population).

In fact, the total passenger-kilometres travelled each year has at least doubled in each capital city since 1977, except for Adelaide (Table 8). For Darwin and Brisbane, the distance has near tripled (albeit coming off a lower base).

The complexity of our lifestyles and the increasing frequency of both parents (or carers) working may play a role in this trend. The ability to effectively link work travel with grocery shopping, school runs, medical appointments and other life activities often leads citizens back to car travel because of time constraints as well as challenges with transporting goods and children. Research shows this has a disproportionate impact on women, who are often undertaking these activities more often (Sarmiento 1998).

Travel in terms of livability and wellbeing is especially challenging for those who

Table 8 Distance travelled by passenger by capital city, 1976–2020

Adelaide	10.0	14.0	4.0	40
Brisbane	10.0	31.0	21.0	210
Canberra	2.0	5.0	3.0	150
Darwin	0.4	1.5	1.1	275
Hobart	1.5	3.0	1.5	100
Melbourne	27.0	57.0	30.0	111
Perth	10.0	24.0	14.0	140
Sydney	31.0	61.0	30.0	97

km = kilometre
Source: BITRE (2020a)

experience financial instability; inequity within transport is sometimes referred to as 'transport poverty'. Many diverse groups experience transport poverty, including low-income earners, youth, the unemployed, people with disabilities, women, ethnic minorities, Indigenous people and outer-urban dwellers (Lucas et al. 2016).

Indigenous communities in smaller urban centres are often far from amenities such as shopping, health care, cultural business, education and social services. Transport is a key enabler for facilitating access to health care, goods and services. It enables Indigenous people and communities to enjoy education and employment outcomes and maintain cultural obligations that require travel. In 2018–19, 13% of Indigenous people aged 15 and over who needed to go to a health provider but did not listed transport/distance as a reason why. And in 2014–15, 75% of Indigenous Australians reported that they could not easily get to the places they needed, with 85% of Indigenous Australians over the age of 15 less likely to have access to a motor vehicle than non-Indigenous Australians (AIHW & NIAA 2021).

Public transport

Access to reliable and regular public transport is another key factor in the livability of our urban environments. It is a more sustainable form of travel for the environment and is important for various age groups and abilities, given that not all citizens are eligible for drivers licences. Proximity to public transport also encourages more active forms of travel, with associated health and wellbeing benefits.

The AUO assessed access to transport based on average distance to the closest public transport stop, the proportion of dwellings within 400 metres (m) of a bus stop, and frequency of services (Table 9). It found that, across Australia's 21 largest urban areas, access to regular public transport was best

Table 9 Livability indicator (access to transport) in Australia's 21 largest urban areas, 2018

Urban area	Access to transport (percentage of dwellings within 400 metres of public transport with a reasonable service, and ranking)
Adelaide	57% (3)
Albury–Wodonga	4% (17)
Ballarat	43% (6)
Bendigo	34% (8)
Brisbane	33% (9)
Cairns	15% (15)
Canberra	65% (1)
Darwin	23% (12)
Gold Coast – Tweed Heads	25% (11)
Geelong	38% (7)
Hobart	23% (12)
Launceston	13% (16)
Mackay	1% (19)
Melbourne	48% (4)
Newcastle–Maitland	31% (10)
Perth	46% (5)
Sunshine Coast	22% (13)
Sydney	61% (2)
Toowoomba	3% (18)
Townsville	20% (14)
Wollongong	33% (9)

Source: Adapted from AUO (2018)

for residents living in Canberra, followed by Sydney and Adelaide.

In general, the AUO found that the larger the city or urban area, the more available and frequent the public transport. However, there was a notable difference between the quality of services in the inner-city areas and the outer city areas, with regional cities different again – they generally have reduced levels of access to regular public transport.

Despite the benefits of public transport, its use as a proportion of total travel across all Australian capital cities (excluding commercial vehicles) between 2015–16 and 2018–19 only changed modestly (+1%). This modest increase was largely driven by the proportional increase in public transport in Greater Sydney (+2%) and Hobart (+1%), with proportions in all other capital cities remaining constant.

The exception to this was 2019–20, when the use of public transport decreased significantly in many cities (–2% of all travel excluding commercial vehicles). The most significant declines occurred in Greater Sydney (–5% of total trips) and Darwin (–3%). These changes were driven by the COVID-19 pandemic and the associated rapid increase in working from home, combined with broader travel restrictions (see COVID-19 pandemic).

A survey of Australian households conducted during the first wave of the pandemic in Australia (March 2020) found that:

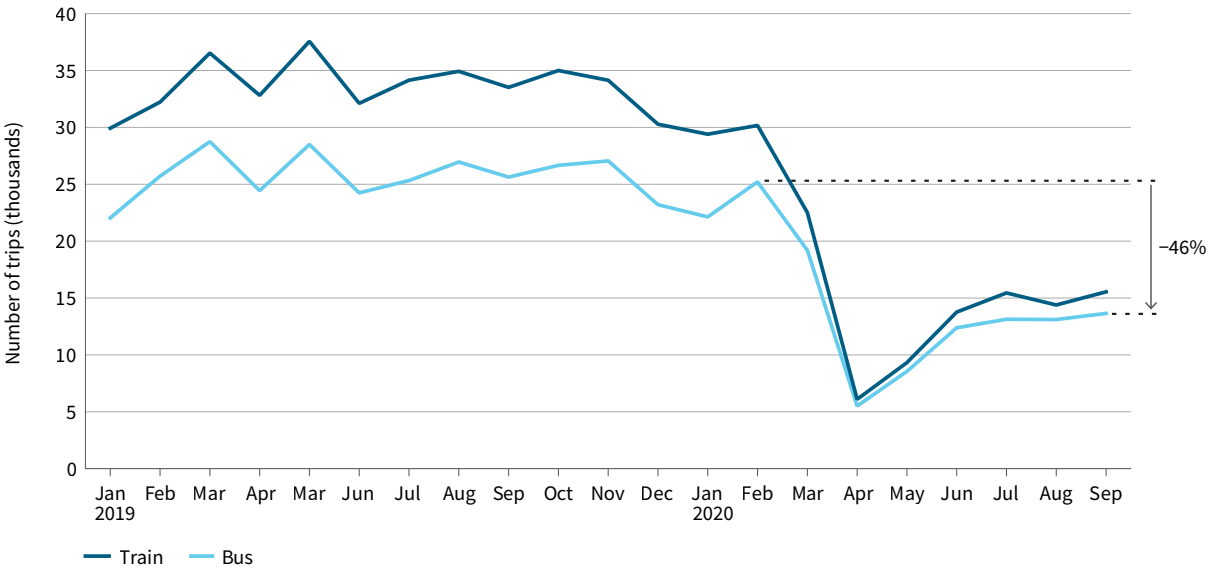
> … trips for all purposes had fallen, with the greatest drop occurring in travel to work, from an average of 7 per week down to 3. In aggregate, significant falls are also observed for the purposes of childcare and education, social and recreation, general shopping, personal business and for purposes of caring for the sick or elderly. As a proportion of household trips, commuting remained relatively constant at approximately 30% of all household trips, with falls in childcare and education (from 10% to 4%) and social and recreation (18–13%), but food shopping now accounts for 29% of trips (up from 17%). (Beck & Hensher 2020)

The reduced capacity of existing forms of transport, and perceptions regarding its safety, also affected how we travelled across our urban environments. For example, during the initial stages of the pandemic in Greater Sydney in 2020, Transport for NSW recorded a decline in trips from 2.0–2.5 million per day to less than 0.5 million (Skatssoon 2020). Bus patronage remained 46% lower than pre-pandemic levels and ferry patronage 71% lower. Conversely, active forms of travel such as walking increased, with one survey finding an increase from 14% to 20% of trips during the early months of the pandemic (Beck & Hensher 2020).

According to research by Infrastructure Australia, public transport in most cities fell to 10–30% of normal levels in the initial lockdown but settled at a 'new norm' of about 60–70% in the second half of 2020. This reflected people partially returning to work, and working and travelling more flexibly across the day (Infrastructure Australia 2020b) (see Figure 3).

The March 2020 survey of Australian households found that 33% and 42% of respondents rated trains and buses as their least comfortable methods of travel, respectively. More than half of respondents (58%) were extremely concerned about levels of hygiene on public transport, up from just 5% before COVID-19. The responses varied little by socio-demographic group, with only middle-aged respondents displaying a greater propensity to rate taxi or ridesharing as their most comfortable option of travel (Beck & Hensher 2020).

In keeping with these concerns, the Infrastructure Australia 2020 report found that, following the initial stages of the



Source: Infrastructure Australia (2020b)

Figure 3 Sydney Opal card trips by mode, 2019–20

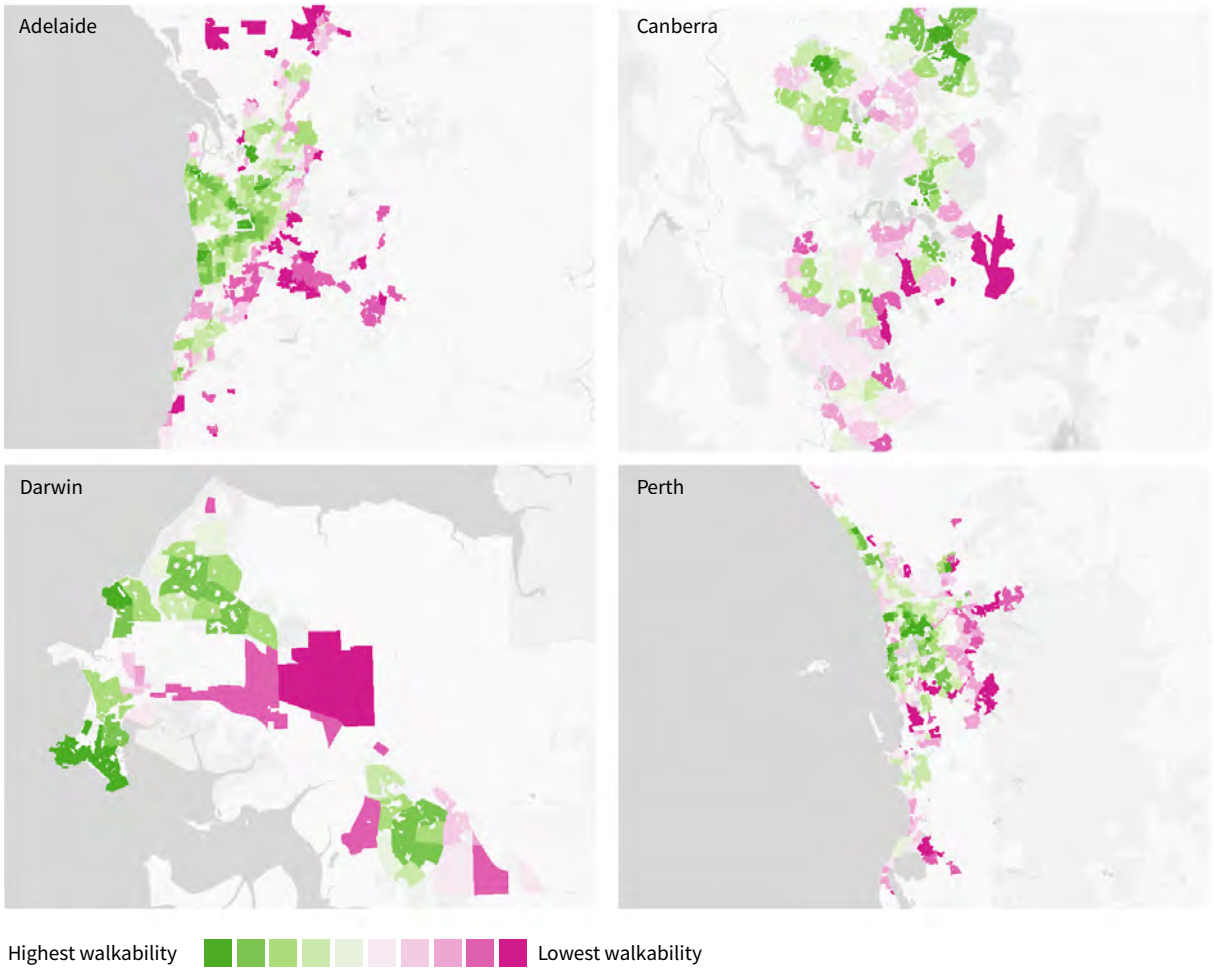
pandemic, overall road traffic levels were quick to rebound, but with less central business district–focused congestion, as more people worked at home, and more online food deliveries and online shopping increased demand for last-mile deliveries. An increase in second-hand car sales was a possible indication that higher car mode shares would continue (Infrastructure Australia 2020b). There are consequently concerns that the attractiveness of the private vehicle may create worse congestion than was seen before the pandemic (Beck & Hensher 2020), thereby adversely affecting the livability of our urban environment and our wellbeing.

Walking

The structure and layout of our urban areas has a critical influence on their walkability and cyclability. Most of our urban councils are recognising the importance of these factors to our livability, with increasing public spending on improvements to support better outcomes. In a survey of councils across Australia for this report, it was found that of those councils actively working to improve the livability of the urban environment for their citizens, 96% were providing more cycling and walking paths and 65% were improving walkability to shops and services.

Walkable and cycle-friendly areas reduce dependence on private vehicles. Walking and cycling are increasingly recognised as proxies for livability, given the many associated lifestyle, health and equity benefits they provide (Ma & Ye 2019). They are considered relatively affordable means of improving access to goods, support services and work opportunities. Furthermore, they reduce carbon emissions, and air and noise pollution (Deakin et al. 2018). Yet, despite these significant benefits, as of 2016 only 3.5% of Australians walked and 1% cycled to work (Table 10).

Measuring the walkability of an area is not an exact science – there are several variables. Walkability is defined by the AUO (2020) as the ‘ease of walking in an area’, being the



Source: Adapted from AUO (2018)

Figure 4 Sample of walkability in 4 of Australia's 21 largest cities, 2018

composite of 'local neighbourhood attributes, including street connectivity, dwelling density and the index of access to services of daily living'.

The AUO's assessment of walkability, as an input to its livability index, concluded that of Australia's 21 largest urban areas, the more urban and densely developed areas were more walkable (Figure 4) (AUO 2020). Walkability notably declined in all assessed cities towards the city fringe and greenfield development areas.

Another measure that is being used to quantify the walkability of an area is a Walk Score. This approach analyses walking routes to services, population density and road metrics to provide a score for walkability out of 100 (Walk Score 2021). For Australian cities with more than 200,000 inhabitants, this approach found results broadly similar to the AUO approach: denser urban environments were more walkable and provided more-accessible services, amenities, jobs and public open green spaces (Table 10). The most walkable major city in Australia is Sydney, but it is only ranked as 'somewhat walkable', which means

Table 10 Walk score Australia's 21 largest cities, 2020

Urban area	Walk score (out of 100)	Classification	Most walkable suburbs
Adelaide	54	Somewhat walkable	Adelaide, Glenelg and Stepney
Albury–Wodonga	58 / 40[a]	Somewhat walkable / car-dependent	North Albury, South Albury, Glenroy, West Albury, East Albury / Wodonga, West Wodonga and Bandiana
Ballarat	41	Car-dependent	Ballarat Central, Lake Wendouree and Soldiers Hill
Bendigo	39	Car-dependent	Bendigo, Ironbark and Kennington
Brisbane	51	Somewhat walkable	Brisbane City, Fortitude Valley and Spring Hill
Cairns	41	Car-dependent	Cairns City, Parramatta Park and Manunda
Canberra	40	Car-dependent	City, Kingston and Barton
Darwin	45	Car-dependent	Darwin City, Wagaman and The Gardens
Gold Coast – Tweed Heads	48 / 39[a]	Car-dependent	Broadbeach, Surfers Paradise and Coolangatta / Tweed Heads, Kingscliff and Tweed Heads South
Geelong	53	Somewhat walkable	Geelong, Geelong West and South Geelong
Hobart	44	Car-dependent	Hobart, Battery Point and Glebe
Launceston	43	Car-dependent	Launceston, East Launceston and Invermay
Mackay	36	Car-dependent	Mackay, Mount Pleasant and West Mackay
Melbourne	57	Somewhat walkable	Carlton, Fitzroy and Fitzroy North
Newcastle–Maitland	49 / 36[a]	Car-dependent	Newcastle, The Hill and Cooks Hill / Lorn, Maitland and South Maitland
Perth	50	Somewhat walkable	Northbridge, Perth and Highgate
Sunshine Coast	44	Car-dependent	Caloundra, Kings Beach and Moffat Beach
Sydney	63	Somewhat walkable	Haymarket, The Rocks and Sydney
Toowoomba	46	Car-dependent	Toowoomba City, East Toowoomba and South Toowoomba
Townsville	40	Car-dependent	Townsville City, Mysterton and Thuringowa Central
Wollongong	48	Car-dependent	Wollongong, Gwynneville and Fairy Meadow

a One score is for the first city listed, and the second score is for the second city.
Source: Walk Score (2021)

that 'some errands can be accomplished by foot'. A further 6 cities were identified as somewhat walkable and 14 cities score within the 'car-dependent' tier.

Walking Country

Walking Country is an essential part of Indigenous people's ability to connect to Country. This connection takes place on many levels, including physical, emotional and spiritual. Connecting to Country promotes the sense of belonging to their environment that Indigenous people have, whether this environment is urban or regional. Walking Country is also a reminder for Indigenous people of their need to maintain their cultural obligations, such as custodianship and care for Country (see the Indigenous chapter).

Walking Country encourages a place-based approach to planning and design that can better incorporate specific or unique aspects of places including identity and language. It can also enhance knowledge and awareness of the environment through observation, thus promoting custodianship.

Walking Country has become a key component of many tourism offerings, particularly in urban areas, and such ventures allow opportunities for Indigenous people and communities to share and take pride in their culture and assert their belonging. This also provides significant employment and educational opportunities for Indigenous communities (Carr et al. 2016).

Walking trails and paths that seek to include Indigenous heritage, living culture, belonging and ongoing presence are important to educate the wider population. They are also important for Indigenous communities, so they can enjoy the physical, spiritual and emotional benefits of connecting to Country in a culturally appropriate way (Brand et al. 2016).

Cycling

Cycling is an important form of active transport and continues to be 'one of the most common forms of physical activity' (Munro 2019:18). Despite this, between 2011 and 2019, cycling declined as a form of transport for commuting – dropping from 15.5% in 2017 to 13.8% in 2019 according to Austroads. Despite the proportional decline as a form of transport, actual numbers are increasing because of population growth, particularly in capital cities (Munro 2019).

As with walking, during 2020 cycling became more popular as a means of travelling and recreational activity during the COVID-19 pandemic (Bromhead 2020). In many cities, footpaths were widened and new cycle paths were created to accommodate this shift. For example, during the pandemic, Brisbane City Council trialled the CityLink Cycleway, a network of dedicated cycling facilities. The Council experienced a strong response to the trial, recording a 16% increase in active travel across Brisbane from January 2020, with more people choosing to walk and ride compared to the same period in 2019. The number of people riding a bike to work in the city more than doubled between 2006 and 2016. Brisbane City Council estimates that, on average, a car in Brisbane only carries 1.1 people, but takes up the same space as 5 people riding bikes (Brisbane City Council 2021c).

Safety and security

Part of an urban area's livability relates to its perceived safety and sense of community security.

The Australian Bureau of Statistics 2016 Personal Safety Survey found that 1 in 2 women (53%) over the age of 18 had experienced sexual harassment during their lifetime. Research by Plan International found that 90% of young women surveyed

across Greater Sydney said they felt unsafe on the city's streets at night and 92% felt uncomfortable taking public transport alone after dark. This finding was reinforced by research from the City of Sydney on how women travel around Greater Sydney, which found that 'safety and harassment shapes and limits women's active transport choice' (City of Sydney & C40 Cities 2020). Therefore, safety was perceived to be a significant barrier to increasing the number of women walking and cycling around the city.

Research by the City of Sydney identified that, although separated cycleways and street lighting were important to helping women feel safe, these measures needed to go hand in hand with well-designed, inclusive public spaces and behaviour change to encourage women to shift from their cars (City of Sydney & C40 Cities 2020).

Many cities around the world are actively changing how they design cities to enhance perceived and actual safety. For example, following London's lead with a Women's Night Safety Charter, the Greater Sydney Commission designed a Women's Safety Charter to support the development of a female-friendly city. This concept recognises that a city that is safe for women is safe for everyone. The charter has more than 100 government and industry partners who have committed to designing cities for women; collecting, sharing and reporting relevant data; and taking collective action.

Case study Roads to Home

Roads to Home is a planning and infrastructure program designed to address the longstanding infrastructure and servicing inequality experienced by 61 Indigenous communities located on former missions and reserves across New South Wales. While Indigenous community members may move away from reserves or missions for education or work, they retain a deep spiritual and cultural attachment to these lands.

When, in the past, ownership of a discrete Indigenous community was transferred to the Local Aboriginal Land Councils (LALC) under the *NSW Aboriginal Land Rights Act 1983*, the road reserves were often in poor condition. The LALC had limited funding to undertake the required and ongoing maintenance. This issue remains a problem today, as infrastructure deteriorates further, significantly affecting the quality of these urban environments and the wellbeing of the communities that live within them.

The substandard condition of the road reserves complicates municipal service provision such as waste management, and contributes to environmental health issues such respiratory disease, gastrointestinal disease and skin disease due to dust, flooding and build-up of waste.

The Roads to Home program was designed to address these issues. It seeks to deliver essential road reserve infrastructure upgrades to enable land to be subdivided. It also provides the option for road reserves in Indigenous communities to be assigned to local government for ongoing maintenance. The road reserve includes storm water and other drainage, kerb, guttering and footpaths, street and public space lighting, upgraded road surfaces, telecommunications and power.

Subdividing the land will enable improved land management, increase economic independence by allowing each household to be on its own individual lot. This will provide different housing management options and improve access to services such as household waste collection, postal delivery, emergency vehicles and community transport.

The benefits from the program are expected to be improved chronic health conditions and a positive influence on mental health. The infrastructure upgrades of Roads to Home will also enable Indigenous people to continue to live on Country and stay within their communities, continuing cultural connection to Country and strengthening local connections for overall wellbeing. It is also expected to contribute to broader psychological wellbeing due to receiving equivalent services to residents in the wider local government area.

Roads to Home is a pillar of the Solution Brokerage declaration relating to Indigenous community land and infrastructure issues in NSW. It helps the LALCs to better support economic, community and cultural uses of other Indigenous land acquired through the *Aboriginal Land Rights Act 1983.*

The natural environment

Our urban spaces can be seen as purely artificial constructions, but every urban environment incorporates – and significantly benefits from – elements of the natural environment. Access to nature, green spaces and biodiversity has also been found to have important livability and wellbeing benefits to urban citizens. Also, urban spaces and the built environment do not erase Indigenous belonging and custodianship of the land, as Yuin man Jade Kennedy explains:

> Country is ever present. Regardless of the built environment, regardless of the bitumen and asphalt, beneath the concrete, Country always is and always will be. And Country is not just the physical landscape. It absolutely is the natural environment. It is the birds, the bees, the animals, the reptiles, the life in the sea, but it's also the relationships between people and the relationships between people in their place. It's the culture of the people and their place. It's the story and the continuity of that story of a place and its peoples, of its way of being. And it's the interrelationship of all these things. (Barrow et al. 2020)

Green cover

While there is a positive trend towards increasing green cover in urban areas, many urban areas are still making up for long-term losses. The Greener Spaces Better Places

consortia have been monitoring the extent of green cover (trees of more than 3 m and shrubs typically under 3 m) across 131 local government areas in Australia (Figure 5). It found that:

- 69% of council areas surveyed experienced an overall loss of green cover between 2013 to 2020
- 62% increased their green cover between 2016 and 2020 (Greenlife Industry Australia & Hort Innnovation 2020).

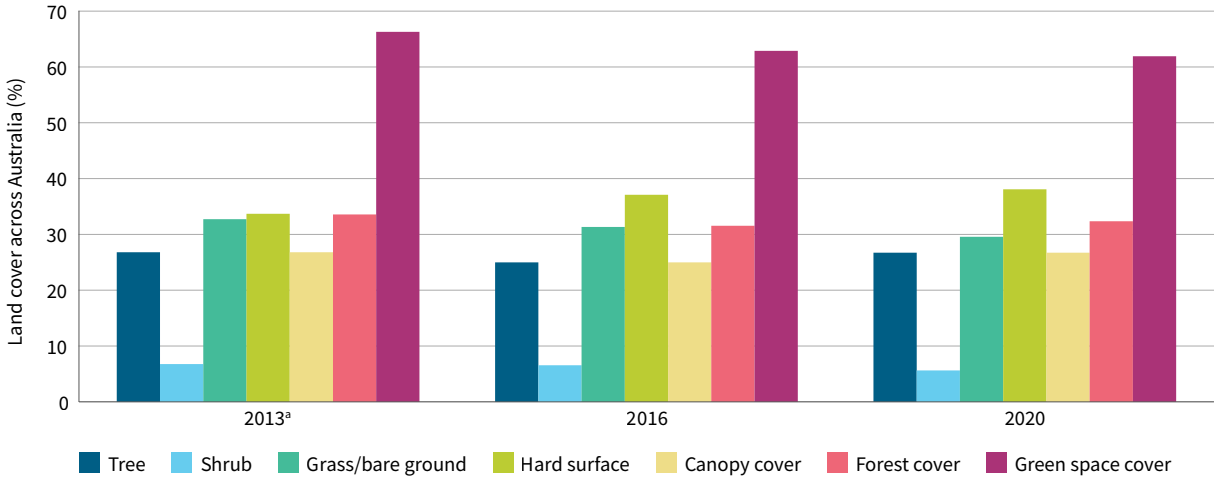
This result shows a positive shift towards increasing green cover in government policy, with most (88%) of the 131 councils surveyed developing or maintaining a strong management framework to address urban forest cover on public land, together with strong organisational and community support to implement this work. Most councils surveyed identified that these gains mostly relate to public land, with presently limited potential to drive positive outcomes on private land.

Aggregating these data to a state and territory level showed that, between 2016 and 2020, Tasmania and Queensland recorded the highest percentage of increase in the urban tree canopy cover (Figure 6). During the same period, all states (except for South Australia) experienced a decrease in the percentage of shrub cover and all (except for Northern Territory) experienced a decrease in the percentage of grass or bare groundcover.

The same study found that the top 5 areas for green cover were:

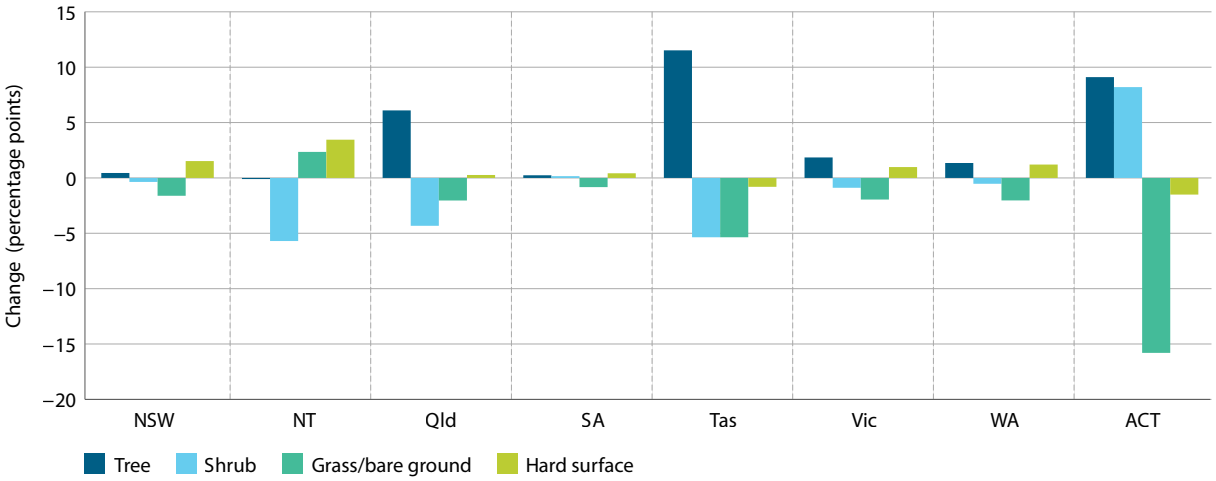
- Cairns Regional Council, Queensland (82.9%)
- Yarra Ranges Council, Victoria (78.6%)
- Hornsby Shire Council, New South Wales (78.6%)
- Kingborough Council, Tasmania (73.9%)
- Sutherland Shore Council, New South Wales (+72.6%).

Wyndham City Council, Victoria, had Australia's lowest recorded level of green cover with 5.4%.



a The percentage of land cover was estimated as the 'average of percentage of land cover' across the local government areas.
Source: Hurley et al. (2020)

Figure 5 Percentage of land cover change across 131 local government areas in 2013, 2016 and 2020



ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: Hurley et al. (2020)

Figure 6 Percentage of land cover change across states and territories, 2016–20

The top 5 local government areas that increased their green cover between 2016 and 2020 were:

- Launceston, Tasmania (+9.5%)
- the Sunshine Coast, Queensland (+8.4%)
- Sutherland Shire Council, New South Wales (+8.2%)
- Kwinana, Western Australia (+7.9%)
- Glenorchy City Council, Tasmania (+7.1%).

Areas experiencing a loss in cover included Palmerston, Northern Territory, which lost an estimated 8.5%, partly because of bushfires and their effects (Greenlife Industry Australia & Hort Innnovation 2020).

Between 2016 and 2020, 73% of local government areas (LGAs) increased the extent of their hard surfaces. Of interest, many of the LGAs that gained hard surface cover did so at the same time as gaining urban forest cover. These areas also experienced the greatest population growth, indicating that urban greening was being successfully planned and delivered alongside urban development and intensification. Examples of such areas are:

- Vincent (+2.3% urban forest cover, +2.1% hard surface)
- Parramatta (+2.8% urban forest cover, +1.2% hard surface)
- Adelaide (+3.6% urban forest cover, +1.2% hard surface)
- Cockburn (+4.4% urban forest cover, +2.2% hard surface) (Hurley et al. 2020:19).

Despite the positive improvements, the Greener Spaces Better Places research suggested that 67% of our urban places will face moderate to very high challenges to maintain or grow green cover over the next decade.

Access to natural places

The urban environment includes green spaces (e.g. parks, woodlands, nature conservation areas, gardens and sports fields) (Farahani & Maller 2018) and blue spaces (e.g. creeks, rivers, dams, ponds, estuaries and wetlands).

Collectively, these spaces provide an array of livability benefits by:

- mitigating the adverse effects of urbanisation noise and air pollution (WHO, 2017)
- cooling the urban environment with green cover (see Urban heat)
- providing space for physical activity and contact with nature, which provides significant health and wellbeing benefits for citizens (WHO EURO 2017)
- providing opportunities for social connection and cohesion, which result in improved levels of neighbourhood and community satisfaction (WHO EURO 2017)
- providing financial benefits through a positive correlation with property values (Tyrväinen 1997, Clayton 2007)
- enabling Indigenous people to connect on a regular basis to specific spiritual and cultural places for custodial, ceremonial or other cultural obligation reasons.

Despite these benefits, the extent and quality of green cover is declining in our urban areas (see Green cover). Furthermore, access to open spaces varies notably between and within urban areas. Research by Farahani et al. (2018) found that green spaces are often inequitably distributed across cities (Shanahan et al. 2014). Often, areas of socio-economic advantage have more tree canopy cover than areas of lower advantage (Shanahan et al. 2014, Schwarz et al. 2015). Also, as Saunders et al. (2020) highlighted from Dobbs et al. (2017): 'cities with greater levels of inequality have been shown to exhibit more fragmented and lower quality urban vegetation overall'.

While green spaces generate notable health and wellbeing benefits and may reduce income deprivation–related health inequalities (Mitchell & Popham 2007), the converse is also true. That is, poor access can be associated with negative health outcomes. Researchers argue that, if left unchecked, this 'green gentrification' could exacerbate inequities by limiting the benefits of green spaces to specific groups (Pauli et al. 2020).

The AUO measured the proportion of the population of the largest 21 urban areas that had a public open space (urban park greater than or equal to 1.5 hectares) within 400 (or 5 minutes) from their homes. For the purposes of the analysis, public open space was defined as 'parks, open areas and places where people can congregate for active and passive recreation and enjoyment'. The analysis found the urban area with the greatest proportion of its residents with access to open space within 400 m was Canberra (72%), with most cities achieving between 40% and 50% (Table 11).

Access is one consideration; the quality and usability of the space is another. A case study of Stoney Creek in Sunshine North, Melbourne, by Farahani et al. (2018) found 'that wildlands and unmanicured greenspaces within cities can trigger negative experiences such as fear, disgust or an unpleasant feeling'. Similarly, this study showed that poor maintenance was associated with a sense of unsafety because of perceived natural hazards, such as the presence of snakes. One interviewee referred to the area not being safe for his dogs or himself.

Table 11 Livability indicator (access to open spaces) in Australia's 21 largest urban areas, 2018

Urban area	Access to open space (percentage of dwellings within 400 metres, based on a walkable road network distance; ranking)
Adelaide	47% (11)
Albury–Wodonga	52% (8)
Ballarat	58% (2)
Bendigo	42% (14)
Brisbane	56% (5)
Cairns	43% (13)
Canberra	72% (1)
Darwin	50% (9)
Gold Coast – Tweed Heads	57% (4)
Geelong	44% (12)
Hobart	40% (15)
Launceston	37% (16)
Mackay	55% (6)
Melbourne	49% (10)
Newcastle–Maitland	58% (3)
Perth	57% (4)
Sunshine Coast	53% (7)
Sydney	50% (9)
Toowoomba	42% (14)
Townsville	43% (13)
Wollongong	43% (13)

Source: Adapted from AUO (2018)

Case study Kaurna Kardla Parranthi – Kaurna cultural burns – Adelaide, South Australia

The cultural burns undertaken in May 2021 on Kaurna Country in Adelaide's parklands show the importance of recognising and enabling cultural practice in connecting Indigenous peoples to Country and to their ancestors. It also allows groups to fulfil their custodial obligations in caring for Country and provides valuable biodiversity outcomes.

The cultural burns on Kaurna Country are part of an ongoing commitment from the City of Adelaide to honour and foreground Kaurna people and their culture and deep knowledge of Country. This is concurrent with programs that have resourced and championed Kaurna language revival and dual naming across the City of Adelaide (Kaurna Warra Pintyanthi 2021b, Kaurna Warra Pintyanthi 2021c, Kaurna Warra Pintyanthi 2021d) (see the Heritage chapter).

The cultural burning project is known as Kaurna Kardla Parranthi ('to light a fire') (Kaurna Warra Pintyanthi 2021a) and is part of the *City of Adelaide stretch reconciliation plan 2018–21* (City of Adelaide 2018), which seeks to more meaningfully incorporate Kaurna people and their knowledges with several projects related to incorporating Indigenous understandings of native biodiversity management. A joint project between Kaurna community, the City of Adelaide and the SA Department for Environment and Water, with the aid of cultural fire practitioner Victor Steffensen and the Firesticks Alliance, the Kaurna Kardla Parranthi has been met with a great deal of excitement by stakeholders and community members. Kaurna and Narungga man Jeffrey Newchurch, the chairperson of the Kaurna Yerta Aboriginal Corporation, explains the wider opportunities for connecting to Country offered by the burning program:

> For me, the significant part of it is camping the night before and the night after. It allows us to sit by a campfire, to share each other's stories, to share conversations with other people that we get to know. And from my perspective, an Aboriginal perspective, it allows a journey of healing. We've been at risk since settlement … what was done to us in the past. To have a position to sit down by camp and share, it's very important. Healing is something we take for granted. We're returning to Country and sitting on Country'. (Skujins 2021)

Cultural fire practice is increasingly being seen as viable in urban areas to effectively manage Country and empower Indigenous people and Traditional Custodians. As with all cultural fire, fire practice in urban areas is only effective when Traditional Custodians are empowered to lead and are the decision-makers and authorising body, with Indigenous governance structures supported (Freeman et al. 2021) (see the Indigenous chapter).

