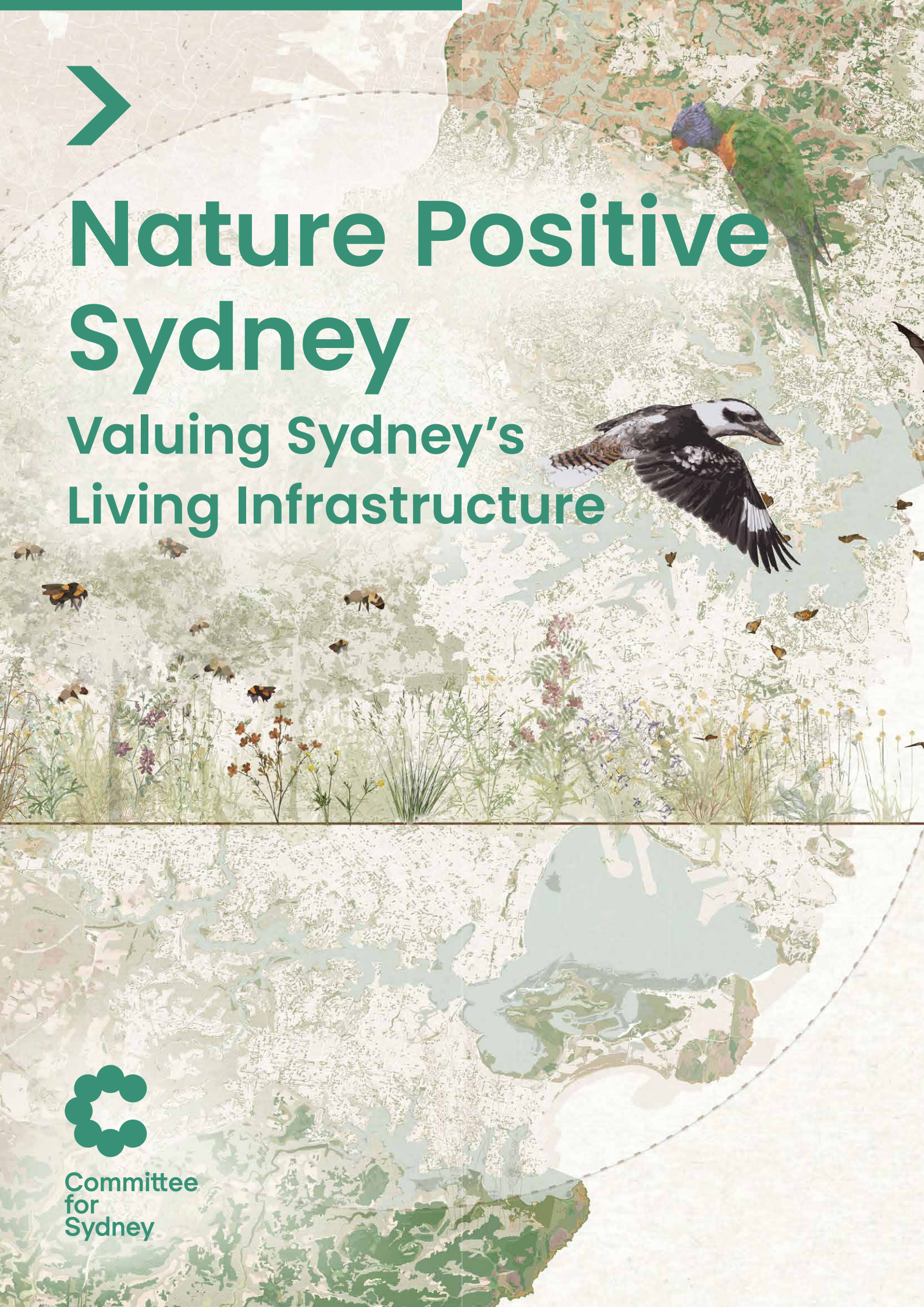
Nature Positive Sydney

Valuing Sydney's Living Infrastructure



Committee for Sydney

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Introduction

Greater Sydney is defined by its living infrastructure in so many ways. The image of urbanity perched against the harbour and ocean is what people all over the world see when they think of Sydney. A ring of national parks around the city provides an escape for day trips or longer. People love the parks, rivers, harbour and beaches.

We live on Country that has been continually cared for over tens of thousands of years by Sydney's Aboriginal people. The Eora are generally acknowledged as the coastal people of the Sydney area, with the Dharug (Darug) people occupying the inland area from Parramatta to the Blue Mountains, and the Dharawal people's lands mostly confined to the area south of Botany Bay, extending as far south as the Nowra area, and across to the Georges River in Sydney's west. Today, Greater Sydney has the largest gathering of Aboriginal people in Australia with many families originating from homelands across NSW and the nation.

Nature positive cities

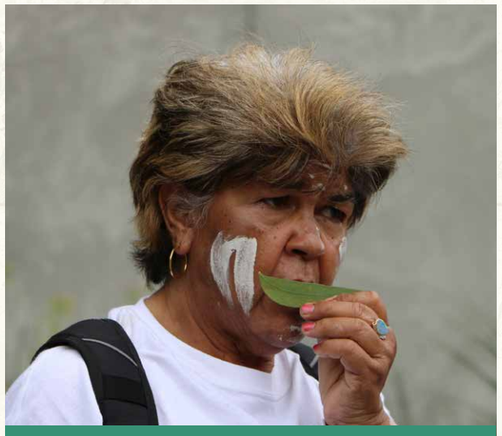
'Nature-positive' is the term used to describe a world where nature – species and ecosystems – are being restored and regenerated rather than declining. Research shows nature-positive solutions can help cities rebuild in a healthier and more resilient way while creating opportunities for social and economic development.

To Aboriginal people, the landscape is made up of many interrelated features. These include land, water, plants and animals, places and stories, historical and current uses, and people and their interactions with each other and place.

Language is the starting point, with First Nations knowledge of place being found in names like Parramatta, 'the place where the eels lie down.' Adopting this continuous process of connecting and healing Country is fundamental. This means taking a long term, even timeless, view of nature and its value for wellbeing, edible and medicinal plants, retaining connections to waterways in their natural shapes and forms, retaining connections to natural landscapes in terms of preserving the form of the landscape (for example, by not developing ridges), and preventing further cultural heritage loss through development.

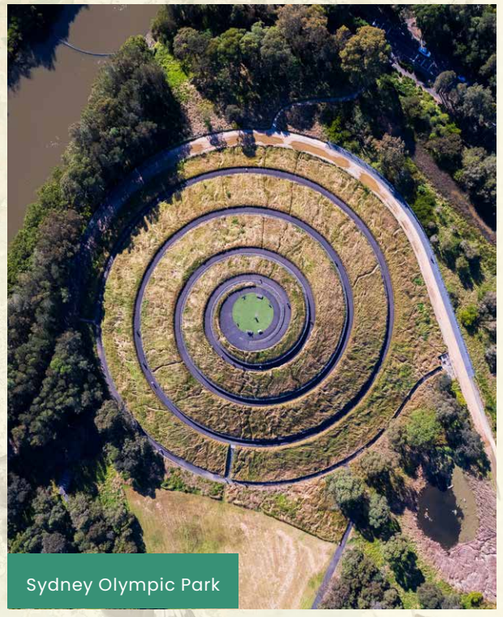
Many of Sydney's roads and side streets – from George Street and Oxford Street to Parramatta Road – are based on the original tracks and pathways created by Aboriginal people before the First Fleet arrived in 1788.[1] Parramatta Road connected Aboriginal communities from Wiradjuri Country, through the Blue Mountains to Sydney, passing an important gathering area now established as Victoria Park, alongside the University of Sydney.

Sydney has some wonderful examples of preserving and enabling living infrastructure in the city, and a strong basis to improve connection between people and nature. Our natural assets – waterways, coastline, national parks, native bushland – provide a diverse environment for people and nature to thrive together. This ranges from relatively small, curated spaces like the 30ha of Royal Botanical Gardens and the Domain, to the 400ha of native flora and fauna at Australian Botanic Garden, Mt Annan, and the 2000ha bushland 'corridor' within the Western Sydney Parklands featuring remnant and regenerated bushland and wetland ecosystems. And located approximately 45km southwest of Sydney, between the Georges River and Illawarra Escarpment, is the 7200ha Dharawal National Park, Nature Reserve and State Conservation Area.



Aunty Margret Campbell of Dreamtime SouthernX

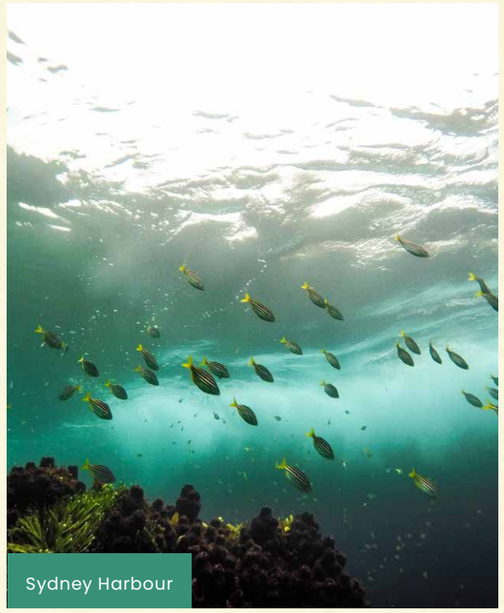
Source: ICC Sydney



Sydney Olympic Park

Source: unsplash

The regeneration of an old industrial site to create Sydney Olympic Park at Homebush has transformed that place into wetlands of global significance, supporting a rich natural environment that includes more than 250 native animal species, over 400 native plant species, and three endangered ecological communities, most of which can be experienced along the bike trails, walking paths and scenic boardwalks.



Sydney Harbour

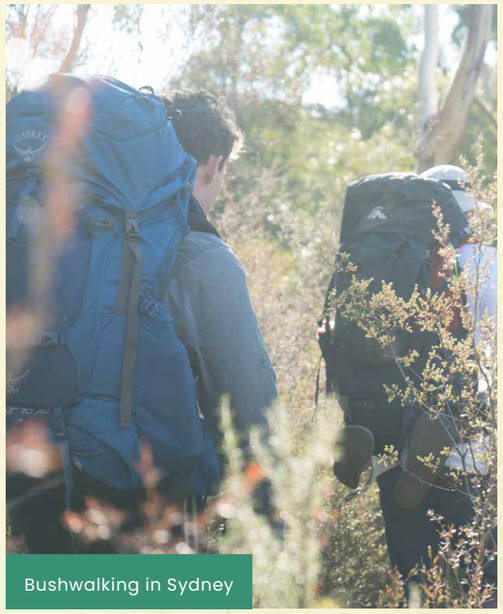
Source: unsplash

One example of the potential of our city's rooftop spaces is the South Eveleigh Community Rooftop Garden,[2] which set out to create and maintain Australia's first Indigenous rooftop farm for urban food production, using more than 2000 edible, medicinal and culturally significant plants.

Feeding into our harbours and bays are Sydney's many rivers including the Hacking and Georges Rivers in the south, the Nepean, Wianamatta-South Creek and Parramatta Rivers in the centre and west, and the Hawkesbury River in the north. Sydney Harbour itself has more fish species (588) than are known to occur in the entire Mediterranean Sea, and is considered the most biologically diverse harbour in the world.

1 https://www.abc.net.au/news/2018-05-17/curious-sydney-aboriginal-pathways/9676076?nw=0&r=HtmlFragment

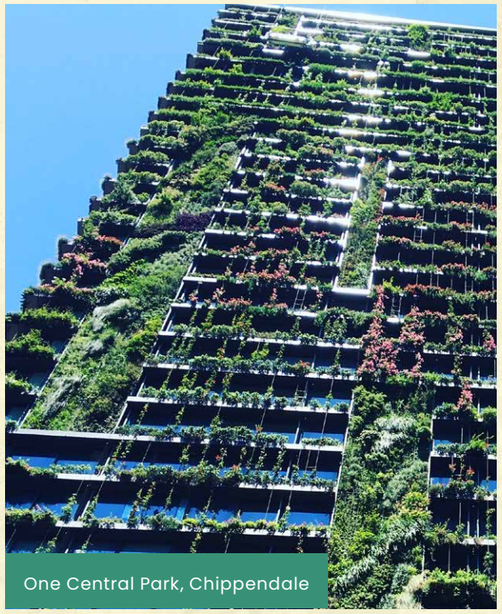
2 https://www.landscapeperformance.org/case-study-briefs/south-eveleigh-community-rooftop-garden



Bushwalking in Sydney

Source: unsplash

Australians value their connection with nature. In a 2020 poll by leading global research firm Ipsos,[3] connection to the outdoors and nature was one of the top reasons why Sydneysiders like living here. In the summer of 2020/2021, visitation to NSW National Parks was up over 150%, and in 2020 Australians bought more plants than ever, spending $2.6 billion.

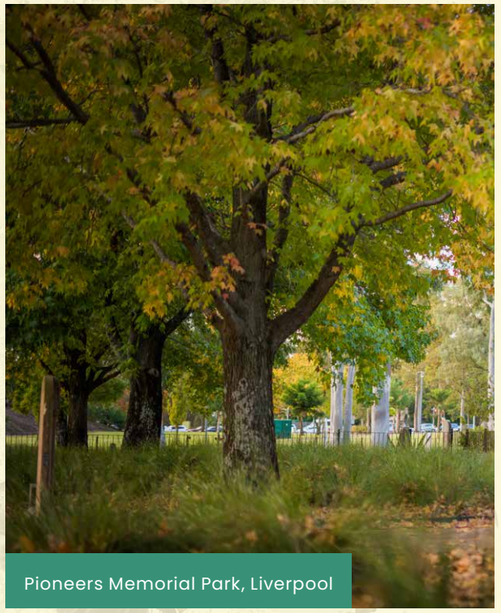


One Central Park, Chippendale

Source: unsplash

The provision of living infrastructure has been elevated as a priority across the city. Significant effort from state and local government, as well as partnerships with non-government organisations, has resulted in increased tree planting across Greater Sydney, the development of tree canopy targets and guidance, and the collection of high quality, accessible urban canopy data. Despite these efforts, maintaining and expanding Sydney's living infrastructure remains an ongoing challenge.

Green cover is not equitable across Sydney, and councils have highly variable levels of resourcing dedicated to living infrastructure planning, delivery and maintenance. Thus, providing and maintaining living infrastructure presents a notable challenge, compounded by current limits to increasing tree planting on private land. Further, there are inequities in our levels of access to living infrastructure across the metropolitan area – while in some parts of Sydney open space is within an 800m walk, in areas on the urban fringe, open space can be up to 2km away.



Pioneers Memorial Park, Liverpool

Source: Liverpool City Council

While there is more work to be done, continuing the momentum generated under the Greening our City Premier's Priority is critical. Supporting councils through accurate and regularly updated datasets, grant funding, guidance and addressing planting trees, vegetation and diverse ecosystems on private land will ensure the long-term delivery of some elements of our much-needed living infrastructure in Greater Sydney.

