LAND AND HOUSING CORPORATION

RIVERWOOD ESTATE STATE SIGNIFICANT PRECINCT

Green Infrastructure Study

S20-0099

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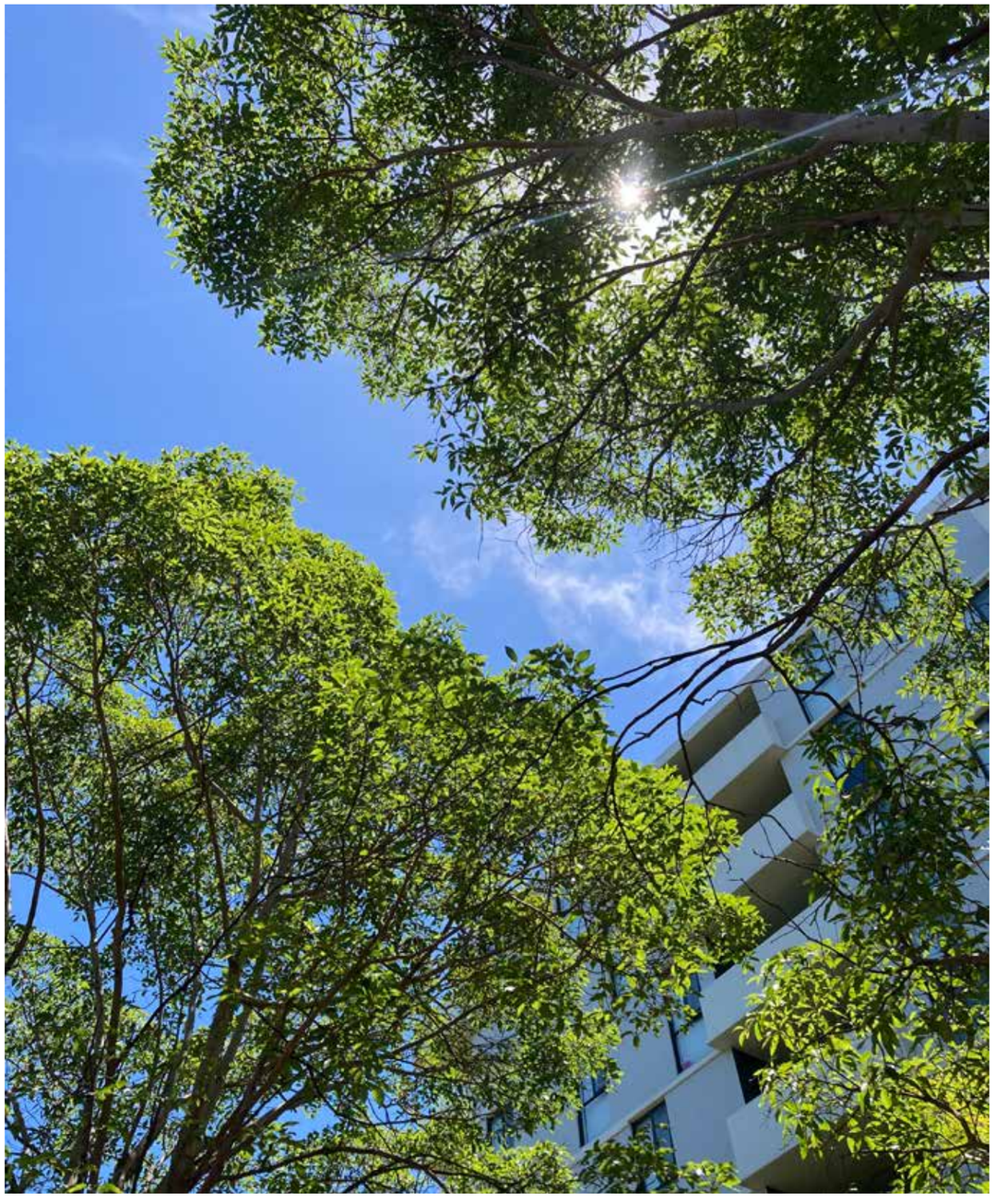

CLOUSTON associates

RIVERWOOD ESTATE
STATE SIGNIFICANT PRECINCT
GREEN INFRASTRUCTURE STUDY

Client:

NSW GOVERNMENT Land & Housing Corporation

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Note: this document is Preliminary unless validated

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1. INTRODUCTION

1.1 PURPOSE OF THIS REPORT

NSW Land and Housing Corporation (LAHC) has engaged CLOUSTON Associates to prepare a Green Infrastructure Study to support the planning proposal for the Riverwood Estate State Significant Precinct.

This Green Infrastructure, Ecology, Urban Forest and Greening Study (known as the Green Infrastructure Study) is part of a suite of study requirements that ensure a coordinated approach and that the redevelopment is integrated in a sustainable and well-designed urban framework.

This study has been prepared by CLOUSTON Associates, who are suitably qualified Landscape Architects.

This report seeks to identify opportunities for the provision and integration of green infrastructure within the Riverwood master plan.

In preparing this report, CLOUSTON has consulted with the NSW Department of Planning, Industry and Environment's Public Spaces team.

Study Requirement	Report Section
Prepare a Green Infrastructure Study for the precinct that: • Identifies the existing situation, including constraints, opportunities and key issues	2
• Outlines the likely impacts of the proposal in relation to climate change, heat impacts and community health needs (i.e. mental and physical health)	4
• Provides detail of proposed green infrastructure principles and how they will be incorporated into the proposal (consistent with Greener Places)	4.1
• Includes an urban forest and greening strategy, outlining the percentage of greening and canopy cover across each land classification (e.g. streets, parks, private land) and private property zoning type	4.3.1
• Includes measures to address storm water retention management and opportunities for beneficial reuse	4.3.5
• Informs and supports the preparation of the proposed planning framework including any recommended planning controls or Development Control Plan provisions that would deliver an appropriate green infrastructure and sustainability outcome.	6

The study is to demonstrate consideration of: • Relevant case studies and transferable principles that will apply to the proposal	7
• Percentage and distribution of greening and canopy cover across all private (including green roofs and walls) and public domain areas within the precinct;	4.2
• Retention of existing trees and provision of new trees, the capacity of the proposal to allow for the growth of new trees to maturity	4.3.1
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• The use of advanced sized trees in any street, open space and site landscaping;	4.3.1
• Water sensitive urban design and integration with the flood study, plus options for potential alternative water supply	4.3.5
• The Premier's priority for 'Greening our city' and 'Greener public spaces	1
• Management and funding arrangements to support the ongoing performance of green infrastructure including WSUD. This should include suggested measures to deliver the aspired public benefit	6

1.2 GREEN INFRASTRUCTURE

Green infrastructure is the network of green spaces, natural systems and semi-natural systems that support sustainable communities (Greater Sydney Region Plan 2018).