Urban biodiversity

Far from being ecological deserts, our urban areas play an important role in supporting a diverse range of flora and fauna, including providing critical habitat for endangered species:

> … urban environments also offer unique prospects for biological conservation, which can in turn provide a range of important benefits for human health and wellbeing. Sustainable cities are cities that work for people and nature together. Recent enthusiasm for 'nature-based solutions' to address liveability challenges has seen urban greening become a common inclusion in urban planning. While this is an important advance, biodiversity is rarely considered in these initiatives and even best-practice international examples of nature-based solutions often come without significant biodiversity gains. It is through the green spaces and other green infrastructure of a city that its human inhabitants can interact with nature and receive the many health and wellbeing benefits of biodiversity and ecosystem services. For these benefits to be realised, access to nature must be delivered within the urban fabric of cities, rather than marginalised in large reserves a long way from population centres. (Bekessey & Parris 2020)

Urban habitat ranges from street trees, lawns, parks, urban forests, cultivated land, wetlands, lakes and streams and private yards, to less obvious locations such fill and transfer stations, tips, general rubbish and waste treatment plants.

Despite this diversity of habitat, most of our urban areas have not been planned to support animal habitat. Rather, they have been largely developed by removing habitat and fragmenting land and green corridors, which has resulted in changes to resource availability. In creating our urban environments, we have also introduced exotic species and altered local climates, which has caused significant habitat loss. For example, 3 of Australia's largest urban areas – Brisbane, Perth and Sydney – are established within 2 global biodiversity hotspots (Mittermeier et al. 2011). These cities have at least 1,500 species of endemic plants, yet they have lost more than 70% of native vegetation cover through development (Pauli et al. 2020).

Other threats to biodiversity in urban areas are:

- fragmentation from urban sprawl, and logging and agricultural expansion
- vehicle strikes and dog attacks
- the impacts of climate change, including more intense bushfires, droughts and extreme heat events (ACF 2020).

Many cities and governments are incorporating aspects of 'biophilic' (connecting people and nature) design as the importance of nature in our cities and urban spaces is becoming better understood and supported. (Mata et al. 2020).

Case study The importance of remnant grasslands in urban areas for maintaining and reinvigorating Indigenous knowledge and agricultural practice

The potential of Indigenous agricultural knowledge and practices in addressing the challenges of climate change is well recognised internationally (IPCC 2020). Although it is only recently coming to be widely recognised, Australia's Indigenous people have a long and complex tradition of agriculture, which has been significantly undermined through colonisation (Pascoe 2014). Root crops such as murnong, and native grains such as kangaroo grass, were commonly cultivated, for example, in and around Melbourne in the early 1800s, and were particularly abundant in native grasslands (Gott 1983).

Only small remnants of native grasslands remain in peri-urban Melbourne and they are at extreme risk of urban development (Perkins 2021):

> Less than 5% of the original extent of both communities remains, although patches in good condition are likely to constitute less than 1%. Most known remnants are small – under 10 hectares in size. Many patches of these ecological communities require recovery efforts because they are so degraded, due to weed and feral animal invasion and loss of native biodiversity, that their capacity to maintain ecosystem function is impaired. These ecological communities provide habitat to several nationally and state-listed threatened species. (DSEWPaC 2011)

Remaining areas of native grasslands in the region should be recognised not only for their contribution to biodiversity, but also for their importance as Indigenous food sources. Remnant grasslands are fundamental to the potential contribution of Indigenous knowledge and practices to climate-resilient food production in Melbourne's food bowl (Allam & Moore 2020, Crivellaro 2020, Epa 2020). Traditional foods are suited to the Australian environment and have the potential to be an important consideration in the many challenges of climate change and food security (Mathew et al. 2016).

Many Traditional Owner groups across Australia are beginning to re-awaken and reinvigorate food knowledge and agricultural practice (Black Duck Foods 2021, FNBBAA 2021).

Threatened species

A report by the Nature Conservation Council 2020 found that 25% of all nationally listed threatened plants and 46% of nationally listed threatened animals can be found in 99 of Australia's largest towns and cities. The same report identified that Australian cities have a disproportionately high number of threatened species and are home to, on average, 3 times as many threatened species per hectare as rural environments.

More than 370 threatened species listed in the *Environment Protection and Biodiversity Conservation Act 1999 are found in Australian cities and towns* (Soanes & Parris 2020), and more than 30 of Australia's threatened species can only be found in urban areas (Table 12). This highlights the critical importance of our urban environments to biodiversity imperatives. National conservation policy should adapt to recognise the important role cities play in planning for and managing threatened species (Ives et al. 2016).

Table 12 Sample of threatened species by major urban area

City	Number of threatened species
Brisbane	30
Central Coast	39
Gold Coast – Tweed Heads	39
Hobart	29
Melbourne	46
Newcastle–Maitland	33
Perth	35
Sydney	80
Sunshine Coast	26
Wollongong	29

Source: ACF (2020)

Threatened species in urban areas are under increasing threat, mainly because of habitat destruction. While the new approaches to urban sustainability and regeneration, supported by citizen science, are being trialled to address this (see Urban planning and collaboration), between 2000 and 2017, habitat loss continued to be significant in urban areas. The 5 urban areas that experienced the most significant habitat loss (urban forest and woodland) were Brisbane, Gold Coast – Tweed Heads, Townsville, Sunshine Coast and Sydney. In these 5 areas combined, at least 20,212 hectares (ha) of forested urban threatened species habitat was destroyed. More forested urban habitat was destroyed in Queensland (12,923 hectares) than in any other state or territory (Table 13).

The 5 species most affected by habitat destruction were the red goshawk (14,877 ha), the grey-headed flying fox (13,522 ha), the koala (13,053 ha), the Australasian bittern (12,274 ha) and the regent honeyeater (9,242 ha).

Empowering Indigenous perspectives and aspirations within urban environments, especially in terms of custodial responsibilities to Country, empowers actions to protect endangered and threatened plants and animals (Barrow et al. 2020). Ranger projects and Working on Country projects that empower Indigenous communities are not just viable in remote areas, but can also bring great value to urban areas, especially when we consider the proven wellbeing outcomes of working on Country for Indigenous communities and the environment (see case study: Kaurna cultural burns).

Table 13 Total urban threatened species habitat cleared in each state and territory, 2000–17

Qld	12,923	64
NSW and ACT	3,960	20
WA	1,789	9
Tas	673	3
Vic	372	2
SA	300	1
NT	195	1

ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: ACF (2020)

Biodiversity benefits

While urban areas can threaten species, their communities can also play a key role in the solution (ACF 2020) (see Management approaches). A 2019 survey of 55,000 people by the Australian Broadcasting Corporation found that an 'appreciation of the natural environment' was the second-most important aspect of 'being Australian' (Crabb 2019). Because of this value, a growing number of Australians are actively working to protect and reintroduce wildlife into our urban areas.

Biodiverse urban areas are not only considered valuable for the ecology that lives within them, but the identity, health and wellbeing of urban citizens.

For example, it has been found that views of trees and grass from apartment buildings help to enhance adult residents' ability to cope with major life issues and mental fatigue. Such views also improve a child's capacity to concentrate (Tzoulas et al. 2007). Studies also show that the integration of nature with workplace design – for example, by providing a view of nature from a workplace – can reduce sick leave and increase productivity (by 6%) compared with workers without a view (Garrard et al. 2015).

Air quality

The urban environment can significantly affect the quality of our air through emissions from human activities such as vehicle traffic, wood combustion heaters and industry. Air quality can in turn have a significant impact on the quality of our urban environments and our wellbeing, as well as urban and marine biodiversity wellbeing.

Internationally, indoor and outdoor air pollution is considered one of the worst environmental risk factors for human health, causing 7 million premature deaths every year (Lelieveld et al. 2015). Air quality can be heavily influenced by the topography of our urban environment; variables include ventilation (e.g. access to sea breeze or air being trapped in a basin), tree canopy cover and biogenic emissions (e.g. pollen and eucalyptus oils).

Comparatively, air quality in Australia's urban areas is considered good (see the Air quality chapter). The air pollutants of most concern in Australia are particles suspended in the air that are less than 2.5 microns across ($PM_{2.5}$) and ozone. In Europe, concentrations of $PM_{2.5}$ vary from 8.5 to 29.3 milligrams per cubic metre (mg/m^3). By comparison, in Sydney they average 7.5 mg/m^3 and in Perth 4.4 mg/m^3 (Pauli et al. 2020).

This overall good result can be affected by extreme events such as bushfires and dust storms. For example, during the 2019–20 bushfires, Canberra experienced the worst air quality measurements of anywhere in the world (Filkov et al. 2020). Conversely, events such as the COVID-19 pandemic resulted in periods of improved air quality because of travel restrictions.

Case study Urban wetlands are Indigenous places

Reproduced with permission from the authors of *Recognising the conservation and cultural value of urban wetla*nds (Soanes et al. 2020):

> Many cities in Australia were founded on wetlands and waterways that are integral to Indigenous history and culture. In Perth, for example, wetlands sat gently on the lower parts of the ancient dunes that compose the Swan Coastal Plain, a relatively narrow strip of sandy country located between the Indian Ocean and the Yilgarn Plateau. The country was so swampy that early European records described some sections only being able to be crossed by horse. Today, the Perth railway station, located between the Perth CBD and the vibrant Northbridge, sits right at the margin of what was once a large, rich wetland, known as Goologoolup. In Melbourne, the Parkville campus of the University of Melbourne is built on the unceded lands of the Wurundjeri peoples of the Woi Wurrung language group, who have belonged to and been custodians of the lands for more than 65,000 years. The waterway which once meandered through the site was drained and covered over, now only existing as an underground watercourse.
>
> These wetlands and waterways were thriving cultural ecosystems, providing important meeting places, important resources of plant and animal life, and important pathways through the landscape for First Nations Peoples. Indigenous peoples have always gathered on and around wetlands and waterways due to the wealth of biodiversity, which provided food, technologies and medicines.
>
> Even when suburbia started expanding, camps were established on the outskirts, often near wetlands and creeks. As cities developed, wetlands were drained to give way to farmland, many were transformed into rubbish tips, horse racing courses, golf courses and sports ovals. Some wetlands were transformed into sealed lakes in residential developments, while others completely gave way to built-up landscapes. Only a few wetlands and waterways in urban areas have retained some of their ancient features and natural vegetation.

Yet, these wetlands and waterways – including those that may have 'disappeared' or run channelled under our streets – are Indigenous places of immense cultural value and meaning. They form a fundamental biophysical component of a city's environment. Embedding their cultural and ecological values in urban planning could provide a holistic foundation complementing the spatially partitioned, administrative boundary-driven approach in which urban lands and waters are often managed (Richard Walley, personal communication).

Places that have 'disappeared' could be reinstated through urban design and urban greening. Places that are degraded could be restored, and landscape connectivity around them improved. Places that are still thriving could be nurtured and celebrated. Indigenous stories and knowledge could guide natural resource management and biodiversity conservation practices. School children could learn about the ecological and cultural values of local wetlands and waterways. Locals and visitors could wander through the city and experience and engage with its history and culture beyond what the immediate built environment offers them.

Resource availability and security

Access to reliable water and energy is a basic human right. It is also critical to the effective operation and livability of our urban ecosystems. Working to redesign and rethink our water and energy systems to ensure better availability and security to all urban areas are some of the most important urban challenges and opportunities we face today.

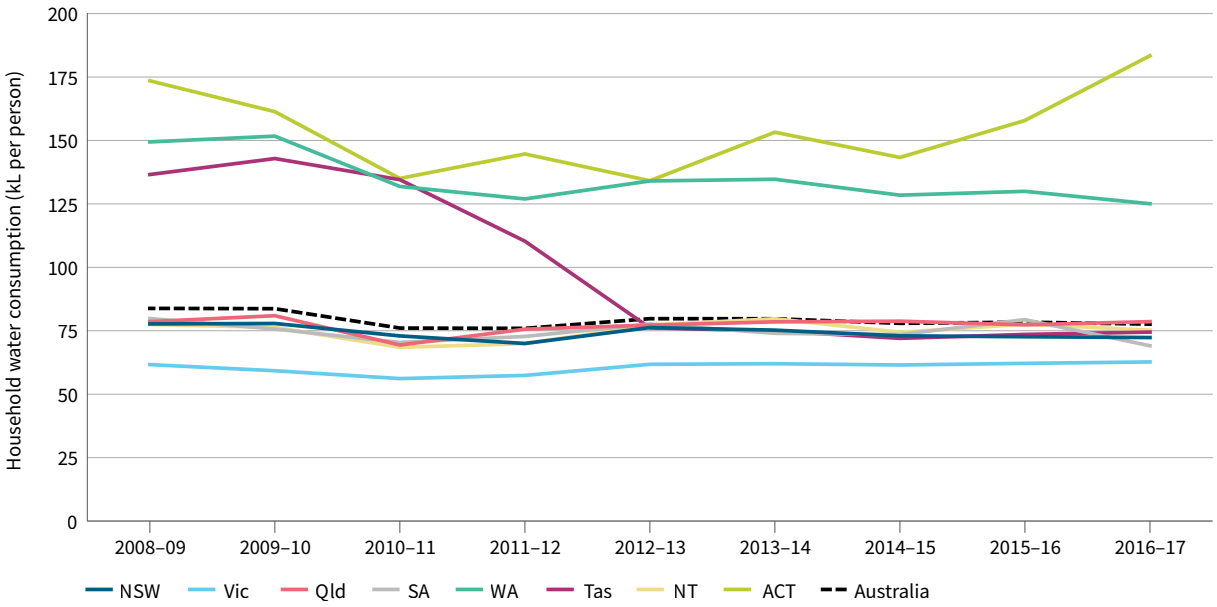
Water

Potable (drinkable) water, waste water and storm water are interrelated components of the urban environment that, if not managed, will have serious repercussions for human and environmental health. Effective water and stormwater management also plays an important role in supporting the quality and flow of water within our urban waterways, along with the greening of our private and public gardens, parks, ovals and bushlands.

Water consumption

While average water consumption rates across Australia fluctuate depending on availability, they remain some of the highest in the world. Capital city water use per person decreased by 16% during the millennium drought (the drought in southern Australia that lasted from 2000 to 2010, although in some areas it began as early as 1997 and ended as late as 2012). But, in the 8 years after (up to 2016–17), they remained relatively stable without any further efficiency gains (Figure 7).

Water consumption rates vary by location. For example, households in Sydney and Perth consume almost twice as much water (219 kilolitres; kL) as households in Melbourne (148 kL) each year (BOM 2019b). The Australian Capital Territory, New South Wales, Queensland and South Australia display similar consumption patterns; however, in response to volumetric pricing, Tasmanians have almost halved their water use since 2008 (Infrastructure Australia 2019).



ACT = Australian Capital Territory; kL = kilolitre; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: ABS (2019b)

Figure 7 Per-person water use by household, 2008–09 to 2016–17

The volume of water required for many of our urban environments continues to grow along with the population, but the amount of water that can be supplied to our households depends on climatic conditions combined with government policy. For example, the 14% increase in water supplied to Adelaide during 2017–18 (Table 14) is most likely a reflection of the dry, hot summer and low rainfall during the period (BOM 2021a). By contrast, the decrease in supply in Melbourne during the same period is largely attributed to ongoing water-saving measures.

Water demand from industry is growing. The electricity and gas sectors are the highest users of water, largely for hydro-electricity generation. They extract water directly from the environment (95,968 gigalitres (GL) from rivers, lakes and groundwater) and use desalinated water.

Water availability

Drinking water in Australia is largely supplied from 3 sources – surface water (9,209 GL or 93% of the total); groundwater (595 GL or 6% of the total) and sea water for desalination (132 GL or 1% of the total) (ABS 2021g).

A reduction in rainfall, such as the 20% reduction experienced in 2018–19, results in significant challenges to urban water supply and requires a corresponding reduction in water usage. During 2018–19, water consumption reduced by 9% across Australia in response to water restrictions and 'water wise' rules (Table 15). During this period, supply was augmented from existing storages, groundwater and desalination facilities (see Resource consumption).

Table 14 Average annual residential water supplied (kL/property)

Major urban centre[a]	2013–14	2014–15	2015–16	2016–17	2017–18	Change, 2016–17 to 2017–18 (%)
Adelaide	183	186	206	171	195	14
Canberra	203	188	195	190	197	4
Darwin	407	409	405	361	368	2
Melbourneb	150	149	154	149	148	–1
Perth	254	244	240	223	219	–2
South East Queenslandb	164[c]	160	159	158	155	–2
Sydney	206	201	201	206	215	4

kL = kilolitre
a The figures exclude bulk utilities because they do not supply to customers.
b Melbourne and South East Queensland figures are the weighted averages for the respective retailers (i.e.W8/C2 – total connected residential properties: water supply).
c Redland City Council did not report against this indicator in 2013–14.
Source: BOM (2019b)

Australia has the highest per-person surface-water storage capacity of any country in the world (Infrastructure Australia 2019). As at January 2019, capital city water storages were at between 48% (Perth) and 88% (Hobart) of capacity (Figure 8) (Infrastructure Australia 2019). Groundwater extraction provides around 40% of water for Perth, whereas only around 10% of its water comes from surface water (Infrastructure Australia 2019).

In 2019–20, major Australian dams were at 48.8% of capacity compared with 84.2% in 2011–12 (BITRE 2020a). In Greater Sydney, the combined water storage dropped by 40% from 2017 to 2019. However, recent rain in Greater Sydney's catchments has resulted in an increase from 50% dam levels in 2019 to 100% in August 2020, which presented a different risk for the city in the form of flooding (Cox & Morton 2020). In early 2021, Western Sydney and surrounding areas experienced flooding.

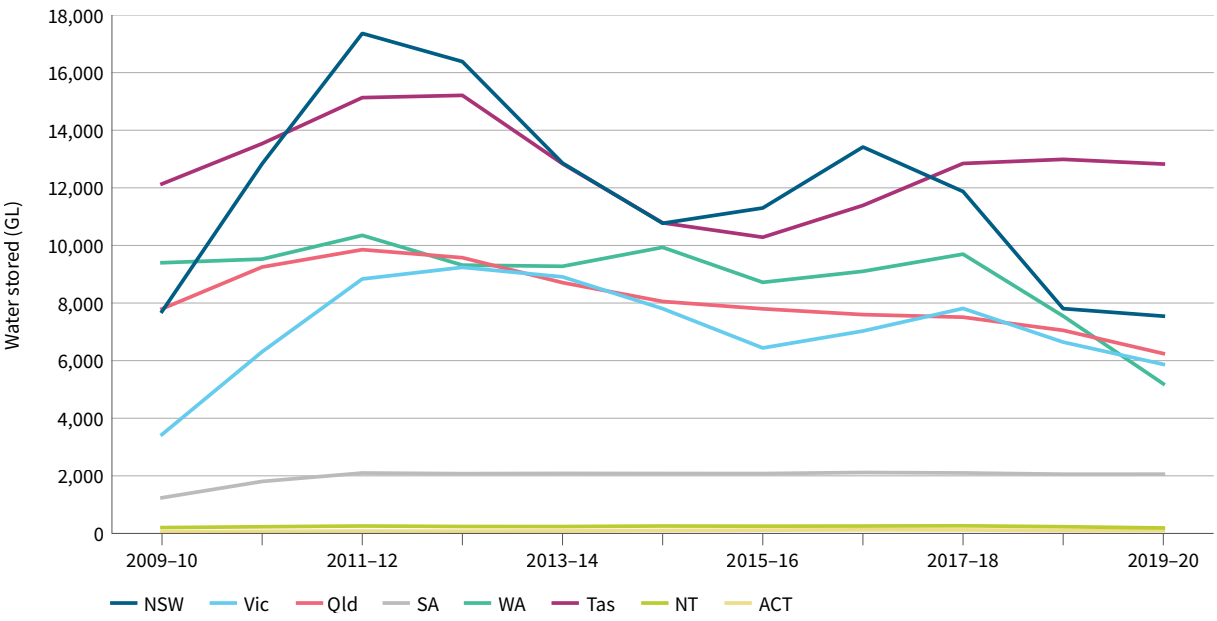
The need for greater water storage and supply sparked significant investment in water infrastructure from 2003–04. Major projects related to the South East Queensland water grid and the construction of desalination plants in New South Wales, Queensland, Victoria and Western Australia. Expenditure declined following the completion of these projects, returning to trend (BITRE 2020a).

Desalinated water is an alternative source of potable water. Several Australian cities built seawater desalination facilities between 2007 and 2012 in response to the millennium drought. Most of this capacity has been underused since construction, except for Western Australia, where it provides approximately half of Perth's supply and is being used to replenish aquifers as part of a broader integrated water supply scheme. Drier conditions over recent years have led a number of other major cities' utilities to initiate

Table 15 Total water use and Australian area average rainfall, 2014–15 to 2019–20

Year	Average rainfall (mm)	Total water use (GL, thousand)
2014–15	423	15
2015–16	467	14
2016–17	596	14
2017–18	441	15
2018–19	352	13
2019–20	347	11

GL = gigalitre; mm = millimetre
Source: ABS (2021g)



ACT = Australian Capital Territory; GL = gigalitre; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: BOM (2021b)

Figure 8 Water storage in major dams by state or territory

supply – or prepare for initiation – from their desalination facilities, including in Adelaide, Melbourne and Sydney (Infrastructure Australia 2019:607) (Figure 9).

Water recycling and re-use

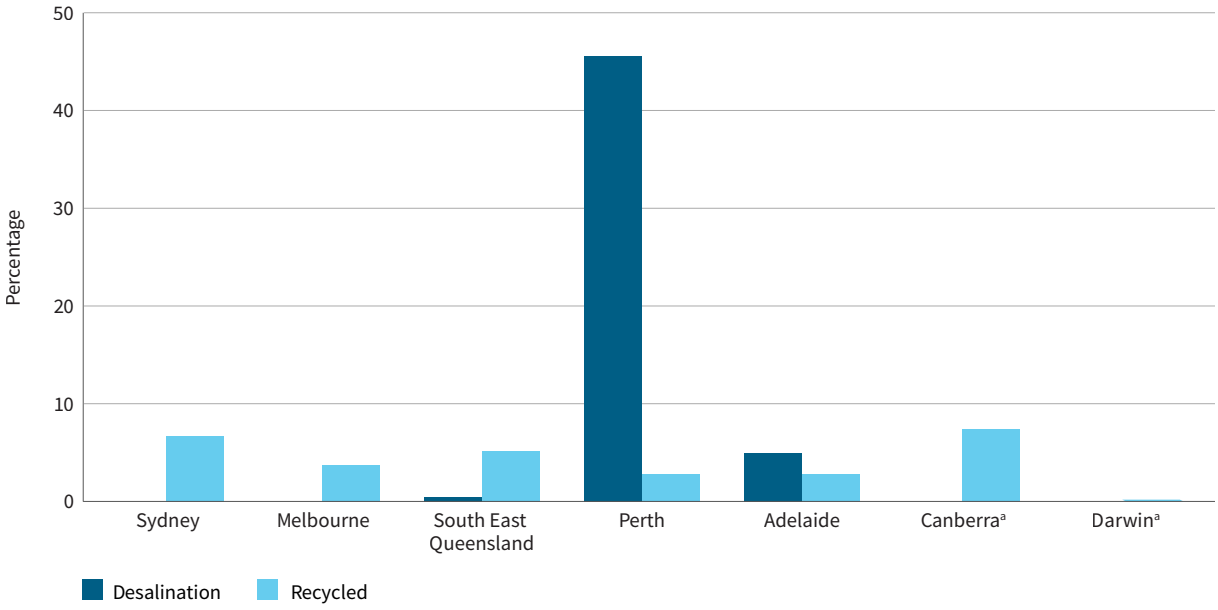
The total volume of recycled water supplied to customers increased modestly (+6%) from 2015–16 to 2019–20 (Table 16). However, trends varied between cities. Changes were most marked between 2018–19 and 2019–20 – for example, with Adelaide and Darwin significantly decreasing their use of recycled water, and Canberra and Perth increasing.

In 2018–19, the supply of re-use water (generally nonpotable water transformed from waste water) increased to 324 GL from 318 GL in 2017–18. The main user was agriculture, at 97 GL (see Resource consumption).

Water quality

The quality of our drinking water is good overall (Infrastructure Australia 2017). It is regularly monitored against the Australian Drinking Water Guidelines, which provide clear guidance on standards for service providers.

A survey of customers about water quality in 2016 found that overall satisfaction was good, averaging a score of 7.2 out of 10. Scores were, however, higher for urban providers (scoring 7.24 out of 10) compared with regional providers (7.02 out of 10) (WSAA 2016). Such variation reflects challenges identified by Infrastructure Australia with the monitoring, reporting and auditing of water services and their comparative quality in regional and remote areas, with results being less frequent and sometimes not publicly disclosed.



a Canberra and Darwin do not have desalination facilities.
Source: Infrastructure Australia (2017)

Figure 9 Proportion of water from desalination plants and recycled in capital cities and South East Queensland, 2015–16

Table 16 Recycled water supplied (megalitres), 2015–16 to 2019–20

Major urban centre	2015–16[a]	2016–17[a]	2017–18	2018–19	2019–20	Change, 2018–19 to 2019–20 (%)
Adelaide	28,481	21,564	26,564	30,533	23,803	–22
Canberra	4,053	4,404	77	60	75	25
Darwin	80	541	451	488	0	–100
Melbourne[b]	34,892	32,442	38,147	45,535	42,877	–6
Perth	10,212	9,568	12,100	9,817	20,681	111
South East Queensland[b]	19,822	14,755	13,056	15,445	14,874	–4
Sydney	43,342	28,340	42,833	44,020	46,919	7

a Data for 2016–17 and earlier are sourced from the 2016–17 published National Performance Report, as the definition of W26 changed from 2017–18.
b Melbourne and South East Queensland figures for W26 are the aggregated figures for the bulk utility and the retailers.
c Seqwater and Redland City Council did not report against this indicator in 2015–16.
Source: BOM (2021a)

The same customer survey found satisfaction with drinking water quality was highest in Canberra, Melbourne and Sydney. Satisfaction with the quality of the water was also found to be a strongly related to trust and value for money (WSAA 2016).

The quality of our urban waterways is another key factor in the livability of cities. A growing number of programs have been put in place across the country to rehabilitate our blue grids or waterways for recreational activities such as fishing, swimming and boating. One example is the Parramatta River in New South Wales, which was reopened for public recreation in 2015 after being closed for 72 years due to poor water quality (Infrastructure Australia 2019). The Parramatta River Catchment Group's Our Living River campaign aims to make the waterway swimmable by 2025 (Parramatta River Catchment Group 2021).

The South Australian Government's River Torrens Recovery Project, led by Green Adelaide, commenced in 2014. It aims to improve water quality and ecosystem function in the river and the coastal waters where it enters the sea by better managing stormwater run-off and contaminants. These improvements support community enjoyment of the Torrens Linear Park, which runs alongside the river through Adelaide and is also a refuge for urban wildlife and pollinators. The ancient river red gums and reed beds found in the park hold important cultural significance to the Kaurna people – the Indigenous people of the Adelaide Plains (Green Adelaide 2020).

Energy

Energy is a critical resource to support the function of the urban environment, with homes and industries consuming more than two-thirds of the world's total energy (mostly derived from fossil fuels). In Australia, residential uses combined with construction, transport, manufacturing, electricity, gas and water account for 71% of nation's greenhouse gas emissions (DISER 2020a).

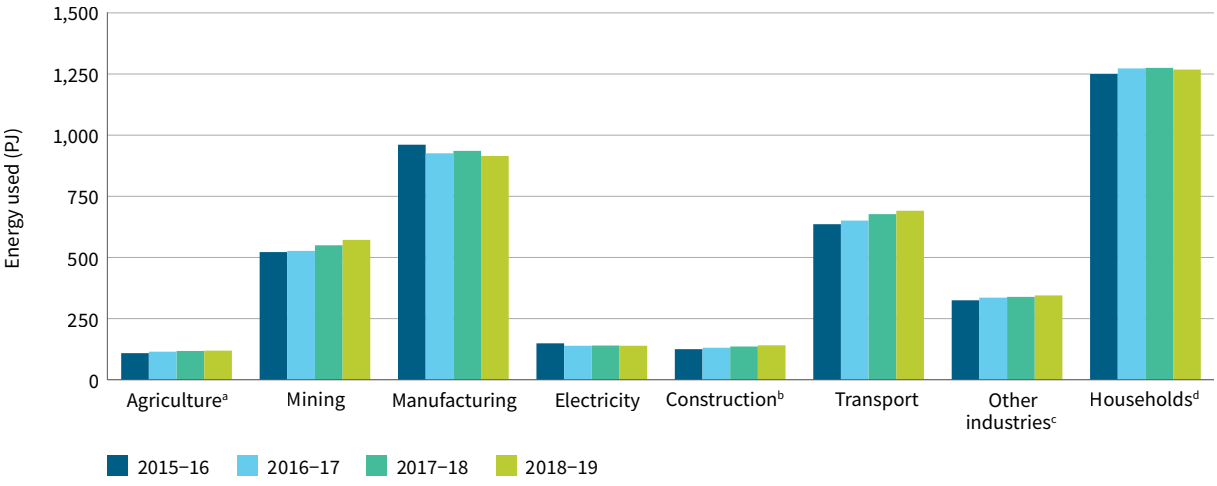
The Australian population grew by 1.5% to reach 25.4 million people in 2018–19. In comparison, Australia's energy consumption rose by 0.6% in 2018–19, compared with an average growth of 0.7% a year over the previous 10 years. Most of the growth that occurred in 2018–19 was in the mining sector, with a 3% decline occurring in manufacturing in the same year (DISER 2020b).

Across Australia, households remain the most significant users of energy in 2018–19 (1,268 petajoules; PJ), followed by manufacturing (915 PJ) and transport (691 PJ) (Figure 10). This represented a decline of 2.2% since 2016–17 in household energy use with a similar decline of 1.4% occurring for industry energy intensity over the same period (ABS 2020d).

Fossil fuels (coal, oil and natural gas) accounted for 94% of Australia's primary energy mix in 2018–19 (Table 17). Oil (including crude oil, liquefied petroleum gas and refined products) was the largest component of supply (39%), followed by coal (29%), gas (26%) and renewables (6%).

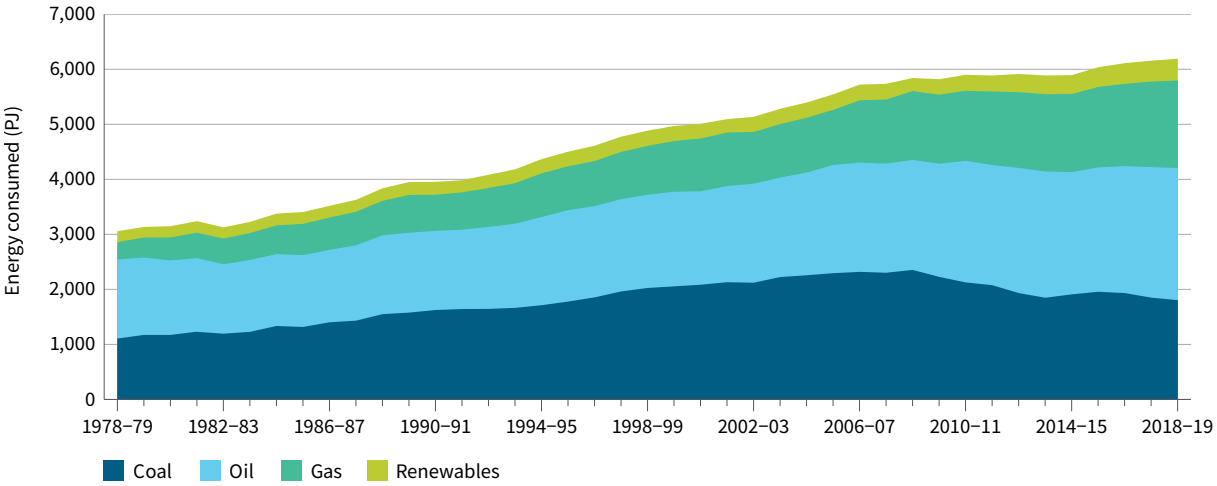
Coal consumption is the only fuel source to have declined in the past 10 years. This change is largely due to reductions in brown and black coal-fired electricity generation as renewable energy generation grew strongly; +5% in 2018–19 and 3.9% over the 10-year average (Figure 11). The increase was driven by 50% growth in solar energy and 17% growth in wind energy consumption.

Consumption of bagasse, the remnant sugar cane pulp left after crushing, declined by 9%



PJ = petajoule
a Includes forestry and fishing
b Includes gas, water supply waste services
c Includes postal and warehousing
d Includes government use
Source: ABS (2020d)

Figure 10 Final use of energy by industries and households, 2015–16 to 2018–19



PJ = petajoule
Source: DISER (2020b)

Figure 11 Australian energy consumption by fuel type, 1978–79 to 2018–19

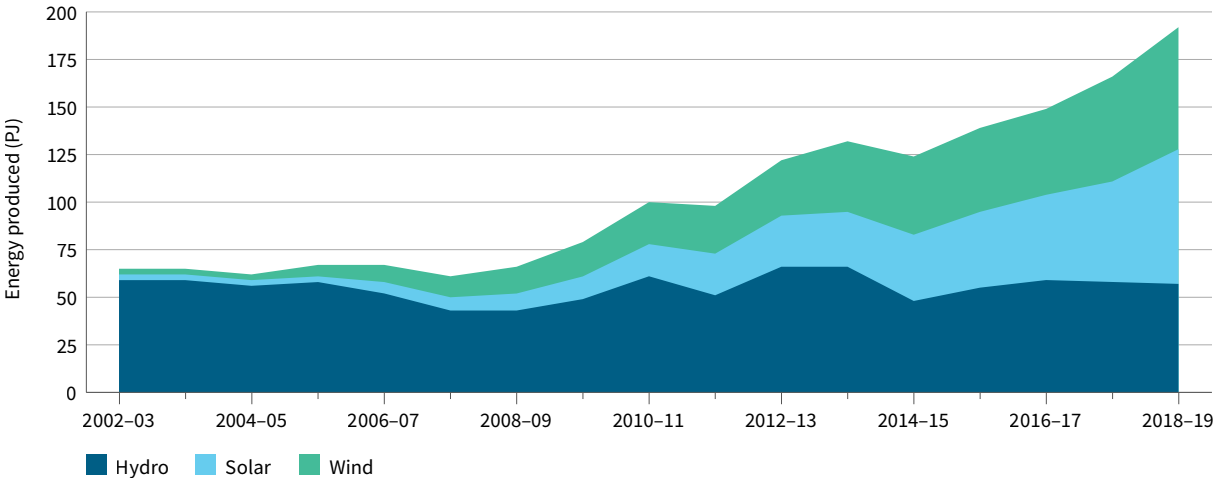
Table 17 Australian energy consumption by fuel type

Energy type	2018–19		Average growth	
	Petajoules	Share (%)	2018–19 (%)	Over 10 years (%)
Oil	2,402.1	38.8	1.3	1.7
Coal	1,801.6	29.1	–2.5	–2.3
Gas	1,592.7	25.7	2.2	2.7
Renewables	399.6	6.4	4.6	3.9
Total	**6,196.0**	**100.0**	**0.6**	**0.7**

Source: DISER (2020b)

but remained the largest source of renewable energy in Australia at 23%. Use of hydro energy was flat in 2018–19, but wind and solar energy grew rapidly over the 10-year period. Combined, these energy types now form 33% of all renewable energy consumption, up from 11% a decade ago. Wind energy surpassed hydro energy for the first time in 2018–19 (Figure 12) and energy from solar photovoltaic systems grew by 50% in 2018–19 (DISER 2020b).

Solid municipal and industrial waste generated 5 PJ of energy in 2018–19, up from 1 PJ 5 years ago. Biogas from landfill, sewerage and other sources provided a further 16 PJ of energy in 2018–19 (DISER 2020b).



PJ = petajoule
Source: ABS (2020d)

Figure 12 Key renewable energy sources, 2002–03 to 2018–19

Assessment State of the urban environment

2021

Somewhat adequate confidence

Most Australian cities have good levels of livability, especially when compared with cities in other countries. Livability and the impacts that its components have on the environment varies from inner areas to city fringes, as well as from large urban environments to small towns. The growth of our cities, compounded by the impacts of climate change, is increasing the pressure on our resources and especially our water supplies. Waste recycling and disposal continue to be a challenge.

Related to United Nations Sustainable Development Goal targets 11.1, 11.2, 11.3, 11.7

Assessment Livability – Major city (21) (+1m)

Medium confidence

The livability of Australia's largest cities is increasing with a greater focus on improving access to urban services, expanding and connecting the green and blue spaces, as well as access to a broader choice of jobs and housing. However, livability varies between areas. Inner and older parts of large cities have seen increases in livability, but outer areas have seen worsening in their situation with loss of tree canopy, increasing heat waves, long commute time and lack of good amenities.