Federal Park, Glebe

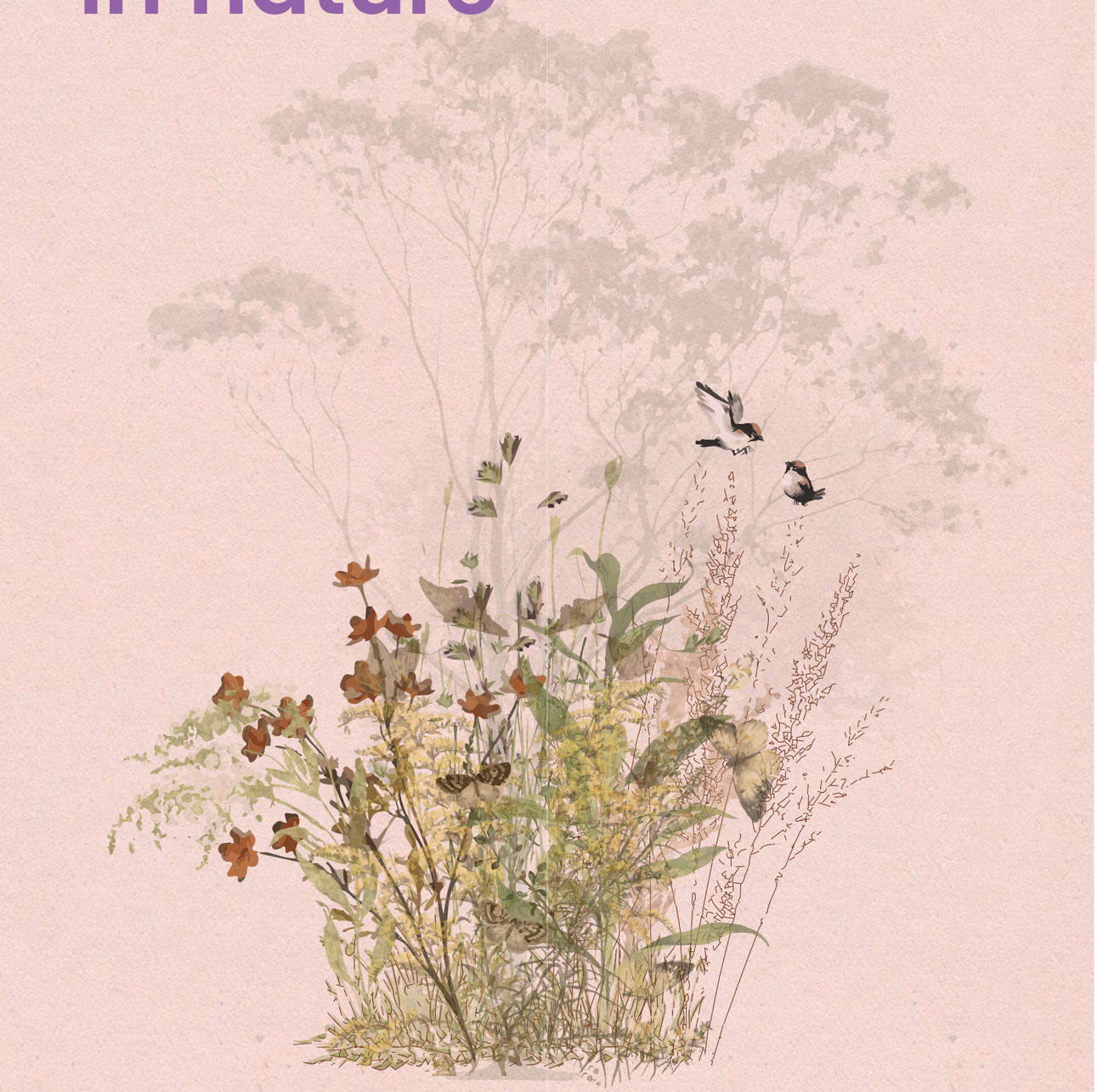
Source: pixabay

By taking a nature positive, Country-centred design approach, we believe Sydney can be one of the world's leading 'biophilic' cities – one that embeds living (natural) infrastructure in its design, planning and management. A city that recognises the essential need for daily human contact with nature, as well as the many environmental and economic values provided by nature and natural systems. A city that provides the opportunity to combine traditional urban greening with non-traditional elements such as green roofs, walls and facades can set out on a path to becoming a nature positive city.

This report lays out a roadmap for how to do that.

3 https://www.ipsos.com/en-au/life-in-australia

Why invest in nature



There are five clear benefits from increasing nature in urban areas

Reducing heat and improving air quality

The growth in population and industry in western Sydney brings rising temperatures into sharp focus – and the confluence of factors driving that, including climate change and the urban heat island effect. This forces us to consider the cooling potential of blue and green living infrastructure to mitigate the impacts of this rising heat, and the need to support equity of access to green spaces.

While climate change is often considered a threat for the future, in western Sydney the temperatures recorded in 2019 show extreme heat is already a reality. There is significant difference between the experience of heat in Sydney's east compared to the west. By 2090, under a projected 'worst-case' climate change scenario, the eastern suburbs will experience 22 hot days in a year, which is what Richmond will experience by 2030 (Heatwatch).

With an increasing number of heatwave days, investing in living infrastructure is urgent. Further east, with 90% of future housing in Sydney occurring as infill in existing suburbs, there is further pressure on how we make density liveable.

The economic benefits of nature are extensive – in Australia and globally

$44 TRILLION Nature's economic value generation

Increasing tree canopy by 10% could increase individual value of local properties by AUD $50,000

$3.7 TRILLION Net benefits of halving deforestation

Nature-based outdoor recreation contributes AUD $11 billion to the Australian Economy

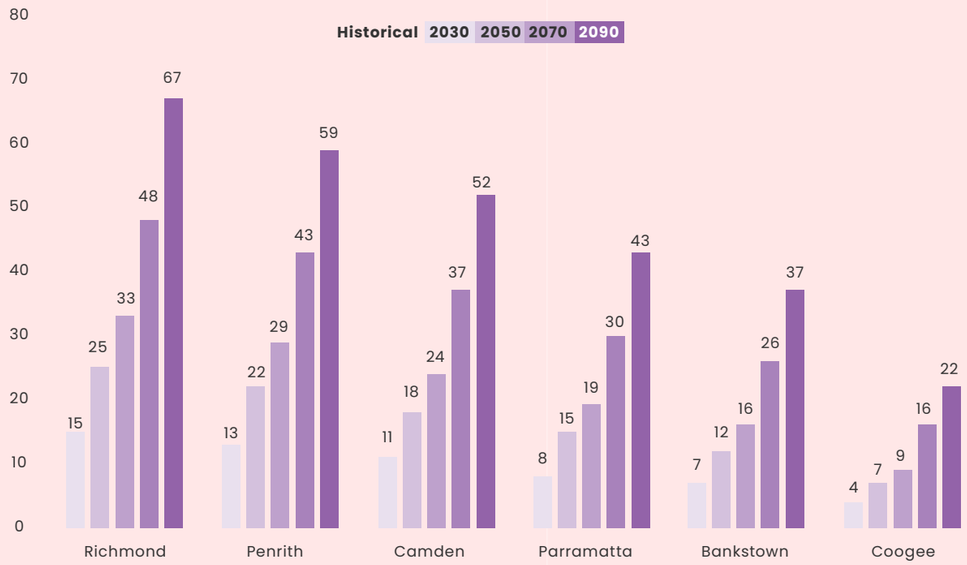
Great Barrier reef contributes **AUD $7.8 billion** a year and supports 69,000 jobs

Trees absorb more than 3 million cubic metres of water reducing stormwater runoff and costs

$500 million investment in conservation and land management programs **6,690 full-time jobs** **and $1.2 billion in long-term economic benefits**

Trees remove an estimated 2,241 tones of carbon each year from the air

Figure 1: Sydneys west will experience even more days over 35 degrees in the future



Source: Recreated from HeatWatch: Extreme heat in Western Sydney Ogge et al. 2018[4]

More shading and cooler spaces will reduce heat and the associated heat stress of those living in areas impacted by the urban heat island effect. Doubling tree canopy in Melbourne would lead to an estimated 28% reduction in heat related deaths,[5] which is significant given a recent community survey of western Sydney residents indicated as many as 55% of those with air conditioning sometimes don't turn it on because of the cost.

Many people in vulnerable communities may not have air conditioning at all, or access to vehicles to travel to cool refuges during heatwaves, compounding their vulnerability. Researchers have identified the importance of shade, and access to public transport, in enabling community interactions in hot areas, and access to public transport. People don't stand around talking in the sun, but if there is shade there is a greater likelihood of that interaction occurring. However, in creating cooler urban spaces, we need to recognise indigenous trees may not provide as much shade as exotic trees – dappled light is a characteristic of the Australian landscape rather than the strong shade of European trees.

While these impacts are being felt now, NSW Treasury projects that by 2061, between 700,000 and 2.7 million additional days of work will be lost in NSW every year due to the higher frequency and intensity of heatwaves. A recent report from Sweltering Cities found 66.8% of respondents reported feeling unwell on hot days or during heatwaves, and one-in-eight people had to seek medical care because they were unwell in the heat.

The adverse health effects from exposure to air pollutants are well researched, each year approximately 2500 deaths (equivalent to about 29,000 years of life lost) in Australia are attributable to urban air pollution.[6] Air pollution is of particular concern for urbanised populations, which are generally closer to pollution sources – carbon dioxide, nitrous oxide, ozone and particulates – and urban living tends to be more reliant on indoor environments where air contaminants possibly have higher concentrations.

"The cooling and shading benefits of tree canopies in suburban streets can also reduce air conditioning bills by as much as $400 per year"

Living infrastructure[7] can help reduce air pollution levels through air purification. Adding vegetation and trees to create urban forests and parklets improves the physical health of residents by removing all forms of air pollution from the air, which reduces the frequency and health impacts of respiratory issues from poor air quality. Equally, maintaining and expanding our existing bushland provides the 'lungs' of the city, fighting a constant battle against the human-induced pollution we generate to fuel our lives.

Cities across Australia are already experiencing the impacts of increased urban heat

Melbourne would experience an estimated 28% reduction in heat related deaths by doubling tree canopy

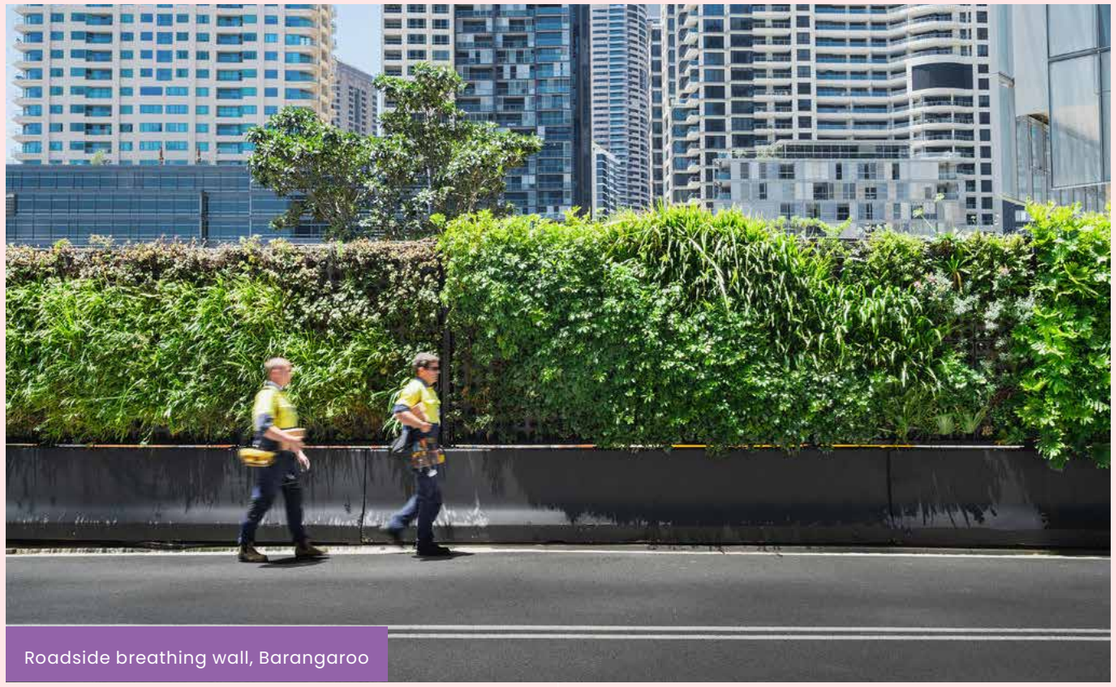
Between 700,000 and 2.7 million additional days of work are forecast to be lost every year (across NSW) by 2061 due to the higher frequency of very hot weather.

5 Hoh, A (2017) Sydney squeeze: Lower your electricity bills and reduce the heat island effect by planting more trees. https://www.coolaustralia.org/sydney-squeeze-lower-electricity-bills-reduce-heat-island-effect-planting-trees/

4 Ogge et al (2018) Western Sydney Heatwatch, The Australia Institute https://australiainstitute.org.au/wp-content/uploads/2020/12/Western-Sydney-Heatwatch-WEB.pdf

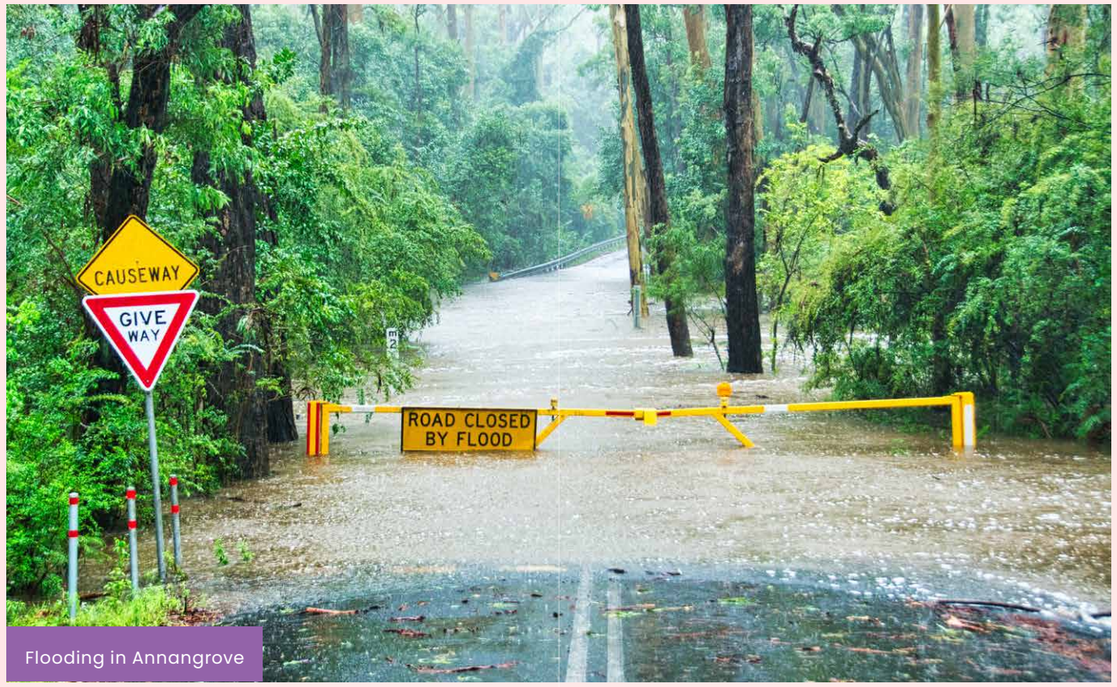
6 AIHW (Australian institute of Health and Welfare) (2019). Australian burden of disease study: impact and causes of illness and death in Australia 2015, AIHW, Canberra.