It is the web of interrelated natural systems that underpin and are integrated into our urban fabric (Draft Connecting with Country framework)

It consists of connected elements such as parks and open spaces, backyards and gardens, waterways and wetlands, streets, roof gardens and living walls.

Elements of Green Infrastructure
Source: Greater Sydney Region Plan

Green infrastructure is strategically planned, designed, and managed to support a good quality of life in an urban environment.

Green infrastructure should not be thought of as individual elements in the landscape, but as components that interact with other urban systems including continuous soil and water networks.

It is seen as a three-dimensional envelope that surrounds and connects buildings, streets and utilities.

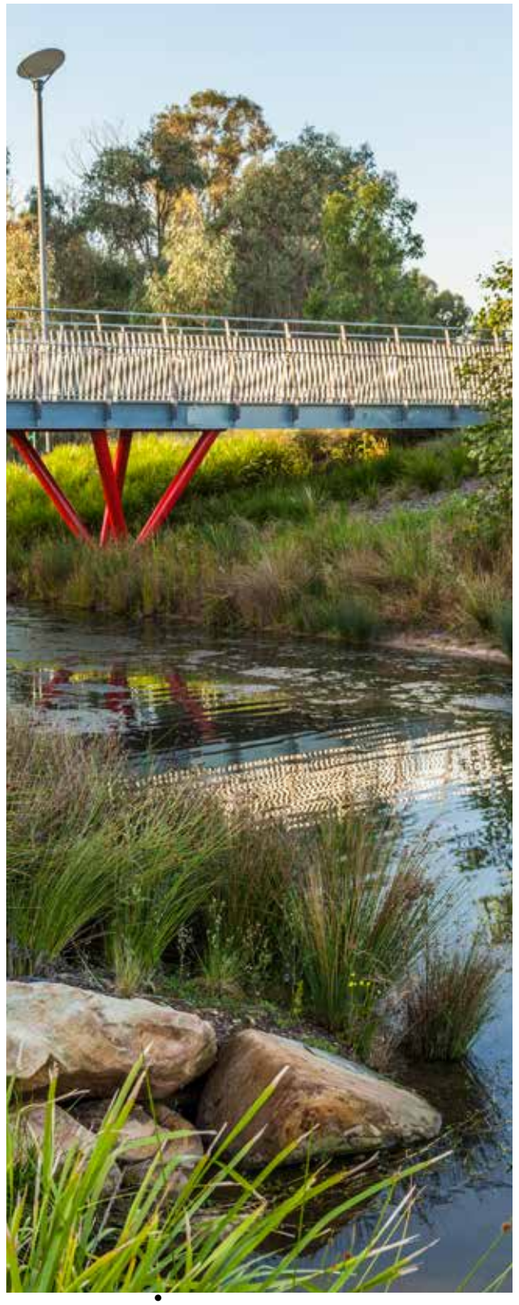
A green infrastructure strategy can be deployed at a landscape scale, transcending private and public land, geographic and municipal boundaries.

Green infrastructure and public spaces are essential for liveability. The NSW Government has made a strategic commitment to increase green and public spaces through the Premier's Priorities:

- The 'Greening our city' priority aims to increase the urban tree canopy and green cover across Greater Sydney by planting one million trees by 2022. This is part of a broader commitment to plant five million trees by 2030.
- The 'Greener public spaces' is another important Premier Priority to provide greater access to quality, green, open and public spaces closer to homes. The aim is to increase the proportion of homes in urban areas within 10 minutes walk of green and public spaces by 10% by 2023.

The network of green spaces and water systems deliver multiple benefits to urban communities, including:

- Habitat and biodiversity
- Ecological services - clean water and fresh oxygen
- Carbon capture and sequestration from trees and soil ecologies
- Recreation opportunities
- Connection to nature
- Visual amenity



1.2 GREEN INFRASTRUCTURE

Tree Canopy
Trees are a major component of green infrastructure, and the urban forest focuses on larger populations of trees and tree canopy rather than individual trees.

Tree Canopy Cover is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. (Greener Places 2020)

The *Draft Greener Places Design Guide* outlines the benefits of urban tree canopy cover including:

- shelter and shade for people and wildlife;
- improved air quality;
- absorption of rainfall (reduced stormwater processing by wastewater facilities);
- reducing the urban heat island;
- heating and cooling savings; and
- carbon dioxide sequestration.

Research has shown a number of direct benefits of urban tree canopy cover to human health including:

- reduced stress
- reduced obesity
- reduced hypertension
- reduced heart conditions
- improved cognitive function
- improved mental health

2. SITE AND CONTEXT

2.1 THE SITE

The Riverwood Estate State Significant Precinct (the Study Area) is an area of 30.5ha located within the Canterbury Bankstown LGA.

The Study Area contains a large area of government-owned land (16.7ha owned by LAHC) and is of state importance in achieving key government policy objectives, particularly renewing social housing and increasing housing supply.

The Study Area is bound by Belmore Road to the east, the M5 Motorway to the north, Salt Pan Creek Reserve to the west and Killara Avenue to the south.

The majority of the site is located within walking distance, approximately 5-15 minutes, from the Riverwood Station.