Assessment Livability – Urban areas between (pop 1,000,000 – and 10,000)

Medium confidence

This category of assessment puts together 2 categories from 2016: 10,000 to 100,000 and 100,000 to 1,000,000 people.

Overall, urban areas in this category have a good level of livability, with reduced traffic levels and levels of emissions, and improving air and water quality. There are varying pressures related to the expansion of the urban footprint and varying levels of access to local services and goods. Some urban areas in this category could also face resource security challenges.

Location is one of the main aspects related to the pressures. The impacts of climate change and other elements are experienced differently between inland and coastal areas. Smaller regional cities have suffered extreme bushfires, floods, mice plagues, and skills and labour shortages. This leads to an overall poor grade in livability in these areas. However, smaller cities provide more choices for people who want to work remotely and better prospects of improved livability.

Assessment Livability – Smaller urban areas <1,000 people

Low confidence

Smaller urban areas have less impact on the natural environment and enjoy less traffic congestion, but they may require greater travel to urban services, employment, food and recreational facilities. These areas may also have energy and water security and quality issues. However, these smaller regional cities have also suffered extreme events and shocks, as explained in the previous category.

More evidence is required, as the data available on smaller places are unclear.

Assessment Resource availability and security

Medium confidence

The security and sustainability of our resource use continues to be strained as populations grow and the effects of climate change increase in severity. Larger cities place greater pressure on resource availability; however, the security of resources in smaller urban areas is often more of an issue given they do not have the critical mass to support significant infrastructure investment.

Fast-accelerating climate change is threatening resource availability and security, leading to an overall assessment of the state as poor. However, there are some management opportunities, especially in water and energy. Waste management continues to be a challenge.

Assessment ratings

For assessments in the 'Environment' section

- **Very good**: The environment is in very good condition, resulting in enhanced environmental values.
- **Good:** The environment is in good condition, resulting in stable environmental values.
- **Poor:** The environment is in poor condition, and environmental values are somewhat or slowly declining.
- **Very poor:** The environment is in very poor condition, and environmental values are substantially and/or rapidly declining.

Trend

- **Improving:** The situation has improved since the previous assessment (2016 state of the environment report).
- **Stable:** The situation has been stable since the previous assessment.
- **Deteriorating:** The situation has deteriorated since the previous assessment.
- **Unclear:** It is unclear how the situation has changed since the previous assessment.

Pressures

Climate change

Our global climate is changing (see the Climate chapter). Temperatures are increasing, rainfall patterns are changing, sea levels are rising, and the frequency and magnitude of extreme weather events are increasing (IPCC 2018).

Our changing climate and the associated increase in extreme events have a significant impact on the safety, health and wellbeing of citizens and biodiversity, the durability of our built infrastructure and the resilience of our urban ecosystems.

Indigenous communities, both urban and remote, as with other marginalised communities, are disproportionately affected by many aspects of climate change. (For more on the effects of climate change on Indigenous communities, see Indigenous built environment and the Climate and Indigenous chapters.)

Urban heat

The impact of rising temperatures and the increasing frequency of heatwaves is a growing challenge for urban areas. Rising temperatures particularly affect cities because of the 'urban heat island effect', in which urban areas are warmer than the surrounding land. This is a result of the presence of roads, pathways, buildings and dark roofs that trap and absorb heat more than green (e.g. gardens and parks) and blue (e.g. rivers and creeks) surfaces.

With the urban heat island effect, temperatures in our urban areas can be 1–7 °C higher than in surrounding areas. Research in Adelaide found a difference in temperatures between urban and rural areas of 5.9 °C (Soltani & Sharifi 2017).

These notable differences are expected to become even more pronounced with climate change. The Intergovernmental Panel on Climate Change estimates that 'even if global warming is restricted to below 2 °C, there could be a substantial increase in the occurrence of deadly heatwaves in cities if urban heat island effects are considered' (IPCC 2018). This will have significant implications for our urban areas.

Forecasts reported in the 2016 state of the environment report remain the same in 2021:

> CSIRO and BoM projections of the average number of days per year with maximum temperature above 35 °C in 2030 (Table 18) for the future Representative Concentration Pathways (RCPs) increases considerably, particularly in northern areas of Australia and at some inland urban areas with greater warming (e.g. Canberra airport). By 2090, the number of days above 35 °C shows a moderate increase for some cities under the RCP2.6 scenario, and numbers increase significantly for most cities under the other 2 scenarios. (Coleman 2016:32)

Table 18 Average number of days above 35 °C, under various climate change scenarios

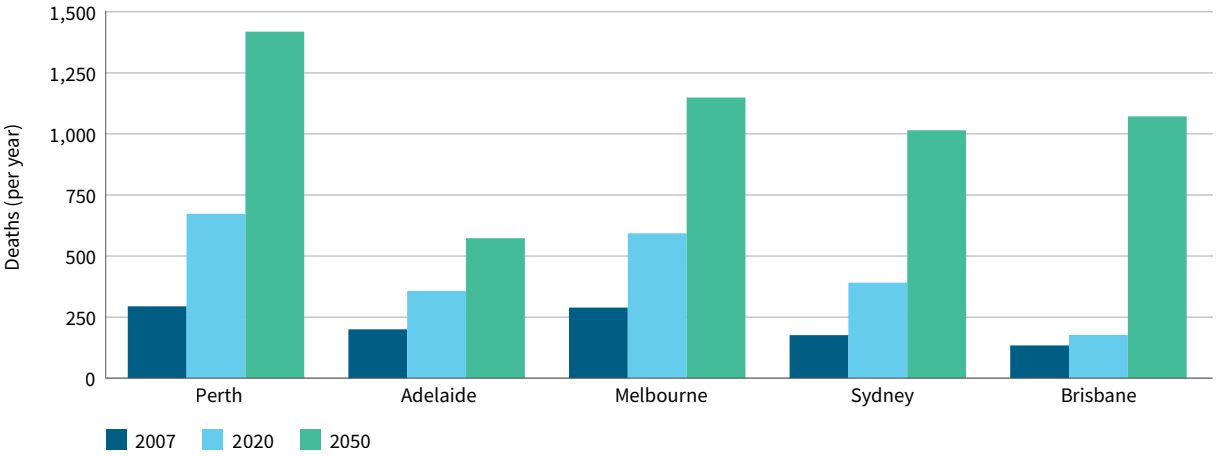
City	1995	2030 RCP4.5	2090 RCP2.6	2090 RCP4.5	2090 RCP8.5
Adelaide	20.0	26.0	28.0	32.0	47.0
Alice Springs	94.0	113.0	119.0	133.0	168.0
Amberly	12.0	18.0	18.0	27.0	55.0
Broome	56.0	87.0	95.0	133.0	231.0
Cairns	3.0	5.5	5.5	11.0	48.0
Canberra	7.1	12.0	13.0	17.0	29.0
Darwin	11.0	43.0	52.0	111.0	265.0
Dubbo	22.0	31.0	34.0	44.0	65.0
Hobart	1.6	2.0	2.0	2.6	4.2
Melbourne	11.0	13.0	14.0	16.0	24.0
Mildura	33.0	42.0	44.0	52.0	73.0
Perth	28.0	36.0	37.0	43.0	63.0
St George	40.0	54.0	58.0	70.0	101.0
Sydney	3.0	4.3	4.5	6.0	11.0
Wilcannia	47.0	57.0	60.0	67.0	87.0

Note: The table shows 2030 under Representative Concentration Pathway (RCP) 4.5, and 2090 under RCP2.6, RCP4.5 and RCP8.5, based on model changes for 2020–39 and 2080–99 relative to 1986–2005.
Source: CSIRO & BOM (2015)

Impacts on livability and wellbeing

Urban heat significantly affects livability. Recent analysis shows that increased exposure to higher temperatures (generally more than 28 °C) (WSROC 2018) results in negative impacts, including on sleep, health, crime, income and labour productivity (WSROC 2018). These impacts are particularly apparent during heatwaves, which are defined by the Australian Bureau of Meteorology as a period of 3 or more consecutive days of high maximum and minimum temperatures. The impacts are most severely felt by the most vulnerable – older people, children and those with existing medical conditions.

Heatwaves can worsen existing illnesses (morbidity) and can cause death (mortality; Figure 13). In fact, heatwaves kill more Australians than any other natural disaster – they are more deadly than storms, fires and floods combined (WSROC 2018). According to the Western Sydney Regional Organisation of



Source: DAWE (2017)

Figure 13 Estimated annual average number of heat-related deaths, selected capital cities, 2007, 2020 and 2050

Councils (WSROC), between 1987 and 2016 in Australia, more than 500 people lost their lives as a result of heatwaves and a further 2,800 were injured (WSROC 2018).

Heat contributes to the deaths of more than 1,000 people aged over 65 across Australia each year, with some sources identifying excess heat as contributing to as many as 1.7 million deaths between January 2006 and October 2017 (Longden 2020). This pressure is forecast to grow (Figure 13), and is particularly concerning in the context of Australia's ageing population (Wilson et al. 2011).

The WSROC action plan identified that heat-related illness is likely to worsen with climate change, as is the risk of respiratory problems. The action plan states that 'extreme heat exacerbates air quality issues such as pollution from vehicle emissions, industrial fumes and bushfires as well as increased ground-level ozone and dust and pollen levels' (WSROC 2018:25).

Many desert-based Indigenous communities are experiencing such extreme heat that they are unable to continue to live in their own Country during certain times of the year, creating disruption to community governance and cultural practices.

Impacts on infrastructure and landscape

Heat and heatwaves place significant pressures on our infrastructure and resources such as energy and water. Residential electricity use can be 3 to 4 times higher than normal on days that are 35 °C or hotter, placing stress on the power grid (WSROC 2018) and increasing the risk of blackouts or power shortages. These have a potentially more significant impact during a heatwave by increasing the likelihood of death when vulnerable communities are left without air-conditioning. WSROC identified that the 'continuity of energy supply is often the

difference between life and death in a severe heatwave' (WSROC 2018:25).

Increasing levels of heat also affect the natural environment. Changing climates can lead to shifting habitat zones and breakdowns in crucial ecological cycles. These shifting habitat zones, combined with the loss of habitat due to an increase in development, can have tremendous impacts on the health of animals and plants in the natural environment. Increased heat can also have a significant impact on household pets (WSROC 2018).

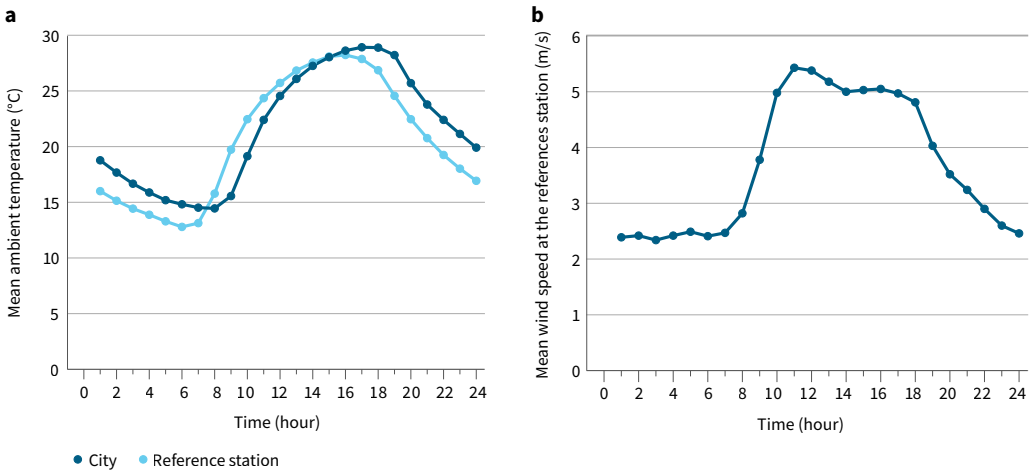
Effects on green cover are of particular concern because increasing green space is one means of mitigating the exposure of urban citizens to heat. The Clean Air and Urban Landscapes Hub report, *Risks to Australia's urban forest from climate change and urban heat*, found that, by 2070, 14% of all public trees (22% of species) in Australian cities are at high risk from increased temperatures in the emissions-limited climate change scenario, and 24% of all public trees (35% of species) in the business-as-usual emissions scenario (CAUL Hub 2017).

Case study Alice Springs heat study

Source: Haddad et al. (2020)

Alice Springs, Northern Territory, is an urban area that is home to 39,391 people (DITT 2021). Surrounded by an arid desert environment, the city experiences a hot dry summer and cold winter. A recent study of heat in Alice Springs, undertaken with support from the Northern Territory Government, found that between 2018 and 2019 Alice Springs experienced 69 days of 35 °C and 17 days of 40 °C or above. This was higher than that observed in other Australian cities (Zuo et al. 2015). The frequency of warm conditions exceeded 2,700 hours, which is about 3 times higher than that calculated for Sydney with a temperate climate (BOM 2019a) (Figure 14). However, very hot hours above 37 °C were about 10 times more frequent in Alice Springs compared with Horsley Park in Western Sydney.

Because of their potential to induce heat stress and dehydration, these conditions were considered a severe threat to the residents of Alice Springs. These extreme conditions were also recognised as having significant implications on energy demand to cool buildings, with energy demand being about 3 times higher in Alice Springs than in Sydney (Santamouris et al. 2017). This additional demand leads to increased energy poverty experienced by low-income households.



m/s = metre per second
Note: Solid lines are linear interpolations between measured points.
Source: Haddad et al. (2020)

Figure 14 (a) Mean ambient temperature in the city and the airport against time of the day. (b) Mean wind speed at the reference station against time of the day

The study also looked at ways in which temperatures could be mitigated. The results show that a combination of mitigation technologies – including shading, cool pavement technologies, urban greening, evaporative cooling and solar control strategies – can decrease the maximum ambient temperature.

Bushfires

Bushfires are natural events in Australia and many native species have evolved to rely on fire for regeneration. Indigenous people have used fire for thousands of years to manage Country. The removal of Indigenous people from the land, and landowners then adopting a non-Indigenous land management framework, has contributed significantly to the occurrence of extreme fire events (Fletcher et al. 2021).

Since the 1950s, records show that the frequency and duration of extreme fire weather across large parts of Australia has increased, especially in southern Australia. Climate change is a major contributor to this trend because increases in temperature and reductions in rainfall and atmospheric moisture content increase landscape drying. We are seeing an increase in the annual number of extreme fire danger days across Australia. In addition, increased levels of carbon dioxide in the atmosphere can increase plant growth, thus increasing the amount of fuel in the environment.

Bushfires can threaten urban areas, particularly those near the urban fringe or vegetation corridors. For example, the bushfires in the south-east of Australia during the 2019–20 summer destroyed 3,094 houses (Parliament of Australia 2020). Other urban areas and cities such as Canberra were heavily affected by the smoke, which travelled many hundreds of kilometres from the fires (see the Air quality chapter).

Indigenous cultural fire management knowledge is being sought by landowners, and is employed to varying degrees across Australia. This practice is being investigated as part of a wholistic land management approach (see the Extreme events chapter).

Rainfall deficiency and drought

Australia is the driest inhabited continent (DAWE 2021). With Australia's changing climate, rainfall patterns are also changing, with some parts of the country expected to spend more time in drought (and a greater intensity of drought), which will affect water reliability for our urban areas (see Water).

For example, between early 2017 and mid-2020, much of Australia experienced significant drought conditions. As of December 2019, Australia was experiencing some of its lowest levels of rainfall on record. Regions affected include South East Queensland, pastoral South Australia, most of south-west Western Australia, and much of the Northern Territory and central Australia (BOM & CSIRO 2020) (see case study: The 2017–19 Australian drought in the Climate chapter). During this time, river levels fell, water storage significantly decreased and soils became drier, reducing agricultural productivity and the livability of communities across Australia. The significant water shortages placed noticeable strain on urban areas, necessitating water restrictions. In some regional areas, water security became such an issue that water needed to be trucked into towns.

Extreme rainfall and flooding

While rainfalls across the southern parts of Australia have been well below average levels in recent years, Australia still experiences severe rainfall events due to natural climatic cycles. Climate change is also increasing the likelihood of extreme weather events such as heavy rainfall (BOM & CSIRO 2018). With climate change, 'the intensity of short-duration yet extreme rainfall events has increased by around 10% or more in some regions and in recent decades' (BOM & CSIRO 2020).This is especially true in the northern parts of Australia.

One of the main natural climate cycles is the El Niño–Southern Oscillation, which alternates between La Niña and El Niño patterns. La Niña causes increased rainfall across much of Australia, cooler daytime temperatures (south of the tropics) and warmer overnight temperatures (in the north). According to Bureau of Meteorology data, in eastern Australia, the average December–March rainfall during La Niña years is 20% higher than the long-term average, with 8 of the 10 wettest periods occurring during La Niña years. While this can be a positive for agricultural production, this also increases the likelihood of severe flooding threatening urban areas during La Niña summers, as experienced along the east coast of Australia in 2021.

La Niña also results in earlier onset of the monsoon season and a greater likelihood of cyclones earlier in the season. In fact, historical trends show that twice as many cyclones will make landfall during La Niña years as during El Niño years. Furthermore, the only years with multiple severe tropical cyclone landfalls in Queensland have been La Niña years. This means an increased likelihood of major damage and flooding related to strong winds, high seas and heavy rains (BOM & CSIRO 2020) for most of our urban environments that are located along the eastern seaboard.

This climatic outlook has placed several urban areas on notice. Flooding will particularly affect those built close to waterways, in low-lying areas and where there is a large amount

of impervious groundcover (e.g. concrete pavements or bitumen roads). For example, Western Sydney has a high probability of flooding owing to its topography.

Flooding is also a challenge for many Indigenous communities, whose urban environments are often built on the outskirts of urban areas or on land that was not claimed by others because it is liable to flood. Many Indigenous communities may experience multiple evacuations over the course of the year, disrupting employment and education routines that are often already inconsistent. Many lower socio-economic urban areas may also be at greater risk because they can have less green cover, so less water can be absorbed by the soil (see Green cover).

Sea level rise

Sea levels are rising because of climate change. The warmer ocean waters are expanding, and ice in the higher latitudes is melting. The rate of change is accelerating. Combined with more frequent and severe storms causing storm surges, this creates an increasing risk of coastal erosion, shoreline recession, and permanent or more frequent inundation of low-lying coastal regions and estuaries. This will damage coastal infrastructure and communities (see case study: Sea level rise and the Torres Strait islands in the Climate chapter).

Sea level rise and associated impacts will affect not only the natural environment, but our urban infrastructure, food security and human health. It is estimated that the value of housing and infrastructure at risk from sea level rise in Australia exceeds $226 billion (DCCEE 2011).

This is significant because most Australians live near or on our coasts: 7 out of Australia's 8 capital cities are on the coast and only 4 of the 18 cities with populations greater than 100,000 are located inland. In fact, it is estimated that 80% of Australia's population lives within 50 kilometres of the coast (Cechet et al. 2011). Since 2016, the coastal urban population has increased, spreading particularly into the south-west of Western Australia, around Darwin and areas surrounding Australia's capital cities (i.e. Geelong, Newcastle, the Gold Coast).

As Coast Adapt (2017:1) states, 'the Torres Strait is a region of national and international significance for its cultural and environmental values. The region faces a number of climate change risks, most notably the impacts of progressive sea level rise. Coastal erosion and inundation have been pressing issues for a number of communities for many years' (CoastAdapt 2017).

Adaptation

The urban planning profession has been calling for an integrated national response from all levels of Australia's governments to better manage current and future urban development and land use via a national coast plan or strategy (Infrastructure Australia 2020a). Experts have also called for the restoration of national funding for coastal planning and management research to better support and prepare coastal communities and assets to address the adverse effects of climate change (House of Representatives 2009, ACCA 2019). Hazard and inundation mapping are underway for most developed sections of the Australian coast. This will enable governments to better appreciate the scale of infrastructure and private properties at risk as sea level continues to rise.

However, to truly address these pressures, we need to change where we build and adapt what we have built along our coasts. Options include:

- retreat, by which houses or infrastructure are moved out of the impact zone

- accommodation, such as raising floor levels (Table 19)
- protection, which includes hard engineering structures, such as seawalls and groynes, and a range of softer engineering options, such as beach nourishment or replenishment, beach scraping and dune management.

Population

Population growth forecast

The growth rates of some of Australia's capital cities are some of the highest in the developed world and these have placed growing pressure on the urban environment to expand either upwards (in terms of urban density) or outwards (in terms of urban sprawl). Most growth (76%) in the past decade has occurred in Australia's 18 largest cities, with 39% of the existing population located in Melbourne and Sydney alone.

Despite the potential impacts of the COVID-19 pandemic on population growth and spread across Australia (see COVID-19 pandemic), revised forecasts continue to expect strong population growth across the country. It is now expected that Australia's overall population will reach just over 28.7 million people by 2031 (Centre for Population 2021).

Current forecasts anticipate that the proportion of people living within Australia's 18 largest cities will decline over the coming years by 7 basis points to 69% (Table 20).

Table 19 Minimum height (metres) structures would need to be raised to avoid sea level rise, in selected locations, in 2030, 2050, 2070 and 2090

Location	2030	2050	2070	2090
Albany	0.13–0.14	0.24–0.28	0.36–0.50	0.50–0.81
Bunbury	0.12–0.13	0.22–0.27	0.34–0.47	0.47–0.75
Darwin	0.12–0.13	0.21–0.26	0.32–0.45	0.43–0.71
Fremantle	0.12–0.13	0.22–0.28	0.34–0.47	0.47–0.76
Geraldton	0.12–0.13	0.22–0.27	0.35–0.48	0.49–0.78
Mackay	0.13–0.14	0.22–0.28	0.33–0.47	0.44–0.73
Newcastle	0.14–0.15	0.24–0.30	0.36–0.53	0.49–0.86
Port Adelaide	0.13–0.14	0.24–0.28	0.36–0.50	0.50–0.81
Port Hedland	0.12–0.13	0.21–0.26	0.32–0.44	0.43–0.70
Sydney	0.14–0.15	0.24–0.30	0.35–0.52	0.48–0.84
Townsville	0.13–0.14	0.23–0.28	0.33–0.47	0.44–0.74
Victor Harbor	0.12–0.13	0.21–0.25	0.32–0.44	0.43–0.69

Note: Covers all Representative Concentration Pathway emissions scenarios.
Source: CSIRO & BOM (2015)

Table 20 Projected population growth

City or region	2020–21	2030–31	Net increase	Change (%)
Sydney	5,357,300	5,971,400	614,100	11
Rest of NSW	2,798,400	2,948,700	150,300	5
Melbourne	5,171,700	6,164,400	992,700	19
Rest of Victoria	1,547,100	1,695,400	148,300	10
Brisbane	2,579,100	2,943,600	364,500	14
Rest of Queensland	2,616,300	2,890,100	273,800	10
Perth	2,126,800	2,447,900	321,100	15
Rest of WA	532,400	542,600	10,200	2
Adelaide	1,372,700	1,488,700	116,000	8
Rest of SA	392,700	395,100	2,400	1
ACT	431,400	466,900	35,500	8
Hobart	240,800	272,100	31,300	13
Rest of Tasmania	301,600	311,300	9,700	3
Darwin	142,300	144,000	1,700	1
Rest of NT	97,600	94,900	–2,700	–3
Total Australia	25,708,200	28,777,100	3,068,900	12

ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; SA = South Australia; WA = Western Australia
Source: Centre for Population (2021)

Notwithstanding this, Melbourne and Sydney are still expected to grow by 19% and 11%, respectively, to host 42% of Australia's population by 2031. Indeed, all capital cities and states are expected to experience positive population growth, apart from the area outside of Darwin in the Northern Territory.

Australia's significant housing growth has been exemplified by the rapid rate of housing construction activity in Canberra, Brisbane, Melbourne, Perth and Sydney, which has been high by international standards. In 2018, Australia produced housing faster than any other Organisation for Economic Co-operation and Development country apart from South Korea, at 8.2 completions per 1,000 people. In 2010, the rate was 6.8 per 1,000.

Looking forward, the strong growth forecasts (Table 21) indicate that this high level of housing construction will need to continue.

Reflecting this anticipated need, state and territory urban planning authorities are targeting an additional 121,000 dwellings on average each year to meet demand or an additional 1.2 million homes across Australia over the next decade. This increase is the equivalent to an 11% increase on all existing dwellings in the country.

The most significant dwelling increases being planned for are in Greater Sydney (more than 36,800 per year) Greater Melbourne (43,000) and Perth (20,500). Collectively, these 3 cities are planning to build 100,000 new homes a year or 82% of all new dwellings in Australia. These same 3 states have parallel job targets to meet the needs of these new residents.

Drivers of growth

Much of Australia's population growth has been driven by overseas immigration (see Figure 15). Cities such as Sydney and Melbourne traditionally experience significant levels of immigration, with many immigrants subsequently moving out to other urban areas across Australia (outmigration). However, these trends are fluctuating. For example, in recent years, Greater Sydney has experienced a lower rate of out migration because of higher levels of employment in the city compared with regional areas.

In 2020, government-imposed restrictions in response to the COVID-19 pandemic resulted in significant changes to immigration. The ban

Table 21 Targeted housing and employment growth by capital city, 2016–31

City	Housing target	Average annual housing target[a]	Employment target
Adelaide (SA Government Attorney-General's Department 2017)	248,000 by 2045	8,266	n/a[b]
Brisbane (Queensland Government 2017)	188,200 by 2041	7,528	n/a
Canberra (ACT Government 2018)	100,000 by 2041	4,347	n/a
Darwin (based on calculations from DLPE 2015)	48,000 by 2055–65	960–1,200	n/a
Hobart (STCA 2011)	26,500 by 2035	1,060	n/a
Melbourne (DELWP 2017)	1,550,000 by 2051	43,000	+690,000 by 2031
Perth (DPLH 2018)	800,000 by 2050	20,512	+834,000 by 2050
Sydney (Greater Sydney Commission 2018)	736,000 by 2036	36,800	+817,000 by 2036

n/a = not available
a Averaged calculated by authors based on overall housing target and target year.
b South Australia is targeting more than 43,500 additional jobs across 9 key sectors in its State Growth plan (SA Government 2021).

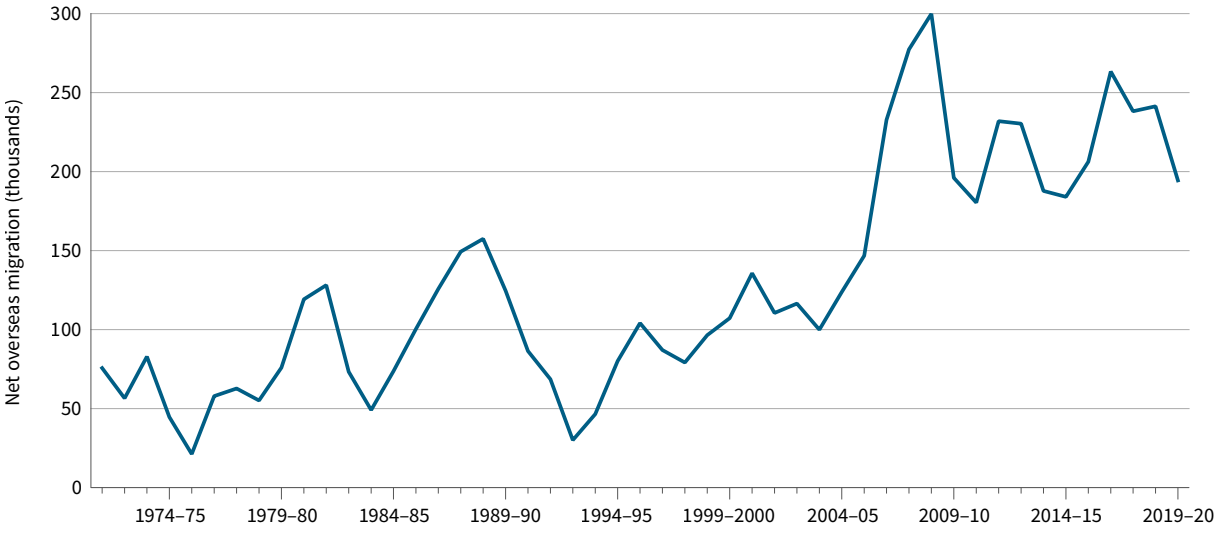
was initially on those travelling to Australia from China on 1 February 2020 and by 20 March 2020 all overseas travel was banned.

Between March 2019 and March 2020, overseas migration to Australia was 220,500 people (ABS 2021d). In 2021, it is forecast to drop to 34,000 (about 15% of the previous year) (Prime Minister of Australia 2020). Conversely for 2019–20, the number of Australian-born citizens returning to Australia increased through the year, from –12,360 to 19,220, reflecting the call for citizens to return home at the start of the pandemic (ABS 2021e).

Responses to the COVID-19 pandemic are also expected to have had significant impacts to interstate migration. New South Wales had the highest net loss through interstate migration during 2019–20, when 110,760 people moved to another state or territory, but only 89,873 moved to New South Wales, resulting in a loss of 20,887 (Figure 16). Greater Sydney also had the greatest negative migration at –30,087. Over the same period, Queensland had the highest net interstate migration at 25,348.

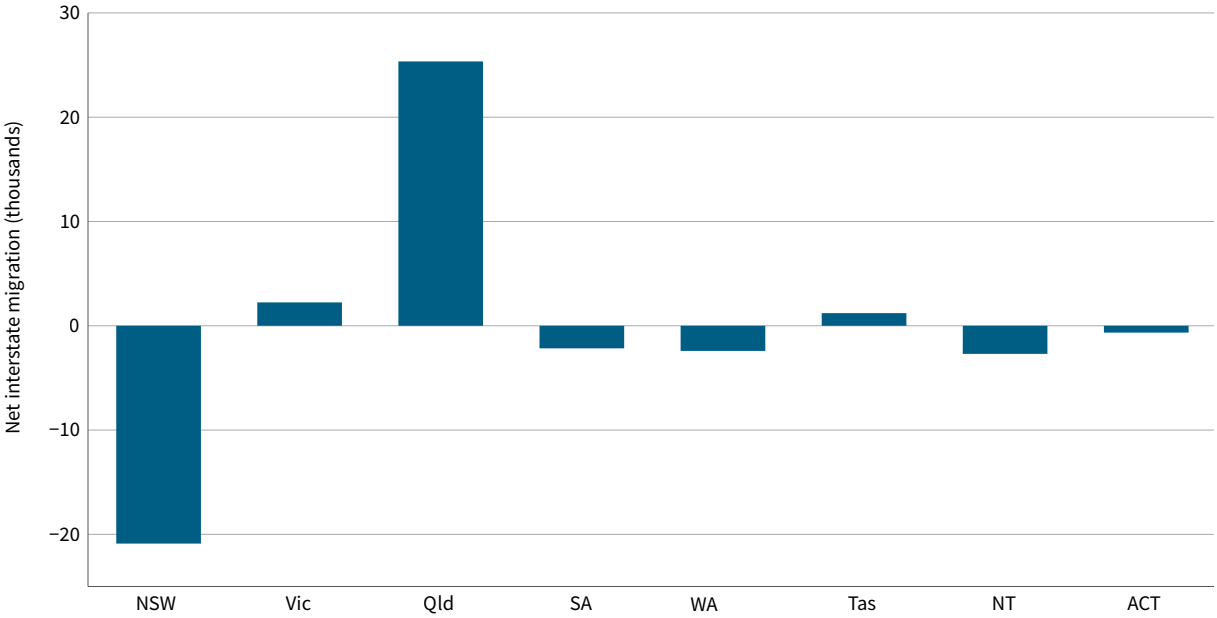
While fluctuations in interstate migration are not uncommon, one suggestion is that the growth in the net loss of population from capital cities in the September quarter was not the result of a city exodus but rather because fewer people moved into capital cities in 2020. That is, without international migrants moving to capital cities, the long-term trend of people relocating to urban areas around major cities has become more apparent. Caution is therefore suggested in concluding that net migration from capital cities is an indicator of decreasing satisfaction with city lifestyles or a growing desire for rural lifestyles. These changes may mask the considerable variability in the types of moves people are making, where they are going and why (Davies 2021).

Natural increase is another driver of population growth. Fertility rates are influenced by confidence in the economic environment (i.e. people may decide to defer having a child until conditions improve). The COVID-19 pandemic has also affected citizen confidence, potentially influencing already declining fertility rates across Australia. The Australian Government has predicted that, in the longer term, fertility may decline to the lowest ever levels for Australia. This continues a pattern



Source: ABS (2021e)

Figure 15 Net overseas migration to Australia, 1971–72 to 2019–20



ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: ABS (2021e)

Figure 16 Net interstate migration, 2019–20

we have been seeing for decades where successive generations of women are having fewer children (Centre for Population 2020).

The combined implications of migration, fertility levels and the impact of COVID-19 on immigration on population growth across the country have been remarkable and led 2020 to show the slowest population growth since World War 1. Australian Bureau of Statistics (ABS) modelling shows that, under a worst-case scenario, Australia's population in 2040 will be 31.8 million people – 1.4 million people or 4% less than if COVID-19 had not happened (Charles-Edwards et al. 2021).

Urban densification and expansion

How recent changes to projected population growth will affect the shape and extent of our urban areas and the distribution of growth across Australia is yet to play out. Reduced population growth could reduce pressure on the need to expand our existing urban areas or create new ones. Conversely, changes to how we work and to our lifestyle (i.e. seeking better access to green spaces) could result in greater demand for homes with bigger backyards on the lower-density urban fringe.

Discussions with lead planning authorities in Victoria and South Australia have identified that, during 2021, demand for development within greenfield areas on the fringes of existing urban areas has been high. National Market reports verify this view – in the March 2021 quarter, a new record in terms of activity was established for the greenfield housing market at 6,219 net lot sales per month (65,000 annualised). A significant component of this growth occurred in the Melbourne market, where the March 2021 quarter saw sales increase by 49% compared with the same time the year before (Research4 2021).

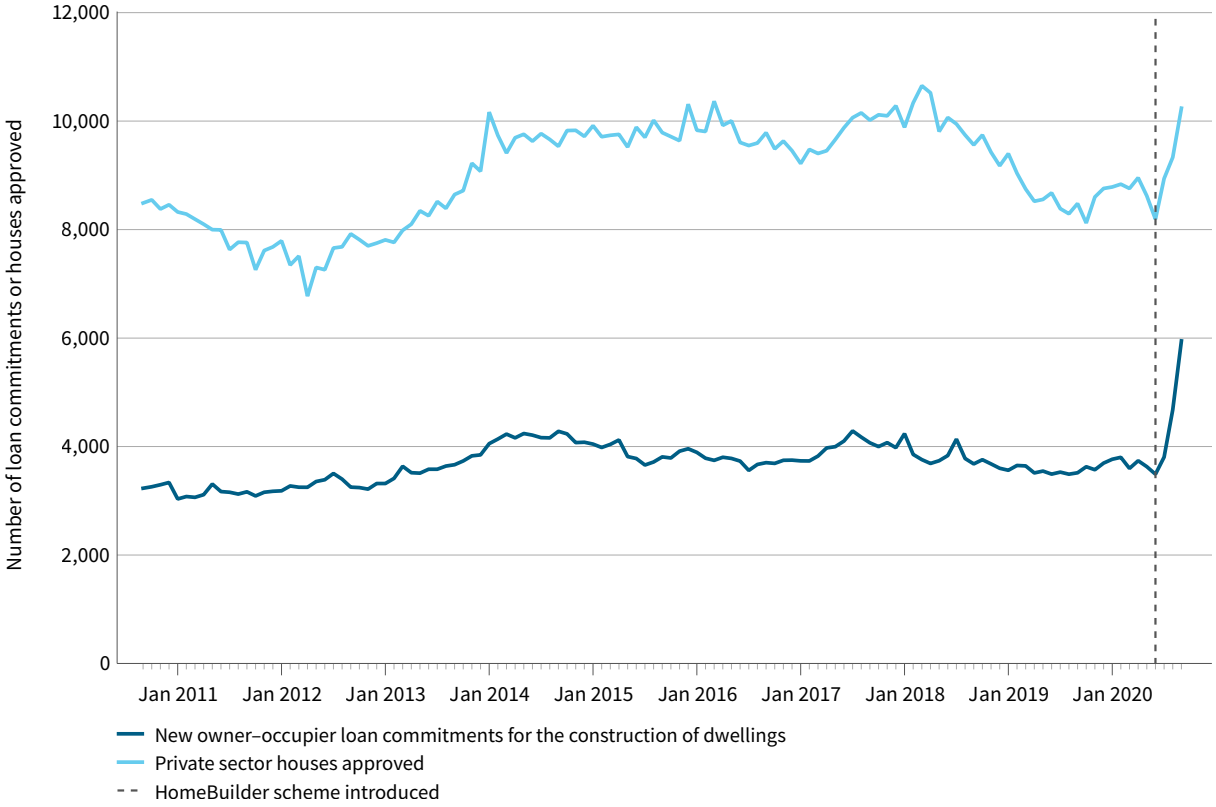
This significant growth in demand and subsequent supply (Figure 17) is expected to be in part a result of national schemes to stimulate economic activity such as the Home Builder Subsidy in addition to lifestyle choices spurred on by events such as the COVID-19 pandemic. This observation is supported by a national study by Infrastructure NSW that shows significant increases in the number of dwelling approvals since the introduction of the economic stimulus.