7 Irga, P.J., Burchett, M.D., Torpy, F.R, (2015), Does urban forestry have a quantitative effect on ambient air quality in an urban environment?, Atmospheric Environment, 120 (2015) 173-181.



Roadside breathing wall, Barangaroo

Source: Junglefy



Flooding in Annangrove

Source: Unsplash

The corollary is without a habitable environment, economic and social structures have the potential to fray. One of the key benefits of investing in environmental restoration through growing living infrastructure is that it avoids this potential for breakdown of social and economic structures.

Climate resilience

Increased urban vegetation and ecosystems, such as mangroves and wetlands, provide opportunities for carbon capture and sequestration to support climate mitigation. Climate-related events, such as flooding, storms and sea level rise, can be mitigated by providing space for intact floodplains, restoring river and creek basins, improving water quality, and allowing water to infiltrate the ground. Vegetation can provide effective and less costly stormwater remediation for pollutants and sediment. For instance, Victoria's parks network provides an estimated $46 million per year in flood protection benefits[8] from avoided infrastructure costs alone. Across Sydney, new initiatives are emerging to make Sydney's rivers and harbour more swimmable to increase opportunities for recreation, but also to create additional strategies for cooling in the face of rising temperatures.

One of the most compelling reasons to green cities – both directly and indirectly (e.g. through tanks used to irrigate green roofs and walls) – is creating the capacity to intercept water and thereby reduce damage in flood events. Based on studies by Melbourne Water[9] in the Port Phillip region, the current value of 'living infrastructure' that intercepts water and reduces annual average damage is $339 million per year. At Daramu House, Barangaroo, the green roof reduced stormwater flows by 99% compared to its sister building, International House.

We also need to respond to the changing climate, which will influence what species are able to survive in the warmer and dry and wet extremes, both in response to environmental conditions, and also possible biosecurity risks, and pest and pathogen incursions. We need a stronger focus on both species diversity and genetic diversity in any new project or initiative to ensure built-in resilience – this is an opportunity for climate ready and climate resilient plantings to be a focus.

Without living infrastructure to bolster the city's resilience, we are likely to see increased devastation from human-induced climate change. The most recent IPCC report[10] highlights that Australia's future climate will experience an increase in heat and cold extremes as well as an increase in heavy rainfall and flooding events.

8 Valuing Victoria's Parks https://www.parks.vic.gov.au/about-us/valuing-victorias-parks

9 https://www.melbourne.vic.gov.au/SiteCollectionDocuments/quantifying-benefits-green.pdf

10 Climate Change 2022: Impacts, Adaptation and Vulnerability https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

Health and happiness

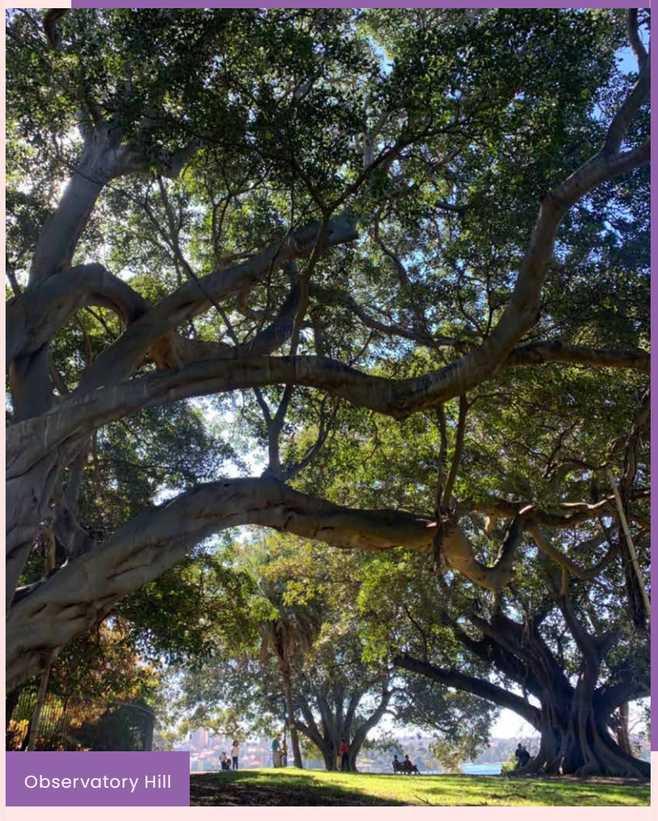
The impact of rolling lockdowns and Covid-19 related constraints has reinforced the value of accessing and engaging with nature. A growing body of research demonstrates that spending time in nature improves mental as well as physical health. Whether it is a quick stroll through a local park or a dip in the river or ocean, studies suggest it makes us more productive, creative and attentive. Exposure to plants and other natural elements improves concentration capacity, which results in better learning experiences.[11] Workplaces that incorporate elements of biophilic design have also been shown to improve workplace performance, with up to 10% of employee absences being attributed to architecture with no connection to nature.[12] Wellbeing, concentration, creativity and general health are influenced by daylight, colour, air and temperature. Street trees and other forms of urban greening also play a part in reducing cardio-metabolic health problems and contribute positively to our mental wellbeing.

A University of Wollongong study found adults with 30% or more of their neighbourhood covered in some form of tree canopy had 31% lower odds of developing psychological distress.[13] The same amount of tree cover was linked to 33% lower odds of developing fair to poor general health. In Sydney during the pandemic, engagement with nature, which includes natural spaces, water, beach and woodland, was up 54% in September 2020 compared with February 2020.[14]

While many residents across Sydney have access to nature, and see the benefit to housing prices, cooling and social cohesion, access is not equitable. In some parts of Sydney, open space is within 800m or 10 minutes walk, while in areas on the urban fringe, open space can be up to 2km or a 25-minute walk. Proximity is one factor, access is another. For example, The Dairy in the Western City Parklands is only accessible by car – pedestrians and cyclists need to cross a four-lane road without a crossing or traffic light, a challenge that is being addressed through the NSW Government's Parks for People program.

Evidence of the benefits of nature in healthcare

The psychologically restorative benefits of green space are now well-documented. Green spaces, such as healing gardens, can serve as therapeutic landscapes, offering refuge and respite for people experiencing loneliness, which may stem from some form of trauma. While usually provided for patients, these settings might also offer sanctuaries for health professionals experiencing burnout.[15]



Observatory Hill

Source: unsplash

Nature is playing a growing role in healthcare, with NSW Health sites like Callan Park in Sydney's inner west using nature to support facilities like the non-profit We Help Ourselves (WHOS). In 2005, NSW Health published a literature review on mounting evidence that gardens in healthcare settings had a restorative effect on stressed patients. More recently, researchers at University of Wollongong and UNSW found that a more than 30% tree canopy target within 1.6km is associated with reduced odds of developing:

- psychological distress (by 31%), and poor general health (by 33%)[16]
- loneliness (by 25% in general, and by 52% in single-person households).[17]

These researched benefits were put into practice through the Greening Our City Premier's Priority to plant 1 million trees by the end of 2022. In partnership with Landcare NSW, the program has planted more than 16,500 trees at several major hospital sites in western Sydney (including Westmead, Mount Druitt and Campbelltown). Further smaller plantings have been completed at retirement villages. These sites were chosen partly in recognition of the health benefits of living infrastructure.

11 Jimenez MP, DeVille NV, Elliott EG, et al. Associations between Nature Exposure and Health: A Review of the Evidence. Int J Environ Res Public Health. 2021;18(9):4790. Published 2021 Apr 30. doi:10.3390/ijerph18094790

12 https://www.terrapinbrightgreen.com/reports/the-economics-of-biophilia/

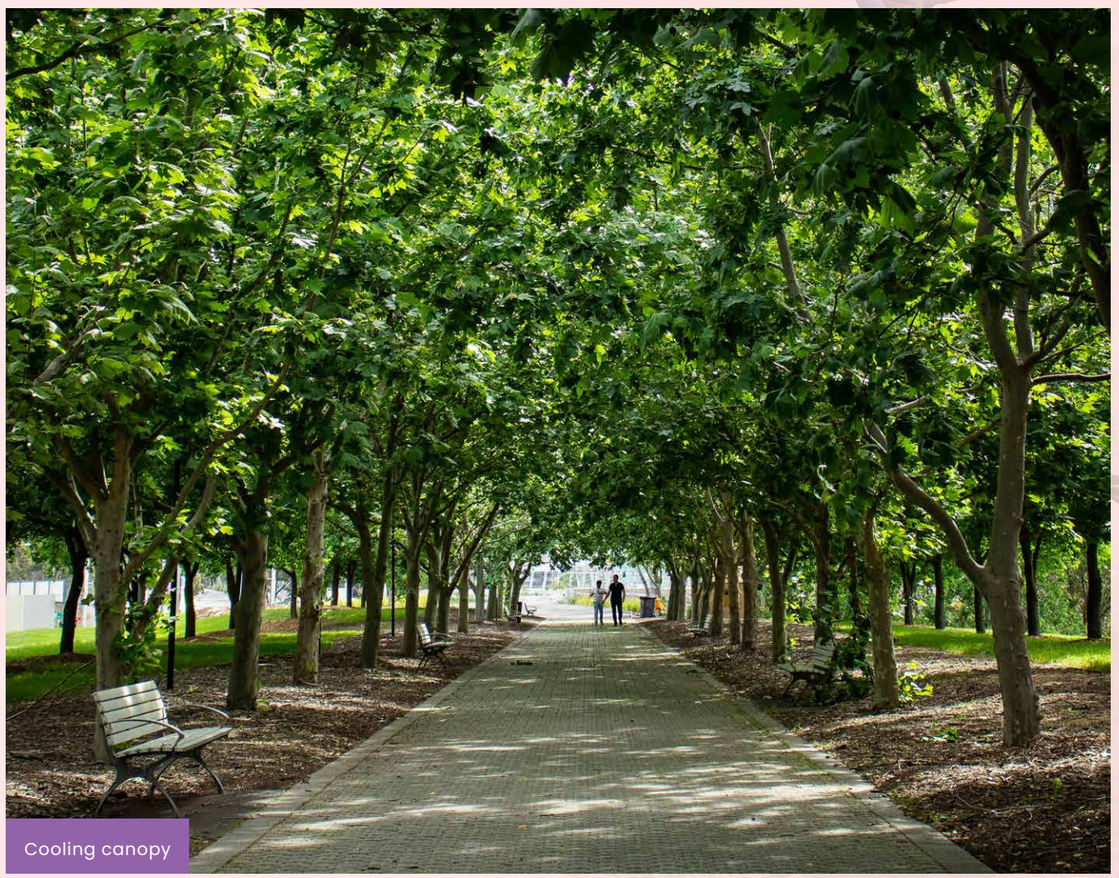
13 Astell-Burt, T., & Feng, X. (2019). Association of urban green space with mental health and general health among adults in Australia. JAMA network open, 2(7), e198209-e198209. https://doi.org/10.1001/jamanetworkopen.2019.8209

14 https://www.afr.com/technology/big-data-shows-nature-is-having-a-pandemic-renaissance-20200917-p55wnk

15 https://theconversation-com.cdn.ampproject.org/c/s/theconversation.com/amp/1-in-4-australians-is-lonely-quality-green-spaces-in-our-cities-offer-a-solution-188007

16 Astell-Burt, T., & Feng, X. (2019). Association of urban green space with mental health and general health among adults in Australia. JAMA network open, 2(7), e198209-e198209. https://doi.org/10.1001/jamanetworkopen.2019.8209

17 Astell-Burt, T., Hartig, T., Eckermann, S., Nieuwenhuijsen, M., McMunn, A., Frumkin, H., & Feng, X. (2022). More green, less lonely? A longitudinal cohort study. International journal of epidemiology, 51(1), 99-110. https://doi.org/10.1093/ije/dyab089



Cooling canopy

Source: Unsplash

Working, living and playing in greener places with strong connections to culture and the natural environment has been shown to create healthier societies. From a First Nations perspective, cultural identity and a sense of belonging to Country and community is strongly linked to health and emotional wellbeing. Aboriginal and Torres Strait Islander Peoples' continued connection with Country over the course of millennia is a source of valuable wisdom and knowledge that can guide all of us to improve the way we plan and design the places where we live, work and play.

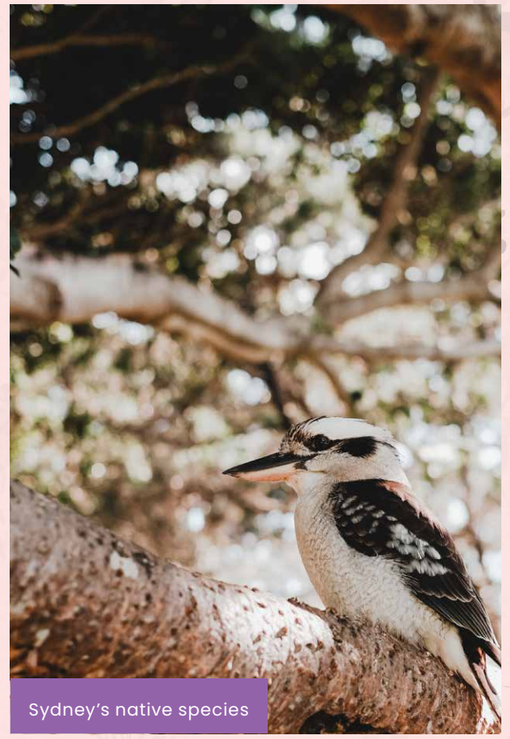
Biodiversity

Cities that value and increase their green and living infrastructure, expanding the opportunities to connect people and nature, can unlock the economic, social and environmental benefits of nature and natural systems. The biodiversity benefits of micro-forests/urban bushland and blue and green corridors linking existing areas also add value for flora and fauna in an urban context. In this way, biodiversity provides capacity for ecosystems and people to cope and adapt to climate change. This is a key dimension to the resilience of human-nature systems and an important reason why nature is important in cities; and more importantly, this benefit of nature has implications for the types of nature promoted in cities.