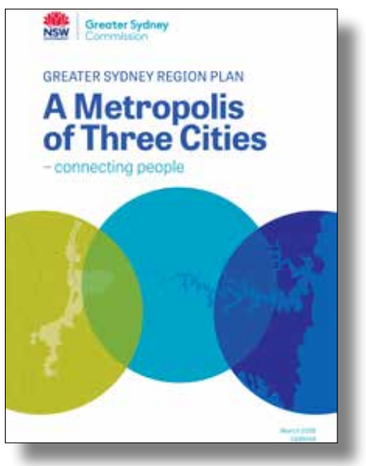
Salt Pan Creek Reserve, to the west of the Riverwood Estate, is a significant green corridor containing important ecological communities, mangroves, wetlands, recreational facilities and walking / cycling trails on both sides of the creek.

2.2 SYDNEY BASIN CONTEXT

Riverwood is located 18km south-west of the Sydney CBD in the City of Canterbury Bankstown Local Government Area. It is 5km from the district centres of Bankstown and Hurstville.

It is part of what the Greater Sydney Commission calls the *Central River City* in their Greater Sydney Region Plan - A Metropolis of Three Cities

The Central River City is an area that is growing substantially, capitalising on its location close to the geographic centre of Greater Sydney.

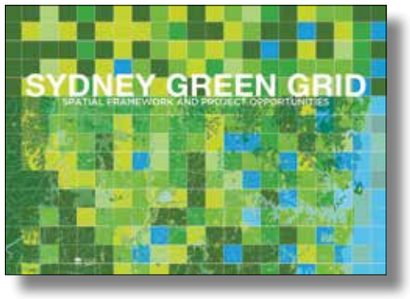


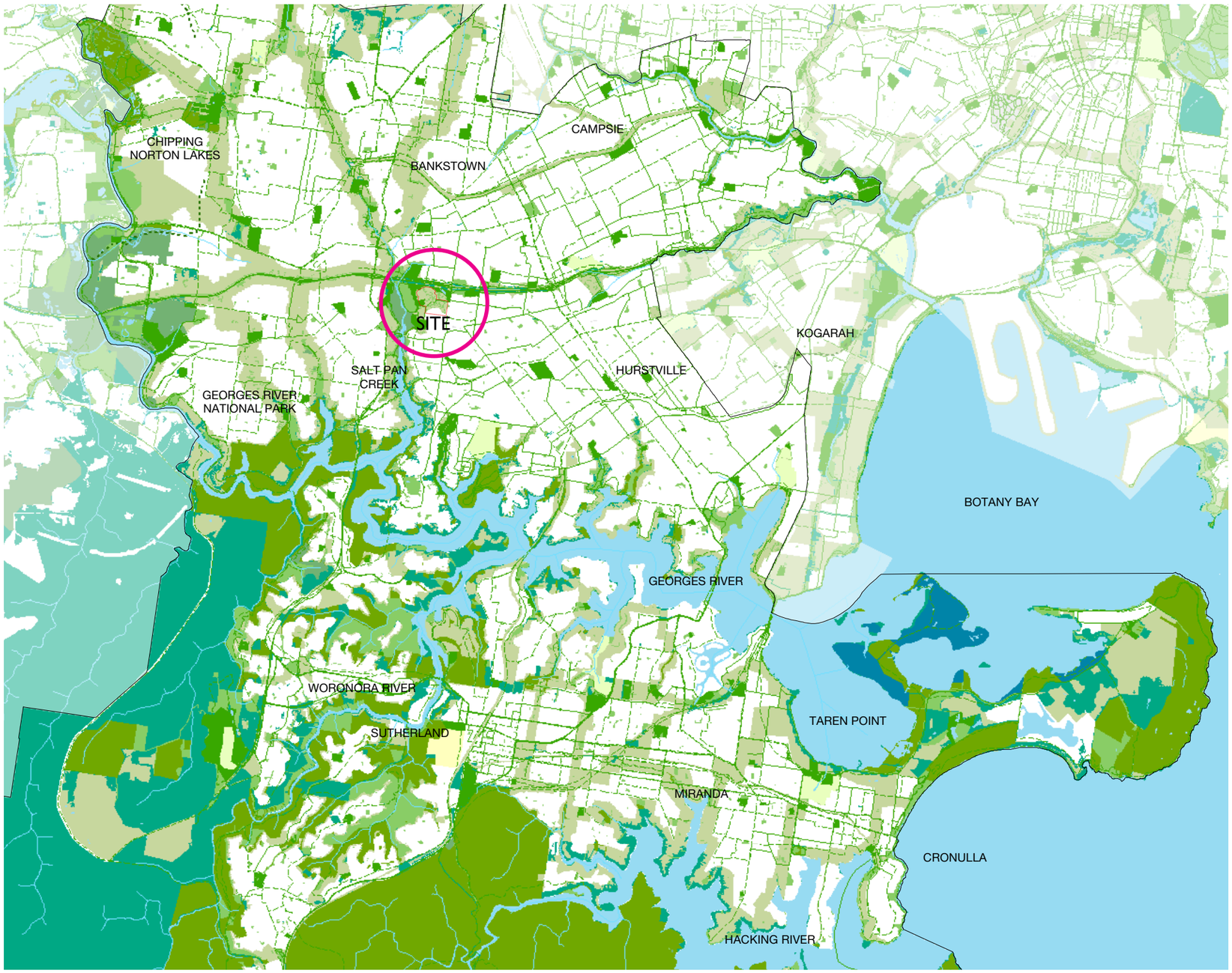
2.3 SYDNEY'S GREEN GRID

Sydney's Green Grid is a long-term vision defined by a green network of high quality open spaces that connect the public realm to the landscape.

The Green Grid is a green infrastructure, design-led strategy from the Government Architect NSW. It includes the full range of open spaces: from national, regional and local parks through to rivers and creeks. Links are fostered in the public realm through enhancing creek corridors, suburban streets, footpaths and cycleways.

In the Central River City, the Green Grid will improve connections to and enhance existing open spaces. Large urban renewal areas such as Riverwood provide the opportunity to improve sustainability through a precinct-based approach. It is a chance to extend and enhance green grid connections into the growing community.