The same Infrastructure NSW study found that, because of the COVID-19 pandemic's shifts towards working from home for many, housing preferences have shifted marginally to larger dwellings with an increased desirability for additional space for a home office or garden.

Key word searches for dwellings with a home office increased by 605% between June 2020 and March 2020, balcony by 50% and garden by 19% (Infrastructure Australia 2020b). At the same time, stagnating median apartment prices have indicated a reduced demand for denser inner urban living and the construction of higher-density apartment blocks has slowed.

While the expansion of our urban areas provides additional – and, in some cases larger and more affordable – homes than brownfield areas, they also present notable pressures to the urban and natural environment. In the case of the urban environment, pressures include:

- the need for expanded or new infrastructure, often resulting in a delay in service provision and additional cost to the



Note: The number of new borrower-accepted commitments (i.e. loan application approved by lender and accepted by the borrower) for the construction of owner-occupied dwellings (seasonally adjusted).
Source: Infrastructure Australia (2020b)

Figure 17 Number of private sector houses approved and new borrower-accepted loan commitments, September 2010 to September 2020

householder to fund the new infrastructure (Garrard et al. 2015)
- the potential for reduced access to local services and jobs, leading to higher transport and energy costs, reduced walkability and increased social isolation (Garrard et al. 2015)
- conflicts with food production, as many cities have traditionally been located close to fertile and high food–production areas.

For the natural environment and green spaces, the potential pressures from greater urban expansion include:

- land clearing, which is the main cause of biodiversity loss in Australia. Land clearing also exacerbates erosion and salinity, reduces water quality, increases the impact of drought and contributes significantly to greenhouse gas emissions (PIA 2016)
- less greenspace and tree canopy cover, at least in the early decades, as existing vegetation is cleared for new development and new vegetation takes time to grow. This can result in significantly greater heat in these areas and reduced rates of walking and cycling for residents
- fewer gardens and thus biodiversity. 'New suburbs in Australia have significantly less cumulative areas of private gardens compared to established suburbs' (Farahani et al. 2018:4)
- greater pressure on our coasts and waterways. These high-value areas are attractive locations for homes, yet they are often sensitive ecosystems that suffer from the impacts of buildings and infrastructure.

The increased rates of urban fringe development occurring in some locations represent a notable contrast to urban planning policies that encourage inner-city living (see Management approaches). An alternative scenario could occur where more people move from larger urban areas altogether to more regional urban areas, helping to ease pressures on our major cities (see Figure 18). During the COVID-19 pandemic, it was estimated that net migration from the capital cities to regional areas increased by 200% (Infrastructure Australia 2020b). A survey by Infrastructure NSW in 2020 found that more than 1 in 10 survey respondents moved during the pandemic, with most of these households moving away from inner cities. This resulting in relatively weaker inner-city housing demand, increased vacancy rates in capital cities and anecdotal evidence of 10–20% increases in regional property prices (Infrastructure Australia 2020b).

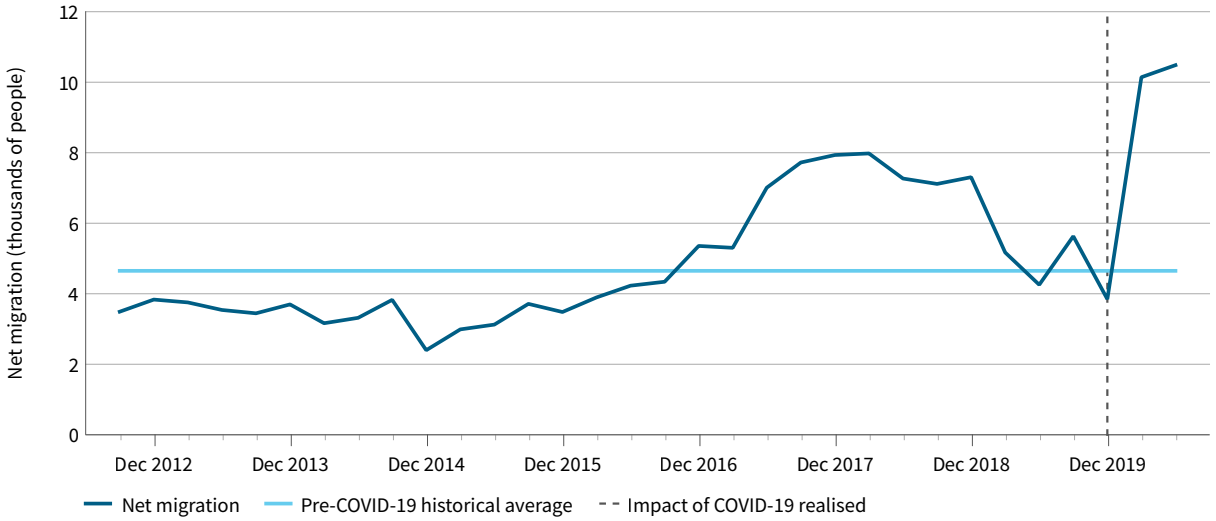
However, there is much debate as to whether this shift towards more regional urban areas is a real and lasting response, or just a short-term trend or the natural in-and-out migration patterns of people from major urban areas (Lennox 2020, Davies 2021).

Travel demand

Travel is a key pressure on the urban ecosystem. As urban areas expand and increase in complexity, more people will need to travel further and to multiple destinations, often increasing reliance on less sustainable methods of travel by private car. The growing need to travel has varying impacts on the environment (e.g. pollution) and our wellbeing (e.g. physical and mental health effects of longer periods spent travelling). The environmental challenges associated with growing travel also has direct physical health impacts to wellbeing: in 2019, there were 1,103 fatal car crashes and 22 fatal aviation accidents in Australia (BITRE 2020a).

Passenger travel methods and times

Most Australians travel by car. Based on passenger transport activity (measured in terms of 1 passenger moving 1 kilometre), in



Source: ABS (2021f)

Figure 18 Net migration from Australian capital cities to regional areas, 2012–20

2019–20, 157.5 billion passenger-kilometres were travelled by car on capital city roads compared with 11.5 billion passenger-kilometres travelled on heavy rail networks. In 2018–19, total vehicle travel (including commercial vehicles) was 214 billion kilometres, steadily increasing from 204 billion in 2014–15 (Figure 19).

The only notable change to the trend of increasing travel by all modes was in 2019–20, when total vehicle travel reduced to 196 billion passenger-kilometres because of the effects of the COVID-19 pandemic (Figure 20).

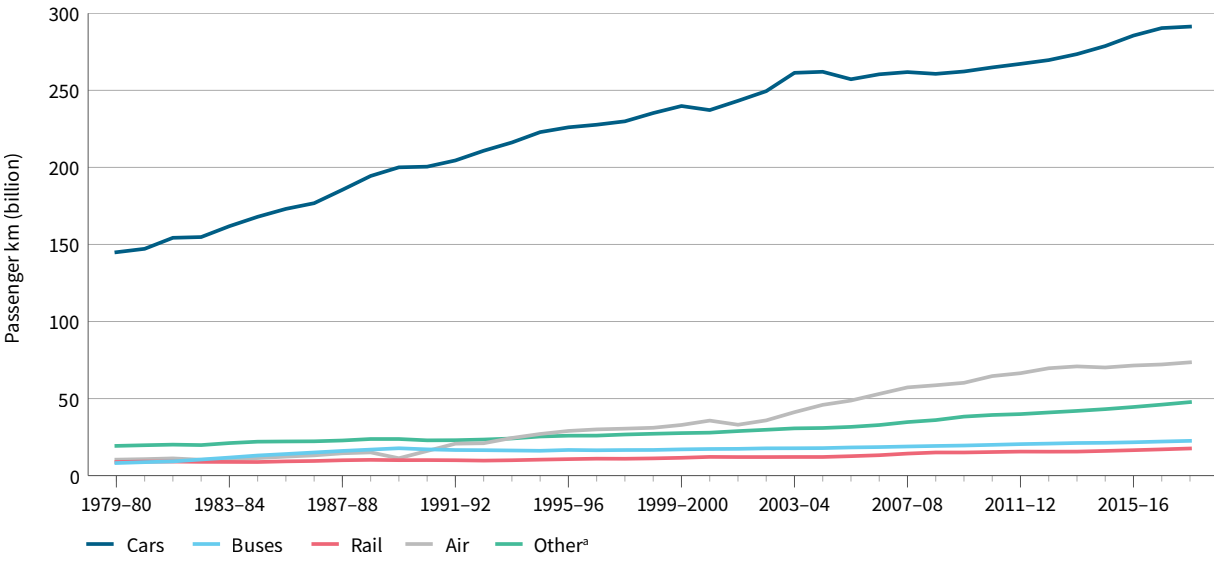
In metropolitan areas, travel by rail has also been increasing (Figure 21). As of 2017–18, there were 726 million heavy rail passenger-kilometres travelled, up from 588 million 10 years before (BITRE 2020c). This positive trend was also abated by the pressures of the COVID-19 pandemic.

Air travel has been most affected by the pandemic. Having steadily increased since 2001, in 2019–20 there were 30.7 million passengers on international flights across Australia, down from 42.1 million the year before. During the same period, there were 45.2 million passengers on domestic flights, down from 60.2 million the year before. Sydney Airport was the busiest in the country, with 32.2 million passengers using the facility in 2019–20, down from 44.4 million in 2018–19 (BITRE 2020c). These declines are likely to be even greater when 2021 figures are included.

Freight transport

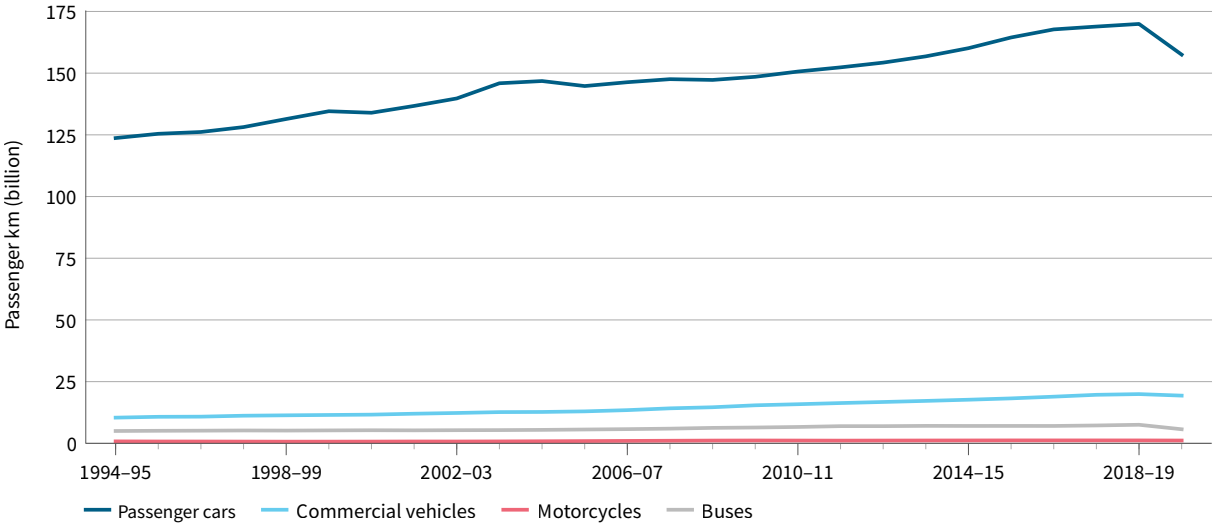
The Australian domestic freight task has been increasing strongly for the past 40 years, with road and rail freight now dominating domestic freight activity. The rapid growth in rail freight task through the mining boom period (2003–12) has largely been driven by rail's movement of iron ore in the Pilbara region (Irannezhad & Hine 2019) (Figure 22).

Freight transport activity is measured in terms of tonne-kilometres (the movement of 1 tonne of freight by 1 kilometre). In 2019–20, there were 224.2 billion tonne-kilometres of freight moved by road and in 2015–16 there were 413.5 billion tonne-kilometres of freight moved by rail (BITRE 2020c).



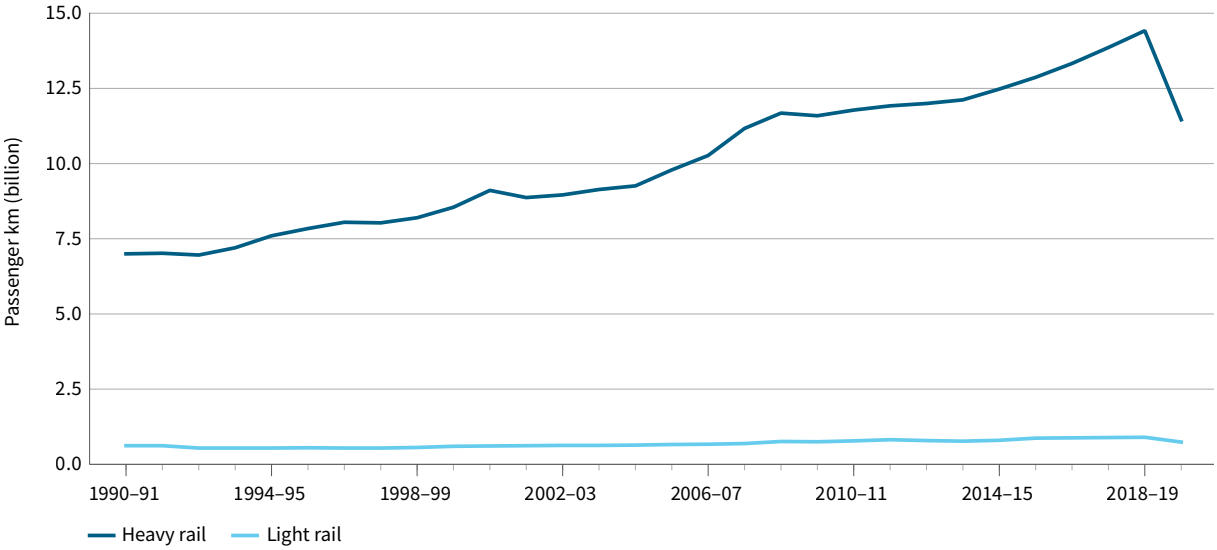
km = kilometre
a Other includes nonbusiness use of light commercial vehicles, motorcycles, etc.
Source: BITRE (2020a)

Figure 19 Australian domestic passenger task, by mode of transport, 1979–80 to 2017–18



km = kilometre
Source: BITRE (2020a)

Figure 20 Total metropolitan passenger-kilometres travelled by road in Australian capital cities, 1994–95 to 2019–20



km = kilometre
Source: BITRE (2020a)

Figure 21 Total metropolitan passenger-kilometres travelled by rail in Australian capital cities, 1990–91 to 2019–20

Urban congestion

After the COVID-19 pandemic, it is expected that demand to travel across our urban environments will return to the former growth trend. This will place greater pressure on our road and rail infrastructure, which will exacerbate existing levels of congestion and demand for new or augmented infrastructure. Urban congestion across Australia is estimated to have cost more than $19 billion in 2016, increasing from $16.5 billion in 2015. This cost is forecasted to reach between $39.8 billion by 2031 (Infrastructure Australia 2019).

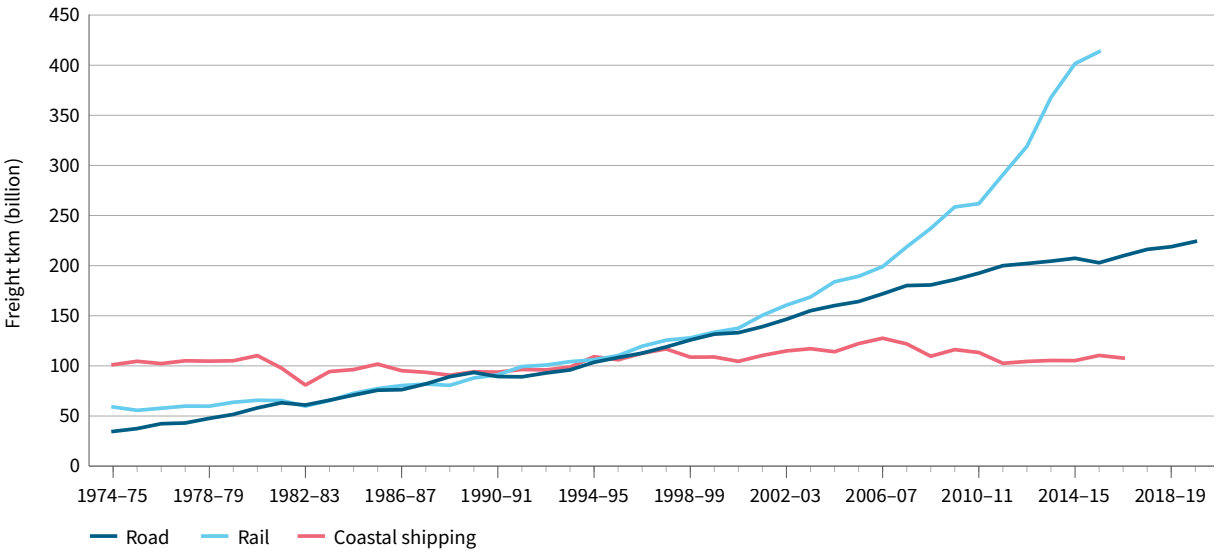
Growing congestion translates into longer commutes and travel times, which in turn increases carbon dioxide emissions. For example, road vehicles contributed 85% of direct greenhouse gas emissions that were generated from all transport modes in 2019–20, compared with 8% from aviation (BITRE 2020a).

Increasing demand to travel also places greater demand on the funding of new transport infrastructure. Despite the growing demand, transport infrastructure expenditure for the public sector peaked in 2009–10 in association with government stimulus. It has been modestly rising once again since 2014–15 (Figure 23).

Private sector spending on transport-related infrastructure peaked in 2012–13, driven largely by demand by mining (BITRE 2020a). As of 2019–20, 51% of infrastructure construction was in the transport sector, with governments spending $28.5 billion in 2018–19 on roads alone.

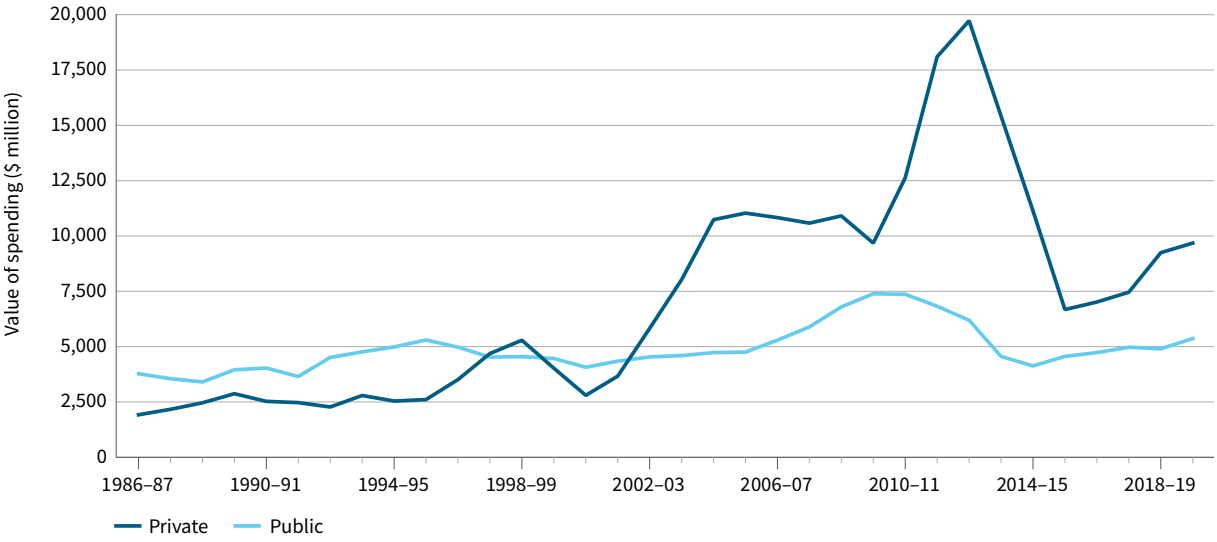
Resource consumption

As growing centres of human and economic activity, our urban areas are increasingly consuming material and energy resources, necessitating investment in the associated infrastructure. Despite this, investment in transport, water and energy infrastructure has declined since its peak 8–10 years ago (Figure 24). Conversely, telecommunications infrastructure expenditure has been steadily increasing over the past 3 decades (BITRE 2020a).



tkm = tonne-kilometre
Source: BITRE (2020a)

Figure 22 Australian domestic freight task, by mode of transport, 1974–75 to 2019–20

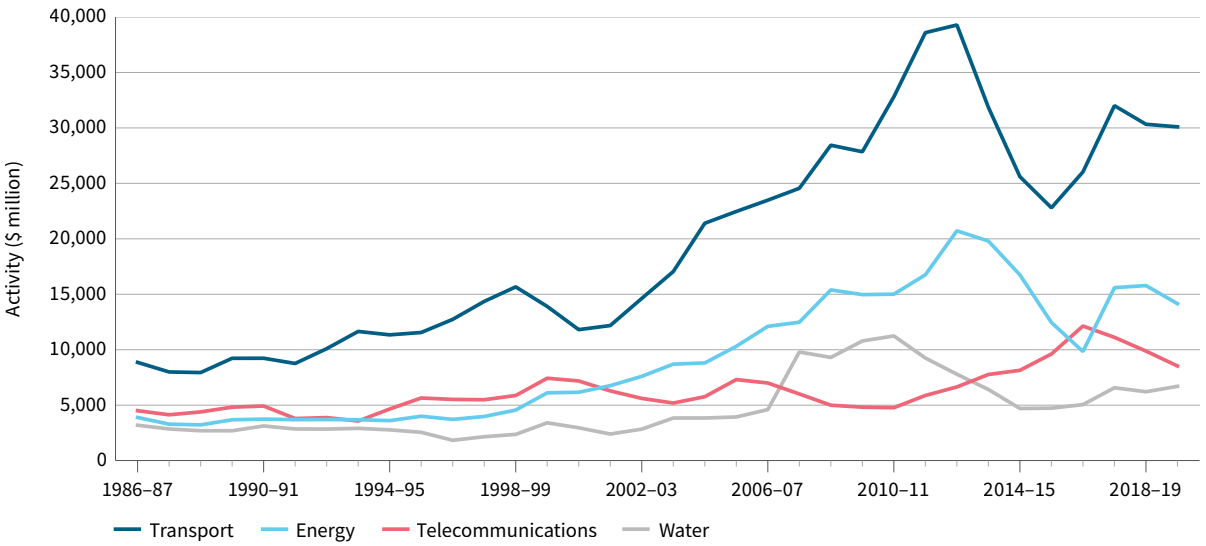


Source: BITRE (2020a)

Figure 23 Value of transport infrastructure spending, 1986–87 to 2019–20

Water

Australian water consumption levels are some of the highest in the world. This fact is anticipated to hold constant with significant increases predicted to 2026 (+39% in consumption levels) and 2056 (+64%) compared with 2009 levels – a total increase of around 1,000 gigalitres each year (Infrastructure Australia 2019). Infrastructure Australia cautions that even these significant increases could be underestimated given our tendency to underestimate long-term population growth in Australia. Indeed, these figures were based on population projections



Source: BITRE (2020c)

Figure 24 Infrastructure construction activity, adjusted by chain volume index, 1986–87 to 2019–20

that were on average 18% lower than the most recent ABS estimates, although they do not account for population adjustments following the COVID-19 pandemic (Infrastructure Australia 2019).

A report by Infrastructure Australia in December 2020 found that water consumption had seen little impact from the COVID-19 pandemic, with infrastructure capacity already in place to accommodate significant peaks (Infrastructure Australia 2020b). However, a survey of all councils in Australia undertaken for this report asked whether water supply and security has been an issue in the past 24 months; 42% of respondents answered 'yes'.

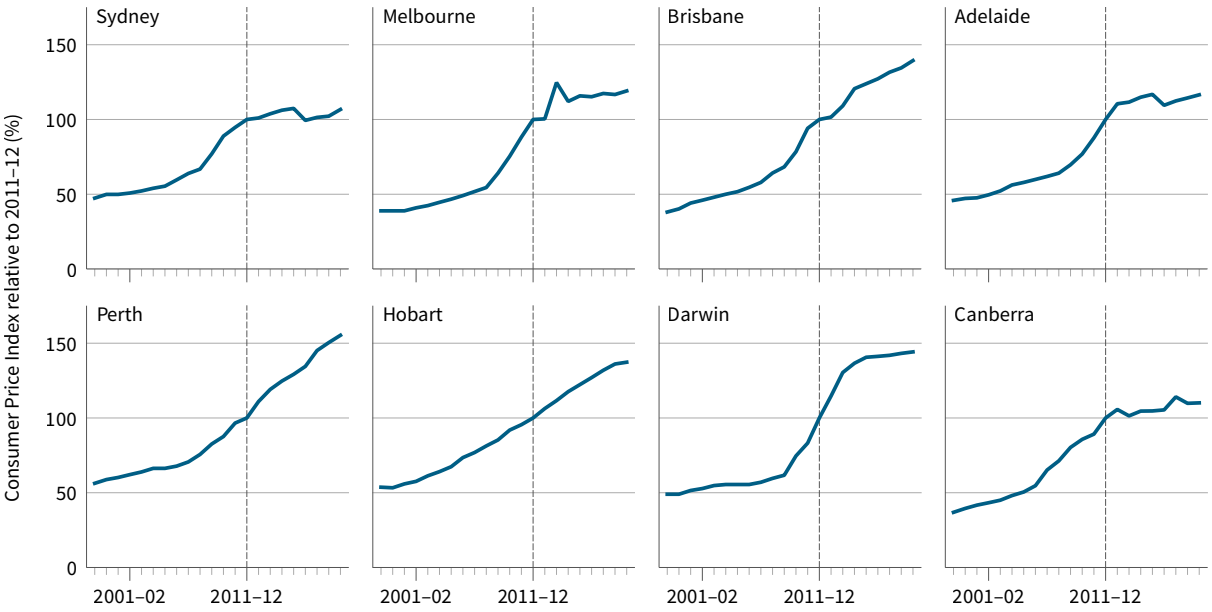
It is anticipated that pressures on water supplies will increase with climate change, as supply is reduced at the same time as demand is increased. As identified by Infrastructure Australia, 'of all the forms of infrastructure, the potential risks and costs of climate change are greatest in the water sector' (Infrastructure Australia 2019). These trends will be exacerbated in the south-eastern parts of Australia that are experiencing a long-term decline in rainfall yet have most of the existing and forecast population growth.

For Australian citizens, growth in urban water and sewerage service prices is placing greater pressure on household budgets, with a notable shift in prices in capital cities occurring over the past decade (Figure 25).

Regional areas

Water supply is a particular challenge for smaller and more regional urban environments that are located away from the coasts. These environments have a more dispersed population across larger areas, and do not have the critical mass of population to generate the economies of scale required for major water and wastewater facilities. Most regional areas rely on surface or bore water without the benefits of alternative sources such as desalination or recycled water systems.

These communities often rely on councils to provide water services rather than larger, cross-jurisdictional water utilities. In New South Wales and Queensland there are



Note: Base year of index is 2011–12.
Source: BITRE (2020a)

Figure 25 Urban water and sewerage Consumer Price Index by Australian capital city, 1998 to 2020

approximately 115 water providers with fewer than 10,000 connections, 48 of which have fewer than 1,500 connections (Infrastructure Australia 2019).

This dispersed and segregated approach affects the standard of service and the level of supply for customers. It reduces urban resilience because communities rely on a single supply source. This fragmented approach can also result in reduced rates of reporting, monitoring, auditing and benchmarking of water quality and provision. For example, 'utilities with fewer than 10,000 connections are not included in the BOM's (Bureau of Meteorology's) national performance report, and those utilities that do report often provide unreliable and inconsistent data' (Infrastructure Australia 2019:615).

These challenges present a significant impediment to not only the sustainability of regional areas and the quality of their urban environments, but their potential for growth.

Remote areas

Smaller and more-remote communities rely on more local sources for their water, which can often have a lower standard of supply and quality compared with more urban areas. These areas have a broader array of water and wastewater assets, including:

- discrete rural water bores, reservoirs and pumping stations
- local on-farm tanks, dams, levees and other storages
- septic tanks and other treatment and disposal systems for residential purposes.

The Australian Infrastructure Audit 2019 found that water and wastewater assets in some remote communities were poorly maintained, routinely failed or provided services at a standard below their intended design. In the Northern Territory, Queensland, South Australia and Western Australia, many remote communities had water quality levels that fail to meet the Australian Drinking

Water Guidelines. This is primarily because most of the drinking water is supplied from groundwater sources that have high concentrations of naturally occurring minerals and chemical contaminants (Infrastructure Australia 2019).

Many more-remote areas have a higher representation of Indigenous people (Infrastructure Australia 2019). Water plays a key role in these communities for not only drinking and sanitation, but for emotional wellbeing, recreation and culture. Limited access to, or reduced quality of, water can compound health issues and increase risks of disease and infection, exacerbating social disadvantage.

Infrastructure Australia points to 'clear evidence that services in many of these remote communities do not meet United Nations' Sustainable Development Goal (SDG) 6: Clean water and sanitation for all, and work against the achievement of broader national objectives, including the Australian Government's Closing the Gap targets' (Infrastructure Australia 2019:619).

Impacts of water pressures

Risks to water security associated with climate change present a challenge for our wellbeing and that of the environment. Our water supply relies heavily on rainfall to replenish storages, streams and groundwater. Infrastructure Australia's 2019 audit found that the reduction in average winter rainfall in south-west Australia has caused a 50% reduction in urban run-off over the past 50 years (Infrastructure Australia 2019), leading to declining streamflows across the southern and south-east regions.

Warmer temperatures associated with climate change are likely to increase the risk of bacterial contamination and blue–green algal outbreaks. Extreme weather events such as bushfires, flooding and coastal inundation may also damage assets or disrupt wastewater treatment processes. When systems fail, there is a risk to the quality of our drinking water and broader urban environment because of sewer water overflow, and debris and sediments washed into creeks, rivers and dams.

The increases in severe rainfall events with climate change will place pressure on the ability of existing urban infrastructure to cope. This is particularly a challenge for older stormwater systems, treatment plants and sewerage networks located in established city areas. Larger and more frequent rainfall events may cause greater load, reduced efficiencies and increased breakage, which may disrupt service delivery. These effects may also require repair, extension and augmentation, which will increase costs. These effects are likely to have impacts on wellbeing, and the costs are most likely to be passed onto the end user – the citizen.

Energy

Electricity use has almost doubled since 1986–87 (BITRE 2020a). The source of this energy varies notably by state and territory, with coal continuing to provide more than 33% of primary energy used in New South Wales, Victoria and Queensland in 2019–20. In the case of Western Australian and the Northern Territory, more than 50% of the primary energy was sourced from natural gas. Renewables accounted for 48% of the primary energy mix in Tasmania. Oil comprised at least 33% of energy consumption across all states, and 25% of energy consumption in the Northern Territory.

A study by Infrastructure Australia in December 2020 found that, during the initial stages of the COVID-19 pandemic, overall demand for electricity and gas remained level, with differences in the distribution of demand between households and business

(Infrastructure Australia 2020b). The same research found that, in Victoria, lower commercial demand (approximately –20%) was offset by higher residential demand (approximately 10–40%) due to the prolonged lockdown, with flexible working driving a softening in the early evening peak. Energy demand also shifted from the CBD to outer suburbs and regional areas as more Victorians adapted to remote working. But once lockdown measures were removed in New South Wales and Queensland, consumption largely recovered (Infrastructure Australia 2020b).

The overall growth in energy demand and the cost of electricity is requiring us to change how we generate our energy, with a growing proportion being sourced from renewable sources. There has also been a notable shift in the design of our energy systems, with a move in thinking away from a more linear, centralised model of energy production and storage towards a more distributed approach.

Solar energy

The growth in solar photovoltaic (PV) and battery systems has been a major contributor to the shift to using more renewable energy sources. As more homes and businesses adopt the emerging technology, energy sourced from solar has experienced significant growth (+58%) over the past 10 years (Figure 26), while energy generated by wind has grown at 17% over the same period (BITRE 2020c).

More than 1.5 million distributed solar PV systems are now installed across the country – one of the highest per-person rates in the world (ASBEC 2016). According to the Australian Government, more than 21% of homes in Australia have rooftop solar PV systems (Infrastructure Australia 2020b). Importantly, solar PV systems are also now being incorporated into a broader range of buildings, including industrial roofs and schools.

State government bodies have created incentives for solar energy – for example:

- In July 2020, the Victorian Government announced an expansion to the state's Solar Homes Program to renters and landlords. Landlords can now apply for an interest-free loan on top of the existing rebate of up to $1,850.
- In November 2020, the New South Wales Government unveiled a $32 billion renewable energy plan with focus on pumped hydro, increasing the share of renewable energy in the state from about 16% to more than 60% by 2030.
- In August 2020, the Western Australian Government launched the Distributed Energy Buyback Scheme, which introduced payments for energy exported to the grid from eligible home batteries and electric vehicles.

Related to these initiatives, solar uptake has improved significantly, with a notable increase in energy generation through PV in all states between 2012 and 2017 (Figure 26). For example, in south-west Western Australia, the amount of large-scale renewable generation connected to the main grid doubled over the past 2 years (WA Government 2021b), and more than 33% of households have now installed a solar system.

At the same time, large-scale renewable generators are supplying an increasing amount of our electricity needs (WA Government 2021a). Improvements in technology and efficiency, along with projected declining capital costs for solar PV systems, will support further uptake. Costs are projected to decline from around $1,505/kW per system in 2020 to around $624/kW by 2050 (Graham et al. 2021).

While large- and small-scale renewables offer great opportunities for low-cost,

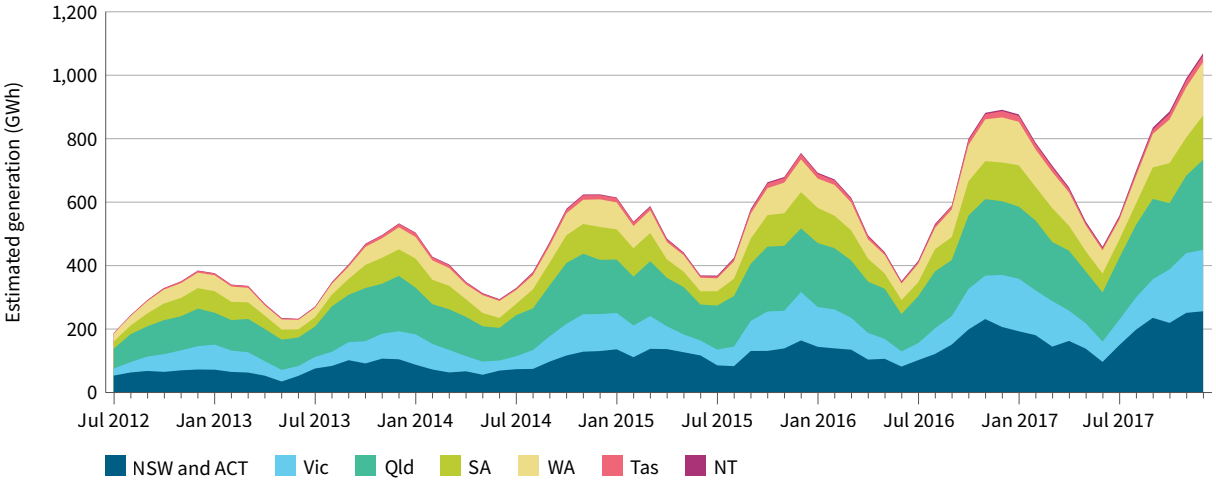
low-emissions energy, they also present challenges in ensuring the security, reliability and affordability of the power system. One means of addressing this is through the trial and rollout of localised household and industrial batteries. The rollout is being enhanced by significant reductions in cost owing to improvements in manufacturing and technology. This resulted in battery uptake increasing by approximately 465% from 2016 to 2017 (Infrastructure Australia 2020b). According to SunWiz (2020), 1 in 13 Australian households with solar panels have battery storage.