We have only recently started to incorporate First Nations knowledge into how we manage bushfire, through cultural burning practices, and selecting native flora that are adapted to local conditions (rather than European plants that often require a lot of water). The Royal Botanic Gardens and Domain Trust, for example, runs Aboriginal planting workshops to not only gain knowledge of how our native flora can be used but also how to properly take care of these native plants, while the biodiversity green roof at South Eveleigh Community Rooftop Garden sets out to create and maintain Australia's first Indigenous rooftop farm for urban food production using over 2000 edible, medicinal and culturally significant plants.

Current maintenance practices are largely based on European conceptions and expectations of tidiness and outdated landscape aesthetics. However, part of this process requires preserving and protecting Indigenous landscape systems and avoiding mixing them with species that don't belong in these landscapes – exotic species can be invasive and compromise the health of Indigenous landscapes. An exemplification of 'Caring for Country' principles, and promotion of design aesthetics, such as flowering native grass verges, would reduce maintenance time, cost and reliance on pesticides and fertilisers.

Increasing trees, vegetation and diverse ecosystems provides a range of habitats including shelter and food for animals,

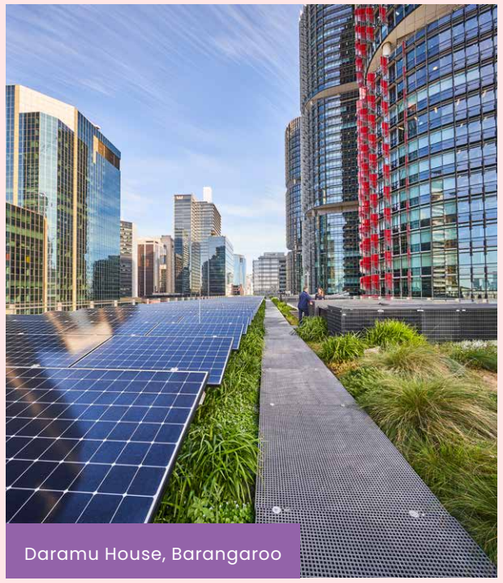


Sydney's native species

Source: unsplash

insects and birds. The kookaburras, flying foxes and lorikeets of Sydney are part of our city's identity, and they need food to not just survive, but thrive in every area of the city. Cities can also be a major refuge for many insect pollinators, providing foraging and nesting sites, larval food plants and nectar that may be less available on intensively managed farmland. The impact of introduced plants on native biodiversity has also emerged as important issue in ecology, with recent international research providing new evidence that the displacement of native plant communities is a key cause of a collapse in insect populations and is affecting birds as well.[18]

18 https://e360.yale.edu/features/how-non-native-plants-are-contributing-to-a-global-insect-decline



Daramu House, Barangaroo

Source: Lendlease

In Australia, UTS research on Daramu House at Barangaroo found the combination of native and non-native planting gave insects and bird life a year round food source and contributed to a nine-fold increase in insects and four-fold increase in bird life.[19] This included findings of the rare Blue Banded Bee and the Lychee Metallic Shield Bug, also rare and a significant discovery seven floors above ground. The challenge remains managing and maintaining these assets in both the public and private realms, and ensuring that when we design and construct our built environments, we are creating habitats not just for humans but for our precious ecosystems.

19 Irga, P et al (2021) Green Roof & Solar Array – Comparative Research Project Final Report July 2021 http://hdl.handle.net/10453/150142

Bees are key to pollination

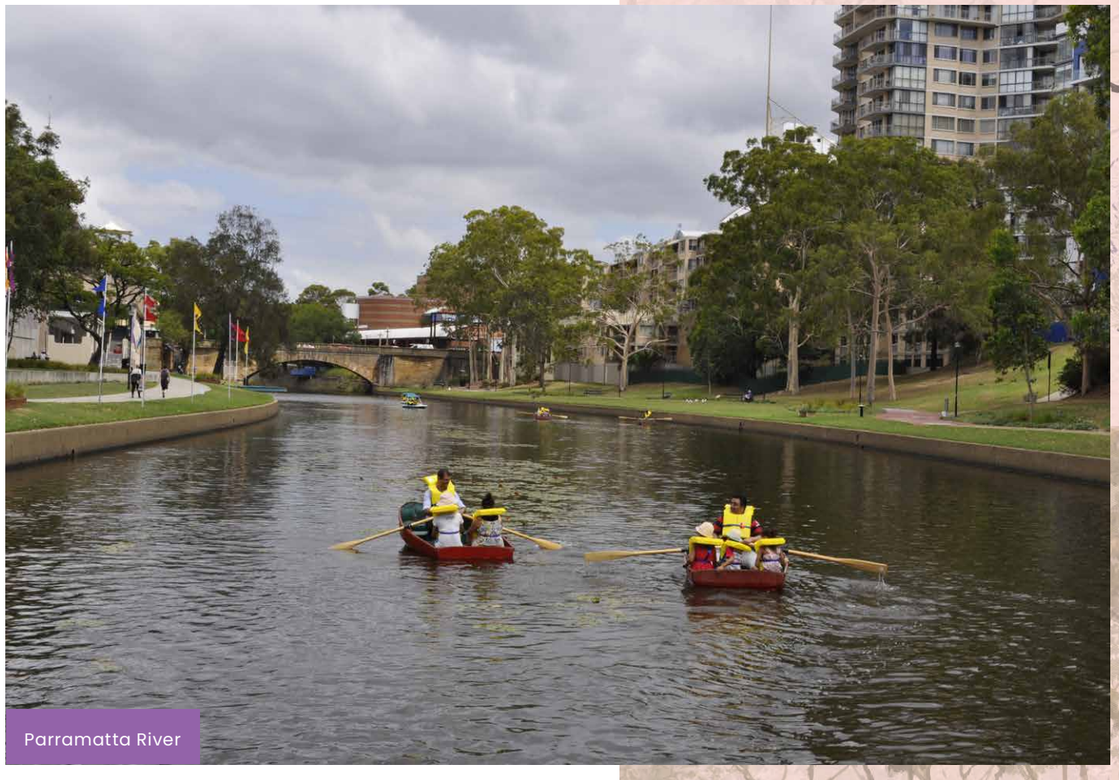
Source: Pexels

Nature is a key part of our connected city systems

Cities are made up of interdependent assets and services. Our energy, water, transport and waste services are all connected, and their reliance on each other determines their ability to provide effective services. We also need to recognise nature plays a role in supporting the functioning of our city. Infrastructure Australia recently highlighted the need to approach infrastructure – including blue and green 'living' infrastructure – using a systems approach.[20] That is, recognising the interdependence of the assets and services that enable our cities to function, and how disruption to one part of the system can have implications for other connected parts of the city.

20 Infrastructure Australia (2022) A Pathway to Infrastructure Resilience - Advisory Paper 1: Opportunities for systemic change http://bitly.ws/y6dX

Blue and green living infrastructure (waterways and green space) is often overlooked and undervalued as infrastructure, particularly in traditional asset management systems. Urban parks support mental health, while urban greening, including trees, green roofs, green walls and street planting can promote urban cooling effects and carbon capture, and stormwater mitigation, healthy waterways and surrounding environments can assist in water filtration, improving Sydney's river and harbour water quality – offsetting traditional physical infrastructure investments that would otherwise be needed to help communities survive and thrive in Sydney now and into the future.



Parramatta River

Source: Flickr

A First Nations world view also suggests there are limitations in taking an entirely human-centred approach to design. If people and their needs are at the 'centre' of design considerations, then the landscape and nature are reduced to second-order priorities. In a 'Country-centred' circle (see figure 2), the natural systems that include people, animals, resources and plants are represented as integrated in a network of relationships through Country – all supporting each other. When thinking about green and blue infrastructure, we need to bring an understanding of Country, of how the natural and human systems interact. This is the fundamental change in thinking that connecting with Country requires.[21]

Inspired by the green grid, an approach to considering Aboriginal and Torres Strait Islander peoples' culture and heritage as part of a holistic concept of the urban environment has been provisionally called the 'Ochre Grid.' Ochre was chosen to describe this idea because it is both a colour and a substance. As a colour it sits alongside the grey (roads), green (parks, landscaping) and blue (waterways) layers of infrastructure familiar to current design and planning for Sydney. Ochre was also chosen because the substance is used in ceremony and painting by Aboriginal and Torres Strait Islander people to share cultural knowledge.

Figure 2: We need to move from a human-centred to a Country-centred approach.[22]

Sydney's emerging green grid

Source: unsplash

21 GANSW (2020) Better Placed – Connecting with Country Draft Framework https://www.governmentarchitect.nsw.gov.au/resources/ga/media/files/ga/discussion-papers/draft-connecting-with-country-framework-2020-11-12.pdf

22 From Draft Connecting with Country Framework, Figure 6, Diagram adapted from German architect Steffen Lehmann, Eco v Ego diagram 2010

10 key moves for growing Sydney's living infrastructure

We envision a city abundant with nature, where knowledge of Country thrives with the built environment, natural systems and species, to create a growing network of living infrastructure, connected by corridors, and culture. A city that recognises grey infrastructure cannot protect it from natural hazards – whether flash flooding, riverine flooding or coastal storms.

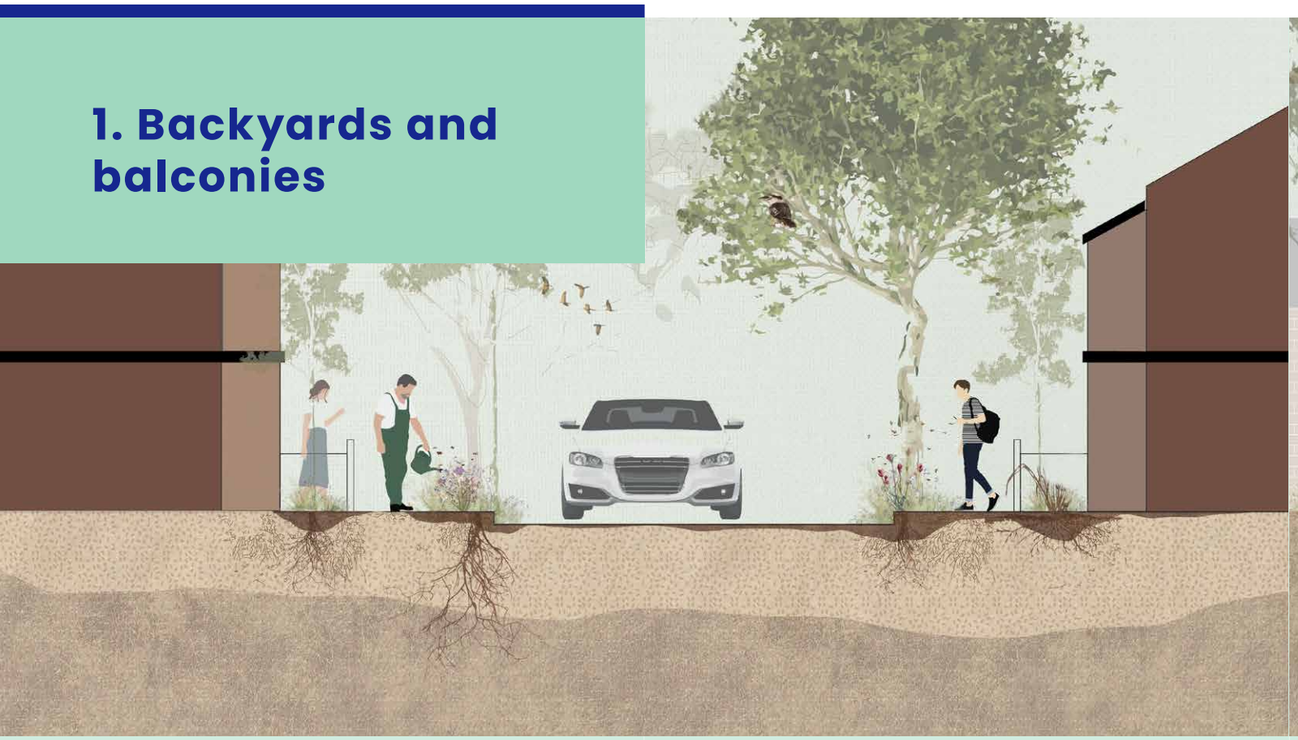
It is a city where green and blue grids are strengthened to create habitat corridors, where people have spaces to dwell, inclusive and accessible walking corridors to gain access to the water's edge, where our creeks are naturalised and become foreshores buzzing with bees and wildflowers and where living infrastructure and rain gardens are the norm, and a place where we have re-established a framework to connect and relate the citizens of the city to the deep memory of Aboriginal Country.[23]

We have extensive urban greening, including trees, green roofs, green walls and street planting, as well as water bodies to mitigate urban heat where it is needed most, diverse species to guard against monocultures and climatic change, and living infrastructure prioritised in every development – small to large – as part of the solution to improving the liveablity of our neighbourhoods, catalysing social interaction and supporting walking and bike riding.

There are some key moves that will encourage and nurture nature back into our city, from the small – household and local opportunities – to city-scale infrastructure corridors and waterways.

23 M. Tyrrell (2020) Exploring New Urban Futures Through Sydney's Hidden Grids in R. Roggema (ed.), Nature Driven Urbanism, Contemporary Urban Design Thinking, https://doi.org/10.1007/978-3-030-26717-9_12

1. Backyards and balconies



The first key move is to encourage more trees, pollinator-friendly flowers and plants at home in our backyards and on our balconies. Urban areas are often sparsely vegetated, devoid of plants and densely built up, thus terraces and balconies have the potential to be retrofitted with suitable greenery. In suburban parts of Sydney, where backyards are ripe for additional vegetation, small changes could trigger big benefits for the city. This would bring the benefits of nature into our homes – studies suggest even 10 minutes of gardening can reduce stress levels and restore positive energy of residents – and promote cooler local environments, contribute to overall plant diversity in the area, and provide stop-off points for birds and bees.

With many workers across Sydney choosing to spend more time working from home or closer to home, encouraging backyard and balcony gardening requires that we rethink what happens on the ground plane of buildings.

The traditional 'community gardening' model, predicated on access to public space to garden, is outdated and not fit for purpose in high density urban contexts. Instead, trialling 'garden clubs'[24] where residents have access to space to grow seedlings, pot up their balcony plants, and compost green waste can provide a range of benefits. This overcomes the practical challenge of lugging 20kg of soil up to the 14th floor of an apartment building, and a communal 'potting shed' on the ground plane of residential buildings would also a encourage community connection and social resilience, activating place and contributing to the character of the street.

24 Credit to Jess Miller (pers comms)

CASE STUDY

James Street Reserve Community Garden

The James Street Reserve Community Garden was established in 2010 on a neglected piece of public land in Redfern, Sydney.