Sydney Green Grid Existing Values Plan

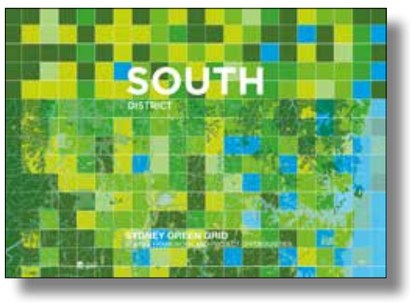
2.4 LOCAL GREEN GRID CORRIDORS

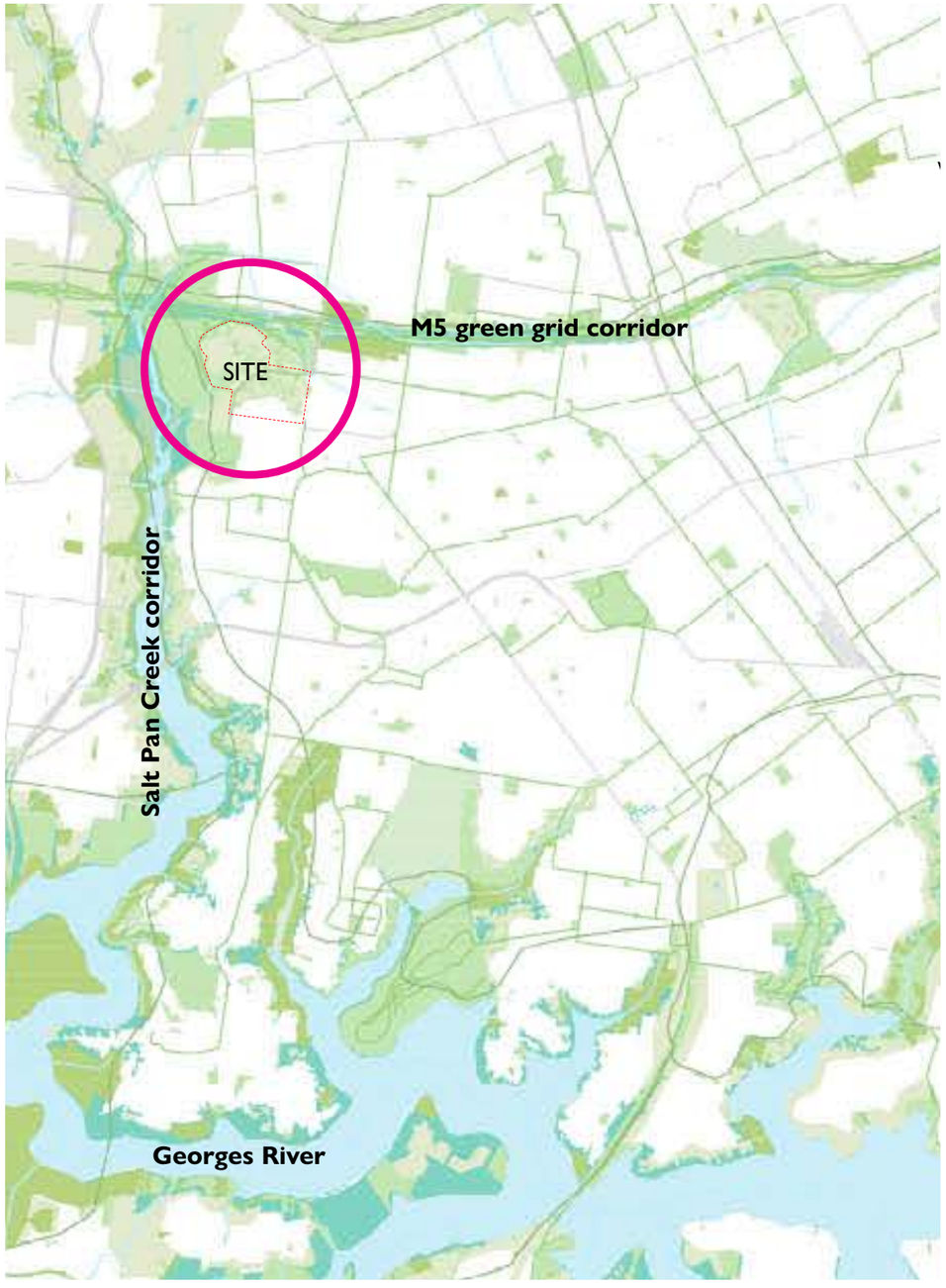
Riverwood sits strategically at the intersection of two Green Grid corridors - Salt Pan Creek Reserve, and the M5 green grid corridor.

Salt Pan Creek corridor
The Salt Pan Creek open space corridor links Bankstown to the Georges River.

It aims to strengthen links between the Bankstown CBD and the Georges River via Salt Pan Creek and Riverwood. Improving links along the creek corridor and connecting nearby town centres such as Riverwood is a key part of delivering Sydney's overall green grid.

The significant areas of mangroves and wetlands give Salt Pan Creek a high conservation value. Recreational facilities and walking and cycling trails are also important considerations.





Sydney Green Grid - SOUTH Green Grid Existing Values Plan with Riverwood site overlaid

M5 Linear Park corridor
The M5 Linear Park is another Green Grid priority corridor. The corridor connects open spaces along the M5 to Wolli Creek, Bardwell Valley Park to the Cooks River.

The M5 Green Grid corridor runs to the north of the Riverwood site.