Large-scale, industrial batteries can store electricity oversupply to be used to stabilise the grid during frequency disruptions. Several major projects are underway, including:

- the 100–129 megawatt-hour (MWh) Hornsdale Power Reserve in South Australia, which is the largest lithium-ion battery in the world. It is also currently undergoing a 50–64.5 MWh expansion
- the construction of the Victorian Big Battery with a capacity of 300–450 MWh, to be completed by Tesla at the end of 2021
- more than 20 trials in Western Australia of new technologies to test and explore more effective and efficient ways of generating, accessing, managing and sharing electricity.

Hydrogen

Renewable hydrogen is an emerging technology that will play an important role in our future energy mix. It has the potential to displace the use of fossil fuels in energy applications such as transport, heat and power generation. It can also provide a carbon-neutral feedstock for a wide variety of industrial processes and provide energy storage and other services to support the reliability of the electricity grid (DJTSI 2021). It is a safe, transportable and storable fuel (COAG Energy Council 2019). Hydrogen is considered a major emerging industry for the nation. It has the potential to generate thousands of jobs and a new export industry worth an estimated $2.2 billion by 2030 and $5.7 billion by 2040.



ACT = Australian Capital Territory; GWh = gigawatt-hour; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: AEC (2018)

Figure 26 Estimated residential photovoltaic generation, 2012–17

Australia's National Hydrogen Strategy states that when used as a fuel, hydrogen's only byproduct is water and there are no carbon emissions. However, whether hydrogen is truly a zero- or low-emissions fuel depends on how it is produced. As pure hydrogen is not found naturally on Earth, it must be extracted from the substances that contain it – water mainly, but also coal, natural gas and biomass – and this takes energy.

Renewable hydrogen is defined as hydrogen produced using energy from renewable energy sources (DJTSI 2021). This can be achieved through electrolysis using renewable electricity (COAG Energy Council 2019).

As with other renewable energy sources, the cost of producing hydrogen has significantly reduced. Over the past decade, for example, the cost of generating electricity from wind has fallen by about 70% and from solar PV by about 80%. The cost to make a hydrogen fuel cell, meanwhile, has fallen by about 60% since 2006 (US DoE 2017). The Australian Hydrogen Strategy forecasts a potential further drop of 30% by 2025.

A key component of Australia's National Energy Strategy is to create hydrogen hubs. These clusters of industrial and business activity may be in urban, regional or remote areas and aim to improve economies of scale. These will be complemented and enhanced by other early steps to:

- integrate renewable hydrogen into the electricity grid
- use hydrogen in transport, industry and gas distribution networks
- reduce carbon
- increase reliability.

Such early steps are being rolled out by each state and territory.

Case study White Gum Valley residential development, Western Australia

Sources: Development WA (2020), Bioregional (2021) and Cabanek et al. (2021)

The White Gum Valley residential development, located 3 kilometres from Freemantle City Centre in Western Australia, is Australia's first internationally endorsed One Planet Community. The One Planet approach was designed by the founders of a social enterprise in London, applying their experiences gained from the multi-award-winning BedZED ecovillage in South London.

The One Planet approach comprises 10 overarching principles ranging from health and happiness, culture and community to sustainable water, zero waste and zero carbon. The principles are supported by detailed goals, targets and guidance documents to achieve more sustainable living outcomes.

Applying this approach, White Gum Valley is a zero-carbon development that has been the focus of a 4-year 'carbon positive living laboratory' (Cabanek et al. 2021)

program with the Cooperative Research Centre for Low Carbon Living. Application of the One Planet principles has meant that the development:

- is a net exporter of electricity
- achieved a 65% reduction in scheme water use compared with the Perth metro average
- has 33% of the lot being developed as timber frame homes, significantly reducing embodied levels of carbon and creating a zero-carbon operational footprint
- reduced car ownership
- provided all residents with access to areas to grow food
- incorporated water-sensitive urban design principles and water-efficiency measures
- increased local biodiversity and tree canopy increase as well as recreational green space for the community
- created a strong sustainability culture among its residents of sharing and cooperation.

The development is the outcome of collaboration between state and local government, private developers and the community.

Source: Image courtesy of DevelopmentWA

Figure 27 Use of solar panels as a source of energy in regenerative design

Waste and pollution

Urban areas produce the highest levels of pollution and waste.

Waste

According to World Bank estimates, the total solid waste generated in the world's cities will increase from 2.01 billion tonnes in 2016 to 3.40 billion tonnes in 2050 (Kaza et al. 2018). A major portion of the solid waste generated is either disposed of as landfill or incinerated, polluting and adding to the carbon footprint of our urban and natural ecosystems (Patil et al. 2020).

According to the ABS (2020a), 'Australia generated 75.8 million tonnes of solid waste in 2018–19, which was a 10% increase over the past 2 years (since 2016–17)'. The rate of growth occurred at a rate lower than population growth, which is encouraging (Pickin et al. 2020). However, declining weights of waste do not necessarily correspond to declining volumes (Pickin et al. 2020).

In comparison to countries such as Norway, Singapore, the United Kingdom and the United States (based on various data sources compiled between 2016 and 2019 by Pickin et al. (2020)), Australia had the second-highest per-person rate of waste generation at 2.13 tonnes, just behind the United States at 2.34 tonnes per person and close to double the amount generated by Singapore at 1.26 tonnes (Figure 28).

Australia also had the second-highest rate of waste disposal per person – 704 kilograms (kg) – behind the United States (771 kg) and in stark comparison to Singapore (119 kg). As a positive, Australia had the second-highest recycling rate at 66%, following the United Kingdom at 74% (Pickin et al. 2020). (Figures are indicative only. Data are compiled for different years (2016–19) and from different sources due to limitations on data availability.)

Sources and types of waste

Most of the waste generated in Australia in 2018–19 was from 4 sectors:

- manufacturing – 12.8 million tonnes (16.9%)
- construction – 12.7 million tonnes (16.8%)
- households – 12.4 million tonnes (16.3%)
- electricity, gas and water services – 10.9 million tonnes (14.4%).

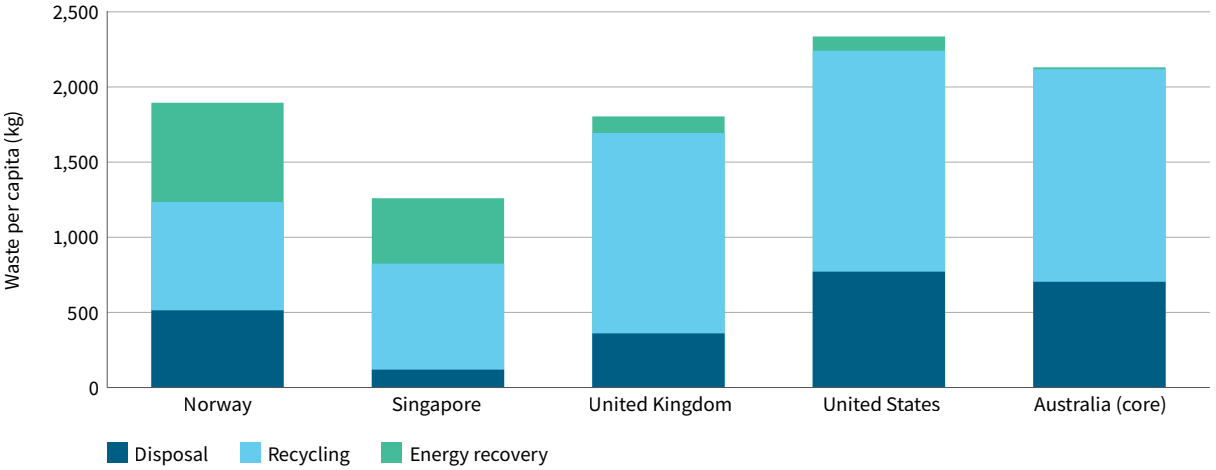
With population and economic growth, household waste has continuously increased across Australia, increasing by 5% alone from 2016–17 to 2018–19.

Households continue to contribute the highest proportion of organic waste (6.4 million tonnes) including 55% of all food waste (3.1 million tonnes). Organic waste increased by 10% from 2016–17 to 2017–18, representing 20% of total household waste (Figure 29). Organics are identified as particularly problematic in landfills as they create leachate, gas and odours (Pickin et al. 2020).

Households were also major contributors to plastic waste (1.2 million tonnes or 47%). While plastic reduced from 4% of total waste in 2016–17 to 3% in 2018–19, only 9% was recycled and 84% was sent to landfill.

Households were also notable contributors to glass waste (1.2 million tonnes or 72%), textile waste (247,000 tonnes or 90%) and e-waste (539,000 tonnes or 40%).

By comparison, manufacturing generated the largest proportion of hazardous waste (1.9 million tonnes or 24%) followed by the construction industry at 21% (1.7 million tonnes). Since 2016–17, hazardous waste tonnage increased by 23%, representing 11% of total waste and up from 9% over the same period; 6% alone relating to tyres (Pickin et al. 2020). By material, the most significant sources



kg = kilogram
Source: Pickin et al. (2020)

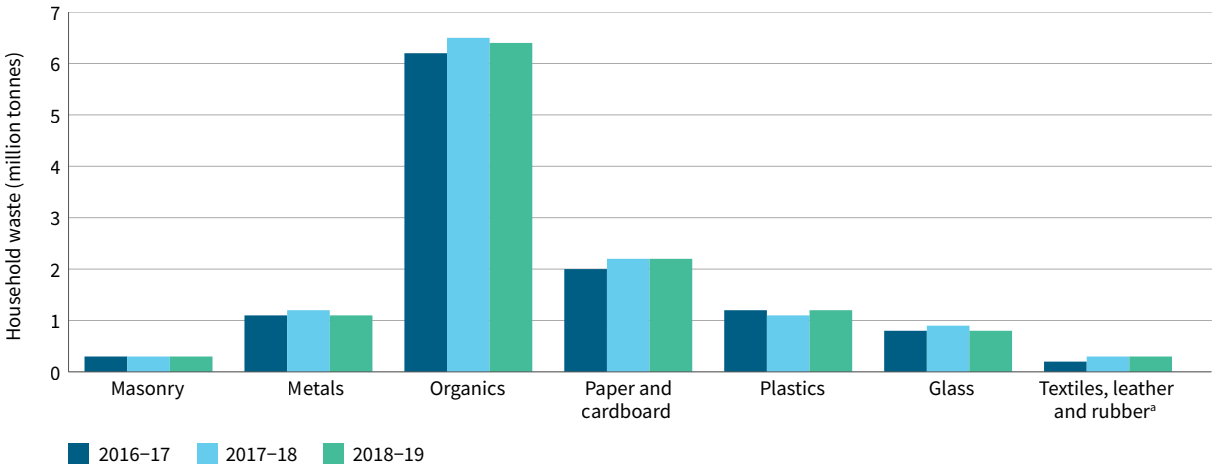
Figure 28 Comparison of annual waste generation and rate per person, Australia and selected countries

of waste were masonry materials (31%), organics (19%) and ash generated from power stations (17%; Figure 30) (Pickin et al. 2020).

Waste management and recycling

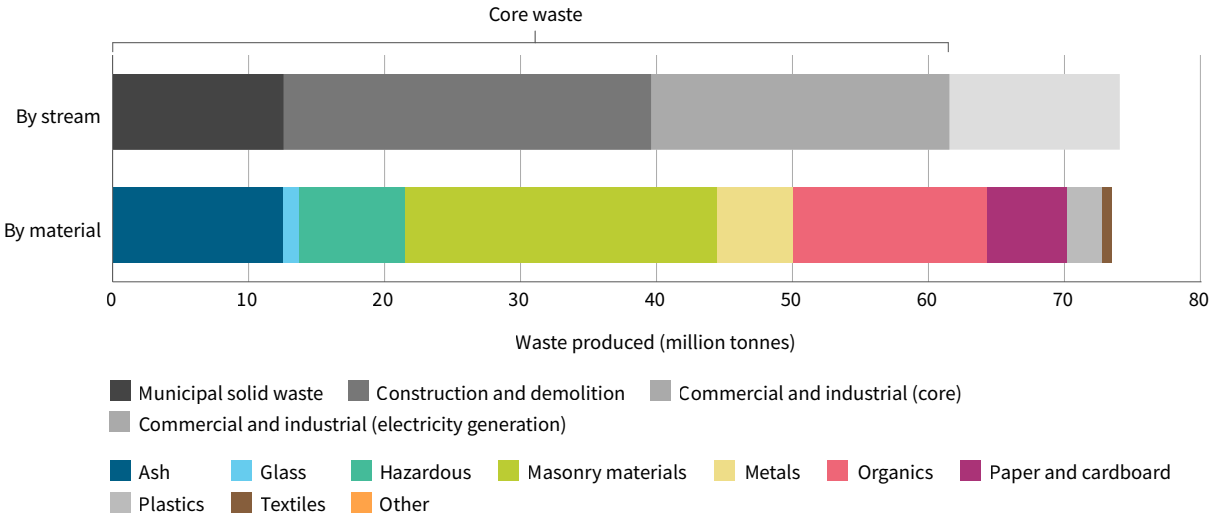
Nearly 60% of products became recovered waste in 2018–19. This is an improvement from 2006–07 when the resource recovery rate was 50% (Pickin et al. 2020). However, our methods of disposal and re-use of all waste can and must continue to be improved. While half of all waste is sent for recycling (38.5 million tonnes), 27% of this is still being disposed of as landfill (20.5 million tonnes) (Figure 31).

Across Australia, about 93% of households have a recycling collection and 49% have an organics collection. Despite this, only 42% of Australian household waste was sent for recycling in 2018–19 (6.4 million tonnes), while 45% was sent to landfill (6.9 million tonnes).



a Excludes tyres
Source: ABS (2020a)

Figure 29 Household waste by waste material, 2016–17 to 2018–19



Source: Pickin et al. (2020)

Figure 30 Waste generation by material and stream, 2018–19

The population-weighted average composition (by weight) for household waste sent to recycling was 48% paper and cardboard, 27% glass, 8% plastics, 3% metals and 13% contamination (ABS 2020a).

In terms of resource recovery and recycling, South Australia was the highest-ranked jurisdiction, with a resource recovery rate of 85% and a recycling rate of 80% (Figure 32) (Pickin et al. 2020).

Plastic

All plastic types had the worst recovery rates at around 15%. Of the 2.5 million tonnes generated, 84% was sent straight to landfill in 2019–20 (ABS 2020a). These poor recovery rates, combined with the impacts of single-use plastics on our natural environment (particularly marine ecosystems), has led to growing calls from communities and industry for measures to ban their use.

Many states, territories and local councils have banned single-use plastic bags. One local council, the City of Hobart, has a local bylaw ensuring food retailers use only plastic that is certified compostable based on Australian Standard AS4736 (Pickin et al. 2020). However, these measures are just a start of what is needed. By current estimates, global production of plastics is forecast to double by 2034 and almost quadruple by 2050 (Pickin et al. 2020).

Current and future waste challenges

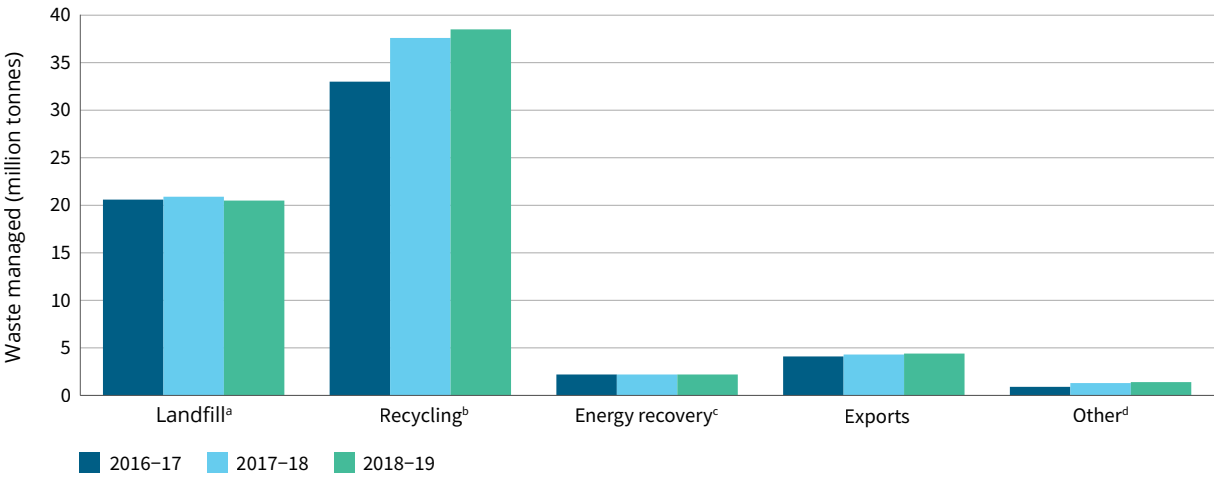
The waste sector is currently facing various pressures and thereby challenges.

One significant challenge relates to falling export rates of waste for recycling, largely due to the restrictions imposed by many of the destination countries in South-East Asia. This is creating notable financial challenges for the industry, which will result in increased waste stockpiling or waste to landfill unless new markets for these materials can be identified.

Regional areas experience particular challenges in the collection and cost of waste management, at the same time as having lower financial resources than larger urban areas. This results in reduced or nil kerbside collection services, and reduced locally accessible recycling infrastructure. It can also increase the need for individuals to travel

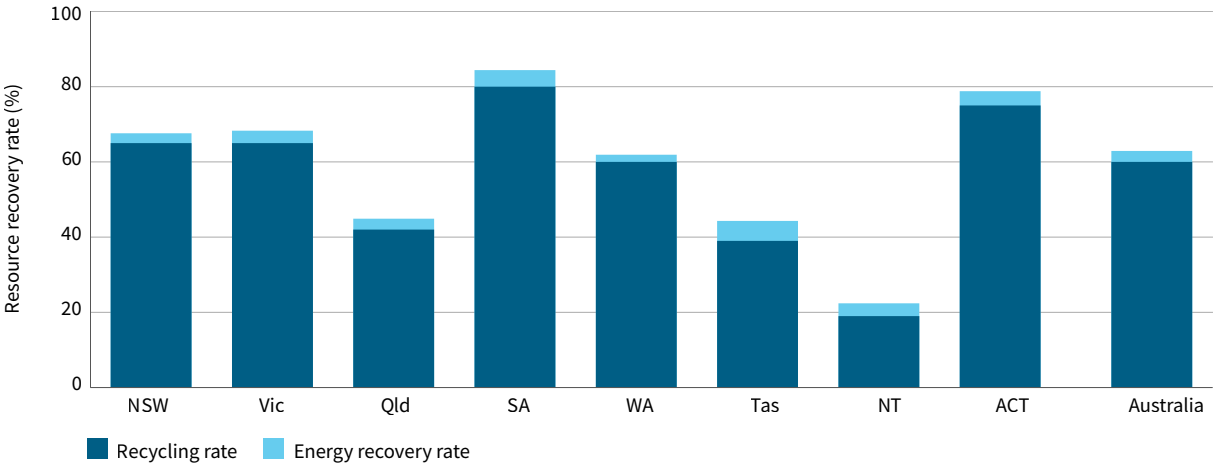
greater distances to dispose of waste. These services and opportunities are often not available at all within remote communities, and are not accessible to less-mobile citizens.

It also means that waste generated in regional areas must be transported to metropolitan recycling facilities. For example, a lack of reprocessing facilities in Tasmania means many recyclables are shipped to Victoria, while various materials recovered in Queensland may be sent to processing facilities in Sydney or Melbourne (Pickin et al. 2020). This pressure also occurs in more metropolitan areas where waste is transported from inner-city areas



a Refers to waste sorted to landfill for disposal only.
b Refers to waste contracted with the intent of being recycled.
c Includes waste sorted to landfill for energy recovery.
d Includes waste subject to treatment and other disposal.
Source: ABS (2020a)

Figure 31 Waste management categories, 2016–17 to 2018–19



ACT = Australian Capital Territory; NSW = New South Wales; NT = Norther Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia
Source: Pickin et al. (2020)

Figure 32 Resource recovery and recycling rates by jurisdiction, 2018–19

to landfills in peri-urban locations, in some instances located hundreds of kilometres away (Pickin et al. 2020). This creates notable travel costs and emissions.

Another challenge is the lack of agreed mandatory standards for factors such as recycled content for packaging and other products. While community expectations are driving change, the largely voluntary approach to date has failed to drive sufficient critical mass to guarantee new markets for recycled material. This is significantly hindering steps towards a more circular economy (Pickin et al. 2020) (see Management approaches).

The COVID-19 pandemic has added to pressures, creating a shift in the type and level of waste generated (see COVID-19 pandemic).

Light and noise pollution

Urban environments can generate significant levels of light and noise that affect the natural environment (i.e. flora and fauna) as well as our wellbeing (e.g. ability to sleep).

Key sources of light pollution include poorly designed artificial lights along with the cumulative effect of city lights. Noise is largely generated by industry and the cumulative effects of households and vehicles.

Light pollution, relating to both the intensity and colour of the light, can affect insect and animal foraging, reproduction and migration patterns (Jones 2018). This can be mitigated through lighting choices (low-blue or amber lights are better), minimising the use of floodlighting and using adaptive lighting that responds to residents' movements by dimming or switching off when not needed. The pressures of noise pollution can be managed by separating noisier activities from more sensitive ones and using improved technologies (e.g. electric vehicles).

COVID-19 pandemic

The COVID-19 pandemic was an unforeseen event that has profoundly affected the state of urban environments. It has highlighted to government, industry and communities the complex and fragile nature of our urban ecosystems, the value of the natural environment for citizen wellbeing and the need to plan for greater urban resilience (see Urban resilience).

As a driver of change, the pandemic has had both positive and negative impacts. The impacts have also varied across time:

- Some impacts have been immediate (e.g. reduced air and vehicle travel has improved air quality).
- Some are likely to be longer term (e.g. changes in where we work and how we travel to work).
- Other impacts are yet to be determined (e.g. changes in our preference of where we live and what this means to the growth and character of our urban areas).

Health and wellbeing

The negative impacts of the pandemic have related to the health and wellbeing of our citizens. This is either through infection or through broader social and economic impacts affecting mental health and wellbeing. The health sector responded by increasing capacity within intensive care units almost 3-fold. It is also adapting to new forms of health consulting – telehealth increased from 0.04% to 35% of all Medicare schedule services during the pandemic (Infrastructure Australia 2020b).

The value of locally accessible and usable open space and services also increased, with government travel restrictions putting a focus back on local neighbourhood character and access to quality spaces across urban areas.

Responses to a survey of local councils across Australia for this report found that more than 45% had experienced an increase in demand for local open space. More broadly, Infrastructure Australia identified a 23% increase in the use of national parks and green spaces nationally and 87% of Australians noticed a positive shift in community attitudes towards urban green space, particularly among those living in high-density areas (Infrastructure Australia 2020b).

The pandemic has also highlighted social inequities in the rollout of digital infrastructure across our urban areas, resulting in lower socio-economic areas being more digitally isolated. This is a key issue when digital access became a critical enabler of household education and information.

A survey of all councils across Australia undertaken for this report asked whether digital connectivity had been a constraint to education, working or recreation since the COVID-19 pandemic; 40% of respondents answered yes and 60% no. A report by Infrastructure Australia identified the move towards regional areas for working from home and living during the pandemic (whether permanent or temporary) may have caused additional strain on a network that was not designed and built for such commercial usage levels (Infrastructure Australia 2020b). Broadband capacity increased by 40% during the pandemic, with the National Broadband Network releasing latent capacity to service providers (Infrastructure Australia 2020b).

In some locations, the potential cumulative impacts of the COVID-19 pandemic and disasters such as bushfires are likely to have compounded accessibility issues and digital inequality (Infrastructure Australia 2020b). The Australian Digital Inclusion Index (ADII) measures digital inclusion. It found that affordability remains the key barrier to digital inclusion and is likely to be exacerbated by COVID-19-related economic slowdown. Approximately 800,000 (20%) of the 4 million primary and secondary students in Australia are from households with the lowest income bracket (under $35,000). These households record an ADII score of 53, which is 10 points lower than the national average (Infrastructure Australia 2020b).

While digital affordability has marginally increased since 2014 and the absolute cost of the internet has gone down, with greater usage households are spending more now than ever on data. The gap is also widening between the lowest and highest income households, with the average household spending approximately 3.5% of disposable income on communications, compared with 10–15% for consumers in the lowest income bracket.

Development and business

The influence of the pandemic on population growth and, in turn, demand for more housing is yet to be determined. Implications for where we choose to live are also playing out (i.e. will there be a sustained growth in demand for larger homes on the urban fringe or will we return to smaller dwellings closer to activities and services within inner-city areas?). Changing living preferences could also lead to less pressure on our inner-city areas to densify, but greater pressure for housing and digital infrastructure within regional or urban fringe areas (see Outlook and impacts).

Australian businesses had to adjust quickly to the pandemic, moving to online platforms and shifting service patterns from CBDs to the suburbs. The pandemic drove 100% growth in monthly online retail, 5 times the annual growth recorded in 2019. At the same time, 9 in 10 Australian firms adopted online collaboration tools and services (Infrastructure Australia 2020b). These new patterns of e-retailing and e-commerce are increasing reliance on local deliveries, freight and logistics

movements across our urban areas, resulting in changes in traffic patterns and times.

The COVID-19 pandemic also brought greater recognition of the importance of local supply chains, reducing reliance on shipping and aviation and thus associated emissions. While these changes have been positive, any resulting decline in global fossil fuel emissions in 2020 are believed to be negligible because the travel changes were significant but brief (Liu et al. 2020). The question is whether changes to onshoring the production of goods and services can be sustained, thereby having a longer-term impact on the need to travel, and so on associated emissions.

Working, travel and transport

In many areas, the COVID-19 pandemic has accelerated trends towards more local working, as a significantly greater share of the population worked from home. The reduced rate of travel across and within our urban areas resulted in higher rates of walking and cycling. In the short term, this resulted in improved air quality because of the associated reduction in vehicle emissions.

A survey of households undertaken during the first wave of the pandemic in Australia (March 2020) found that, before the COVID-19 pandemic, 71% of employed people did not work from home. 'Following the COVID-19 restrictions, the same number almost halved (down to 39%), with a quarter of respondents subsequently stating that they were working from home 5 days a week. As a result, the overall average number of days worked from home per week grew to 2.5, up from 0.8 days' (Beck & Hensher 2020).

However, this approach was not equally achieved across urban areas and occupations, with many forms of employment unable to be undertaken from home (e.g. retail, transport, construction). The same Australian household survey found that the ability to work at home varied according to age, gender and income, with a greater proportion of middle-aged respondents working more frequently from home (both before and during the pandemic). Close to half of those surveyed that were employed stated that their work could be done from home (47%), with those with higher incomes or from middle-aged households more likely to be able to complete their work from home (Beck & Hensher 2020).

The pandemic also shifted thinking to more active forms of transport. Streets were closed to allow for greater walking and cycling activity, and footpaths were widened to allow for improved social distancing. Cycling rates improved and new forms of mobility were considered (e.g. low-speed electric transport including bikes, skateboards and scooters). A survey of Australian councils for this report found that 42% of urban areas experienced an increase in walking and cycling because of the pandemic.

Conversely, the pandemic had a reverse and more adverse impact on public transport patronage, with a return to greater private car use owing to the lack of safety, or perceived lack of safety, of public transport (AHURI 2020). This was manageable in urban areas when many people were working from home, but has the potential to exacerbate urban congestion if left unabated as life returns to normal.

The pandemic also significantly affected interstate and international travel. The survey of Australian households in 2020 found that, at the end of the first week of April, only 2% of respondents were still planning on making a flight of some kind, with 52% delaying travel voluntarily and 46% doing so because of government regulations. Most of the intended travel was personal (79%) rather than business travel (29%).

These figures were significantly greater in the context of air travel – 'interrupted travel was primarily international (63%) compared to

domestic (55%), and almost all personal travel (94%) rather than for business (12%). Almost half of respondents cancelled travel (49%), a large number returned the ticket for a voucher or credit with the airline, with 11% having rebooked their flights for a later date' (Beck & Hensher 2020).

Looking forward, it is anticipated there will be a return to international travel, with many predicting a spike in international travel and tourism once borders open again and a satisfactory level of immunisation achieved. There are also predictions for a move to multimodal transport systems, dominated by public and shared transport. Individual mobility will be provided as a service and a last-mile option (where individual services to your home connect with public services in the wider area). These changes will seek to reduce demand for road spaces and car parking, freeing up space for valuable alternative uses such as open space and retrofitting car parks into community and shared spaces. Technological solutions are also being explored to make travel easier for citizens, such as alerts about when is a good time to travel or when is a bad time, via a simple traffic light system in a smartphone application.

The pandemic has also highlighted the value of a more localised approach to service provision and the need to design our urban areas to provide a mix of uses and services locally. This can reduce the need to travel and improve service provision for when people cannot travel across urban areas.

Pollution

A survey of Australian households during the pandemic found that private car use reduced by 35%. For most respondents who were able to decrease car use, reduction was even greater at 60% compared with pre-COVID-19 pandemic levels (Beck & Hensher 2020). This reduction had recognisable air quality benefits in Australia's major cities, as cited by more than 25% of Australian councils when asked about the implications of the COVID-19 pandemic to their local area. However, 20% of councils surveyed cited an increase in local traffic as an impact while 18% identified a decrease.

These variations in council responses may relate to the varying roles and characters of their urban areas. It may also reflect research that found that as the COVID-19 pandemic restrictions eased, reductions in vehicle travel reversed – private vehicle numbers increased at the cost of public transport, resulting in greater levels of pollution and adverse air quality impacts.

The same survey of Australian councils found that the generation of more waste was one of the top 4 impacts of the pandemic. It is also anticipated that official waste figures will show a shift in the types of waste generated during the pandemic because of changing lifestyle patterns (e.g. more packaging owing to increased rates of home shopping and use of takeaway food services) and for sanitisation reasons (e.g. more medical masks and hand-sanitising containers). With more citizens staying at home to work and school, home improvement projects have likely increased along with the associated waste. However, it would presumably follow that the commercial, tourism, hospitality and industrial sectors affected by the pandemic had periods of significant waste reduction as production and business outputs declined during the same period.

Industry

Industry operating within our urban areas places an array of pressures on the environment. Of note is resource consumption (see Resource consumption), air and land pollutant generation, and waste generation (see Waste and pollution).

Assessment Pressures affecting the urban environment

2021

Medium confidence

Australia's population will continue to grow, putting more pressure on major urban cities to densify and expand, leading to greater travel and overall resource consumption, waste and pollution. The impact of these pressures is currently stable, but climate change is expected to compound the pressures on infrastructure, systems and resources, with the potential to increase impacts and lead to worsening conditions.

Related to United Nations Sustainable Development Goal targets 6.3, 11.b, 11.3, 11.6

Assessment Climate change

2021

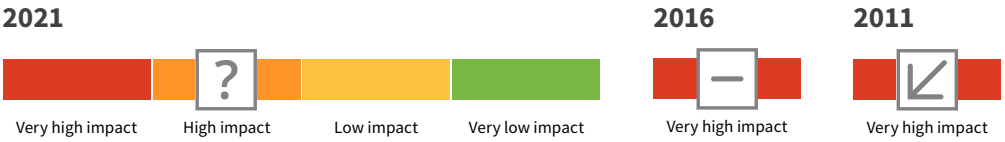
2016

2011

High confidence

Australian urban areas have very high exposure to the climate change impacts. These impacts are expected to increase, placing growing pressure on the urban environment and the livability of its citizens. Climate change is also expected to affect biodiversity in urban areas through greater urban heat; more extreme events including bushfires, drought, extreme rainfall and flooding; and sea level rise.

Assessment Population growth, Urban densification and expansion, Travel demand, Resource consumption, Waste and pollution

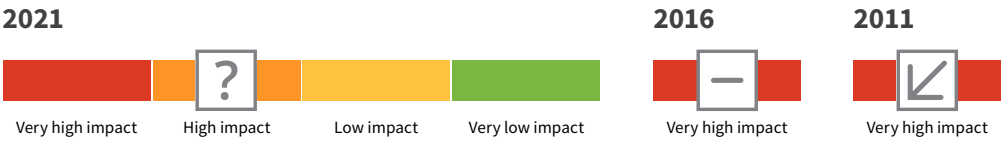


Medium confidence

Despite the effects of the COVID-19 pandemic, it is expected that Australia's population will continue to grow over the medium to long term, putting greater pressure on major urban cities to densify as well as expand. This will imply greater travel and overall resource consumption, producing more traffic congestion, waste and pollution, leading to greater pressures on important environmental and agricultural areas.

At the same time, from an environmental perspective, the migration to regional areas has led to improvements in major cities, particularly in terms of consumption. This trend might be good for cities, but is unclear or deteriorating for regional areas where they may experience more pressure on consumption, infrastructure issues, sprawls due to new development, and increases in house prices. More data on long-term effects are needed.

Assessment Industry, Urban expansion, Resource consumption, Waste and pollution



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Assessment ratings

For assessments in the 'Pressures' section

- **Very low impact:** Pressures do not degrade or only negligibly degrade the state of the environment.
- **Low impact:** Pressures minimally degrade the state of the environment over a small extent and/or with low severity.
- **High impact:** Pressures moderately degrade the state of the environment over a moderate extent and/or with moderate severity.
- **Very high impact:** Pressures strongly degrade the state of the environment over a large extent and with a high degree of severity.

Trend

- **Improving:** The situation has improved since the previous assessment (2016 state of the environment report).
- **Stable:** The situation has been stable since the previous assessment.
- **Deteriorating:** The situation has deteriorated since the previous assessment.
- **Unclear:** It is unclear how the situation has changed since the previous assessment.

Management

Management approaches

Australia's urban environments are managed by 3 levels of government – local, state and territory, and federal. Each of these levels has its own policies, strategies and regulations that are increasingly looking to, and aligning with, a range of international benchmarks and goals, including the United Nation's Sustainable Development Goals.

Contributing to this mix of management approaches are new sources of data and research from citizen science programs, along with a growing recognition of the value of traditional information from Indigenous people. These inputs are being provided in the context of a rapidly changing urban landscape that is responding to the implementation of new technologies and the pressures of climate change.

Urban planning and collaboration

Urban environments are predominantly, designed, curated and influenced by local planning policies, schemes and plans. This local focus allows for a tailored approach to addressing the needs of a particular place and to working with local communities. It also allows for a better understanding of the particular pressures facing a given area and a more targeted set of actions and outcomes.

State and territory governments play an important role in setting the overarching strategic directions and objectives to guide broader outcomes relevant to a larger geographic area. These strategies and policies often define where growth should and could occur, and how it can most effectively be managed to improve urban livability, optimise existing infrastructure and protect areas of high environmental value.

These objectives are important considering the findings of a Parliamentary Inquiry into the Australian Government's role in the development of cities in 2018. The inquiry found that many of Australia's cities are sprawling into peri-urban agricultural areas that have functioned as high-value food production areas. With the effects of climate change and growing livability concerns such as the urban heat island effect (see Urban heat), the pressures on biodiversity and food security are growing. In the case of Melbourne, one submission to the inquiry identified that continued urban sprawl '… will reduce the city's food bowl capacity significantly, from 40% currently to around 18% by 2050' (Sheridan et al. 2015). In response to these issues, many state and territory plans identify urban boundaries to control the sprawl of cities. Examples of such management policies include Melbourne's and Hobart's urban growth boundaries, Greater Sydney's Metropolitan Rural Area and Adelaide's Environment and Food Production Areas.