In the years since, with the backing of the City of Sydney and local businesses, its volunteer members have created an attractive and productive garden with a focus on sustainable and organic practices.

The garden aims to be a space that is ever evolving, attractive, safe and welcoming, and which encourages community spirit, facilitates learning and information exchange, and acts as a role model.

This community garden has led to residents greening up their laneways and gardens/balconies.

2. Streets

All too often, our busiest roads are hostile environments with little to no nature. But there are ways to fix this. On high streets, planter boxes provide an initial buffer to the roadway, and trees can be planted in the verge lane, which provides a parking/drop off lane and prevents clearways that make an unpleasant experience for pedestrians. Main street views can terminate with large canopy street trees, preferably on street corners. Try not to isolate trees in paving, road median strips or other urban settings – trees belong to a family of vegetation – and benefit from communicating with one another.

Residential street verges have capacity for more trees, and can be planted with native understorey or ground cover species, or left to flower, turning verges into wildlife corridors. Local governments across the UK have been able to almost halve budgets for managing roadsides by reducing cutting to three times per year.[25]

Replicating simple irrigation 'hacks' like the leaky drain project in Chippendale,[26] whereby water is diverted from household roofs into the verges before going into the stormwater drain, has been shown to increase both biodiversity and cooling – just through stemming the flow of water and thereby increasing soil quality.

We need to connect the planting of trees in streets and parks to the creation of urban forests and heat mitigation targets, and engage residents in maintaining and caring for the street.

Engaging with communities so they feel empowered to care for place by building an understanding of the benefits living infrastructure can provide is part of the answer.

CASE STUDY

International and local experience

In Seattle, a 'Green Streets' program was introduced that demonstrated to citizens what living infrastructure would be like. In western Sydney, the 'Cool Streets Pilot Project' in Blacktown was designed to empower residents to take the lead in deciding on the layout and type of trees on their street, with a specific focus on improving environmental outcomes and neighbourhood climate resilience.

Along high streets, programs like the NSW Department of Planning and Environment's 'The Festival of Place Open Streets' allows temporary reallocation of car space in urban areas for pedestrians.

CASE STUDY

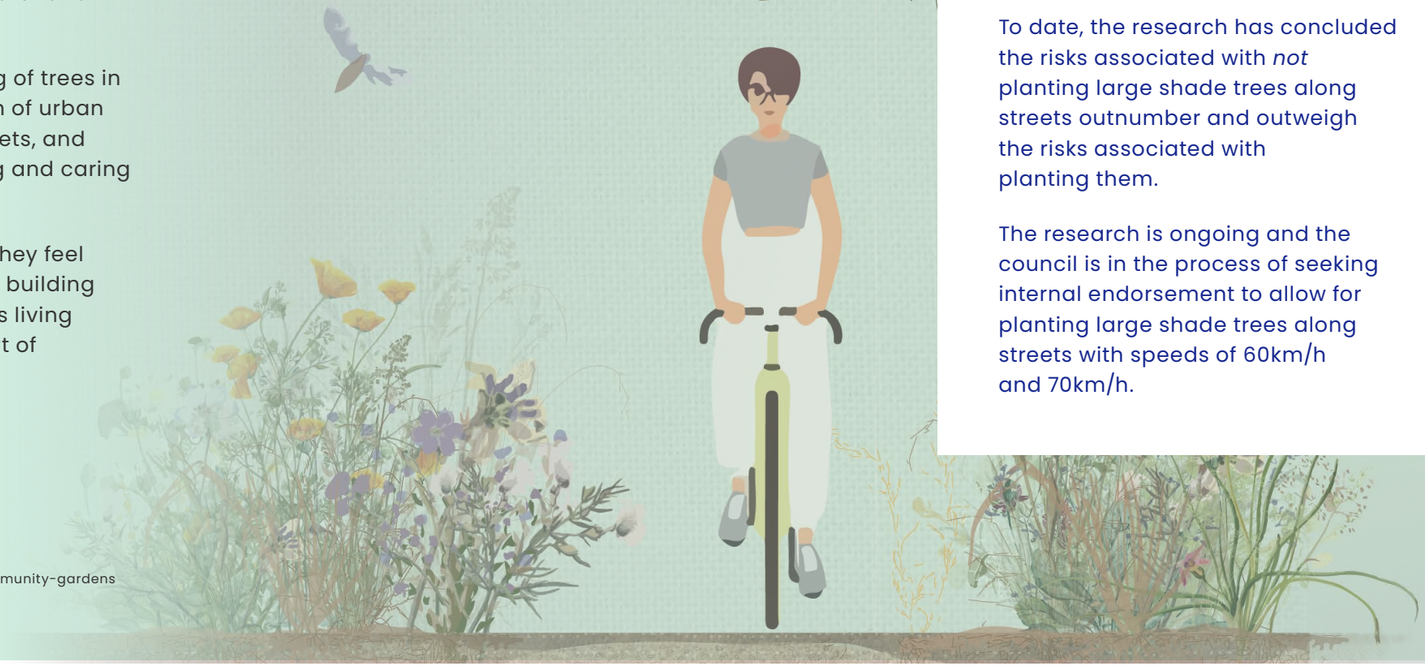
Blacktown City Council - the risks of having, and not having street trees

Local councils do not currently plant large shade trees on streets with speeds above 50km/h. Current guidelines say large shade trees present a safety risk to errant vehicles. However, the guidelines only consider one risk – the risk to the errant vehicles.

Innovative research, funded under the 'Greening our City Grant Program' looked to identify all the risks Blacktown City Council and its community would be exposed to if large shade trees are not planted along its streets – including risks to physical and mental health, environment, economy, infrastructure, society and policy.

To date, the research has concluded the risks associated with *not* planting large shade trees along streets outnumber and outweigh the risks associated with planting them.

The research is ongoing and the council is in the process of seeking internal endorsement to allow for planting large shade trees along streets with speeds of 60km/h and 70km/h.



25 https://www.theguardian.com/environment/2020/mar/14/on-the-verge-a-quiet-roadside-revolution-is-boosting-wildflowers-aoe

26 https://www.sustainablehouse.com.au/community-gardens

3. Laneways and leftover spaces

Our cities in Australia are teeming with leftover spaces, from railway cuttings to car parks and abandoned industrial sites. In the City of Sydney LGA alone, there are 383,00m2 (38/3ha) of narrow streets classified as laneways.[27]

Lanes in quiet alleyways – suburban or inner-city – can also be established as active ecologies by removing paving and increasing greening, providing cool and ecologically vibrant places for people and nature.

This, in turn, also increases walkability as seen through the NSW Government's 'Streets As Shared Spaces' program. In Fairfield, temporary parklets were installed on Kenyon Street, and Cabramatta's Freedom Plaza was turned into a pocket park for three days. The three-day pop up resulted in a doubling in pedestrian traffic through the activation areas.

While laneways and leftover space provide an enormous opportunity for urban greening, it also invites an important conversation about how we can encourage innovative thinking on how public space can deliver equity of use and benefit.

We can use these thousands of leftover 'lazy' spaces to provide more equitable access to nature across the city, expanding opportunities for community gardening, and improving pollinator stepping stones. For instance, setting aside parts of vacant reserves and sites of former buildings or rail corridors, with a focus on creating native wildflower and other vegetation to increase plant diversity, attract pollinators and create more drought-tolerant areas.

27 https://www.cityofsydney.nsw.gov.au/strategies-action-plans/greening-sydney-strategy

4. Parklands and pocket parks

"Country cares for us, has purpose and requires us to take responsibility to help look after the environment"

We need wide open grassy areas for active recreation in our parks, and we also need to complement them with ecologically active spaces. These spaces can also be culturally productive – linked with local or micro-businesses and Indigenous enterprise, particularly if that is planned from the outset, through, for instance, species selection or parkland programming.

While parts of Europe advocate for a rewilding of nature – in effect, letting nature grow and evolve without intervention – from an Aboriginal perspective this suggests nature is inhospitable, uncivilised, uninhabited. In contrast, the Aboriginal perspective is that Country cares for us, has purpose and requires us to take responsibility to help look after the environment.

Increasing tree canopy in and of itself is likely to be insufficient to conserve biodiversity or attract associated species without appropriate consideration of which species to plant, habitat quality and the specific resources required to support certain target species. Again, indigenous trees may not provide as much shade as exotic trees, dappled light is a characteristic of the Australian landscape compared to the strong shade of European trees. Retaining existing large trees in urban areas should be the highest priority for biodiversity conservation, with an increased focus on retaining existing vegetation and habitat.

CASE STUDY

SIMPaCT at Bicentennial Park

From a scientific perspective, cooling is the primary service delivered by urban parks today. Depending on surface morphology and a park's watering status, as well as the speed and direction of wind, the cooler air from inside a park can lower air temperatures hundreds of metres – even several kilometres – downwind. This phenomenon is known as the park cool island (PCI) effect.

The goal of SIMPaCT (Smart Irrigation Management for Parks and Cool Towns) is providing optimal soil moisture levels for all vegetation types in the park.[29] Under these conditions, plants in the park will operate at their maximal rates of transpiration, which in turn results in the highest degree of air cooling.

Machine learning is being used to optimise irrigation management through the creation of a digital twin of the site. Over several months and thousands of simulations, the algorithms have been 'learning' how park irrigation produces optimal soil moisture conditions for different vegetation types under a wide range of weather conditions.

Beyond the park's physical boundaries, the SIMPaCT project will also involve streaming the environmental data online to enable park visitors and residents of Sydney Olympic Park to check park conditions in real time using maps and dashboards.

29 https://landscapeaustralia.com/articles/designing-for-coolth/

Gore Hill Cemetery

Source: M. O'Dea

Cemeteries, which make up 751ha (0.06%) of Sydney, are some of the best-preserved green spaces in modern cities. Cemeteries are already recognised as playing an important role in the creation of Sydney's green grid – an interconnected network of open space that will keep the city cool, encourage healthy living, enhance biodiversity and ensure ecological resilience – in combination with national, regional and local parks through the harbour, ocean beaches, wetlands, rivers and creeks, playgrounds and playing fields.

In Victoria and NSW, enterprises like Living Legacy are working with the Greater Metropolitan Cemeteries Trust in Victoria and Northern Cemeteries in NSW, and investing private money to acquire and care for land such as golf courses and converting them into publicly accessible 'Living Legacy Forests.'[28] This type of solution offers new thinking to old problems like the cost of maintaining parklands. It offers a sustainable burial and cremation option that can also ensure parklands are protected and funded in perpetuity, in a way that does not carry the stigma and potential flooding risk of conventional cemeteries.

28 https://livinglegacyforest.com/cemetery-partners/

CASE STUDY

Connecting Camden White Gum

The 'Connecting Camden White Gum' project is replanting 500 genetically diverse Camden White Gum (*Eucalyptus benthamii*) trees within the Nepean River corridor at Elizabeth Macarthur Reserve, Camden South.

Planting the large canopy trees will help cool the suburb, reduce the urban heat island effect, and strengthen the resilience of Camden White Gum, a species listed as vulnerable under federal and state legislation. The plantings complement existing remnant trees on the site, enhancing existing parklands, building local biodiversity and protecting this locally native species.

5. Rooftops

Residential and commercial rooftops can be turned into green spaces, micro-habitats and community gardens so apartment dwellers get the same benefits as those in lower density living.

Green roofs provide shade, remove heat from the air, and reduce temperatures of the roof surface and surrounding air. They also slow runoff during rain events, reducing the risk of flooding, and have been proven to enhance the performance of rooftop solar PV panels.

Green roofs also support wildlife by giving urban concrete jungles a dose of green space. While they can't entirely replace natural green space, they're perfect for attracting birds, bees and other wildlife to create a thriving eco-friendly habitat. They are also often visible to people living and working in surrounding buildings, providing an opportunity to improve human wellbeing in addition to biodiversity and ecosystem services, if proper consideration is given to their design, location and quality.

However, green roofs will not be able to play the biodiversity role envisaged until policy incentives are implemented to significantly increase the number of green roofs constructed.

CASE STUDY

SkyParks gardens at Westfield Bondi Junction

The benefits of green roofs can be seen in the 2022 AILA award winning SkyParks gardens project at Westfield Bondi Junction.

The site is publicly accessible, and the project included three different garden installations: the coastal garden, bushtucker garden and the pollinator garden.

The project included research into factors affecting plant performance, ambient heat reductions, and a cost-benefit analysis. The Skyparks gardens were delivered by Waverley Council, in partnership with Common Grounds and Scentre Group, with funding from the 'Greening Our City' grant program.

CASE STUDY

Daramu House, Barangaroo

The green roof system implemented at Daramu House, Barangaroo, has already begun to show tangible benefits[30] including rooftop solar panel efficiency improved 3.6% on average, and surface temperature of the roof reduced 20°C.

Animals thrived on the green roof, with insect and bird life increasing nine and four-fold, respectively. Species recorded include the native Australian Blue Banded bee, Australian stingless bees, as well as Spotted Doves and Australian Ravens. The possible presence of predatory birds also suggests the roof may be supporting complex food web systems.

Stormwater modelling on both roofs showed the biosolar roof could reduce flows into the stormwater drains by more than 600 litres per second compared to the conventional roof, which could reduce the impacts of flooding during storm events, particularly where climate instability is leading to longer, drier periods and more intense storm events. Research indicates Daramu House reduced stormwater runoff by 99% compared to its sister building International House.

30 Irga, P et al (2021) Green Roof & Solar Array – Comparative Research Project Final Report July 2021 http://hdl.handle.net/10453/150142

6. Facades

Source: Campbelltown City Council

We can also transform bare building facades – across residential and commercial buildings – into vibrant green vertical ecosystems/habitats. Green walls or facades have the potential to remove air pollutants, reduce urban temperatures, and provide thermal benefits to buildings, as well as improving biodiversity. Sydney is already home to the largest green wall/vertical garden in the southern hemisphere at One Central Park, Chippendale (actually 23 walls totalling 1200m^2), which also reuses wastewater for irrigation and ease of maintenance, but there are many other examples, including a Junglefy 'Breathing Wall' incorporating around 9000 plants in a three-storey commuter car park at Manly Vale and another at Campbelltown Station.

These are examples of phytotechnology (the application of plants into science and engineering) that go above and beyond standard green walls. They are scientifically proven to clean the air through an active ventilation system, and are part of extensive peer reviewed research by University of Technology Sydney since 2014.[31]

To improve adoption of green walls, breathing walls and facades, Australian governments must consider incentives and invest in more education and skills development for this fast-paced emerging industry. Life cycle maintenance for private developers is the most significant pain point.

31 https://www.uts.edu.au/research-and-teaching/our-research/sustainability/our-research/breath-fresh-air

CASE STUDY

Breathing Walls in Campbelltown

In 2020, Campbelltown City Council partnered with Junglefy and the University of Technology, Sydney to deliver a data-driven, industry-leading initiative. A Junglefy Breathing Wall was installed at Campbelltown Station to showcase the importance of living infrastructure in reducing urban heat and improving air quality.