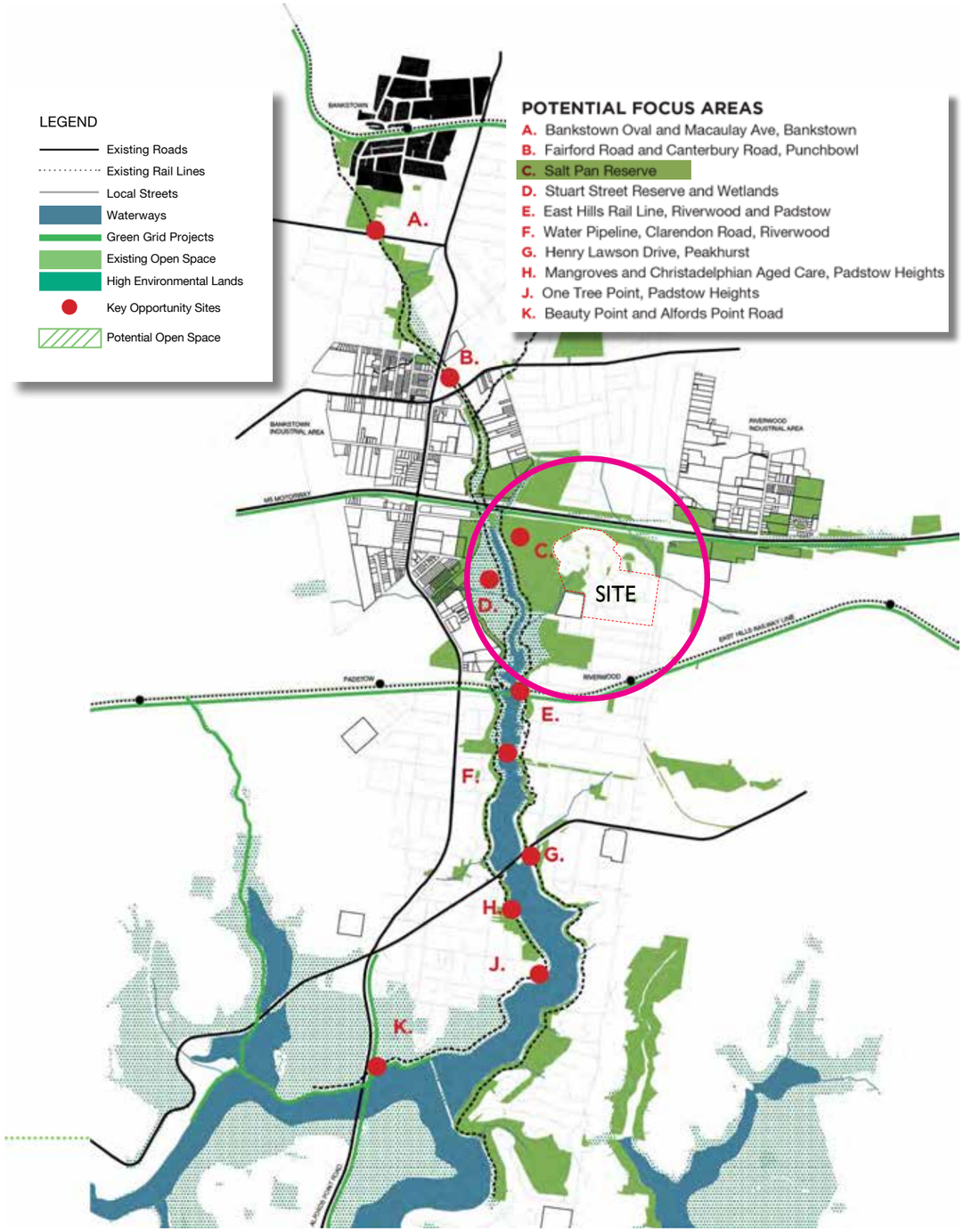
2.5 SALT PAN CREEK RESERVE

Salt Pan Creek Reserve - adjacent to Riverwood Estate - is one of the numerous open spaces along the Salt Pan Creek open space corridor.

The Salt Pan Creek Open Space Corridor has been identified as one of three Sydney Green Grid South District project opportunities.

Salt Pan Creek Reserve, adjacent Riverwood, was identified as a potential focus areas within the corridor.

The City of Canterbury Bankstown has prepared a draft masterplan for Salt Pan Creek Reserve, showing the potential for future sports fields, recreational, social and cultural spaces for the community.



Salt Pan Creek Potential Focus Areas, Fig S.13 from Sydney Green Grid South District

The Salt Pan Creek corridor runs to the west of the Riverwood site.

2.6 GREEN COVER RATING

Greener Spaces Better Places is a national initiative that brings together academia, business, government, community groups and the green industry to share knowledge and find solutions to ensuring as cities and towns grow, so too do the green spaces..

Their benchmarking report *"Where Will all the Trees Be?"* flags the City of Canterbury Bankstown as facing very high challenges to maintain or increase its green cover rating in to the future.

Where Are all the Trees?

Australia's first ever national benchmark of urban canopy, across our cities and suburbs.

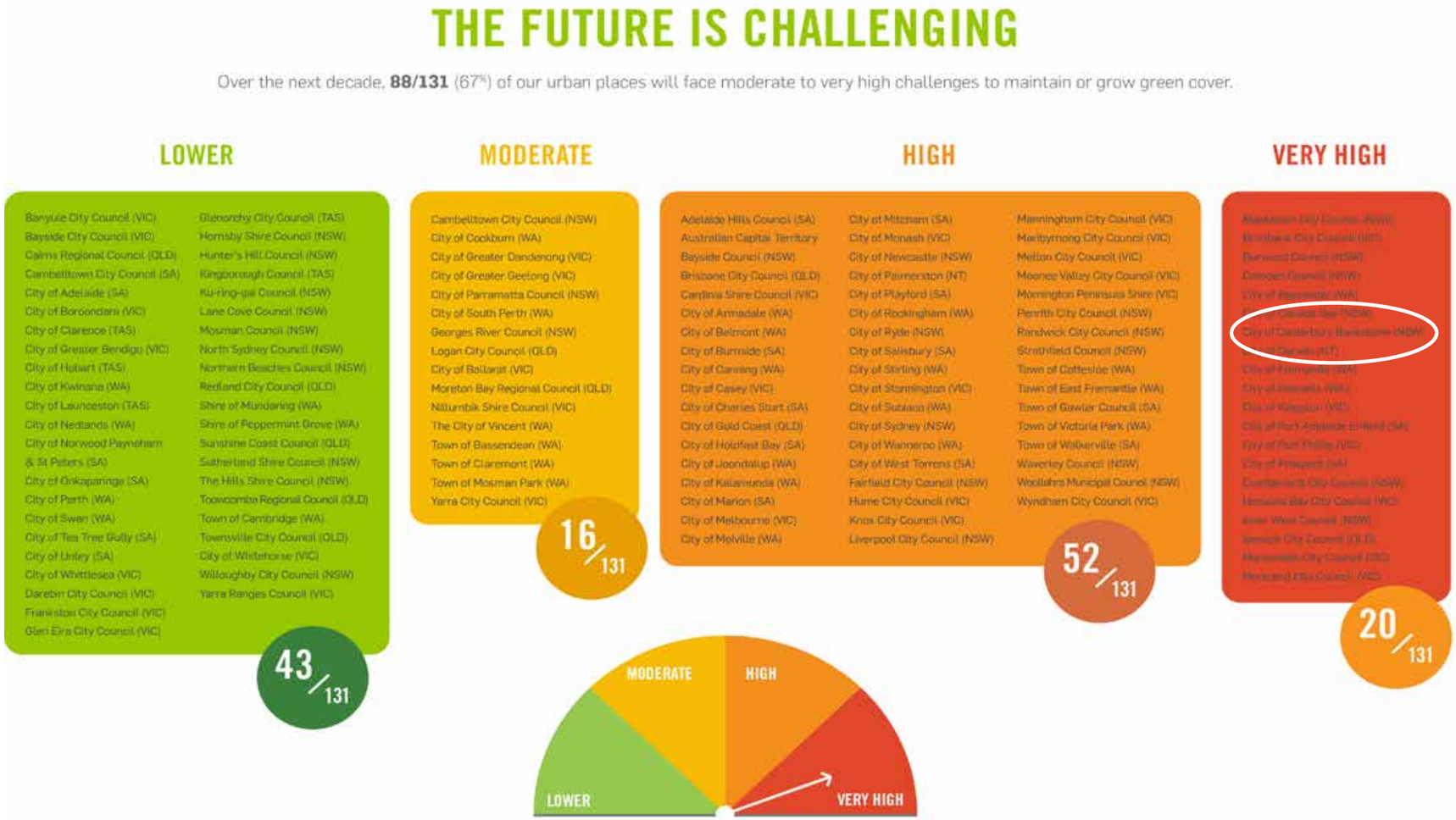
Where Should all the Trees Go?