In addition to these urban boundaries, many jurisdictions manage urban sprawl by targeting an increasing proportion of new development to occur within existing brownfield (inner urban) or greyfield (suburban) areas as infill rather than new greenfield (urban fringe) development. These ratios are provided in overarching strategic plans such as:

- the *2018 ACT planning strategy*, which targets a 70:30 ratio

- the *30-year plan for Greater* Adelaide (2017), which targets 85% of new development to be urban infill and all development occurring within the environment and food production areas, recognising that the existing ratio is at 76:24
- *Plan Melbourne 2017–2050*, which looks at 2 main scenarios for growth. The scenarios vary the established infill to greenfield ratio from 75:35 to 70:30, with the latter ratio referred to as the 'Aspirational Scenario'. These scenarios are being refined further in land-use frameworks presently being prepared by the Victorian Department of Environment, Land, Water and Planning
- the *South East Queensland plan 2017* (2017–2031), which includes Brisbane City and targets a 60:40 ratio, favouring new development in existing urban areas
- the *Perth and Peel @3.5million* plan, which has targeted 47% of new development as infill since 2010 with the remaining 53% as greenfield; it is estimated that this equates to an additional 380,000 infill dwellings by 2050
- the *Greater Sydney Region Plan: a metropolis of three cities – connecting people* (2018), which builds on the 70:30 ratio of previous metropolitan plans. It encourages infill development around transport nodes and all new development to occur within existing areas designated as urban, to retain the metropolitan rural area as a green, agricultural and environmental belt around the city
- the *Southern Tasmania regional land use strategy 2010–2035* (amended 2019), which targets a 50:50 ratio of infill to greenfield development within Greater Hobart, with a minimum net residential density of 15 dwellings per hectare. The strategy also stipulates infill targets for each of the 5 municipal areas.

Targets for a ratio of infill compared to greenfield development are not limited to state and territory plans for capital cities. A survey undertaken of all councils across Australia for this report found that more than 60% of respondents had ratios in their local plans. When asked whether their local government area encouraged most new developments in greenfield or brownfield areas, 60% said brownfield, 33% said greenfield and 8% said 50:50. This direction for predominantly infill development was notable given that 66% of council respondents categorised themselves as remote, rural or peri-urban.

At the federal level, the *Environment Protection and Biodiversity Act 1999* assesses the impacts of proposed new urban development in greenfield areas on matters of national environmental significance. It seeks to assess impacts more broadly than can be achieved on a site-by-site or development-by-development basis. Strategic environmental assessments (SEAs) consider the cumulative impacts of development over time (50 years or more) and determine whether areas are sustainable for development, where development can go and the conditions it must meet to proceed. SEAs have been used in various locations including the Australian Capital Territory (Eastern Broadacre, Gungahlin, Molonglo Valley and West Belconnen), Greater Sydney's Western City, Melbourne's urban growth boundary, and the Perth and Peel regions. A strategic assessment is being progressed for Eastern Broadacre, located to the east of Canberra city. This strategic environmental assessment is assessing employment opportunities, such as industrial land, in the context of several matters of national environmental significance present in this corridor (EPSDD 2021).

City deals

City deals are another means of coordinating multiple levels of government to achieve constructive and lasting urban outcomes by delivering common goals in a defined place. Modelled on the United Kingdom's City Deal approach, which began in 2012, Australian City Deals have prioritised government investment in cities. The first city deal was signed in December 2016 for the City of Townsville, with 8 subsequent deals either signed or under development (Adelaide, Darwin, Geelong, Hobart, Launceston, Perth, Western Sydney, South East Queensland). Based on the success of this model, it has expanded to include 3 regional areas: Barkly (Northern Territory), Hinkler (Queensland) and Albury–Wodonga (New South Wales, Victoria). (See case study: Launceston city deal.)

A key element of the city deals' success has been their design to suit a specific place. Each deal has been negotiated on a case-by-case basis, regarding local objectives, challenges and opportunities. Each city deal has a defined geographic area, with clear outcomes and actions that are monitored annually. Each deal also has clear governance arrangements, delivery timeframes and accountabilities, and performance measures, including indicators.

The deals seek to unlock business investment through economic reform and infrastructure investment to accelerate job generation. The deals also frequently have a strong environmental, safety, security and urban design focus to improve levels of urban activity and livability outcomes. Other common elements of the deals include (PM&C 2016):

- targeted initiatives to strengthen existing or emerging economic hubs, including transport, industry, defence, health and education facilities
- transport infrastructure funding or financing to improve connectivity and increase access to jobs
- housing supply and planning changes to encourage higher-density development, affordable housing and activate value capture
- changes to regulatory and zoning arrangements to encourage commercial growth and allow entrepreneurial approaches to service delivery including the sharing economy
- investments that improve environmental outcomes – such as enhancing public spaces, facilities and active transport options; reducing emissions and pollutants; or improving the sustainability performance of buildings and infrastructure
- maximising benefits from underused state and federal government land – for example, repurposing government land to be used for affordable housing or public space
- integrating environmental criteria into decision-making – such as green coverage to minimise urban heat island impacts, reducing localised air pollution, reducing waste and increasing recycling.

Vision and validate

A new concept – referred to as a 'vision and validate' approach – has emerged to better manage and service our growing urban environment with the right infrastructure at the right time.

Traditionally, city and transport planners have used a 'predict and provide' approach, which predicts where growth will occur based on prior trends and provides infrastructure in response.

Case study Launceston City Deal

Signed in 2017, the Launceston City Deal positions Launceston as one of Australia's most livable and innovative regional cities. The deal brings together the Australian Government, Tasmanian Government and the City of Launceston around 5 key objectives:

- jobs and skills growth
- business, industry and population growth
- a vibrant, livable city
- innovation and industry engagement
- a healthy Tamar Estuary.

Major commitments include a $260 million investment in the University of Tasmania's main campus to eventually accommodate 16,000 students, researchers and staff. Activity will be generated within and surrounding the campus through a $19.4 million investment in the Launceston City Heart Project. This project aims to enliven Launceston's historic central business district to create a competitive, vibrant and compelling city centre for locals and visitors.

The deal also seeks to increase housing choice. Through the Tasmanian Planning Scheme reforms, the deal seeks to work with developers to increase in infill development and make better use of vacant brownfield and greyfield land in the city centre.

An important infrastructure objective of the deal related to the exploration of financing options for upgrades to Launceston's combined sewerage and stormwater system. This includes through the Clean Energy Finance Corporation.

Improving the health of the Tamar Estuary and Esk River catchments was also identified as a key deliverable, given the important role the estuary and its catchment plays in the wellbeing of wildlife as well as local tourism. The City Deal, through the Tasmanian Government, established the Tamar Estuary Management Taskforce (TEMT) to oversee the development of the *Tamar Estuary River health action plan* by the end of 2017. Reporting to the Launceston City Deal Executive Board, the TEMT will measure the success of the action plan by the degree to which it reduces pollution from urban and rural land uses and addresses pollution from the combined sewerage and stormwater system (DITRDC 2017).

In contrast, the vision and validate approach seeks to proactively shape urban environments in line with an agreed overarching vision for an area. It focuses on user needs and aims to provide the necessary urban infrastructure ahead of demand. This can provide greater efficiency of delivery and reduce the cost of provision. At the same time, it can deliver a better quality of life for residents with the services they need available as they move into an area or as it grows.

Another major shift in how our urban areas are managed relates to a greater focus on place. This focus on geography, rather than on a specific service or issue, has allowed for a more collaborative and integrated approach to managing the pressures of our urban spaces across multiple levels of government and service providers. By thinking of a place as an ecosystem of activity, a greater collective understanding of issues and how they interact can be gained by city planners and leaders. This can in turn lead to a more collaborative and less siloed response. For example, improvements to a place need a combination of road, transport, green, service and design improvements, requiring a collective and aligned response by all relevant government departments, agencies and local stakeholders.

The Australian Government's City Deals provide examples of both 'vision and validate' and place-based approaches (see City deals). The joint investment by the New South Wales and Australian governments in the $11 billion Stage 1 Greater Western Sydney Airport Metro is one such example. The project (due for operation in 2026), takes an approach different from other retrospective investments in rail lines (DITRDC 2021). It is designed to reshape Greater Sydney by providing the first north–south rail line in Western Sydney. In doing this, it will catalyse development in more than 11,000 hectares of greenfield land and create more than 200,000 jobs.

Integrated management

Place-based approaches to managing pressures on our urban areas that are led and funded by local and state governments can be more localised and nuanced. However, such approaches present challenges in addressing pressures that are common across Australia and that have nationwide implications.

A review of urban planning strategies across Australia by the Planning Institute of Australia (PIA) found that there was an absence of a single holistic plan for how and where Australia's urban areas could and should accommodate growth.

PIA argues that, although the Australian Government influences urban conditions and environments by controlling immigration and major infrastructure investment decisions, it lacks accountability for any specific place. City deal locations are the notable exception. It can also provide 'spatially blind' national policies that unintentionally influence the shape of our cities and regions.

The PIA found this failure to achieve a 'line of sight' across the 3 levels of government is resulting in a mismatch between where and how growth and social changes are occurring across Australia and the infrastructure and services needed to support them. It concluded that this was resulting in '… significant community fatigue and frustration at the lack of alignment of integrated planning' (PIA 2018). Infrastructure Australia reinforced these concerns, highlighting the absence of a national population policy (and growth projections) as particularly problematic for effective and timely infrastructure delivery. Failure to think holistically inhibits consideration of cumulative and longer-term pressures on the environment (e.g. pollution and waste generation).

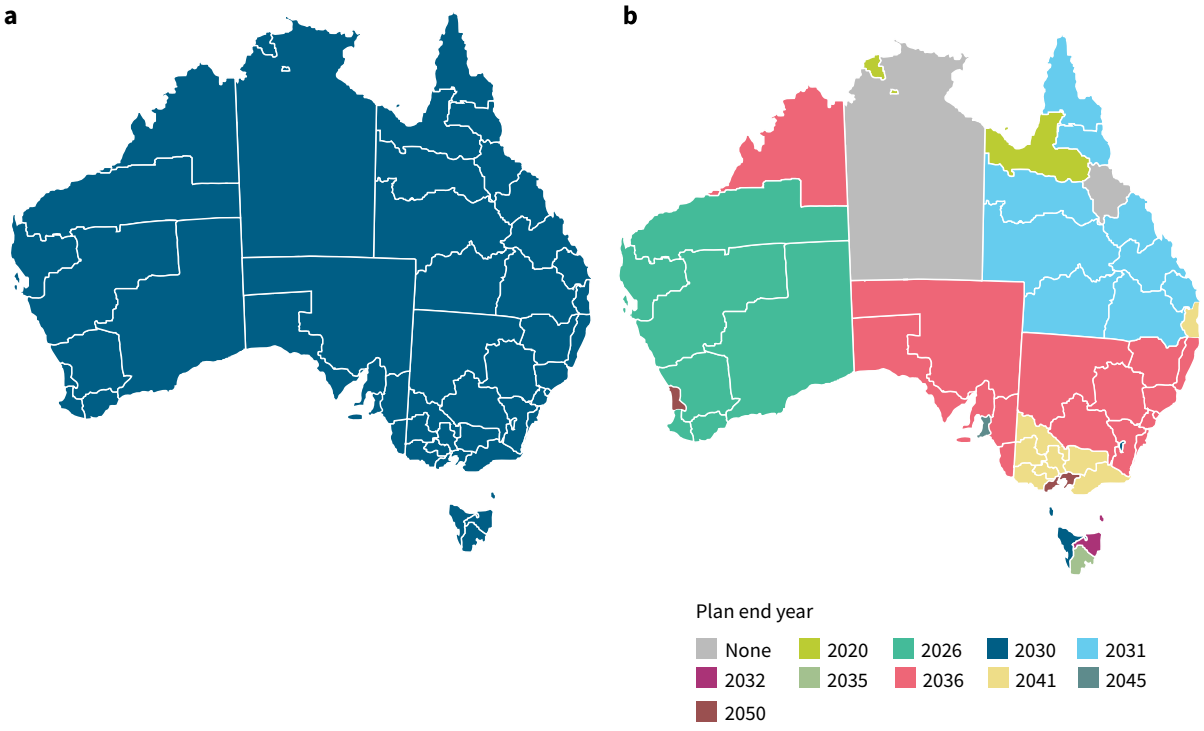
The PIA based its observations on a review of 57 regional plans across Australia. The

review found that most parts of Australia were covered by regional plans, except for large areas in the Northern Territory and Townsville. Collectively, these plans were assuming a population of around 3 million by 2050. However, there was a lack of coordination on timeframes, with 11 different planning horizons (Figure 33). The number of local, state and territory planning authorities, together with a lack of cross-state coordination, resulted in varying and misaligned assumptions, inconsistencies of timeframes and approaches.

The PIA also found that:

- plans often nominated population growth targets, yet as local and regional plans they failed to plan for variations to national immigration
- fewer than half the plans included targets for future housing needs
- only 13 of the 57 plans included explicit future job growth targets. Even fewer of the plans considered the nature of future jobs and their implications for planning activities and services within our cities and regions
- most of the 57 plans showed only partial integration of land-use and infrastructure planning. Many regional plans lacked either a transport or other infrastructure component. Where infrastructure matters were considered, it was generally not linked to assumptions for long-term growth.

To address these shortfalls in managing our urban environment, the PIA proposes a national strategy for the sustainable management of our urban environments – that is, a national settlement strategy. Such a strategy would establish key directions, targets and performance indicators to be consistently followed by regional (state and



Source: PIA (2018)

Figure 33 (a) Regional plan boundaries, as of June 2018, and (b) end dates for regional plans, 2020–50

territory) and subsequent local plans. It could take a holistic view of where and how Australia should grow based on environmental and economic factors, including how and where the projected demand for an additional 1.2 million new dwellings over the next decade should be accommodated across Australia and within our urban areas. This will help ensure that the right infrastructure is funded and delivered to create more sustainable outcomes.

The PIA identified the benefits of such a potential strategy as enhanced community confidence, more efficient and effective investment in urban infrastructure, and improved urban livability and wellbeing outcomes for future generations.

The 2018 Parliamentary Inquiry into the Australian Government's role in the development of cities supported the need for a national plan of settlement to set a vision for our what our cities could and should look like over the next 50 years and to provide a pathway to achieve that vision. It recognised the need to better link vertically and horizontally across governments to align infrastructure with land use to maximise the value of both.

The inquiry findings also recognised that this was not achievable without the coherent vision that comes from a more place-based focus through master planning (Parliament of Australia 2018b). In addition to a national plan, the inquiry recommended governance changes including creating a Minister and Department for Cities and National Settlement, with the national Office of Chief Planner to oversee the creation and implementation of any subsequent plan.

The inquiry identified that links between cities and regions were critical, and there was a need to see regional development as integral to a broader pattern of national development. It supported the 'hub-and-spoke' model of development and more effective transport modes such as high-speed rail being prioritised between urban centres on the east coast of Australia. To support the redistribution of growth from our major cities and the economic sustainability of regional and rural areas, the inquiry also recommended regional areas focus on their point of difference by highlighting the economic and lifestyle advantages of living in regional communities through a cost-of-living index.

Sustainable net zero cities

Sustainability is a well-established term in urban management, often cited in legislation as an overarching objective for urban planning and development. Urban sustainability seeks to improve the livability of our urban areas, including their ecological, social and economic components, without leaving an environmental burden on the future generations.

It is increasingly argued that, to best address urban challenges, we need to move away from thinking of sustainable development simply as a means of reducing resources and reducing waste towards the concept of regenerative development. The notion of the regenerative city was outlined in 2010 by the World Future Council as a city that regenerates its ecological footprint, not just minimises it (Girardet 2010). The regenerative approach extends the concept of sustainability to one that aims to 'turns the curve' to dramatically reduce environmental impacts (Newman 2020).

A key factor in turning the curve relates to Australia's commitment to reaching net zero emissions by 2050 as a signatory to the Paris Climate Change Agreement (see the Climate chapter). To achieve reductions and work towards a net zero economy, it will be necessary to rethink our urban structures and systems, how we live within them and the materials we use to build them. For example,

the absorption of excess carbon from the atmosphere could be achieved through measures such as carbon-absorbing cement, carbon-negative plastics, biogenic building materials and carbon-negative landscaping (Newman 2020). We will also need to fast-track the transformation of Australia's energy systems, including the manufacture, use and exporting of green hydrogen, and ongoing investment in grid-scale renewables from virtual power plants and microgrids to large-scale batteries to achieve more distributed models of energy storage. We will also need to support the manufacturing industry to use clean technologies and manufacture new technology for clean energy projects. A focus will also be needed on transforming our transport systems, including its electrification and where possible a move towards the most sustainable form of travel – walking.

Many suggest that the move towards decarbonisation and a net zero economy could be accelerated through post-pandemic economic recovery packages and urban policy considerations (G30 2020, Jung & Murphy 2020, OECD 2020).

The circular economy

The concept of a circular economy is an important manifestation of urban sustainability and regeneration. A circular economy seeks to minimise or eliminate waste and greenhouse gas emissions through better urban infrastructure and service design, using a system of closed loops that rely on renewable energy sources such as sunlight and wind instead of fossil fuels. As the name suggests, it seeks a shift from a linear 'take, make, dispose' economy, to a circular model using the 3 Rs approach: to reduce our use of resources, re-use what we have and restore our ecosystems.

This approach is being developed by Australian, state and territory governments through various programs, including the CSIRO's preparation of a circular economy roadmap (Schandl et al. 2021). The roadmap reviews 4 materials that are common waste streams in our economy: plastics, tyres (automotive and mining), glass and paper. The roadmap identifies a range of economic, social, environmental and resource efficiency benefits for Australia to transition to a circular economy (Schandl et al. 2021).

Australian policy-makers are increasingly applying a circular economy (Geissdoerfer et al. 2017), with many plans and policies developed (or under development). For example:

- The *National waste policy action plan 2019* has a specific focus on a circular economy (DAWE 2019).
- New South Wales has prepared the *NSW circular economy policy statement 2019 – too good to waste*, which has provided a basis for the preparation of the 20 Year Waste Strategy for NSW.
- Queensland has launched a Circular Economy Lab, which is an incubator for start-up companies.
- The 2020–21 Tasmanian budget dedicated more than $30 million to waste and resource recovery initiatives across Tasmania.
- Recycling Victoria has prepared a 10-year plan – *A new economy* – based on circular economy goals and principles.
- Western Australia references the circular economy in their *Waste avoidance and resource recovery strategy 2030* (Schandl et al. 2021).

Industry is also actively engaged in achieving more circular outcomes. Examples include the first apartment made in Australia using waste materials, built by developers Mirvac in collaboration with the UNSW Centre of Sustainable Materials Research and Technology (SMaRT Centre 2021).

Urban resilience

Urban resilience refers to the capacity of the urban ecosystem and those living and operating within it to retain or recover structure, functions and amenity after experiencing shocks and stresses (adapted from the definition from 100 Resilient Cities (Rockefeller Foundation 2021)). Resilient systems not only respond to and adapt more readily to shocks and stresses, but can emerge stronger after impacts to thrive.

According to the City of Sydney (City of Sydney 2021):

> … chronic stresses weaken the fabric of a city on a day-to-day or cyclical basis. Examples include ongoing issues such as rising inequity, increasing pressures on healthcare services, a lack of social cohesion and inadequate public transport. Acute shocks are sudden, sharp events that threaten a city. Examples include heatwaves, bushfires, floods, disease outbreaks and cyber-attacks … Resilient Cities has developed the city resilience framework to provide a lens to understand the complexity of city systems and the drivers that contribute to their resilience.

The Resilient Cities Framework is one of several frameworks that have been developed to help urban areas prepare for and better manage the physical, social and economic shocks and stresses facing our urban environment. This framework has been moved forward by some of Australia's most influential local councils, including the City of Sydney and City of Melbourne in partnership with 100 Resilient Cities – a group of like-minded international cities pioneered by the Rockefeller Foundation. Australia's first resilience strategy was produced in Melbourne in 2016 with input from more than 1,000 individuals from 230 organisations, Melbourne's 32 local councils and the Victorian Government (City of Melbourne 2016).

The strategy sets out a series of actions to make Melbourne a more viable, livable and prosperous city. A Chief Resilience Officer supports its implementation.

The Resilient Sydney Strategy was prepared in 2018 in consultation with local communities, the New South Wales Government and the 33 local councils of Greater Sydney. It established a city-led network of chief resilience officers, bringing together knowledge, practice and partnerships to fund and mobilise communities, city governments, urban practitioners and partners to deliver impact-driven resilience strategies and projects (City of Sydney 2021).

A survey of all local councils in Australia for this report found a strong focus on urban resilience to respond to climate change and improve sustainability. When asked whether their council was addressing these pressures through a specific plan, 74% of survey respondents answered yes, 22% answered no and 4% were not sure. The nature of the plans included climate action, response and emergency plans and strategies; resilience, adaptation and urban sustainability strategies; and net zero targets. Many of these plans and strategies were supported by coastal management, biodiversity, energy and tree canopy or urban forest strategies. Most were less than 5 years old, with the oldest prepared in 2010 and the most recent in 2021.

Infrastructure resilience

The effective function of our built environment and our quality of living increasingly relies on the quality and extent of urban infrastructure. Accordingly, significant investment is occurring or planned to occur in health, transport, utility, education and digital infrastructure across Australia. For example, in the 2020–21 Budget, the Australian Government delivered a 10-year, $110 billion investment in transport infrastructure. This provided up to $5 billion

towards the Melbourne Airport Rail and up to $1.05 billion towards the Perth METRONET. It built on the 2017–18 Budget commitment to the $10 billion National Rail Program, which is a major, long-term commitment to invest in passenger rail networks within and between our cities and their surrounding regional centres.

The National Rail Program includes contributions towards:

- the Western Sydney Rail (St Marys to Bringelly) ($3.5 billion)
- a fast rail between Geelong and Melbourne ($2 billion)
- upgrades the Beerburrum to Nambour line in Queensland ($390 million)
- the electrification of the Gawler line in Adelaide ($220 million)
- the Gold Coast Light Rail Stage 3A ($112 million).

Contributions have also been made to the first stage of Brisbane Metro, a 21 kilometre network of electric vehicles connecting 11 locations in Brisbane (Brisbane City Council 2021b).

The 2020–21 budget also included a new $4 billion Urban Congestion Initiative to target urban road congestion. It also committed to providing $10 billion for the Bruce Highway Upgrade Program from 2013–14 to 2027–28 to better connect urban areas from Brisbane to Cairns. These budget commitments support broader infrastructure investment programs for roads and rail, including the Roads to Recovery Program, the Bridges Renewal Program and the Black Spot Program.

State and territory governments are also making large investments into infrastructure pipelines in their 2020–21 budgets, including:

- $107 billion by New South Wales (Rabe 2020)
- $80 billion by the Victorian Government (Invest Victoria 2021)
- $16.7 billion by South Australia from 2020–21 to 2023–24 (Infrastructure SA 2021)
- $4.3 billion over the 4 years to 2023–24 by the ACT Government.

The significant value of these new investments also points to new methods of managing demand and making the most of what we have through new technologies (e.g. the application of the internet of things (IOT); see New technologies and the future city) and more effective system operations.

The Australian Business Roundtable for Disaster Resilience & Safer Communities estimated that $17 billion would need to be spent on rebuilding critical infrastructure because of natural disasters affecting Australia by 2050. With climate change, extreme events will increasingly affect our environment, including our urban areas. This will require not only investment in new fit-for-purpose infrastructure, but retrofitting existing infrastructure to tolerate heat, flooding and other extreme events while supporting essential services to the community, businesses and government (see the Extreme events chapter). This is becoming a growing challenge in sectors such as water, where some infrastructure, located below well-established urban areas, is reaching the end of its economic life.

The roundtable's estimations did not factor in emerging risks to our critical infrastructure, such as cyber attacks and extremist acts. The former presents a growing risk to the function of our urban areas, given the growing reliance on a digital economy including online working, shopping, health services, education and socialising. Cyber security is a growing issue given the relative ease with which disruptors

significantly affect the function of our urban areas (i.e. our ability to turn on a tap for water or flush a toilet) through cybercrime. The Australian Government Department of Home Affairs seeks to achieve 'a more secure online world for Australians, their businesses and the essential services' through the investment of $1.67 billion over 10 years to deliver *Australia's cyber security strategy 2020* (Australian Government 2020).

Infrastructure Australia found that, compared with other Organisation for Economic Co-operation and Development countries, Australian infrastructure networks have proven to be resilient under pressure and open to innovation (Infrastructure Australia 2020b). Despite this, the COVID-19 pandemic has highlighted the need for us to rethink how, where and what we build infrastructure. For example, we may need to better consider the health implications of our infrastructure by allowing for greater ventilation, physical distancing and cleanliness; or the shape of our urban areas given social changes in where we work and how we travel (see Travel management). These changes will most likely result in changes to the cost–benefit analyses of new and retrofitted urban infrastructure, increasing operating costs and contributing to more waste generation.

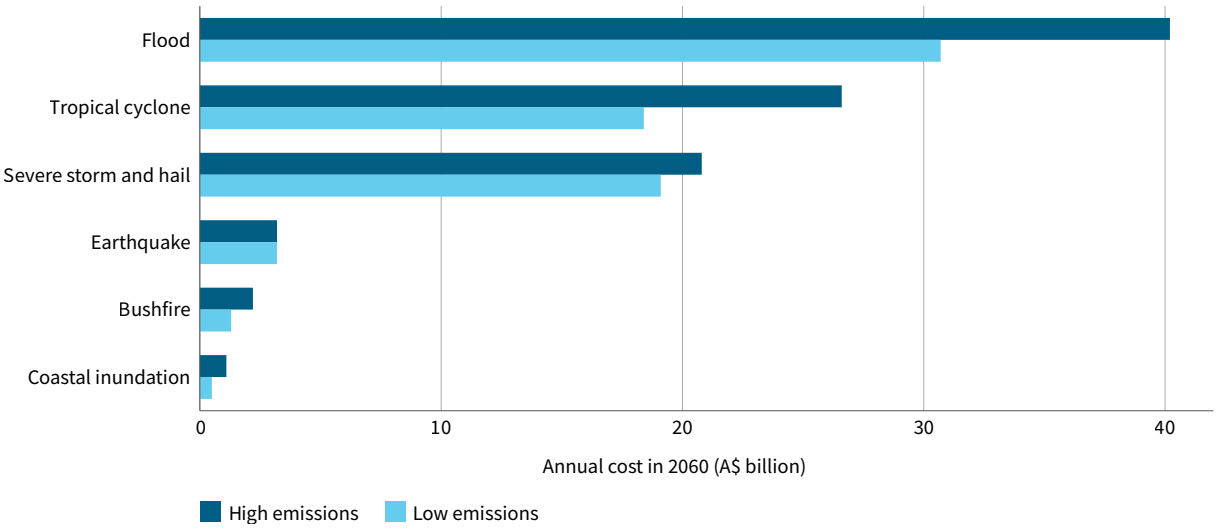
A new approach to supporting effective decision-making regarding the infrastructure needs of an area is known as a Place Infrastructure Compact (PIC). Successfully piloted by the Greater Sydney Commission, the PIC methodology identifies scenarios for growth, and assesses the capacity and cost of all existing and future infrastructure that may be needed (including transport, roads, schools, community and green infrastructure) to service the anticipated level of growth within an area. The growth compact can be used to recommend to relevant government departments the development sequencing that should occur within a defined area to most efficiently and cost-effectively deliver a complete community outcome, as well as the likely proportion of funding that could be sourced to fund it.

The growth compact is now being applied to the greenfield areas of the Western Sydney, allowing for a direct comparison of the true cost of developing inner-city to greenfield areas on a per-person and per-job basis. This is important analysis because, while infill development can reduce pressures to expand our urban areas into greenfield areas, it can also increase pressures on existing inner-city infrastructure. The PIC concept is helping to highlight these challenges and the true cost of infill development to local and state governments.

Reducing disaster risk and improving recovery

Disasters generated by extreme weather events and climate change are now occurring at rates beyond our historical experience. Population growth, expanding urban areas and the increasing frequency and severity of these events now increases the vulnerability of more Australians and urban environments (National Resilience Taskforce 2017). The 2019–20 catastrophic bushfire season claimed 33 lives, destroyed 3,000 homes and an estimated 13 million hectares while severely impacting local communities. Such events test the limits of capacity and capability in Australia (National Resilience Taskforce 2017).

In addition to the significant safety and wellbeing implications of disasters are the stresses they place on the economy. 'In 2017, Deloitte Access Economics estimated that disasters cost the Australian economy approximately $18 billion per year over the past decade. This is predicted to increase



Source: National Resilience Taskforce (2017)

Figure 34 Forecast of the economic cost of extreme events, 2015–50

to $39 billion a year by 2050 if current development patterns and population growth remains unchanged' (Littleproud 2020:3) (Figure 34). At least 50% of these costs come from the impacts of disasters on health and wellbeing, education, employment and community networks (National Resilience Taskforce 2017).

On the global scale, Australia is an active contributor to initiatives to increase our resilience to extreme events. These events include the World Humanitarian Summit and the New Urban Agenda. Australia also works towards the Sendai Framework for Disaster Risk Reduction 2015–2030, the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change. Building on these initiatives, standards and goals, the National Resilience Taskforce mapped the vulnerability of Australia, which led to the Council of Australian Governments (COAG) endorsing the National Disaster Risk Reduction Framework in March 2020.

The framework identified a common agenda for collective action and 3 immediate disaster risk reduction strategies to pursue:

- improved resilience of the telecommunications network
- adaptation of the built environment
- improved national natural hazard data and intelligence.

COAG subsequently tasked emergency management ministers to develop a national action plan to implement the framework.

The first national action plan to implement the National Disaster Risk Reduction Framework highlights the actions the Australian Government is taking to enable the nation to reduce disaster risk. Consistent with the framework, it recognises that no single jurisdiction, agency or organisation has the capacity to identify or address risk, and build community trust and confidence.

The action plan has a series of priorities, including:

- raising public awareness and providing hazard risk information, particularly in the priority areas of land use and development, building and infrastructure, and finance
- making climate and disaster data and information available and accessible to support accountable decision-making and investment through the work of the Australian Data and Digital Council. For example, the Australian Flood Risk Information Portal enables flood information (flood maps, studies and satellite imagery), currently held by different sources, to be accessible from a single online location
- mainstreaming disaster and climate risk requirements into standards and codes, particularly in the priority areas of land use and development, building and infrastructure, and finance
- reviewing how investment decisions for infrastructure are informed by avoided losses (tangible and intangible) and how broader benefits are assessed through cost–benefit analyses. For example, in the Australian Capital Territory, improved analysis of risks will improve management of processes during power outages while strengthening the resilience of the territory's traffic network
- considering how to adapt the built environment to future climate and hazard conditions through research and changes to the National Construction Code (by the Building Ministers' Forum), and learning from comparable experiences in Canada, New Zealand and the United States.

The national action plan also identifies relevant commitments in the city deals (see case study: Darwin Living Lab) for climate and disaster risk reduction initiatives. For example, in Townsville, an intergovernmental water security taskforce, convened as part of the Townsville City Deal, provided several recommendations to improve the security of Townsville's water supply. These are now being implemented across 3 levels of government – the Australian Government, Queensland Government and the Townsville City Council.

The national action plan is being implemented by a new National Recovery and Resilience Agency, which will support local community responses to large-scale natural disasters. It will advise government on policies and programs to mitigate the impact of future major disaster events, while drawing on advice from the scientists of the Australian Climate Service to help better anticipate, manage and adapt to climate (Prime Minister of Australia 2021).

Case study Darwin Living Lab

The future looks hot for Darwin. The city is already experiencing the kind of increase in hot days that were predicted for the year 2030. Climate projections suggest a significant increase in the average number of days per year ≥35 °C, with actual measurements showing a new record of 45 days ≥35 °C during 2019, compared to an average of 18 days per year that reached at least 35°C between 1991 and 2020. In 2019, the City of Darwin declared a climate emergency, recognising the escalation of climate impacts in the city. The Darwin Living Lab is responding to this sense of urgency.

The Darwin Living Lab was established in 2019 to help Darwin develop into a thriving cool capital of northern Australia. A 10-year collaboration between CSIRO, the Australian and territory governments, and the City of Darwin, the lab is testing and evaluating urban innovation ideas from the territory and around the world in 'real world' experiments to improve the city's livability, sustainability and resilience.

By taking a collaborative approach with local, interstate and overseas practitioners, planners, developers, governments and scientists, the first phase of the Living Lab has 3 focus areas:

- Smart City Initiatives, which use data and digital innovation to stimulate innovation and learning by bringing together leading experts to exchange ideas for a more connected and livable Darwin
- Heat Mitigation Initiatives, which support urban cooling trials that enable a cooler and greener, climate-adapted city. This includes monitoring and benchmarking outcomes to provide an accessible resource for Darwin on ways to cool streetscapes, adopt climate-sensitive approaches to building design, and use living infrastructure strategies appropriate to the dry tropical climate
- Energy-Efficient Home Design, which looks at trialling new approaches to deliver cooler and more energy-efficient buildings in the tropical north.

CSIRO is developing a monitoring and evaluation approach to track the changes made through the Living Lab while translating the knowledge and experience gained into products and services for other tropical cities in Australia and the Association of Southeast Asian Nations region.

The Darwin Living Lab is complemented by other CSIRO urban living labs across Australia, including Western Sydney and a proposed third lab in Canberra. These place-based collaborations address sustainability and resilience issues, and test ideas in different climates and urban contexts.

Source: CSIRO (2019b). © CSIRO Australia

Figure 35 The Darwin Living Lab

Buildings and infrastructure efficiency

A key factor in achieving greater urban resilience, sustainability and a circular economy relates to the design of our buildings and urban infrastructure, and the materials we use to construct them.

Australia's built environment is a major energy consumer, accounting for more than 50% of Australia's electricity demand and 23% of our national greenhouse gas emissions (PCA & GBCA 2021). However, there is significant potential for our buildings to be more efficient. To achieve this, existing policies and programs must evolve and expand to ensure a more consistent approach across all building types. Australian Government leadership will also be critical to driving sustainability gains.

The Australian Sustainable Built Environment Council (ASBEC) recognises the significant opportunity for building design, materials and development to make pragmatic and cost-effective reductions in emissions (PCA & GBCA 2021). Data presented by ASBEC from the Office of the Chief Economist at the Parliamentary Inquiry into the Australian Government's role in the development of cities showed that:

> Energy efficiency measures targeting residential buildings implemented between 2005 and 2015 had already driven a 15% reduction in energy usage, compared to projected energy usage. It also noted that improvements had been driven, in large part, by increases to the National Construction Code's minimum energy performance standards. (Parliament of Australia 2018b)

Role of standards and policies

Despite the potential for significant improvements, many contend that current building efficiency and sustainability guidelines do not provide enough support for the scale of change required across Australia. The Green Star System, developed by the

Green Building Council of Australia, and the National Australian Built Environment Rating System are not statutory requirements. They are therefore not consistently applied across or within jurisdictions for new buildings, resulting in significant missed opportunities for more efficiency and sustainability. Their application also raises concerns about the cost implications of applying these standards, with Green Star ratings, for example, often relating to higher-end, larger or premium developments (Parliament of Australia 2018b).

The National Construction Code (NCC), managed by the Australian Building and Construction Board (a Council of Australian Government standards body) also has challenges. The code focuses on building safety, yet includes energy-efficiency standards for residential properties. These standards can be lower than those required by the state and territory governments that administer the code. Therefore, states such as New South Wales supplement the NCC with their own regulations such as the Building Sustainability Index.

Submissions to the 2018 Parliamentary Inquiry into the role of the Australian Government in the development of cities from the ASBEC and the Green Building Council of Australia argued that the residential building performance standards required by the NCC are outdated and fall short of best practice. There is little market incentive for developers or investors in residential properties to go beyond the performance standards required by the NCC (Parliament of Australia 2021). The NCC requirements have been tightened since the Parliamentary Inquiry, but the impact of this is still to be seen.

CSIRO shared research with the Parliamentary Inquiry (2018) indicating that, like developers, investors have little incentive to improve the sustainability of their residential assets. As a result, low-income renters were often left vulnerable to accommodation that is poorly adapted for climate. The Property Council of Australia also urged the Australian Government to develop 'a nationally consistent approach to residential rating' (SCITC 2018), pointing out that individual jurisdictions are implementing a patchwork of different rating schemes in the absence of a national approach.

Improvement of existing buildings has also been slow because of various barriers, including awareness and financial disincentives. Accordingly, energy intensity has only improved 2% across the commercial sector and 5% in the residential sector from 2005 to 2015 (ASBEC 2016).

ASBEC identified that broader improvements outside the market leaders in Australia have and should continue to be driven by government programs and regulations, including improved minimum energy performance standards for buildings and appliances.