Junglefy Breathing Walls are a natural system that demonstrated to clean and cool the air, as well as provide acoustic, biodiversity and biophilic benefits. The Breathing Wall covers a total of 40m^2, including 160 modules and more than 1200 plants of 12 different species.

Permanently installed environmental sensors provide ongoing real-time information on the effectiveness of the Breathing Wall in cooling and improving air quality. The findings are being analysed by the University of Technology, Sydney and will form part of an international research publication on the benefits of breathing walls.

After the Breathing Wall was installed, Western Sydney University captured thermal images of the immediate area, showing a reduction in surface temperature of as much as 30°C.

7. Schools and hospitals

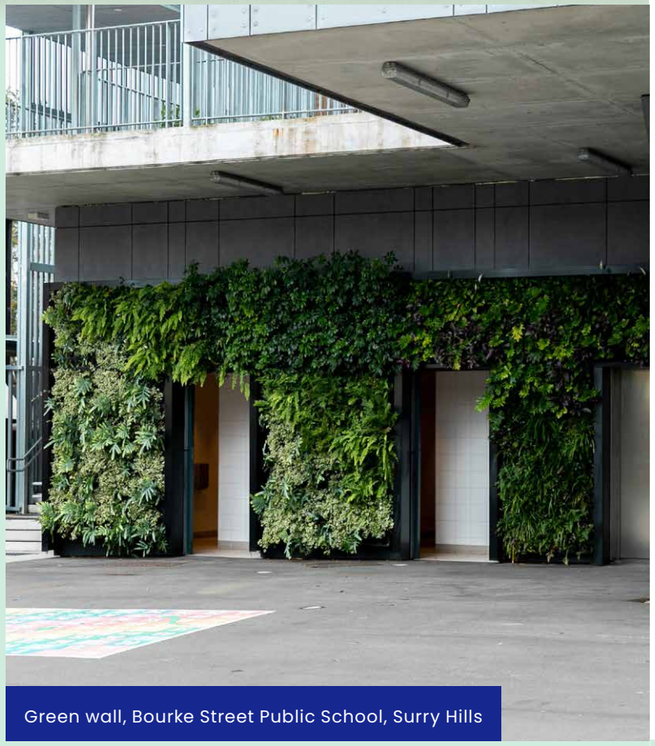
Hospitals are already identifying the benefits of biophilic design to patient recovery. This includes ensuring patients have as much visual connection with nature, through the design and use of public space curtilages of hospitals, optimising views of green spaces through windows, enhancing indoor and outdoor plants, the presence of water, and bringing in as much natural light as possible. Evidence suggests these features help patients recover faster, while reducing staff stress and improving emotional wellness.

The design of the new children's hospital building at Westmead incorporates principles of biophilic design, with natural light, and physical and visual connection to green spaces. A nearby river is also reinterpreted in the architecture of the building, and an Aboriginal meeting place also forms part of the design. The 'Greening Our City' program, in partnership with Landcare NSW, has planted more than 16,500 trees at several major hospital sites in western Sydney, including Westmead. These sites were chosen partly in recognition of the health benefits of living infrastructure.

Schools are another focus for engaging in nature, not just within the grounds and as part of the curriculum, but as an asset at the centre of a local community that needs to be cool enough for outdoor play during Sydney's harsh summers, as well as being connected by green corridors to enable walking and cycling to and from home.

In Paris, by gradually replacing asphalt with vegetation and/or testing new materials and new methods to cool schoolyards, more than 600 schoolyards will become places for learning and wellbeing, as well as 'cool refuges' for community members vulnerable to heat waves.[32]

32 https://www.theguardian.com/cities/2018/aug/16/could-greening-every-paris-schoolyard-cool-the-city



Green wall, Bourke Street Public School, Surry Hills

CASE STUDY

Bed & Breakfasts for Bees, Birds, Butterflies & Biodiversity

Sydney's B&B Highway program (Bed & Breakfasts for Bees, Birds, Butterflies & Biodiversity), supported by the NSW Department of Education, aims to create pollinator pathways across Sydney with hubs in public schools and other educational and community centres.[33] Citizen science, through data collection and pollinator and plant identifications, is a key part of the initiative.

Engaging children and young people in nature experiences is a good way for them to learn about the importance of nature and to become champions for change.

The 'Cooling the Schools' program is being delivered in partnership with Department of Planning and Environment's 'Greening Our City' program, Greening Australia and the Department of Education. It seeks to increase canopy cover through tree planting and education across Greater Sydney to create shade and reduce urban heat in schools. By the end of 2022, Cooling the Schools will have planted more than 19,500 trees at 130 schools with over 8000 students engaged, targeting the hottest areas of Greater Sydney, based on research undertaken by Western Sydney University.

Source: Junglefy

33 https://www.ps.org.au/bb-highway-about

8. Infrastructure corridors, railways and roads

We can transform our transport corridors into green or blue connectors by taking advantage of major infrastructure investments. We know corridors preserved for future infrastructure are some of our most biodiverse areas. Sydney already has a plan for a blue-green grid, connecting existing green spaces and waterways with bike lanes, rail corridors, canals, roads and highways that enable an ecological and human connection.

Sydney's transport agency is one of the largest landowners in the city and can have an outsized impact on how nature is enabled or constrained. The Future Transport 2056 strategy commits to enrich our cities with nature through maintaining and improving existing high-quality transport landscapes or transforming underutilised transport land into a valued component of our state's living infrastructure system.

Existing and new transport connections – from metro rail to local bikeways – have the opportunity to enhance ecological and mobility connections as part of the realisation of the blue-green grid across the city. There is an opportunity to lead the development of network planning through a lens of green corridors.[34]

34 Green Transit Oriented Development (SGS Economics and Planning) https://www.youtube.com/watch?v=oBi7MiSQpDo

CASE STUDY

From overhead powerlines to aerial bundled cables

Overhead powerlines limit the available planting space on many streets. While trees can be planted under powerlines, they must be approved species under 8m height – often these do not provide the broad canopy that many councils are targeting as part of urban heat reduction strategies. Most of the community anger at pruning practices comes from legacy inappropriate species that were planted under the wires decades ago.

Some engineering solutions to the problem exist. Powerlines can be relocated underground, however, it is prohibitively expensive in most cases, extremely disruptive to construct in established neighbourhoods (~$150k) and creates other problems such as tree roots interfering with powerlines.

For less than a tenth of the cost (~$11k), the overhead bare wires can be upgraded to aerial bundled cable (ABC), which take up less space and can significantly reduce the minimum vegetation clearances needed around the wires. Since 2000, Ausgrid has installed more than 1500km of low voltage ABC, making up just over 22% of the low voltage overhead network. Using aerial bundled cable, trees can be directionally pruned around wires, so large trees and overhead powerlines can safely coexist.

As part of its draft plan for 2024-29, Ausgrid consulted the community on a $20.8 million program to co-fund aerial bundled cabling with councils, providing a 50% contribution to councils (as well as a higher 70% contribution to certain priority councils). This program would fund the upgrade of over 1900 spans across the Ausgrid network area. This funding is proposed as a program to tackle urban heat by supporting increased urban canopy and is part of a broader climate resilience program.

Image: Sebastian Pfautsch

CASE STUDY

Parramatta light rail green tracks

More than 1.3km of 'green track,' with grass or shrubs planted between and beside the tracks instead of asphalt or concrete, have been laid as part of the Parramatta light rail project.

Research from Western Sydney University showed the green track will perform important environmental functions that improve the amenity and ecology of the local area, particularly in Parramatta where summer heat and more general heat island effects are of concern for public health and infrastructure integrity.[35]

The award-winning project has been recognised for its capacity to bring back open, pervious and green space into contested inner cities.[36]

35 https://researchdirect.westernsydney.edu.au/islandora/object/uws%3A48951
36 https://aila.awardsplatform.com/gallery/OEZZaYEG/GZpdDboY?search=ea92224315480e3b-47

9. Rivers and waterways

Sydney's major waterways are obvious but not always accessible. Our smaller streams are often hidden underground, or in concrete channels used to drain water away. By returning stream beds to natural conditions, and creating adjacent paths and habitats, we can activate Sydney's blue grid. Some rivers and waterways could also provide ecologically-driven human infrastructure, such as cycleways, footpaths and natural swimming pools.

Plans to plant millions more trees in Sydney have direct implications for water infrastructure and maintenance. Trees assist with evapotranspiration and preserve water in the landscape – by slowing down how quickly or directly water travels into stormwater drains – we can channel that water into street trees, gardens, nature strips and parks to increase biodiversity and improve urban cooling and recreational access.

We also need to take a long-term view and recognise the impacts of climate change on river systems. This means planning for climate-change-induced ecosystem migration by creating buffers to wetland and mangrove areas so they can gradually migrate as river levels rise. Initial precinct planning for Wianamatta South Creek in western Sydney considered the Probable Maximum Flood – an approach that has dual benefits of reducing flood risk, and retaining water in the landscape, to enable the green-blue infrastructure needed to combat urban heat.

CASE STUDY

Urban Plunge

Sydney Water's Urban Plunge program has been designed to accelerate the delivery of more swimming and recreation opportunities in Greater Sydney's rivers, creeks, lakes and inlets.

It builds on the work Sydney Water has been doing with councils, government agencies and the community as part of the Parramatta River Catchment Group to improve water quality and support the activation of new swimming sites on the river.

The expertise developed through this partnership has positioned Sydney Water to drive a broader vision for swimming across the city, making the process faster, easier and safer for councils and other landowners to open swim sites.

While water quality is recognised as the most significant barrier, new technologies are enabling authorities to measure water quality in real time, and predict water quality in response to major rain or other significant events.

The vision is that everyone in Sydney lives within 30 minutes of a swim site – however, the current reality is many Sydneysiders live almost an hour from somewhere to swim.

The NSW Government's timely 'Places to Swim' program is aligned with Urban Plunge, providing grant funding to give people opportunities to get in the water more often.

10. Greenfield development areas

While much can be done in existing urban areas, greenfield development sites create an opportunity to conserve as much existing nature as possible, and improve the local environment and connections beyond. We need a stronger focus on both species diversity and genetic diversity in any new project or initiative. It is critically important to ensure any new project has built-in resilience – providing an opportunity for climate ready and climate resilient plantings to be a focus.

We should not underestimate the role of designers – who have the capacity to help usher in a new urban environment, designed to restore natural ecosystems threatened by climate change. We must deliver cooler and cleaner air, restore biodiversity, build climate resilience, and nurture health and wellbeing. And we need to support and expand training and job creation for future maintenance of this critical infrastructure.

As detailed earlier, increasing tree canopy is likely to be insufficient to conserve biodiversity or attract associated species without appropriate consideration of which species to plant, habitat quality or the specific resources required to support certain target taxa. And conserving existing large trees in urban areas should be the highest priority for biodiversity conservation, as well as the many other benefits that such trees provide, alongside an increased focus on retaining existing vegetation and habitat.

There is a planning policy opportunity to better safeguard deep soil on greenfield sites by constraining floorspace ratios. While it's hard to require planting on private sites (although free plants, subsidies and so on may help), planning can control how much site is taken up and, therefore, how much is left over for non-build surfaces. While urban heat can be addressed in a range of ways – design, changes to planning controls (e.g. the Wilton DCP) – embedding biophilic principles offers a much broader range of benefits and is a superior strategic approach.

Thornton Estate, Penrith

Source: Penrith City Council

CASE STUDY

Wianamatta South Creek / Bradfield aerotropolis

At the Bradfield aerotropolis, planning, design and delivery of built environment projects are using the 'Connecting to Country'[37] framework. Listening to Country and learning from it to inform design choices has translated into:

- Using water as a structuring system for the precincts
- Protecting ridgetops and creek lines as open space and landscape
- Arranging street and urban patterns to connect high and low points of topography as well as vegetation with water
- Providing a visual connection between sky, vegetation, landform and landscape.

Much work has also been done to understand the cultural role Wianamatta Creek played for Aboriginal people[38].

Today, Wianamatta, also known as South Creek runs 80km through the heart of western Sydney from Oran Park in the south to the Hawkesbury River at Windsor in the north. In times of drought, it can be ephemeral, drying up over long stretches for months or years, only to flow rapidly during heavy rainfall.

The Western Parkland City presents an opportunity to design with Country, and integrate nature into the new city and its suburbs.

In fact, the integration of green and blue corridors into the design of the western city centres is the only way they can remain liveable in the face of climate change, particularly rapidly rising temperatures and extreme heat events.

CASE STUDY

Riparian zones

Planting in riparian zones along waterways is a feature of five NSW Government Greening Our City grant-funded projects. These zones were identified by each council as needing improvement.

Projects include in-fill plantings along waterways, conversion of stormwater channels into more natural creeks, and creating links to other natural areas enhancing local biodiversity.

The riparian plantings create connected biodiversity corridors, increase habitat for local fauna, improve water quality, reduce urban heat island impacts, and provide high quality open spaces for recreation. Plantings improve the existing vegetation, creating more resilient natural areas.

CASE STUDY

Urban tree canopy targets and development controls study

The NSW Department of Planning and Environment is developing an evidence base for applying urban tree canopy and deep soil targets for the public domain (parks and streets) and private domain (various scales of residential and industrial sites) in urban areas across NSW. The targets are being tested across multiple development scenarios to ensure they were realistic and representative of the broad range of development in the state.

The study's targets are being embedded in state-led precinct planning and are helping councils across Greater Sydney develop targets in their own urban forest strategies.