This updated report also measured vulnerability of places based on heat mapping and socio-demographic data.

Where Will all the Trees Be?

This latest update looks at changes over time as well as which places will be most and least challenged to grow and maintain green cover in the future.

'Where Will all the Trees Be?' is the third installment in a series running since 2013



Source: Greener Spaces Better Places WHERE WILL ALL THE TREES BE? The 2020 update of green cover benchmarking in our cities and suburbs

2.7 OPPORTUNITIES AND CONSTRAINTS - EXISTING SITE

OPPORTUNITIES

1. Salt Pan Creek Corridor on Riverwood's doorstep is a Green Grid priority corridor
2. M5 corridor to the north is another Green Grid Priority Corridor
3. Salt Pan Creek Reserve has potential for recreational open space
4. Approximately 1000 trees exist on site
5. Many significant and mature trees that provide shade, amenity and habitat

One of the many mature existing trees providing shade, amenity and habitat on site, source: CLOUSTON site photo

Riverwood existing aerial photograph, source: Architectus. Orange highlights indicate small disconnected open spaces.

CONSTRAINTS

1. Small, isolated and under-used open spaces (orange highlights)
2. Overhead power lines impede growth of street trees
3. Salt Pan Creek Reserve - a former tip - has limited biodiversity value in its current form
4. There is limited physical and visual connection to Salt Pan Creek Reserve and the wider open space corridor
5. Many existing trees are of poor quality or in poor condition

Overhead power lines restrict street trees, source: CLOUSTON site photo

3. THE PROPOSAL

3.1 THE PROPOSAL

The proposal features approximately 3,900 dwellings including a mix of private and social housing. Buildings range from 3 to 12 storeys.

The public domain principles promote active living streets, with a variety of gardens, parks and outdoor spaces. The aim is to create a legible permeable neighbourhood that is a joy to walk through.

Much of the existing primary street network is retained while creating a new street hierarchy to encourage connectivity, legibility and walkability.

Roosevelt Ave is the main entry boulevard, and a Community Greenway connects Riverwood Public School with open space.

Riverwood Master Plan, source: Architectus

3.2 OPPORTUNITIES AND ISSUES - PROPOSED MASTER PLAN

OPPORTUNITIES

- Creating a cool green connected city landscape
- Placing people and livability at the heart of all decisions
- Replanting new trees with dense leaf structure to deliver a connected street tree canopy
- Retention of remnant native vegetation
- Linking the green grid via the street network
- Making green open space a focus of the neighbourhood, not just left over space
- Connecting the community to Salt Pan Creek reserve and waterway
- Improving water quality before it flows into the Salt Pan Creek catchment
- Capturing and reusing water runoff

Riverwood Illustrative Masterplan, source: Architectus

ISSUES

- Extensive loss of existing canopy expected, with some mature trees removed to accommodate new streets and built form.
- Many existing trees could be subject to greater than 20% encroachment of the tree protection zone - the area set aside to protect the viability and stability of the tree
- Extensive basement car parking will limit planting opportunities on podiums
- Buildings overshadowing is likely to affect soft landscape growth

4. GREEN INFRASTRUCTURE PRINCIPLES

4.1 GREEN INFRASTRUCTURE KEY PRINCIPLES

The four principles that will help deliver green infrastructure in NSW are defined in the Government Architect NSW's ***Greener Places*** design framework:

INTEGRATION

Integration promotes multipurpose infrastructure that mimics nature, provides critical ecosystem services and supports healthy and active living.

With a global transition away from single-purpose grey infrastructure, the Riverwood master plan proposes to combine green space with urban development and infrastructure.

CONNECTIVITY

An interconnected network of high-quality open spaces - including physical and functional connections - benefits people and the local wildlife.

The Riverwood master plan highlights the importance of open green spaces that connects town centres, public transport hubs, nature, employment and residential areas.

MULTIFUNCTIONALITY

Multifunctionality represents the ability of green infrastructure to deliver multiple ecosystems, environmental and other services simultaneously.

The Riverwood master plan supports high-quality and high-performing green spaces promoting social, environmental and economic benefits.

PARTICIPATION

Participation refers to the planning process that includes all and incorporates the knowledge and needs of diverse parties.