The Parliamentary Inquiry concluded that, although substantial sustainability gains had already been made, particularly among top-tier commercial office buildings, more could be done to facilitate ongoing improvement to the environmental sustainability of Australia's buildings. Opportunities included:

- the expansion of successful programs such as the Commercial Building Disclosure Program to smaller commercial office buildings
- market incentives for sustainability measures beyond the standards of the NCC through the introduction of a building rating and disclosure scheme, like the Commercial Building Disclosure Program.

To achieve better environmental outcomes, the committee identified the need for 3 strategies:

- strengthening the NCC minimum standards for environmental sustainability
- establishing a national plan towards zero-carbon buildings by 2050
- extending mandatory disclosure schemes for buildings' sustainability ratings and rating schemes in general.

Potential improvements

The technology already exists today to achieve zero-carbon buildings. Distributed solar photovoltaic (PV) systems can eliminate remaining emissions, resulting in zero-carbon buildings by 2050. Furthermore, better use of building data and autonomous controls can significantly improve building efficiencies to reduce operational emissions (i.e. energy used to heat, cool and light buildings).

Several organisations are now preparing roadmaps towards net zero construction. One example is the Zero Carbon Buildings Commitment that challenges business, organisations, cities, states and regions to reach net zero carbon in operation for all assets under their direct control by 2030, and to advocate for all buildings to be net zero carbon in operation by 2050 (WGBC 2021). Signed by 28 city governments worldwide, including the City of Sydney, the collaboration includes the Green Building Council of Australia, the World Green Building Council and C40 Cities.

Emissions from buildings can also be reduced by using existing technology and smart design to suit the climatic region (DISER 2021a). The 'passive design' approach has the potential to not only reduce household costs but improve the quality of living, making homes and work environments more comfortable and quieter with better indoor air quality. These features also boost resilience to the adverse effects of extreme weather. 'Parramatta City Council is mandating minimums of 5 or 6 Green Star Ratings as part of the design specifications for its urban renewal projects. Similarly, the Queensland State Government has set Green Star Rating targets to improve the sustainability of its building portfolio' (Parliament of Australia 2018b).

Major infrastructure also has a critical role to play given the significant materials they use, including steel and concrete manufacturing, which make up more than 14% of global emissions. Projects such as the $16-billion Sydney Metro City & Southwest Project are implementing measures to achieve at least a 20% reduction in carbon emissions associated with construction when compared to business as usual (Sydney Metro 2019), driving major signals to market through their procurement.

Increasingly, the urban environment is turning towards buildings and infrastructure being producers of energy (e.g. solar panels) and food (e.g. vertical farms or roof gardens) rather than consumers. Building materials are being redesigned to reduce the energy required to produce them and the level of waste they generate through the construction or demolition process (see Waste and pollution). New materials can also make the built environment more eco-friendly. New plastics can replace current building materials (CSIRO 2019a), and modular buildings can be designed that can be adapted over time to improve their use and sustainability.

Case study Indigenous roof gardens

In some cases, urban gardens are providing both food production and connection to culture.

Waraburra Nura rooftop garden, University of Technology Sydney

Source: Aryton (2020)

The Waraburra Nura (Happy Wanderer's Place) Indigenous rooftop garden at the University of Technology Sydney (UTS) provides valuable localised Indigenous cultural curriculum. Waraburra Nura features many indigenous plants and showcases Indigenous knowledge associated with these plants, including:

- understandings of relationships between plants through combination planting and how these relationships inform their efficacy as medicine and for nutrition
- information related to Indigenous cultural practice and agriculture, showcasing their uses for technologies, nutrition and medicines.

Providing a biodiverse haven for insects and birds and a calming and relaxing environment for students and staff in a heavily built-up environment, this garden is complemented by extensive educational offerings specifically aimed at growing students and staff understandings of Indigenous people, culture and knowledge. The garden has been used to connect to Country on campus, and features in the curriculums of UTS subjects in art, Indigenous studies, medicine, education, science, Indigenous political history, design studies, the Graduate School of Health and more.

Yerrabingin rooftop garden, Redfern, Sydney

Sources: Yerrabingin (2021), van Egmond (2020) and Green Magazine (2021)

Yerrabingin ('we walk together') is an Indigenous-led group delivering cultural landscapes within urban areas, undertaking projects aimed at delivering environmentally conscious native landscapes based on Indigenous knowledge and design principles.

Yerrabingin provides employment opportunities for many Indigenous Australians. It also creates intercultural opportunities for the broader public. Although they have delivered many projects, perhaps their most famous is the urban rooftop farm located in South Everleigh, Sydney, also named 'Yerrabingin'.

This farm, set on top of an office building, covers around 500 square metres and is home to more than 2,000 edible, medicinal and culturally significant indigenous plants being farmed and shared through commercial relationships. The farm also incorporate educational offerings that centre on Indigenous knowledge of plants. The social and cultural outcomes of Yerrabingin projects are positive, and the biodiversity benefits of converting roof space in a heavily built-up industrial area are significant.

Bringing nature and green back

With growing recognition of the health and wellbeing benefits of being close to green spaces and biodiversity (see Livability), many communities are turning to new approaches to bring nature back into our urban environments. Green and blue spaces are now recognised as critical urban infrastructure, with urban planners and governments increasing the extent and network of such spaces.

These approaches range from urban forest strategies and the mapping of the green and blue grids across urban environments, to the design of new infrastructure such as roads, bridges, drains, seawalls and piers to support ecology. Many approaches also recognise the importance and opportunity of involving Indigenous people in efforts to bring nature back: 'Bringing nature back into cities has the potential to become an environmentally just and culturally inclusive dimension of the 21st urban sustainability agenda upon which future generations of city-dwellers rely' (Mata et al. 2020).

By mapping existing green and blue networks, local and state governments can better plan for and connect small fragmented ecological areas (including wetlands) to allow for the better movement of animals, and their feeding and breeding needs.

Given the pressure on land availability in urban areas, there is also a growing recognition of the need to cohabitate our urban green spaces for mutual benefit. By considering ecology in the design phase of infrastructure and buildings (known as 'biodiversity-sensitive urban design'), the urban environment can make a more positive contribution to biodiversity conservation. Rather than restricting it to fragmented remnant habitats, biodiversity can be incorporated into the built form by applying a range of approaches such as:

- bird-friendly windows
- roof-cavity roosting spaces
- nesting bricks
- wall crevices
- porous pavement
- bioswales
- rain gardens
- green streets, roofs, walls and parking lots.

Garrard et al. (2017) proposed a framework that moves away from the concept of 'offsetting' to one that values the place-based value of nature. The 5 principles of this framework are:

- maintain and introduce habitat – plan and build new developments in areas of low ecological value so they maintain and introduce habitat rather than destroy it
- facilitate dispersal – connect habitats via private and public land or green lanes; reduce weeds and exotic predators via landscaping with indigenous plants, and establish pet containment programs
- minimise threats and anthropogenic disturbances – reduce run-off and nutrient loads by using vegetated swales and rain gardens, which also deliver biodiversity benefits; minimise noise and light pollution with sound barriers; implement temporary road closures; and dim or reconfigure streetlights
- facilitate natural ecological processes by reducing disturbances such as fire and flooding
- improve potential for positive human–nature interactions through better-quality urban design and community stewardship, and addressing conflicts between biodiversity and safety objectives.

Increasingly, communities are playing a key role in managing the green and blue networks in their urban environments by working collaboratively to reintroduce native species and plants. Communities are restoring

bushlands and changing gardening practices to encourage wildlife back into backyards, on verges and in remnant areas. Simple acts such as the introduction of subtropical rainforest plants into suburban backyards has, for example, significantly increased the number of brush turkeys in the Greater Brisbane region since the 1970s (Jones et al. 2004).

Policies such as the *Action plan for listed migratory species* (Australian Capital Territory) also play an important role by managing the impacts of residential development on wetland sites. As part of the plan, noise and lighting impacts from residential or recreational development must be considered in development plans near wetland sites.

Applying Indigenous knowledge brings plant and other species back into the urban environment and improves the sustainability of our urban areas. It also recognises Indigenous cultures and their connection to Australia's natural and urban environments. A key starting point is applying Indigenous knowledge of the climate to better understand the characteristics of a particular urban area (see case study: Understanding climate) to enable better built environment design, plant selection and management measures to improve livability outcomes.

Research projects such as the Which Plant Where program have been exploring where current species may or may not thrive under the more extreme climates that Australian cities face. The project is an example of effective collaboration and joint funding between research, government and industry organisations to better manage our environment. Other programs such as Gardens for Wildlife are encouraging residential gardeners to use indigenous plant species known to attract insects to increase biodiversity (Mata et al. 2021). Indigenous-owned and operated nurseries, such as IndigiGrow in La Perouse, New South Wales (IndigiGrow 2021), and the Dalki Garringa Native Nursery (Barengi Gadjin Land Council 2021, Dalki Garringa Native Nursery 2021) are using traditional knowledge to support environmental projects and caring for Country initiatives, as well as better understanding of native plants and their role in the environment.

Case study Urban forest strategies

Source: GA NSW (2020b)

Over the past 10 years, there has been growing recognition of the importance of urban forest strategies to both improve livability and better manage urban environments. Local and state governments are increasingly preparing policies and standards to address this through metropolitan and local government strategies or programs for planting trees, and creating open spaces, green corridors and networks, and green walls and roofs.

A recent survey by the Horton Innovation found that 88% of 131 councils surveyed across Australia had an urban forest strategy or were developing one, 61% had an endorsed tree canopy target on public land and 26% had a target relating to private land (Hurley et al. 2020).

There is also extensive activity at the Australian Government, and state and territory levels, including:

- The Australian Government's $37 million investment to plant 20 million trees by 2020.
- One of the Australian Capital Territory Government's key goals is to develop an urban footprint that secures a 30% tree canopy cover and 30% permeable surfaces as part of its Living Infrastructure Plan. The plan sets the direction for maintaining and enhancing trees, soils and waterways to keep Canberra cool, healthy and livable in a changing climate. This direction is supported by changes in the *Tree Protection Act 2005* (ACT) to protect the mature trees while making room for new ones.
- In Victoria, the Nature in the City Strategy (2017) and Greening the West program aim to increase green space by 20–25% by 2030 and double the urban tree canopy by 2050. The Victorian Government has prepared a draft Open Space Strategy for Metropolitan Melbourne in response to action 93 of the 5-year implementation plan for *Plan Melbourne 2015–2017*, which seeks a whole-of-government approach to cooling and greening Melbourne and supports local urban forest strategies. The Victorian Planning Authority's Precinct Plan Guidelines also set a 30% tree canopy target in growth areas.
- In New South Wales, the Greater Sydney Region Plan sets an overall target to increase tree canopy from 23% to 40%. This is supported by the premier's priority to plant 5 million trees across Greater Sydney and the appointment of the first Minister for Planning and Public Spaces. Further details on the green and blue network along more refined targets by place and development type are provided in the Greener Places Design Guide (i.e. 15% for central business district areas, 25% in medium- and high-density and light commercial areas, 40% in suburban areas).
- In Western Australia, the Department of Planning, Lands and Heritage, in partnership with the Western Australian Local Government Association, has developed a comprehensive guide to assist local governments manage their urban forests and enhance urban tree canopy. The department has also prepared a comprehensive online mapping tool in collaboration with CSIRO, which can track tree canopy cover and growth over time.

Table 22 Australian and international tree canopy targets

City	Existing tree canopy cover (year)	Urban tree canopy target	Target date
Melbourne[a]	22% (2017)	40%	2040
Adelaide[a]	27.8% (2017)	>30%: 20% increase; <30%: no net loss	2045
Perth[a]	19% (2016)	30%	2036
Toronto, Canada	27% (2008)	40%	2060
Washington, DC, USA	35% (2009)	40%	2029
Detroit, USA	22% (2008)	40%	n/a
New York, USA	24% (2006)	30%	2036
London, UK	20% (2008)	30%	2050

n/a = not available; UK = United Kingdom; USA = United States of America
a City refers to local government area.
Source: GA NSW (2020b)

Management of specific pressures

As our urban areas expand and increase in complexity, there is a growing need to break the nexus between growth and negative impacts. This is a significant ambition, but our governments and citizens are working to reduce their environmental impact through more strategic and forward planning, increased efficiencies, new technologies and changes in lifestyle to reduce consumption.

Travel management

The need to travel across and between our urban areas has a direct and adverse impact on the natural environment because we build roads and generate pollution. It also has significant impacts on our health and wellbeing by reducing the livability of our urban areas. To manage and reduce these impacts, city and transport planners are not only reshaping how we get around our urban areas, but the extent to which we need to travel.

Two key policy approaches are being applied:

- The first approach seeks to reduce the need to travel by creating more complete local neighbourhoods and centres of activity near where people live. Australian cities are managing this through various strategies such as the 20-minute neighbourhood (*Plan Melbourne 2017–2050*) or the 30-minute city (Greater Sydney Commission 2018) and the *ACT Transport Strategy 2020*. These plans would allow people to live within 20 or 30 minutes of the jobs, services and educational opportunities they need by bringing a mix of services and opportunities closer to suburban areas (Reid 2020).
- The second approach seeks to encourage and enable people to live closer to existing services and infrastructure. This increases brownfield or infill development

through greater urban densities, thereby reducing urban sprawl and the associated implications for the natural environment surrounding our urban areas. This approach is often referred to in town planning terms as the creation of polycentric urban environments – that is, urban areas with multiple centres of activity that bring services closer to where people live.

The success of policies such as Melbourne 2030, developed and released in 2002 (Victorian Department of Infrastructure 2002) and the subsequent Inner Melbourne Action Plan – adopted in 2005 (IMAP Councils 2005) – are now recognised as having transformed Melbourne by increasing the success of existing activity centres, creating more centres, and enabling higher urban density. Similarly, Fortitude Valley in Brisbane was identified for urban renewal by the Brisbane City Plan 2014 (Brisbane City Council 2014, Brisbane City Council 2021a), transforming it from a primarily commercial district to a mixed-use area, resulting in a 54% increase in population density between 2014 and 2019.

To support these approaches, Australian urban planners are investing in the design and delivery of record levels of city-shaping public transport (see Infrastructure resilience). New public transport is being planned to better connect existing centres of activity to improve access to jobs (see City deals).

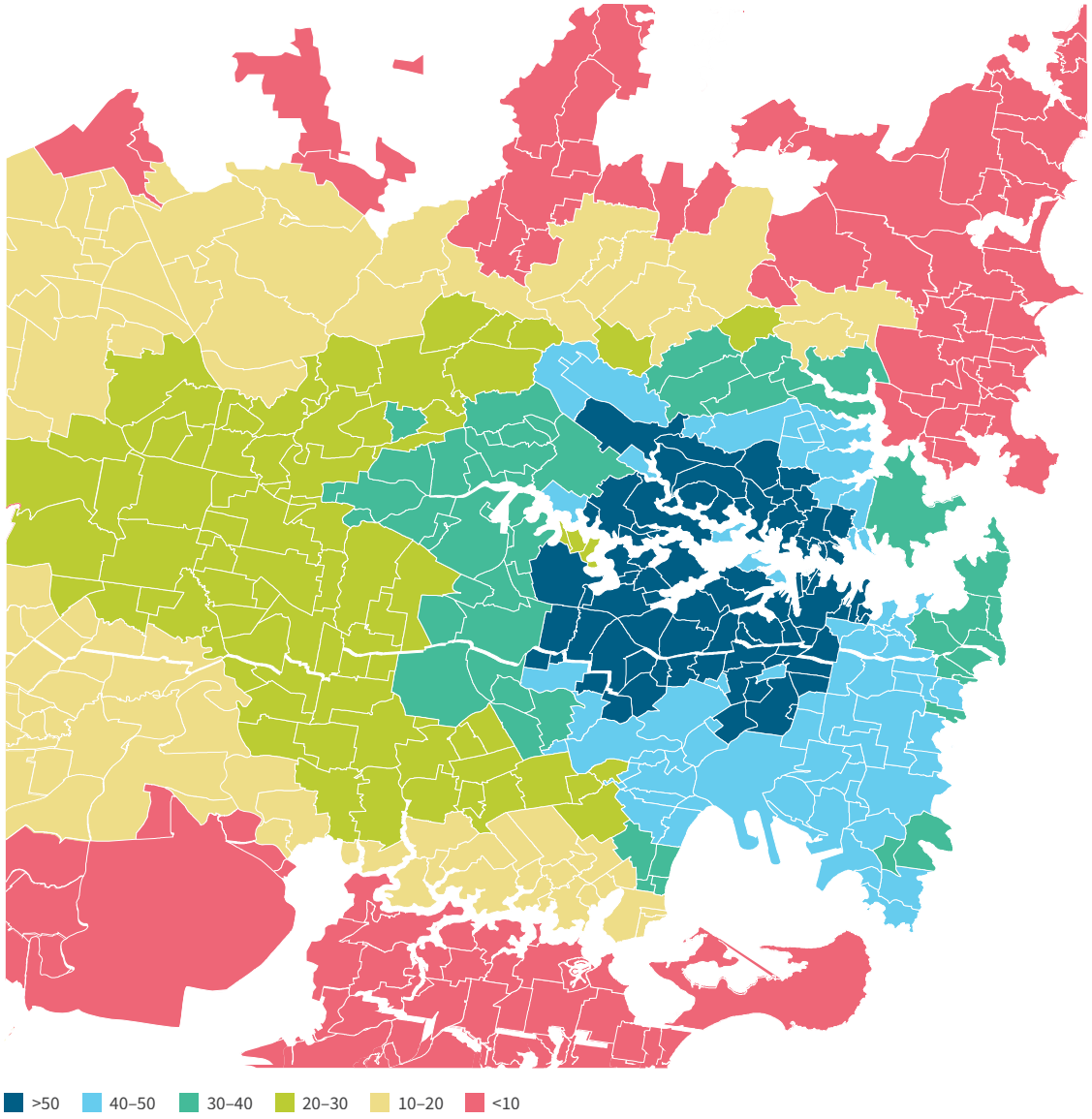
Greenfield and fringe areas often have the lowest levels of livability because of their poor level of accessibility to services and open spaces, particularly by more active forms of transport such as walking and cycling. Despite urban policies such as the 20-minute neighbourhood and 30-minute city, a 2015 study by Deloitte predicated that the 200,000 people that had to leave Western Sydney daily for work each day would increase to 340,000 by 2041 (Deloitte 2015). Furthermore, the Grattan Institute found that outer suburbs of Greater Sydney had poor access to the most attractive jobs and needed to travel well over the 30-minute target now established for Greater Sydney (Figure 36).

As Australia shifts into recovery following the COVID-19 pandemic, it will be important to support the retention of working from home to reduce the load on our transport systems (see COVID-19 pandemic). But it will also be important to ensure that it does not exacerbate the social divide. Given that not all jobs are available locally, particularly in urban fringe locations and regional areas, many citizens will need to continue to travel. Investment in digital as well as transport infrastructure will be key components of a more equitable response.

Waste management

Population and economic growth have translated into more waste. When the value we put on our time grows faster than the price of material goods, waste production increases further (Pickin et al. 2020). New management approaches are now seeking to break this link and turn the waste we generate into a resource that is not an inconvenience, but rather a valuable part of our economy. Ultimately, the aim will be to create a fully circular economy (see The circular economy).

Research shows that, by improving Australia's recycling rate by 5%, an additional estimated $1 billion could be added to Australia's gross domestic product (GDP) (Schandl et al. 2021). Analysis by CSIRO found that, in 2016, only 2% of lithium batteries were collected in Australia with the remainder sent to landfill. This lack of collection and processing infrastructure equates to an estimated lost economic opportunity of up to $2.5 billion by 2036 (King & Boxall 2019).

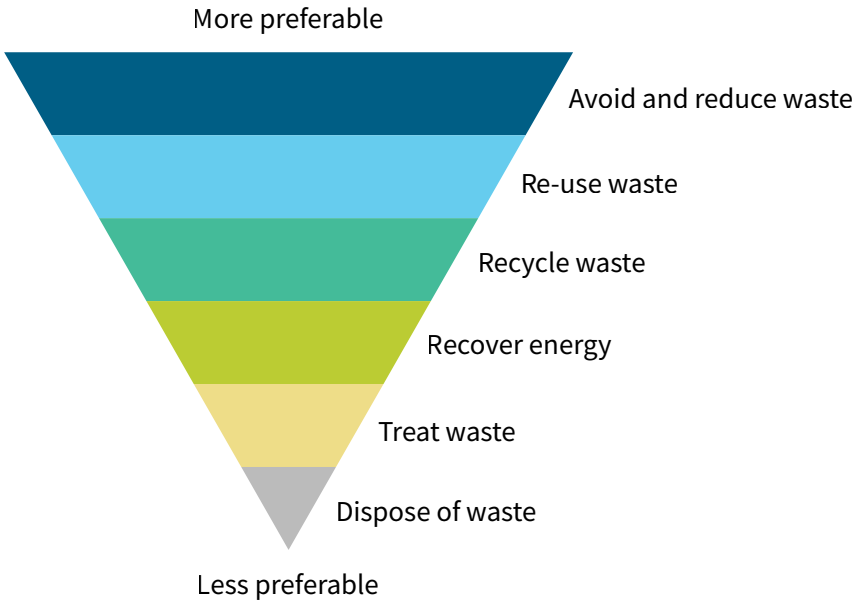


Source: Kelly & Mares (2013)

Figure 36 Percentage of jobs that can be reached in 45 minutes by car in Sydney, 2011

Australia has committed to reducing waste generation by 10% per person by 2030. There has also been a move towards the concept of a waste hierarchy that ranks options for management based on environmental impacts (Figure 37). The most important of these options is avoidance – that is, not producing waste in the first place, followed by reduction and re-use. The *National waste report 2020* identifies methods to support these changes including better product design, repair, sharing and thoughtful consumption.

Advancements in technology will help us change the types and quantity of waste we generate. Recent shifts from paper to digital communications is one significant example. Other examples include changes in packaging so that it is stronger yet lighter, reducing the weight of our recycling bin contents.



Source: Pickin et al. (2020)

Figure 37 Waste hierarchy

Technology and financial incentives are driving changes in industry, leading to less waste in machinery and system upgrades, just-in-time purchasing, smart packaging systems, light-weighting, and inventory controls (Pickin et al. 2020). A 'smart city' approach is also growing, including the use of 'smart bins' that tell operators when they are full, and robotic and optical sorting equipment that improve material recovery facilities (see Smart cities).

Government policies

State and territory governments have the main responsibility for managing waste through legislation, policy, regulation, strategy and planning, as well as permitting and licensing waste transport, storage, treatment and disposal operations. One of the challenges facing the sector has been the diversity and inconsistency of approaches across jurisdictions (DAWE 2013). This challenge, combined with the lack of a requirement for the re-use and recyclability of materials, has limited economies of scale and the identification of new markets for recyclable material.

To help manage these challenges, the Australian, state and territory governments, together with the Australian Local Government Association, updated the National Waste Policy in 2018. The policy has a strong ambition to move towards a circular economy. The subsequent *National waste policy action plan 2019* established targets and actions to implement the policy, and noted that the National Waste Report would provide both baseline and ongoing performance data for the 7 national targets (Tomaras 2020):

- ban the export of waste plastic, paper, glass and tyres, commencing in the second half of 2020
- reduce total waste generated in Australia by 10% per person by 2030
- achieve an 80% average resource recovery rate from all waste streams, and in agreement with the waste hierarchy, by 2030

- significantly increase the use of recycled content by governments and industry
- phase-out problematic and unnecessary plastics by 2025
- halve the amount of organic waste sent to landfill by 2030
- make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions.

The 2019 action plan's targets are supported by recent Australian Government announcements of financial support under the Recycling Modernisation Fund, to be applied in conjunction with state and territory funding programs. Another key initiative is the development of national standards and common definitions for waste and resource recovery data and reporting. Importantly, the Australian Government is leading this initiative, with collaboration from all state and territory authorities.

Other initiatives include the legislation of:

- the 2025 National Packaging Targets
- mandatory procurement targets
- mandatory recycling labelling
- a new Centre of Excellence to mentor and drive best-practice product stewardship schemes
- the Australian Recycling Investment Fund, provided through the Clean Energy Finance Corporation.

Private sector and community action

The *National waste report 2020* provides examples of where changes are occurring in the private sector, including community-led repair initiatives across Australia such as:

- Repair Cafes and Men's Shed workshops
- selling second-hand goods through community shops
- collecting and redistributing excess food goods
- new sharing platforms.

Construction sites are increasingly re-using excavated soils and rethinking building design so buildings can be purposefully deconstructed to maximise re-use and recycling (Pickin et al. 2020).

Private sector interest is also growing in taking the methane-rich gas generated in landfills and turning it into energy that is sold to the grid (Pickin et al. 2020). This market will be explored through facilities under construction in Western Australia, with others planned in New South Wales, Queensland, Victoria and Western Australia. However, the *National waste report 2020* identified that the development of these facilities is subject to the successful resolution of several factors with notable lead times, including establishing long-term supply contracts, accessing large capital investments and commissioning new technology in Australia.

Water management

For many, safe, reliable and affordable water is largely taken as granted (Infrastructure Australia 2019). However, it is projected that, by 2050, 25% of the world's population will suffer severe water shortages (UNDP 2015) and Australia will not be an exception. If we do not think about water management now, our urban areas will be left unprepared for another major drought, the cost of delivery will increase and urban livability will fall.

To meet the challenges of water security in a changing climate, there is a need to move to more sustainable and integrated water management practices. This means a move from a 'capture, use and dispose' approach to one where we use, recycle and re-use water resources (Infrastructure Australia 2019). This approach is starting to be applied

in some areas in Australia (see case study: Integrated water management). However, to be truly effective, we require a nationwide and fundamental shift in how we think about and value water, how we govern our water systems (from catchment to retail) and how we consume water.

In this regard, Infrastructure Australia cautions against investment decisions being made in times of crisis, using the $10 billion investment in desalination plants made during the millennium drought as an example. While these plants provide an effective form of insurance against drought, the Productivity Commission's analysis found that most of the investment in desalination capacity was potentially unnecessary or ill-timed as the plants have largely remained unused (the exception being Perth). The Perth desalination plant supplies around 48% of the city's water supply needs. Victoria's desalination plant has provided 76 gigalitres (GL) of potable water over the past 3 years, and the Victorian Government has ordered a further 125 GL for 2019–20 in response to dropping water storages. The Sydney desalination plant also entered 'restart mode' in January 2019 and provided the first delivery of desalinated water in March 2019, as Sydney's combined dam levels dropped below the 60% trigger.

We also need to learn how to manage water in the landscape better, thereby avoiding the substantial energy cost of transporting it. This requires the adoption of water-sensitive urban design principles and approaches including mimicking natural hydrological processes in the catchment. This approach can protect people and property from flooding and inundation while preventing and reducing water pollution downstream. For example, for the Western Australian Drainage for Liveability Program, the Water Corporation WA and Department of Water and Environmental Regulation worked with interested community groups, local authorities and industry to rehabilitate stormwater drains into 'living streams'. This increased community access to green open spaces and improved water quality, biodiversity and drainage.

A better understanding of the climate and water in the landscape is achieved by using Indigenous knowledge together with improved monitoring, testing and reporting across all urban environments, and will help manage pressures. One model is the establishment of partnerships between environmental water managers and Indigenous communities. For example, the *Yarra River Protection (Wilip-gin Birrarung murron) Act 2017* (Vic) identifies the river and its corridor as a single living and integrated natural entity for protection. It also prescribes the Yarra Strategic Plan to give effect to Wurundjeri Woi Wurrung peoples place-based management (DELWP 2020) (see case study: How empowering Indigenous values in urban areas promotes better outcomes for people and country).

Case study How empowering Indigenous values in urban areas promotes better outcomes for people and country

'Gambu gulinj Narrm, Wurundjeri Gulinj nuringianith biik baambuth: The First People of Melbourne, the Wurundjeri people, have been caring for Country since the beginning of time' (Melbourne Water & Victorian Government 2018).

The Birrarung (re-named by the colonialists as 'the Yarra') has always been central to the cultural, spiritual and ceremonial lives of the Traditional Owners of Melbourne. Today it provides 70% of Melbourne's drinking water, and 2,450 hectares of urban parklands and green space surround the Birrarung – it is the lifeblood of Greater Melbourne (Melbourne Water & Victorian Government 2018).

In 2017, the Victorian Parliament passed the *Yarra River Protection (Wilip-gin Birrarung murron) Act 2017,* the first legislation in Australia specifically designed to recognise the Birrarung (Yarra River) as a single, living and integrated natural entity for protection purposes. Recognising the Birrarung as one living entity, despite its traversal across many boundaries and disparate mechanisms of management, reflects the holistic management practices of Traditional Owners. Further, naming the act in the Woi Wurrung language of the Wurundjeri people was aimed at foregrounding Indigenous custodianship of the river.

The conceptualisation of Traditional Owners not just as stakeholders, but also as rightsholders, is also effected through the establishment of the Birrarung Council, a new statutory body comprised of Traditional Owners and others designed to 'give voice' to the Birrarung, a living entity. The bill specifically enables Indigenous governance through the establishment of the Birrarung Council while making specific reference to Aboriginal cultural values, heritage and knowledge of the Birrarung being recognised, reflected, protected and promoted – it is titled the *Yarra River Protection (Wilip-gin Birrarung murron) Act 2017*, (Parliament of Victoria 2017, DELWP 2020).

The foreword from the Wurundjeri people in the Yarra River 50-year Community Vision reflects the care and custodial responsibilities to the Birrarung their people have held and enacted over many millennia. It also exemplifies the need to empower Traditional Owner groups and their custodial responsibilities as an effective means to empower Country:

> The Wurundjeri believe that we need to change how all Victorians think about and actively respect the Birrarung. We believe we need to see not a resource to be exploited but rather to recognise the complex, living system that is sensitive to its surrounds and a uniquely Victorian treasure. By engaging with those partners with whom we now share the river we, together, are capable of turning around the damage of the past and acting to restore the river and its environment for the future use and enjoyment of all. Wurundjeri invites all people to see the Birrarung through our eyes, to talk with us to understand our values, and to partner with us to re-energise the river as we fulfil our cultural duty in bringing the Birrarung back to environmental, cultural, ceremonial and spiritual health. (Melbourne Water & Victorian Government 2018)

Reducing demand

Reduced demand through lifestyle choices and more efficient household and industry infrastructure can take immediate and significant load off urban systems. These demand-led approaches have been successful in Melbourne, Perth, Sydney and many regional areas. They have included formal water restrictions as well as support for water-smart household and commercial equipment (e.g. shower heads, hoses and washing machines). A systems-based approach also allows for using grey water and stormwater sources in gardens, toilets and other activities, further reducing demand.

Recycling water

Even with reduced per-person consumption, population growth in many urban areas will necessitate additional water sources or re-use through a variety of means including direct potable re-use, decentralised recycled water schemes and desalination.

Direct potable approaches inject recycled water directly into the supply distribution system, either downstream of the water treatment plant, or into the raw water supply immediately upstream of the water treatment plant. A key challenge with this relates to the stigma of drinking recycled water and citizen perceptions that this approach could lead to poor health outcomes.

Decentralised recycled water schemes can be more politically palatable because of their smaller scale, but they can result in a higher capital cost from duplicative distribution and reticulation networks. While desalinated water has gained political acceptance, these facilities are not viable for smaller urban areas and those located away from the coast. Furthermore, direct potable re-use is cheaper to produce than desalination (the difference in costs stems from the higher energy costs to treat sea water) and a more flexible part of water networks than decentralised schemes (Infrastructure Australia 2019).

The viability of each of these options will benefit from advances in technology but will also depend on changes in state laws, regulations and, critically, community perceptions. To achieve a more integrated approach to our water, wastewater and stormwater systems, we also need governance that better facilitates a more holistic approach to whole-of-system management.

A model is needed that also works for regional and remote urban environments. This will necessitate lower-cost solutions such as adaptive pricing, more customer-responsive water meters to provide accurate data for users, and new approaches to governance and service delivery. Ageing assets will also need to be managed through technology such as sensors that cost-effectively identify the works needed to make the system more adaptable to future trends and shocks.

There is also growing recognition of the value of irrigation to keep our open spaces green to help reduce heat and promote recreational activity. While this increases demand for water, it can be an effective use of recycled water and stormwater run-off. Advancements in stormwater harvesting technologies allow for greater use of stormwater for nonpotable applications in urban areas, such as water for sporting fields, gardens and plant nurseries.

Case study Integrated water cycle management

Source: Infrastructure Australia (2019)

Across Australia, urban areas are piloting and managing a range of integrated water cycle management approaches to produce potable water and provide an alternative source of water to preserve higher-quality water for households.

Such schemes can also recharge groundwater, provide environmental flows and start to manage public perception of recycled water use. Examples include Kwinana, Western Australia, for industrial use; the Virginia Scheme, South Australia, for agriculture; and Gippsland, Victoria, for both the industrial and agricultural sector.

There are also a few dual-reticulation recycled water schemes for residential uses operating across Australia, including:

- Rouse Hill, New South Wales, which connects a third pipe to allow for grey water to be used for gardens and toilets
- South East Water, Victoria, which provides recycled water to 11,000 residents and agricultural users
- Water Corporation, Western Australia, which treats waste water to a drinking standard to supply 2% of Perth's drinking water at the same time as using recycled water to replenish Perth's deep aquifers as Australia's first Groundwater Replenishment Scheme.

Heat management

The significant health, environment and social implications of urban heat (see Urban heat) have led to various measures to proactively reduce and manage the potential for impacts. In many cases, this has required a collaborative approach by governments and communities to address this issue through physical improvements to our urban environment. Approaches include:

- cool materials – changing what our urban environments are made of can significantly reduce heat absorption. Cool materials are those of high diffuse solar reflectivity and high emissivity value. They can be applied to roofs, pavements and all other horizontal surfaces. A recent study by Sydney Water and the Cooperative Research Centre for Low Carbon Living found the large-scale application of cool materials and water-based technologies could reduce average air temperature in cities by 1.5 °C, with local reductions close to the water reaching 10 °C (WSROC 2018)
- designing with water – water is one of the most effective ways to cool an urban environment because of the cooling effect of evaporation. Recent research finds that waterways such as fountains, ponds, lakes, wetlands, rivers and reservoirs can create 'urban cooling islands', resulting in a notable decrease in urban temperature (WSROC 2018). International research is testing the benefits of more interventionist cooling methods such as evaporative wind

towers, sprinklers and water curtains in public places (WSROC 2018)

- more trees and green cover – increasing tree and vegetation cover provides shade, increases rates of evapotranspiration, and regulates air movement and heat exchange. These factors greatly decrease in ambient temperatures in adjacent urban zones, while helping to mask urban noise, filter urban pollutants, prevent erosion, stabilise soil and improve amenity with associated health benefits for citizens. Government programs across Australia are identifying resilient tree species to provide shade more effectively; implementing new planning standards requiring larger backyards in new residential developments to ensure a tree can be planted and its roots accommodated; and conducting education programs regarding the value of trees, to offset concerns regarding falling tree branches and leaf litter (Figure 38). These measures are being complemented by local councils focusing on tree-planning programs in public open spaces and streets (Phelan et al. 2018).

Resources

Data and monitoring

There is growing recognition of the need to collaboratively agree to urban management strategies and policies. We also need to measure and monitor their effectiveness, so we can adjust, refine or change approaches over time to ensure that they are effective.

New technologies are supporting new data capabilities. For example, geographic information systems and 3D modelling are presenting our urban systems more clearly and in real-time, together with scenarios for change and testing including growth scenarios and land-use planning.

However, there are challenges with the consistency and availability of data, because state and territory data systems have evolved largely independently. Issues with information sharing, common data assumptions, agreed population, employment projections and accountability for issues are exacerbated by the number of local (537), state (5) and

Sources: left – Frasers Property (Greenlife Industry Australia & Hort Innnovation 2020); right – Google

Figure 38 Educational material supporting tree cover, Melbourne

territory (2) governments across Australia, together with the respective state, territory and federal departments responsible for managing issues within our urban areas. Current approaches result in inconsistent data collection by type, definition and time across states, cities and regions. Similarly, some data are difficult to measure and manage across large areas, as it is collected by individual authorities and not always widely shared (e.g. household water consumption). Another challenge relates to the frequently changing quality of data because of collection difficulties and costs.

This creates management challenges in comparing major urban areas across states and territories. It can also be an issue when comparing major urban areas with smaller ones, as governments and research organisations tend to focus on areas of greatest population and business investment. Failure to effectively secure and integrate data sources across the nation is most likely leading to double counting (e.g. overestimating population growth or employment generation) or, potentially worse, undercounting (e.g. failing to plan for the full scale of immigration).