37 GANSW (2020) Connecting to Country – Draft Framework
38 https://www.hassellstudio.com/hk/conversation/wianamatta-rising-charting-the-future-of-a-western-sydney-waterway

Pathway to action

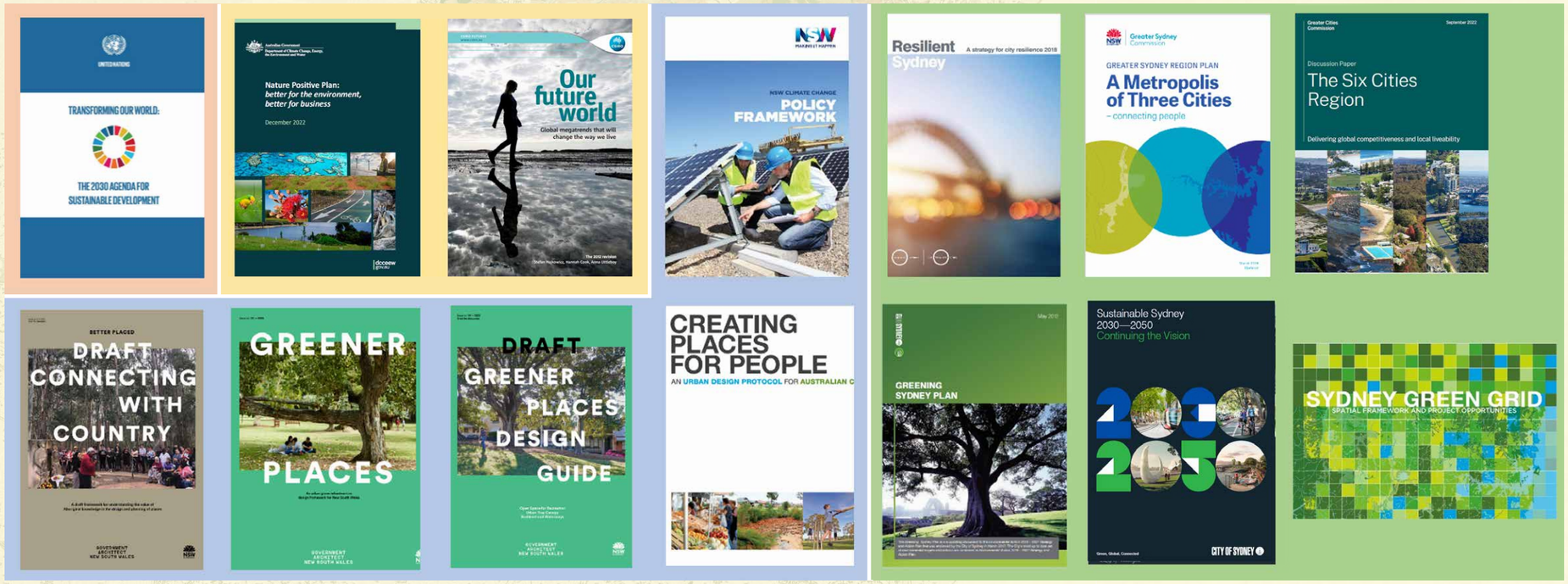


Figure 3 Nature Positive policy frameworks

While we know why we need to increase living infrastructure in Greater Sydney, and we know the key moves to make it a reality, there are real barriers that prevent us from scaling the solutions.
They include the lack of financing and incentives, the need to build awareness and education and a deep connection to Country, as well as the need to establish mandates that embed living infrastructure solutions into developments.

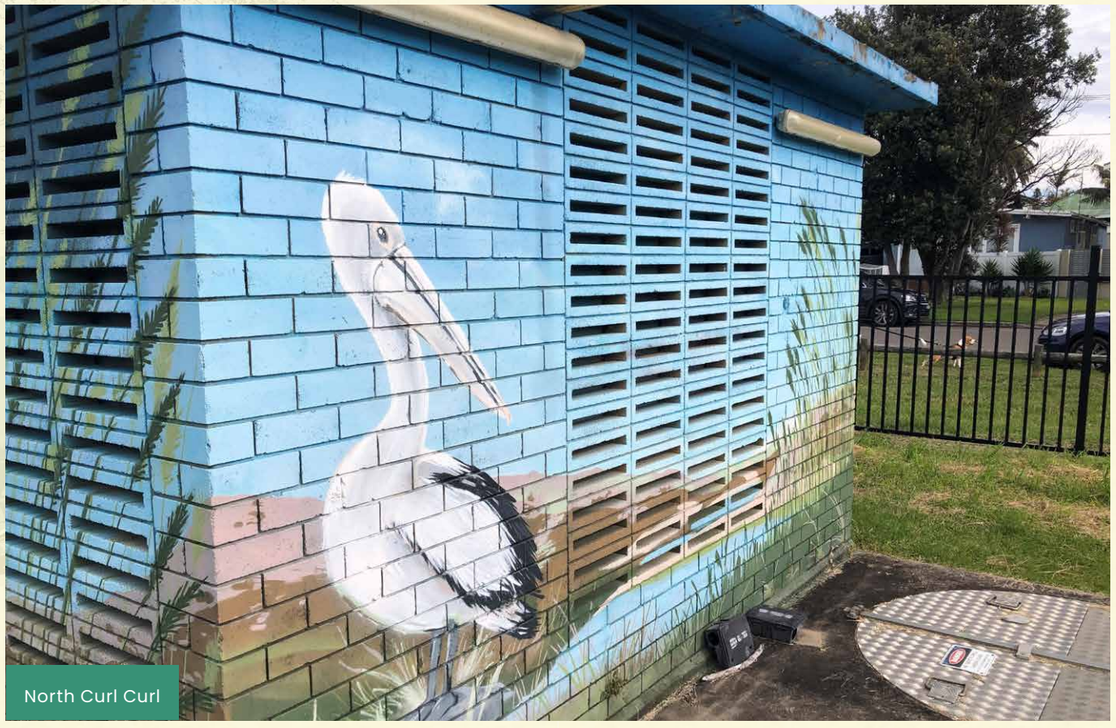
There are many policy documents that speak to the importance of green and blue living infrastructure. From design guidelines to connecting with Country, and local and metropolitan efforts to increase tree canopy and open space. However, few, if any, focus specifically on the need to grow and value living infrastructure as part of creating a vibrant, climate-resilient and healthy environment for our communities.

Historically, asset management has been focussed on the built form, while the opportunity to recognise living infrastructure as an asset has been overlooked.

To appropriately value and frame living infrastructure as an asset, a robust and reliable evidence base is essential. Good data ensures decision makers understand a full range of social, economic, cultural and environmental living infrastructure considerations and can value them appropriately when planning investment decisions and allocating resources. This is particularly important when resources are scarce and competition for them is high.

To overcome the barriers and realise the multiple benefits identified, we need a systemic roadmap that builds on existing efforts, and simultaneously addresses roadblocks, to unlock the potential of living infrastructure.

Our pathway to a nature positive city consists of four directions and nine specific actions, as follows.



North Curl Curl

Source: S.Kernaghan

Source: Unsplash

1. Enable community education and Indigenous knowledge

1.1. Step up education and awareness programs for communities

Urban canopy loss occurs predominantly on private land, so how residents manage their backyards, front yards and even nature strips is a big part of the solution. Bushfires and storms mean we have a complex relationship with trees and other vegetation. Increasingly busy lives mean high maintenance backyards are not for everyone. Equally much of our relationship with nature is cultural and Sydney's population is very multicultural. This is particularly the case in western Sydney. Each cultural group has different values and engages with nature differently, and therefore requires careful consideration in any measures to green the city.

Significant practical knowledge on effective pathways to increase community engagement in biodiversity projects can be found within local governments, hence establishing communities of practice around community engagement in urban nature may be key to knowledge sharing on this topic.

Partnerships between trusted environmental organisations like Greening Australia, Landcare NSW and Planet Ark have enabled the NSW Government to support citizen networks through funding for Cooling the Schools, National Tree Day and Creating Canopies programs. These initiatives enabled individuals, schools and community groups to actively participate in the cooling and greening of places important to their neighbourhoods.

The 'Everyone Plant One' campaign under the 'Greening Our City' program was developed to encourage Greater Sydney residents to plant trees at home and contribute to the broad goal of greening Sydney. The campaign was designed using the results of behavioural science research and emphasised the benefits trees and green cover bring to individual homes and communities.

Government-led or funded programs to educate and/or engage with the community have the potential to change our relationship with nature at the household level. This can be achieved through connecting existing citizen group networks, adopting new ways of engagement in new and existing suburbs, or creating educational campaigns for organisations and individuals that explore the bioregions they live in and the functions and benefits of living infrastructure.

In Seattle, a 'Green Streets' program was introduced that demonstrated to citizens what living infrastructure would be like. In western Sydney, the 'Cool Streets Pilot Project' in Blacktown was designed to empower residents to take the lead in deciding on the layout and type of trees on their street, with a specific focus on improving environmental outcomes and neighbourhood climate resilience. Engaging with communities so they feel empowered to care for place by building an understanding of the benefits that living infrastructure can provide is part of the answer.

***Lead agency**: Department of Planning and Environment in partnership with Resilient Sydney, 33 local governments across Sydney, and NSW Department of Education.*

Source: Pexels

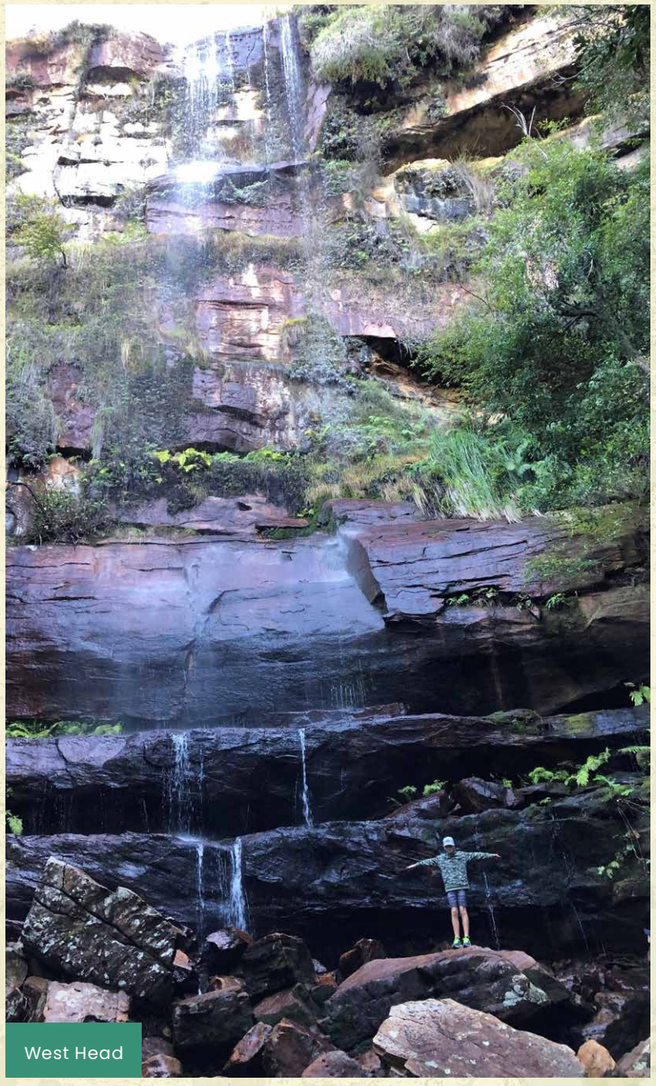
1.2. Establish a Centre for Urban and Indigenous Ecology

This would provide continual research, training and education to mobilise and support work on connecting with Country, urban ecology and living infrastructure.

As our climate changes, we need to be vigilant that what we are planting is going to survive the extreme temperatures and droughts that are ahead of us. We need to ensure our urban environment is supporting the needs of pollinators, migratory birds, and native fauna and soil biota.

We know there is a significant knowledge gap across Australia on how to design, install and maintain biodiverse ecologies in urban environments, a challenge that universities across the city have taken up through various research programs.

We have only just begun to learn from First Nations people across the Sydney basin. Organisations like IndigiGrow, a social enterprise from First Hand Solutions Aboriginal Corporation, sustains people, land and culture by propagating native plants, including bush foods and the critically endangered Eastern Suburbs Banksia Scrub (ESBS). IndigiGrow seeks to pass down First Nations knowledge to their young Indigenous staff and provide opportunities for the wider community to engage and learn about the wide-ranging benefits of native plants. The Royal Botanic Gardens also runs education programs across its sites in the Domain, Mount Annan and Mount Tomah in the Blue Mountains.



West Head

Source: S.Kernaghan

IndigiGrow assisted the Department of Planning and Environment to roll out the Free Tree Giveaway across Greater Sydney, making seasonally appropriate native trees available to Sydney residents to plant, encouraging the expansion of tree canopy in private gardens and increasing habitat opportunities.

There is a great opportunity to include threatened and at-risk species in plantings – and to take the opportunity to include seed production areas for threatened species, at-risk species and popular species (including climate-adapted individuals in the planting palette) – the latter can provide premium resilient seed, which could be used by First Nations businesses, allowing them to develop a premium product that could attract higher prices and income streams.

Our efforts to grow and evolve Sydney's living infrastructure can only happen with an army of skilled researchers, landscape architects, arborists, ecologists and horticulturalists from private and public organisations. Our market of engineers, designers, contractors and facility managers are used to doing business as usual. To move in a new direction, we must acknowledge that behaviour change is needed in the market as well as training and skill development.

The Centre would:

- Integrate First Nations knowledge and the 'Connecting to Country' framework into government and private sector project cycles. project and project site planning
- Develop trade training programs with Indigenous elders, and university and TAFE courses including nature-based solutions and integration into landscape architecture, horticulture and civil engineering programs
- Conduct research, help develop best practice manuals, case studies and guides, and help to alleviate the risk aversion many infrastructure projects, local government authorities and government departments have
- Lead integration of climate change data and projections into living infrastructure strategies (including urban forest strategies)
- Research the economic value of 'living infrastructure' job creation, the potential for training and development in horticulture as a skilled profession that pays trainees equivalent wages to other comparative sectors and vocation like carpentry
- Create a clearing house for apprenticeships.

***Lead agency**: NSW Department of Education supported by IndigiGrow, Royal Botanic Gardens and Domain Trust, Sydney-based universities including Western Sydney University, UTS, UNSW, University of Sydney, Macquarie University, University of Wollongong and Newcastle University, and the Australian Green Infrastructure Network.*

2. Set clear living infrastructure targets, and monitor progress

2.1. Set metropolitan and local targets for living infrastructure

The first move is to set targets at the metropolitan and local government scales. New targets for living infrastructure, including tree planting and canopy increase, vegetation, biodiversity and clean waterways, particularly in those places that have significant deficits and/or where investment in living infrastructure can contribute the most benefit.

These targets should be set in the new Greater Sydney Region Plan, being developed by the Greater Cities Commission, and implemented through District and Local Planning to inform and guide state and local government decisions and planning outcomes.

The NSW Government has made a positive start, committing to a 40% urban tree canopy cover for Greater Sydney by 2036, and providing targeted policy, funding and data support to councils to strengthen strategic management of local urban forests, including local canopy targets and urban forest strategies, such as the City of Sydney's target for 40% green cover by 2050.

The NSW Government's Greener Neighbourhood Program funded 28 Greater Sydney councils to deliver projects in 2022 that enabled increased capacity to analyse tree canopy data, develop urban forest strategies, prepare street tree master plans, and prepare educational campaigns for ratepayers.

Incentives and assessment tools may change new developments and infrastructure, but once residents move in there is an oversized challenge in enforcing regulation to ensure conditions are designed to protect existing trees and grow new ones.

The reality is, without targets (and the ability to accurately measure them), we have no way of tracking whether we are improving the relative quantity or quality of living infrastructure in our city – or whether that living infrastructure contributes to the climate resilient city we seek to achieve. Our targets are often 'input' based – that is, the number of trees planted – rather than the benefits living infrastructure is creating, such as reduced temperatures, reduced adverse health conditions/hospitalisations, biosecurity and biodiversity outcomes, and the role of shade and temperature reductions in enabling community interactions in hot areas. Maintenance is also important as nature needs care to establish itself, and some nature is likely to die off and need replacement.