It includes involving stakeholders in the development and implementation of neighborhood, local, district and regional green infrastructure polices and actions.

4.2 GREEN INFRASTRUCTURE TARGET OUTCOMES

The following outcomes have been developed for Riverwood. These are the overarching ideas that will allow the Riverwood Green Infrastructure system to be fully realised.

RIVERWOOD GREEN INFRASTRUCTURE NETWORK TARGET OUTCOMES

1. 30% of the site covered with tree canopy in 30 years
2. Big shade trees lining both sides of every street
3. Extensive ground cover plants to enhance habitat and biodiversity
4. Connected soil networks with ample soil volume for trees to thrive
5. Green infrastructure on roofs and podiums
6. Continuous green links to Salt Pan Creek Reserve corridor
7. Street trees planted early in each development stage
8. Water cycle expressed on site through stormwater capture and reuse
9. Passive irrigation for all street trees, lawns and parks

4.3 GREEN INFRASTRUCTURE KEY PRINCIPLES FOR RIVERWOOD

The following principles were developed for the Riverwood Renewal to inform how the impact of the proposal is addressed in relation to green infrastructure.

1. TREE CANOPY

Maintain and expand the tree canopy cover when faced with increased building density.

2. SOIL VOLUMES

Connected soil networks with ample volumes to encourage healthy tree growth.

3. PLANT SPECIES

Plant species that promote biodiverse corridors, a connected tree canopy, and a cooler neighbourhood

4. BIODIVERSITY

Protect biodiversity and carefully manage remnant vegetation as green infrastructure.

5. STORMWATER

Protect Salt Pan Creek, and view Riverwood's streets, parks and residences as a water supply catchment for trees.

6. CLIMATE CHANGE

Plant the right kind of trees that will thrive in a changing climate.

7. CLIMATE POSITIVE

Design to sequester more greenhouse gasses than are emitted by a project over its entire lifetime.

8. URBAN HEAT

Maximise tree canopy to optimise shade and reduce the urban heat effects

9. HEALTH AND WELLBEING

Increase access to local green spaces to improve the mental and physical health of the community.

10. LIFECYCLE APPROACH

Consider a whole of life cycle - cradle to grave. Where are the raw materials coming from and what happens to them when they are no longer needed?

4.3.1 TREE CANOPY

Urban tree canopy along streets and in the public domain is greatly valued by communities, and encourages walking and cycling.

It improves air quality by removing fine air particles from the air, provides habitat, reduces ambient temperatures and mitigates the urban heat island effect.

The trees at Riverwood are located on both public and private spaces, including parks, streets and private backyards.

Existing tree canopy coverage at Riverwood is currently 26% of the total site area, consisting of some remnant Grey Box-Forest Red Gum grassy woodland species, planted natives, and exotic vegetation.

The existing tree canopy is of mixed condition. Some trees are of high retention value, and have been identified for protection. Other trees have a low retention value.

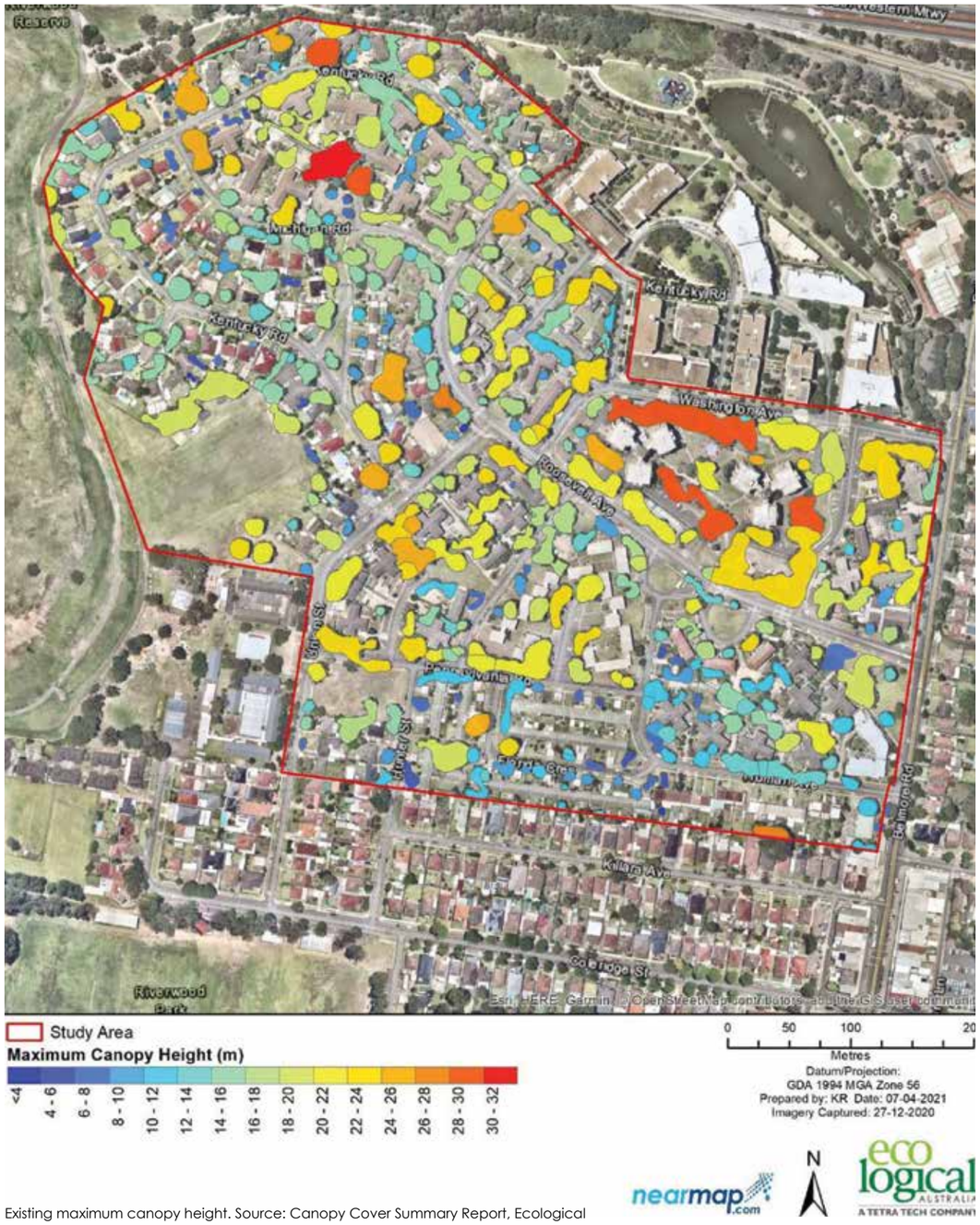
Canopy height varies, with some species reaching 30m. Canopy density also varies, as seen by Ecological Australia's canopy maps opposite and following.