How and what we measure is critical. The Australian Infrastructure Audit 2019 argues that 'Australia's slow progress towards the SDGs (UN Sustainable Development Goals) may be explained by a lack of integration of these types of measures into broader government decision-making processes' (Infrastructure Australia 2019). It is argued that Organisation for Economic Co-operation and Development (OECD) countries that have broadened the scope of their decision-making by developing livability and wellbeing frameworks, in addition to more traditional GDP measures and cost–benefit analysis processes (e.g. France, New Zealand, Sweden and the United Kingdom), have achieved SDG scores above the OECD average (Sachs et al. 2018:94–95).

Attempts to address these challenges include the city deals' approach to measuring outcomes including annual progress reports and 3-year reviews, and the Greater Sydney Commission's approach to the Pulse of Greater Sydney. The latter approach highlights the systems thinking now being applied to urban areas. In systems thinking, there is no one indicator, but a complex set of interactions within urban areas that influence outcomes.

Case study Measuring what matters – the pulse of our urban areas

Urban areas are intricate ecosystems that can present challenges in measuring and monitoring their performance. The Greater Sydney Commission has recognised the importance of measuring the impacts of the *Greater Sydney Region plan – a metropolis of three cities* to allow for benchmarking and continuous improvement.

In developing its approach to the metrics, the Greater Sydney Commission engaged with citizens via panels to determine what was important to them and how to measure and monitor outcomes in the city most effectively. Of greatest importance to citizens were:

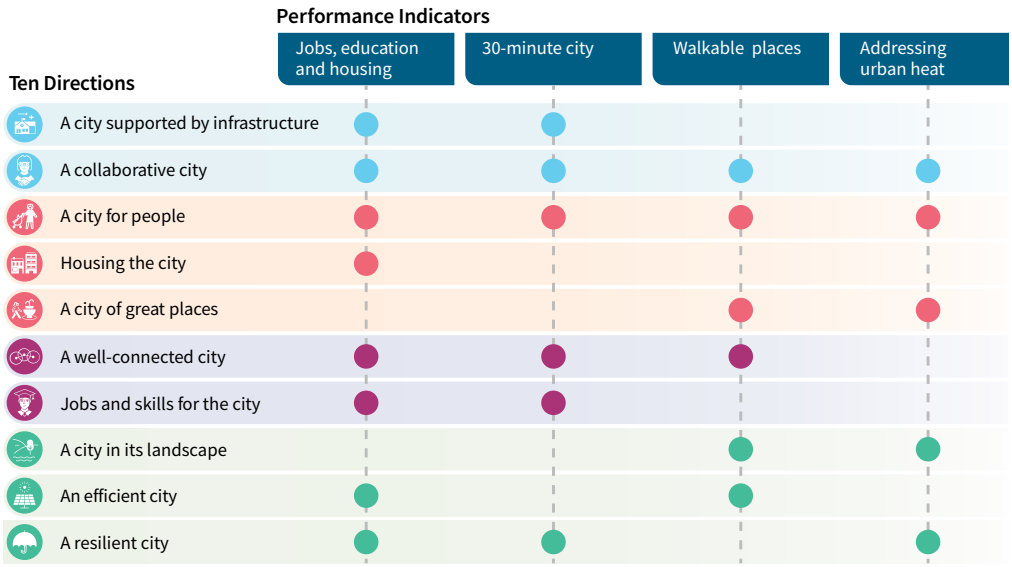
- jobs being closer to where they live
- more affordable education and more high-quality education opportunities

- better access to, and reliability of, public transport, including more opportunities to walk and cycle safely across the city
- more trees and open space for place making and climate resilience to improve quality of life
- improved housing choice and affordability, to be able to live close to family and friends within local areas
- feeling safe and socially connected with local access to shared community facilities and events.

On this basis, the Commission found that what mattered to citizens could not be captured in any one metric. Rather, the best approach was a combination of metrics that spoke to livability as distinct to any one aspect of the urban environment. Four metrics were subsequently agreed and used to measure how planning in Greater Sydney was achieving the 10 objectives or directions of the Greater Sydney Commission's plan:

- access to jobs and education opportunities and housing diversity
- the need for a 30-minute city
- walkability
- urban heat.

These 4 metrics were subsequently applied to the 10 directions of the Greater Sydney Region Plan in a matrix format to create an integrated and systematic approach to monitoring outcomes. In its second year, the Pulse of Greater Sydney measured the outcomes of the 3 cities model (Greater Sydney Commission 2019).



Source: Greater Sydney Commission (2019)

Figure 39 Greater Sydney Plan performance indicators

Community engagement

To effectively manage the threats and pressures to our urban environments, we must look to the very people that experience them the most – our citizens. Whether they are residents, workers, businesses or interest groups, there is a growing recognition by the community of the need to get involved to address these challenges. This is particularly true of younger generations, as reflected in a 2019 UNICEF Australia report that found Australian children were increasingly aware of the threat of climate change, supporting the greater application of renewable energy sources (UNICEF Australia 2019).

While most governments have an array of statutory consultation requirements and best-practice approaches for engaging the community, the value of more genuine engagement and co-design, as distinct from an advisory role, is being recognised. These approaches can be challenging because of the tension often experienced between the speed of planning and government processes and the ability of citizens to become involved. Indeed, there will continue to be pressure for faster development assessment determinations to support economic outcomes or to react to urgent shocks and risks to the urban environment, but the intent is to act from a more informed basis thanks to prior citizen engagement.

By international standards, Australia ranks well in civic engagement, with the OECD Better Life Index 2017 ranking Australia the leading country out of 36 OECD countries.

Indigenous knowledge

There is growing recognition of the importance of Indigenous knowledge of the environment in helping to address some of the issues of effective planning and management, and to improve the quality and resilience of our environment. However, Indigenous knowledge should not be viewed in an extractive framework – for example, what it can 'give' or what can be 'taken' – and used to augment western systems. It must been seen as imperative to the empowerment of Indigenous peoples and to their right to self-determination (Cumpston 2020b).

The empowerment of Indigenous people and Indigenous knowledge is important for rural and regional areas, and our cities. Research on urban areas and their ecology has traditionally relied on non-Indigenous rather than Indigenous knowledge (Pauli et al. 2020). But, before European arrival in Australia, these important ecological systems were managed by Indigenous knowledge systems that carefully balanced and cared for these spaces (Porter & Arabena 2018).

A survey of all councils in Australia for this report asked whether Indigenous advisers were engaged in council policy and strategy development. Of those that responded to the question, 60% answered yes, 30% answered no and 11% did not know. Of those that answered yes, various methods were identified to receive this advice, including regular meetings with Indigenous consultants and the establishment of specific committees or First Nations people advisory groups. Many councils engaged Indigenous consultants for specific projects, and some had a dedicated Indigenous officer to advise on Indigenous matters and engage with community groups.

Respondents advised that Indigenous advice was used to inform many council policies, strategies and development activities near important identified Indigenous sites. It included running community education programs and recording oral history, identifying sensitive sites in geographic information systems, improving protection of heritage and preparing reconciliation action plans. Indigenous knowledge was used to

inform signage on nature trails, place names, coastal management measures, land-use strategies and traditional firestick approaches to managing bushland areas and bushfire hazard reduction.

Although councils are venturing more often into working with Indigenous communities, there are few monitoring, evaluation or reporting activities that have been put in place to quantify or articulate the impacts that these activities are having on improving outcomes for Indigenous populations or the wider population.

Examples of council engagement with Indigenous peoples include:

- Port Hedland Council, where 16% of the population are Indigenous, have prepared a reconciliation action plan that includes targets for consultation, communication, cultural awareness, identification of cultural sites, employment, economic development and enhancing inclusion. The town regularly consults with the local Kariyarra, Ngarla and Nyamal people, and has recently appointed an Indigenous community engagement officer to facilitate partnerships. For example, the Port Hedland Spoilbank Marina development had a community reference group, which included representatives from the Kariyarra Traditional Owners, and traditional artwork, spaces and lookouts were included in the design. Port Hedland Council is currently establishing a Public Art Advisory Panel with Indigenous representation and a memorandum of understanding with Hedland Aboriginal Strong Leaders.
- Lake Macquarie City Council employs a full-time Aboriginal Community Development Officer (ACDO) to consult and communicate with local communities and organisations. The ACDO also delivers programs in accordance with the council's *Aboriginal community plan 2019–2023 Bayikulinan (to act in the future)*. The council regularly undertakes cultural awareness training for internal and external people. It provides up to $15,000 in National Aborigines and Islanders Day Observance Committee (NAIDOC) grant funding with the Aboriginal Grants Committee. The ACDO sits on the committees for the 2 major NAIDOC Week events, and hosts an annual flag-raising ceremony and morning tea at council for staff and community. Lake Macquarie City Council also engages the Miromaa Language & Technology Centre to translate English to the Awabakal language (e.g. the welcome plaques across council facilities, and each library is named in 2 languages).

Naming is one aspect of the urban environment that has recently been a focus, with an increased interest in the use of Indigenous languages in naming and dual naming of places (including cities, suburbs, landforms, streets, or even street art and monuments). One of the social injustices that stems from the historical legacy of colonisation is the racist and offensive naming of geographical locations. This is a longstanding issue that Indigenous people have highlighted, along with the need to articulate the ongoing cultural links between Country, culture and language in an urban environment. Recently, this has led to much public discussion about the significance of place names and the need for acknowledgement or change (also see Dhawura Ngilan: a vision for Aboriginal and Torres Strait Islander Heritage in Australia in the Heritage chapter).

There is also growing interest in recognising the seasonal knowledge of Traditional Custodians (see the Indigenous chapter). Seasonal knowledge is often interdependent with ecological knowledge, such as certain flowers blooming or animals appearing, to signal transitions between seasons. This is why seasonal knowledge is often incorporated

when establishing Indigenous gardens. Schools, early learning centres and councils are increasingly using Indigenous knowledge of ecology and seasons within their landscape designs to promote cross-cultural learning opportunities that are place-specific. An example of one such project that incorporates plants and seasonal knowledge can be seen in Jandakot, Western Australia, on the lands of the Noongar people. Muminbulah Wilak ('spirit of the land') Six Seasons Garden showcases plants and seasonal knowledge as well as creation stories and ecological knowledge (Turner et al. 2017, Cumpston 2020a, Welch & Briggs 2020).

Case study Understanding climate with Indigenous knowledge

Source: Beaupark (2020)

The 4 seasons of summer, winter, autumn and spring are applicable to a European context. But Indigenous knowledge is teaching us that this does not fit the pattern of seasons in Australia. Through discussions with the Darug people of Greater Sydney, researchers from the Clean Air and Urban Landscapes (CAUL) Hub identified a more appropriate pattern of seasons and weather cycles.

This knowledge, initially thought to have been lost after European colonisation, correlates with the changing flora and fauna informing food availability. The CAUL researchers applied this knowledge to decadal-scale records of meteorological records measurements to create a set of 6 quasiseasons for the Western Sydney Region (CAUL Hub 2019).

This approach is the first step in designing an Indigenous seasonal calendar for Greater Sydney. It is also helping to inform broader research concerning air quality fluctuations through the year, and could be used to inform the management of biodiversity, heat and land in urban areas.

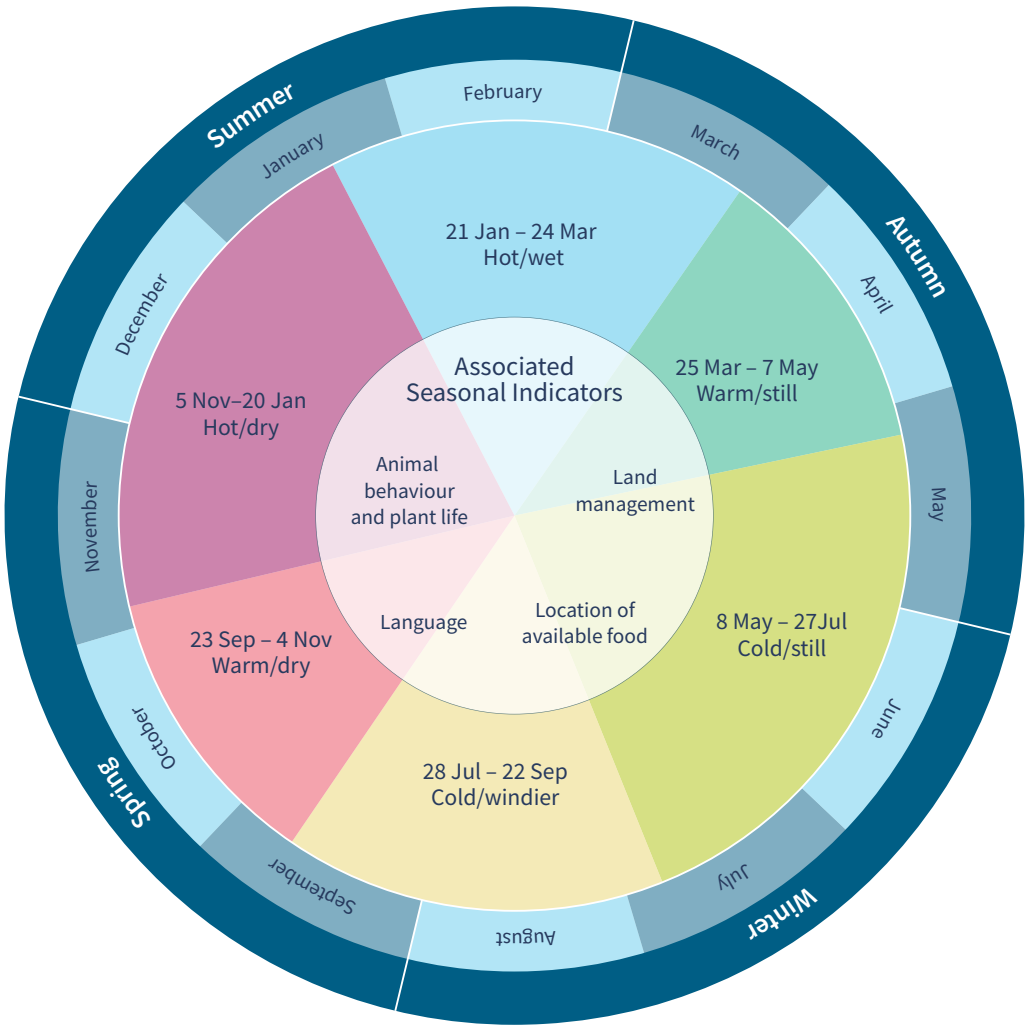


Figure 40 IKALC seasons of Western Sydney, based on weather and time of year

Citizen science

Along with citizen engagement in development processes, there is the growing recognition of the value of engaging citizens in urban research and experiments. Commonly referred to as citizen science, this process can benefit both the research community and the citizen. It can effectively increase the reach and effectiveness of the research and the influence of the citizen on their urban area.

Examples of citizen science include community mapping programs such as the Canberra Nature Map. This online spatial resource allows thousands of citizens to upload sightings of plants, animals and fungi, and have them identified. The data are subsequently used in planning and conservation management. Other examples include FrogWatch, which engages urban citizen science groups in monitoring and managing biodiversity across urban reserves (e.g. the Orchid Society of

Canberra, the Canberra Ornithologists Group), and TurtleSAT, which is an online resource for citizens to help map freshwater turtles in their local area.

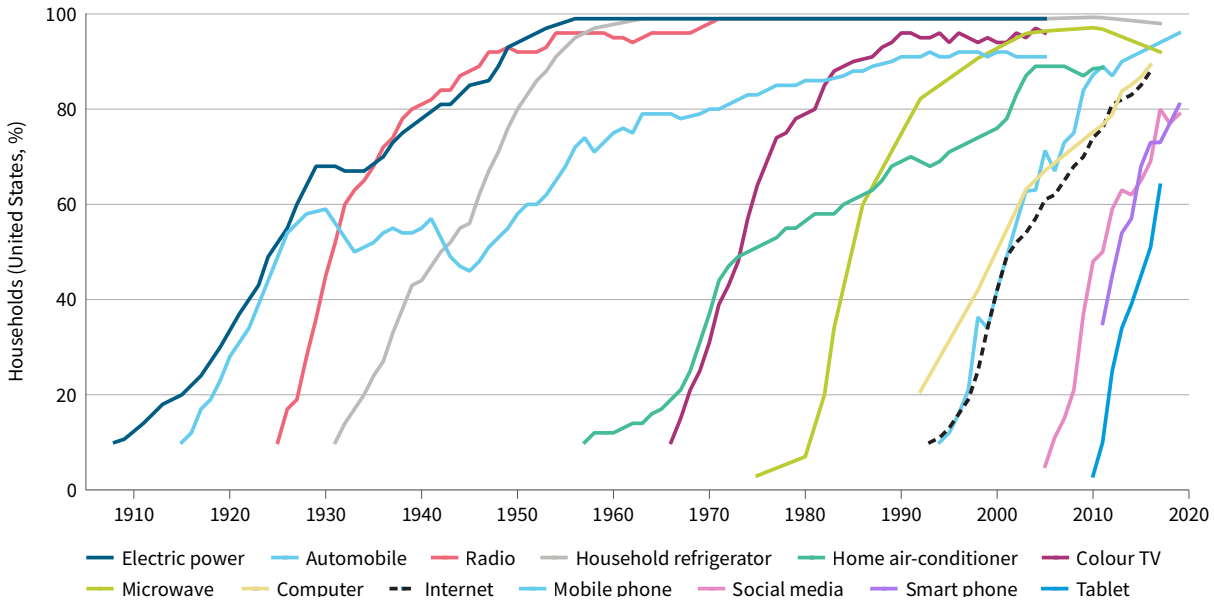
Waterwatch is another successful model powered by citizen scientists to monitor waterways. This collaboration between the ACT Environment, Planning and Sustainable Development Directorate and community-based catchment groups prepares a report based on 1,872 water quality surveys, 184 water bug surveys and 219 riverbank vegetation assessments collected by more than 200 volunteers.

New technologies and the future city

Frequently termed the Fourth Industrial Revolution, the growth of digital technologies is allowing new ways of working using artificial intelligence, machine learning and greater automation. These new technologies, combined with new ways of thinking around a shared economy, will redefine and reshape the livability and state of our urban environments. Importantly, these changes are also occurring quicker than ever before. While the past century has seen notable technological change, what is different today is the rate and significance of change (Figure 41).

CSIRO's *Australian National outlook 2019* identifies the digital economy as still in an 'installation phase' – that is, the phase where technologies are just emerging and are localised to certain industries and companies. The CSIRO argues that the benefits of these new technologies and their productivity gains may not become visible until the 'deployment phase', where widespread adoption enables their full potential to be realised.

In addition, these changes are often occurring before regulations have been designed or adopted by government, and in some cases even conceived as necessary. For example, the ridesharing company Uber was launched in Australia in 2012, but was not formally recognised as a legitimate service across all



Source: Ritchie & Roser (2021)

Figure 41 Technology uptake, 1900–2010

jurisdictions until 2017 (Uber 2018:1). It now operates in 29 Australian cities servicing 3.8 million regular riders (Uber 2018:1).

It is argued that many of these changes will be accelerated as a consequence of innovation achieved during and following the economic shocks created by the COVID-19 pandemic (Newman 2020). The case is made that the next wave of innovation will be away from greenhouse gas technologies towards a new zero-carbon economy. This new economy will focus on mainstreaming climate change mitigation measures such as:

- solar photovoltaics with batteries
- electromobility
- smart city technology, especially sensors, apps and information and communications technology focused on localised distribution and efficient demand management.

The next agenda would be towards grid stabilisation, to be achieved through localised, community-scale batteries. At the same time, new industries such as hydrogen, the circular economy and biophilic urbanism are requiring further research and development to fully replace fossil fuels in heavy industry (Newman 2020).

Communication and information

Smart technology is allowing us to engage with urban citizens better and more equitably. The COVID-19 pandemic also accelerated our acceptance and use of online communications. However, these examples also point to growing challenges in the equity of technology access and challenges associated with cyber security (see Population growth forecast).

There are apparent and potentially growing inequities in access to technology between larger and more regional or rural urban environments. This relates to the economies of scale and favourable business cases that can be developed for denser urban areas. This may exacerbate disadvantage in smaller, more-remote urban areas, affecting school children, health facilities and businesses that do not have reliable internet access.

Infrastructure Australia makes the case that although costs to establish new technologies in remote and regional areas can be higher than for cities, the potential benefits can be greater. For example, internet connections allow regional producers to participate in metropolitan and even global markets without intermediaries. Remote diagnostics and telehealth services can save long trips for patients and assist existing services such as the Royal Flying Doctor Service (Infrastructure Australia 2019).

It is estimated that just over 90% of Australians own a smartphone (world average should reach 90% by 2036) (Deloitte 2018). This has supported the growth of the concept of the internet of things (IOT). Defined as the collection of connected devices, particularly sensors, the IOT allows everyday objects to connect through the internet. The IOT could enhance the operations of objects and services, such as predictive and on-demand maintenance of infrastructure assets and networks. Examples include using smartphones to manage on-demand transport services or control energy use.

New technology is creating new industries for Australia that will have a notable influence on what we learn about our environments and how we manage them. Space technology in particular is a growing area that plays a key role in many day-to-day activities, including weather forecasting, emergency management, internet access, online banking GPS. Worth more than US$350 billion today ($1.1 trillion by 2040) (DISER 2019), the space sector is growing rapidly. The Australian Space Agency was established to optimise this potential, coordinating and sustaining the conditions necessary to grow Australia's space sector.

Transport

New technology and fuels for transport such as battery electric vehicles (EVs), hydrogen fuel-cell vehicles and biofuels will have a significant impact in terms of emissions reduction, fuel security and air quality benefits. EVs currently make up only 0.75% of new car sales in Australia, less than nearly all comparable countries. However, hybrid vehicle sales almost doubled in the last year, increasing from 31,191 vehicles in 2019 to 60,417 vehicles in 2020 (DISER 2021b), and the Australian Government forecasts that battery EVs will make up 26% of new car sales by 2030 (DISER 2021b). Climate Council modelling found that 75% of new car sales by 2030 needed to be electric for Australia to achieve net zero emissions by 2035.

The urban environment presents some barriers to the growth of these technologies, including the limited public charging network for EVs. In response, the Australian Government plans to coordinate private and public investment to enable the efficient rollout of charging and refuelling infrastructure, as one of its 5 priorities for future fuels (DISER 2021b).

In some cases, technological changes will be rapid and unforeseen, while in others they will be foreshadowed and welcomed. Autonomous vehicles fall into the latter category and are expected to evolve from the self-driving features available today (such as steering, parking and braking) into vehicles requiring no human interaction by 2035 as they independently sense their environment via sensors such as radar, sonar, GPS and odometry. What this means for our urban environments is, however, uncertain.

Encouraged because of their environmental, safety and congestion benefits, there is the potential for autonomous vehicles to reduce the need for as many roads, larger roads and parking spaces. This could have significant benefits in terms of reduced urban footprint (roads and car parking currently account for about 33% of our urban land) and the repurposing of roads and car parks into greenspaces or community facilities. As car parking spaces are also a key determinant of development feasibility, the reduced need for this space (including basement car parking) could also result in reduced building costs. The savings may potentially be passed onto the end user, improving the affordability of new homes and workspaces.

In South Australia, the first laws were passed in 2016 allowing for the on-road trials and testing of driverless vehicles and other advanced automotive technology on South Australian roads (SA DIT 2021). This has facilitated autonomous bus trials in popular areas such as the Glenelg Foreshore (SA DIT 2019).

Production and ownership

New technologies in additive manufacturing and 3D printing are changing how we can competitively produce complex, low-volume and high-margin products. We are also seeing the development of new materials that are lighter, stronger, more conductive or self-healing. These advances can improve construction practices while reducing energy consumption and waste generation.

New horizon technologies such as artificial intelligence, synthetic biology, envirotech, medtech, agritech, biotech and renewable energy may address many of the urban challenges we have today, such as food security, waste production and urban heat.

The growing adoption of concepts such as the circular economy, combined with new technologies within our urban areas, are also challenging how we think about ownership and consumption. For example, instead of ownership and overusing resources,

consumption will be based on using services, sharing, renting, co-working and recycling. A sharing economy that seeks to optimise resources is foreshadowed.

This is increasingly referred to as 'prosumption' – the integration between production and consumption. Examples include short-term accommodation (e.g. Airbnb), ridesharing (e.g. Uber), educational services (e.g. Coursera) and financial services (e.g. Zopa). In the case of ridesharing services, 30% of Australians use these services, and a further 16% are likely to use them in the next 5 years (JWS Research 2018).

Smart cities

Advances in technology will be important to how our cities operate. We are already seeing new cities being planned with smart infrastructure at their core. We will see new technology added to old infrastructure and assets to improve efficiencies and capability. The International Data Corporation forecasted that, in 2019, US$96 billion would be spent on smart city initiatives in public transit, public lighting and traffic management – an 18% increase compared with 2018 (Knight Frank 2020).

A smart city uses '… smart computing technologies to make critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation and utilities – more intelligent, interconnected, and efficient' (Washburn et al. 2010:2).

A smart city leverages innovative technologies to 'enhance (the) quality and performance of urban services, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens' (Parliament of Australia 2018a). Smart cities deploy 'smart devices, sensors and software' to equip existing infrastructure with 'the equivalent of digital eyes and ears' enabling 'more efficient and effective monitoring and control of our energy and water systems, transportation networks, human services, public safety operations – basically all core government functions' (Parliament of Australia 2018a).

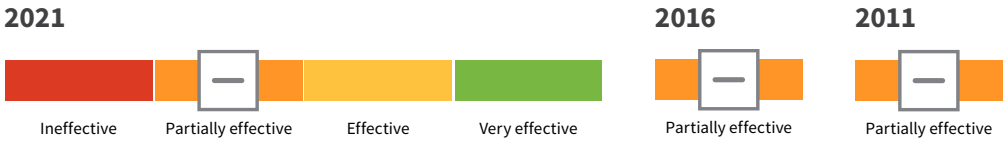
As artificial intelligence is developed and machine learning deployed, new housing developments, precincts and settlements can be designed or redesigned to help achieve zero-carbon outcomes. Sensors applied to water, waste, energy and transport systems can provide real-time data and projections to assist management of demand through greater consumer awareness and behavioural change (Newman 2020).

In Australia, our approach to smart city technology is in its infancy. A key issue with which many urban environments are grappling is the social and organisational aspects of smart cities given the complexity of stakeholders involved, questions around data management and ownership and the increasing risk of cyber attack. All have business, citizen and environmental implications. This is an emerging space, requiring the development of new industry regulations, standards and strategies to catch up with innovations.

Despite these challenges, a survey of all councils within Australia for this report found that 69% of respondents were or were considering the use of smart city technology in their urban areas; the remaining 31% were not. When asked what types of technology they had implemented or were implementing, answers ranged from installing LED streetlights, smart parking services and bins, electric vehicle charging and free wi-fi, to implementing smart devices to monitor irrigation and the impacts of temperature, air pollution sensors, sports fields and the use of nature trails.

One example, referred to as Smart Beaches, sought to address a spate of tragic incidents on New South Wales beaches in early 2019 by using smart devices to collect better information on crowd numbers, activity and localised conditions, eliminating the need for time-consuming manual counting by lifeguards. Another example given by survey respondents was smart benches installed across Yarra City Council (Victoria) to provide free wi-fi and device charging to the most vulnerable in the community to support access to critical information, products and services.

Assessment Management effectiveness for urban environments

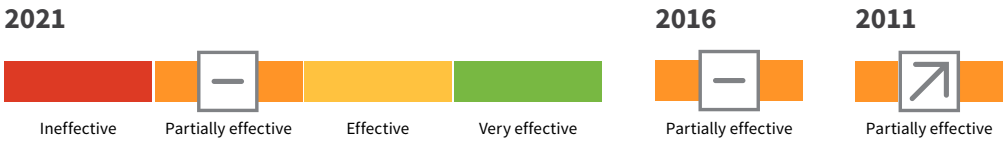


Medium confidence

Current approaches to managing our urban environments are partially effective. While we are starting to move towards urban sustainability and resilience, and there are excellent examples of progress, planning and management are still often fragmented. Lack of national approaches and visions, along with a lack of coordination between different sectors and governance levels, also puts progress at risk. The data needed to support progress are being collected but are not yet being used to effectively drive change.

Related to United Nations Sustainable Development Goal targets 11.a, 11.b, 11.3, 11.6

Assessment Management approaches

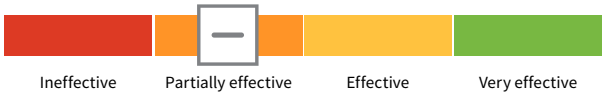


High confidence

Management approaches are assessed as partially effective and stable – despite significant shifts in thinking, new ideas and visions have not yet taken root. The negative impacts of vast and increasing expansion at cities' fringes on natural and agricultural lands still exist. The lack of a national strategy or centralised national commitment is a major hurdle that has kept the management approach unchanged; a shift towards sustainable ways of thinking around place-based planning has been embraced, but not yet fully implemented.

Assessment Management of specific pressures

2021

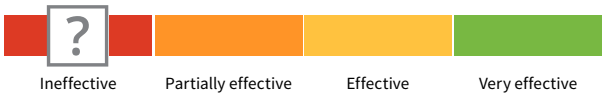


Medium confidence

Governments have developed well-thought-out plans that address the different pressures faced by urban and natural environments regarding travel, waste, water and heat. However, these are yet to be effectively implemented. Although moving in the right direction, progress is slow and fragmented.

Assessment Resources, Data and monitoring, Indigenous knowledge, New technologies and the future city

2021



2016

2011

High confidence

Overall, the number and diversity of resources – such as big data, censors and other technologies – for managing the urban environment have been significantly improving. There is also increasing acknowledgement and understanding of Indigenous traditional knowledge. However, these are not yet influencing decision-making.

The trend is quite unclear. Much thinking has been done in this sphere, but it has not resulted in action. There is a lack of consistency, as well as whole-of-government capacity and genuine interest in using data and technology to drive policy.

Assessment ratings

For assessments in the ‘Management’ section

- **Very effective:** Management measures maintain or improve the state of environment and secure it against known pressures.
- **Effective:** Management measures maintain or improve the state of the environment, but pressures remain as significant factors that degrade environment values.
- **Partially effective:** Management measures have limited impact on maintaining or improving the state of the environment.
- **Ineffective:** Management measures are failing to stop substantial declines in the state of the environment.

Trend

- **Improving:** The situation has improved since the previous assessment (2016 state of the environment report).
- **Stable:** The situation has been stable since the previous assessment.
- **Deteriorating:** The situation has deteriorated since the previous assessment.
- **Unclear:** It is unclear how the situation has changed since the previous assessment.

Authors and acknowledgements

Authors

Sarah Hill

Dr Sarah Hill has a passion for creating thriving cities. As Chief Executive Officer (CEO) of the expanded Western Parkland City Authority, Dr Hill is leading the delivery of Australia's largest and most ambitious city-building project of the past century. This work builds on the vision she co-created as the inaugural CEO of the Greater Sydney Commission. Under Dr Hill's leadership, the commission developed new ways of engaging with citizens, measuring and monitoring key planning outcomes, and aligning growth with infrastructure. Dr Hill has received numerous professional awards locally and internationally, including the 2012 UDIA Women in Development Award, the 2015 NSW Planner of the Year award and the 2016 PIA Australian Planner of the Year award. She is a Fellow and past-president of the Planning Institute of Australia (NSW Division); is an Adjunct Professor at the University of Technology Sydney's Faculty of Design, Architecture and Building; and continues to be a thought leader with a particular focus on the economics of cities and the feasibility of development.

Zena Cumpston

Zena Cumpston is a Barkandji woman with family connections to Broken Hill and Menindee in western New South Wales. She currently lives in Melbourne on the lands of the Wurundjeri people with her partner and 2 young boys. Zena works as a writer, curator, consultant and researcher, and is passionate about truth-telling and undertaking projects that directly benefit her community and Country. In 2021, she curated the show *Emu Sky* for Science Gallery Melbourne, bringing together more than 30 Aboriginal community members from across south-eastern Australia. Running until July 2022, *Emu Sky* explores Aboriginal knowledge through artworks, research and storytelling, and is accompanied by an extensive education program. In 2022, her book Plants, co-authored with Professor Lesley Head and Associate Professor Michael-Shawn Fletcher, will be released as part of the First Knowledges series.

Gabriela Quintana Vigiola

Dr Gabriela Quintana Vigiola is an academic and consultant in the urban design and planning sectors. She joined the University of Technology Sydney in 2012, and lectures in urban planning at the School of the Built Environment. Her interests range from urban design to cultural and psychosocial studies. Her current research focuses on social–urban issues, including informal settlements, housing for 'vulnerable' populations and place making. Dr Quintana Vigiola's previous research focused on place making through culture in informal settlements in Caracas, Venezuela. She is currently developing a study about housing for domestic violence survivors, with a focus on place, displacement and violence.

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Approach

Most Australians live in urban environments. In fact, Australia is one of the most urbanised countries in the world with more than 96% of the Australian population (approximately 24.5 million people) living in urban areas, 68% of whom live within Australia's 8 capital cities.

The structure, form and function of Australia's urban environments significantly influence our cultural connection, enjoyment, and access to goods, services and opportunities. How we live in our urban environment in turn affects the state of our natural environment including the extent of our biodiversity, the sustainability and quality of our natural resources, and the scale of waste and pollution generated. In this way our urban and natural environments form an important and intricate ecosystem that drives not only the livability of our environment but also the wellbeing of most Australians.

This chapter focuses on the interrelationship between the urban and natural environments, and the subsequent implications for the health and wellbeing of both humans and nature. This chapter focuses on the environmental implications of the built environment – as distinct from a broader range of social and economic urban management issues such as housing affordability, job generation and economies – and how they affect humans and nature. Throughout this chapter and the state of the environment report, Aboriginal and Torres Strait Islander people are referred to as 'Indigenous', as per terminology agreed by the greater Indigenous authors group to ensure uniformity and inclusion. Where titles or direct quotes have been used, this terminology may differ, and it is important to note there is no one, universally agreed way to represent groups – the Indigenous people of Australia are incredibly diverse across language, cultures and a multitude of other factors.

The name of the chapter has been changed from 'Built' in the 2016 SOE report to 'Urban' in 2021 to reflect a more contemporary systems-based approach to this discipline. The urban environment is a broad term used to describe the human-made surroundings where people live, work and entertain themselves. The urban environment includes both the physical (built) structures where people undertake these activities and the supporting infrastructures, such transport, water and energy networks. Therefore, the revised term moves the focus in urban planning away from the design, character and form of the physical and built structures of an environment and to the collective context of a city, town or village, including the natural areas between and surrounding buildings.

This chapter focuses on the implications of the urban environment for the natural environment and not the social and economic aspects of the urban environment. Notwithstanding this, it is recognised that distinctions between environmental, social and economic issues and how they relate to the urban environment can at times become blurred.

Where relevant, we have sought to compare findings to the 2016 and 2011 SOE reports. However, in many cases, the data used in 2016 have not been subsequently updated. In these cases, the extensive data that relate to the urban environment have been used from many sources including all levels of government, academics, not for profits and peak industry groups. Data have been heavily drawn from organisations such as the Clean Air and Urban Landscapes Hub of the

National Environmental Science Program, the Australian Bureau of Statistics, the Australian Renewable Energy Agency, the Australian Sustainable Built Environment Council, the Australian Urban Research Infrastructure Network, the Bureau of Infrastructure and Transport Research Economics, and CSIRO. The report has also incorporated academic peer-reviewed publications that are relevant to the chapter. The challenge has been consistency of data across multiple jurisdictions and the significant number and diversity of urban areas.

As this is the first time an Indigenous perspective has been included in the authorship of the SOE report, it has been important to note Indigenous ways of storing and transmitting knowledge. To this end, the use of narrative and storytelling has been used as both a method of articulation as well as a source of data, information and knowledge.

To assess the state of the environment, its pressures and how they are being managed across Australia, 2 methods were used:

- a survey sent to the 537 councils across Australia
- a semi-structured interview with the departments of planning for each state and territory, and the Australian Government.

These inputs have allowed for data verification and provided critical inputs to the assessment process. The assessments of outcomes in the Urban chapter have sought to align with the assessment approach taken in 2011 and 2016 to allow for continuity and tracking of outcomes. The assessments were informed by an expert roundtable comprising one representative from each state and territory government. Representatives from the peak industry groups of the Australian Institute of Architects, the Planning Institute of Australia and the Property Council of Australia were also involved.

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