Paddington Reservoir Gardens

Source: Unsplash

The benefits of living infrastructure are well established. Setting targets that go beyond tree planting and park access, by providing a pathway to achieve Sydney's green and blue grid in a way that responds to climate, biodiversity and biosecurity challenges, will establish the basis for local, neighbourhood and city scale investment in living infrastructure.

Embedding living infrastructure delivery into the NSW strategic planning framework means it becomes part of the regular monitoring and reporting of strategic plans. We therefore recommend an annual implementation plan, within the Greater Sydney Region Plan, to identify priorities and timing for actions in the immediate, short, medium and long term.

***Lead agency**: Greater Cities Commission and local councils, with support from Department of Planning and Environment*

2.2. Monitor and evaluate progress

If we are to truly value the role of nature, and its cultural, economic and social benefits, we urgently need to bring together key metrics to monitor and review progress. These measures need to go beyond 'input' measures like dollars invested, or 'output' measures like number of trees planted, shifting towards measures that reflect the change we want to see, and the impact we want to have on the future of our cities.

The Resilient Sydney Platform is an online data portal that allows for the visualisation of city-scale environmental footprints in strategic planning of climate actions at the city council level. This approach would enable the 33 local governments, as well as some state government agencies and utility providers, to understand key environmental impacts in their communities. The tools are hosted in a user-centred program with a focus on the engagement and training of government officers.

But there is more to measure. Broad scale data capture and analysis, monitoring and cost/benefit is required to prove nature-based concepts in our city in real time/real life. This has been done elsewhere but we need local examples and the story is integral to the growth of the 'green army' and future investment. We need to prove that policy, investment and behaviour change – big and small – can deliver benefits to our communities, reduce infrastructure costs, and demonstrate that we are connecting to Country and on the path to a nature positive Sydney.

We need an annual monitoring report to track progress on goals, directions, impact and actions. It is important to set up a research program with an explicit monitoring, evaluation and learning framework to ensure we are learning about what works and doesn't – especially to understand how these systems perform under a changing climate.

***Lead agency**: Greater Cities Commission, Resilient Sydney, Department of Planning and Environment supported by local governments*

The NSW Department of Planning and Environment is leading the effort towards collecting living infrastructure data at a broader scale. The Greater Sydney Canopy Dataset will provide Greater Sydney councils and NSW Government with information on canopy cover, tree heights, vegetation health and land surface temperature from the cadastre-scale up to region-scale. With free access provided across government, this dataset will become a reliable source of canopy data, and will allow stakeholders to track, monitor and plan for living infrastructure more accurately. The user interface will allow users to analyse data at smaller scales, supporting more targeted decision making.

3. Drive structural investment in living infrastructure

3.1. Introduce a green factor tool to incentivise living infrastructure in new development

Once targets have been established, the next step is to connect new development approvals – residential, commercial and industrial – to achieving these targets.

New development forms part of the opportunity to regenerate Sydney's living infrastructure. To achieve an increase in living infrastructure and canopy cover on private land we recommend that incentives are introduced for private landowners. This could include a range of planning incentives such as an increase in Floor Space Ratio (FSR) that is tied to a green factor tool, and regulations that ensure any proposed loss of living infrastructure is met with a net positive replacement approach (via a fund or similar mechanism). It would also be useful for new projects using this tool to take into account the susceptibility of species to exotic pests and diseases and avoiding the use of them as a forward thinking preventative measure.

Source: Pexels

It may also be worth contemplating floor space bonuses for greening contribution beyond a minimum level in areas that need this investment, and inclusionary zoning mechanisms that require a certain amount of open space to be delivered or contributed to physically or financially as part of the development process, in the same way affordable housing can be provided through such a mechanism.

Green Factor Tools are a living infrastructure assessment tool designed to help with designing and constructing new buildings that are environmentally friendly and include living infrastructure. In London, the Urban Greening Factor (UGH)[39] tool evaluates and quantifies the amount and quality of urban greening that a scheme provides to inform decisions about appropriate levels of greening in new developments.

The City of Sydney is developing a Green Factor Score to evaluate and quantify the amount and quality of urban greening a project provides. All projects in the City of Sydney will need to achieve a required score, based on the type of development, location and other site considerations, to ensure greening is planned for and provided on private land.

The broad introduction of a Green Factor Tool across the development sector would require developers to account for and maximise the regeneration of biodiversity on-site. Linked to local and regional targets, this approach would provide a flexible approach to generating living infrastructure outcomes rather than mandating single trees.

Lead agency: *Department of Planning and Environment, supported by local councils.*

3.2. Establish a living infrastructure fund

Due to the additional costs associated with design, materials and installation of living infrastructure, proponents of major infrastructure and developers are often faced with a list of costs that may deter them from delivering green spaces. Although studies show living infrastructure increases the value of property, these benefits may not be fully realised or received by the proponent. Given the wider benefits to the locality and the city, there is a case for government to incentivise living infrastructure in new and existing buildings in targeted locations. Equally we don't have adequate incentives to maintain or enhance living infrastructure in Sydney, and the industry around creating these opportunities is still nascent.

A NSW Government Living Infrastructure Fund should cover upfront capital costs and ongoing maintenance expenses for living infrastructure. The funding could be derived from either of the following:

I. a living infrastructure rate levied on all rate payers (like the current waste levy)
II. a percentage of funding from (grey) asset recycling to (green) living infrastructure.

Both mechanisms have precedent in funding other social and/or environmental outcomes.

There are many long-term financial benefits resulting from an investment in resilient living infrastructure. In addition, there would be a direct link to job creation in the living infrastructure and horticultural industries as demand grows for services and products, particularly around Indigenous enterprise. There are several global examples of this type of fund that have significantly increased nature in cities.

The Skyrise Greenery Incentive Scheme in Singapore funds up to half the installation costs of rooftop greenery and vertical greenery, and has assisted in greening more than 110 existing buildings in Singapore by retrofitting them with extensive green roofs, edible gardens, recreational rooftop gardens and lush verdant green walls.

This fund could be operated like the Clean Energy Finance Corporation, which seeks to leverage private sector funding to enhance public benefit outcomes through government investment.

Lead agency: *NSW Treasury, with Department of Planning and Environment administering the program.*

3.3. Adopt a framework for valuing living infrastructure in major projects

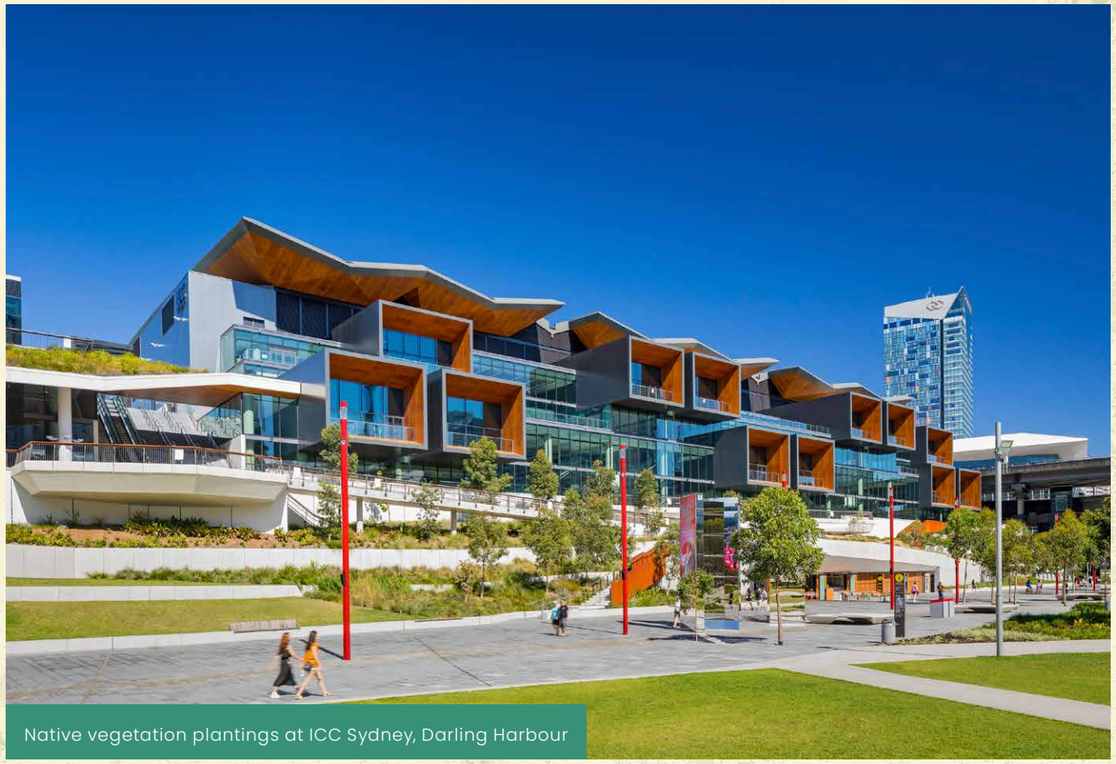
In parallel with new development approvals, we need to address how living infrastructure is considered, and valued, in major infrastructure proposals.

In 2021, Infrastructure Australia released its 'Pathway to Infrastructure Resilience' report,[40] which stated that, "Blue and green infrastructure is not adequately valued for its contribution to reducing risk," and that, "Natural assets provide ecosystem services that can complement traditional infrastructure related services or offset the need for physical investment."

Living infrastructure does not show up in the business cases developed for major infrastructure projects – road, rail, water and wastewater. There is no economic quantification of the benefits that living infrastructure can provide to air quality, reduced heat, social cohesion and biodiversity. This is a missed opportunity.

39 https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/london-plan-guidance/urban-greening-factor-ugf-guidance

40 https://www.infrastructureaustralia.gov.au/publications/pathway-infrastructure-resilience-0



Native vegetation plantings at ICC Sydney, Darling Harbour

Source: ICC Sydney

The NSW Department of Planning and Environment is working with NSW Treasury to finalise a 'Framework for Valuing Green Infrastructure and Public Spaces' (VGIPS). The VGIPS Framework provides a standardised, robust and comprehensive approach to identify, quantify and monetise common costs and benefits associated with living infrastructure. Once finalised, the VGIPS Framework will sit alongside the NSW Government Guide to Cost Benefit Analysis and support practitioners undertaking cost-benefit analyses that include green infrastructure and public space components.

Living infrastructure benefits should be a mandatory part of all business cases, including valuing green and blue living infrastructure as alternatives to grey infrastructure.

In response to flooding across NSW, and the creation of an Infrastructure Betterment Fund by state and federal governments, this approach to valuing living infrastructure could also be applied when consideration is given to if/how places recover (e.g. could repairing a road provide an opportunity to consider if water sensitive urban design might better protect the asset in future and/or during the next flood event).

Lead agency: *NSW Treasury supported by Department of Planning and Environment, NSW Reconstruction Authority and Transport for NSW.*

4. Align asset management and procurement

4.1. Manage living infrastructure as an asset

We have the opportunity to recognise and manage living infrastructure as an asset class.

City governments around the world spend significant time and effort identifying and managing their built capital assets: buildings, pipes, roads, and bridges. The same cannot be said about living infrastructure and the valuable services and co-benefits they provide.

Developed by the US Department of Agriculture Forest Service, the iTree41 system places monetary value on factors such as energy savings, atmospheric CO2 reductions, improved air quality, stormwater runoff and aesthetic and amenity considerations. For example, the NYC Parks Department used the iTree assessment approach to determine that the 600,000 street trees in its five boroughs provide an annual benefit of $122m – more than five times the cost of maintaining them.

Ultimately, Greater Sydney should incorporate the value, maintenance and lifecycle of living infrastructure directly in enterprise asset management software. Any progress documenting and tracking natural assets will foster more effective, long-term planning and management. But state and local government asset management approaches should gain at least a qualitative understanding of each asset and benefit as an important first step. A more comprehensive approach would Include

41 https://www.itreetools.org/

The City of Melbourne has street and park trees managed through an asset register, in addition to garden beds and other vegetation features that require maintenance and replacement to manage risk. This has been pivotal in planning its climate adaptation response through directing tree species plantings and target locations that otherwise would not have been adequately assessed.

tree health assessment as part of the inventory and living infrastructure management process – particularly with a focus on detecting signs of new pest and pathogen incursions.

In Sydney, for natural assets bushland, Campbelltown City Council is looking at using Vegetation Integrity Scores (VIS) and threatened species multipliers to provide a natural asset condition score and Total Fund Deposits under the Biodiversity Conservation Act 2016 to describe levels of service and forecast costs required to maintain/enhance condition. The NSW Government is also working with local councils in Greater Sydney to support the development and management of tree inventories at different scales.

To manage infrastructure as an asset we need to:

1. Formally decide to manage living infrastructure as an asset class
2. Collect the data – understand living infrastructure assets via a register like grey infrastructure – projects like the NSW Digital Twin[42] and SEED (Sharing and Enabling Environmental Data) Portal[43] are data sources that could inform this work

42 https://www.spatial.nsw.gov.au/what_we_do/projects/digital_twin
43 https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU)

3. Regularly value these assets using an agreed valuation framework
4. Standardise a living infrastructure inventory system to enable state and local government to put more resources into maintenance and less into measurement
5. Connect the benefits each asset is generating to the local and metropolitan targets, to identify where capital and operational expenditure should be directed to maintain and enhance those benefits.

Lead agency: Infrastructure NSW (as part of its Asset Management Reform process) supported by Department of Planning and Environment, local governments and the Australian Green Infrastructure Network.

4.2. Embed living infrastructure outcomes in public sector procurement systems

We don't need to reiterate the power of procurement. But we do need to unlock the purchasing power of state and local governments in driving a living infrastructure led approach to new capital expenditure and maintenance.

We can do this by making provisions in all government procurements that require the consideration of living infrastructure alternatives to standard infrastructure. Tender processes should also require a landscape architect to lead the relevant design pieces.

In Green Square, this approach meant roads were designed around deep soil plantings. For the George Street light rail project in the Sydney CBD, small trees were squeezed around underground infrastructure cables.

The beauty of procurement is that a clear policy in procurement and planning can be relied on to see the rules followed through.

A procurement strategy could also leverage the role that government owned land can play.

Lead agency: NSW Treasury, Department of Planning and Environment, supported by regional organisations of councils.

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We would like to thank our Innovation Fund Partners for their support of the Committee for Sydney's research.

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We are proud to work with our Innovation Fund Partners: Dexus, ICC Sydney, Campbelltown City Council, JLL, University of Technology Sydney, University of Sydney and Lendlease.

Resilience Program Partners

We would like to thank our Resilience Program Partners for supporting the Committee for Sydney's work to drive solutions to our most pressing resilienc challenges.

Our Resilience Program Partners are leaders in their respective fields, embracing the transition to a decarbonised future, and adapting to a changing climate.

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