Vegetation Community	Total Canopy Area	Max Canopy Height	Average Canopy Height
PCT 849 - *Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain*	0.14 ha	25.49 m	13.87 m
Planted natives	4.63 ha	30.30 m	11.13 m
Exotic vegetation	3.18 ha	28.90 m	8.12 m

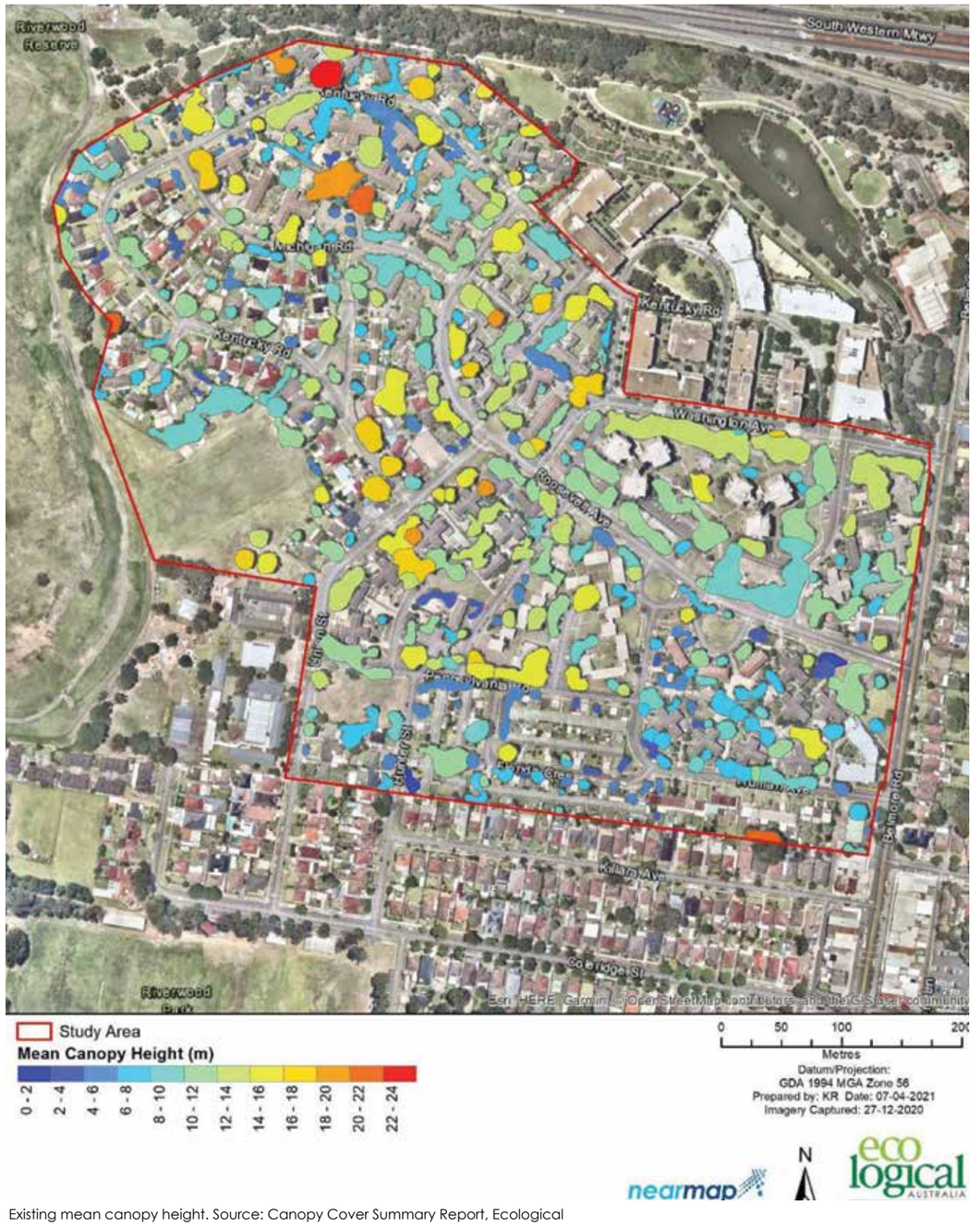
Canopy analysis of present mapped vegetation. Source: Ecological

Existing canopy density. Source: Canopy Cover Summary Report, Ecological

4.3.1 TREE CANOPY



Existing maximum canopy height. Source: Canopy Cover Summary Report, Ecological



Existing mean canopy height. Source: Canopy Cover Summary Report, Ecological

4.3.1 TREE CANOPY

The Riverwood Renewal project will likely have significant impact on existing trees.

Tree removal will be required to deliver civil and road works, basement excavation and building construction.

The master plan aims to retain as much existing vegetation as possible and completely avoids impacts on remnant native vegetation within the Study Area.

The diagram opposite indicatively shows the extent of tree canopy that may be impacted by development activities. The existing tree canopy may be reduced to just 4% (see dark green line in table below) if tree retention is not carefully considered in the design phases of the redevelopment.

The light green canopy cover in the diagram is a high level indication of trees to be accommodated in the detailed design phases of the project.

The Riverwood High Retention Tree Report indicates there are 299 high retention value trees that are considered important and should be retained and protected.

A minimum of 50% of high value trees are to be retained. Investigations into the retention of additional high value tress are to be conducted and a report justifying their removal submitted with any development application

Potential tree canopy retention

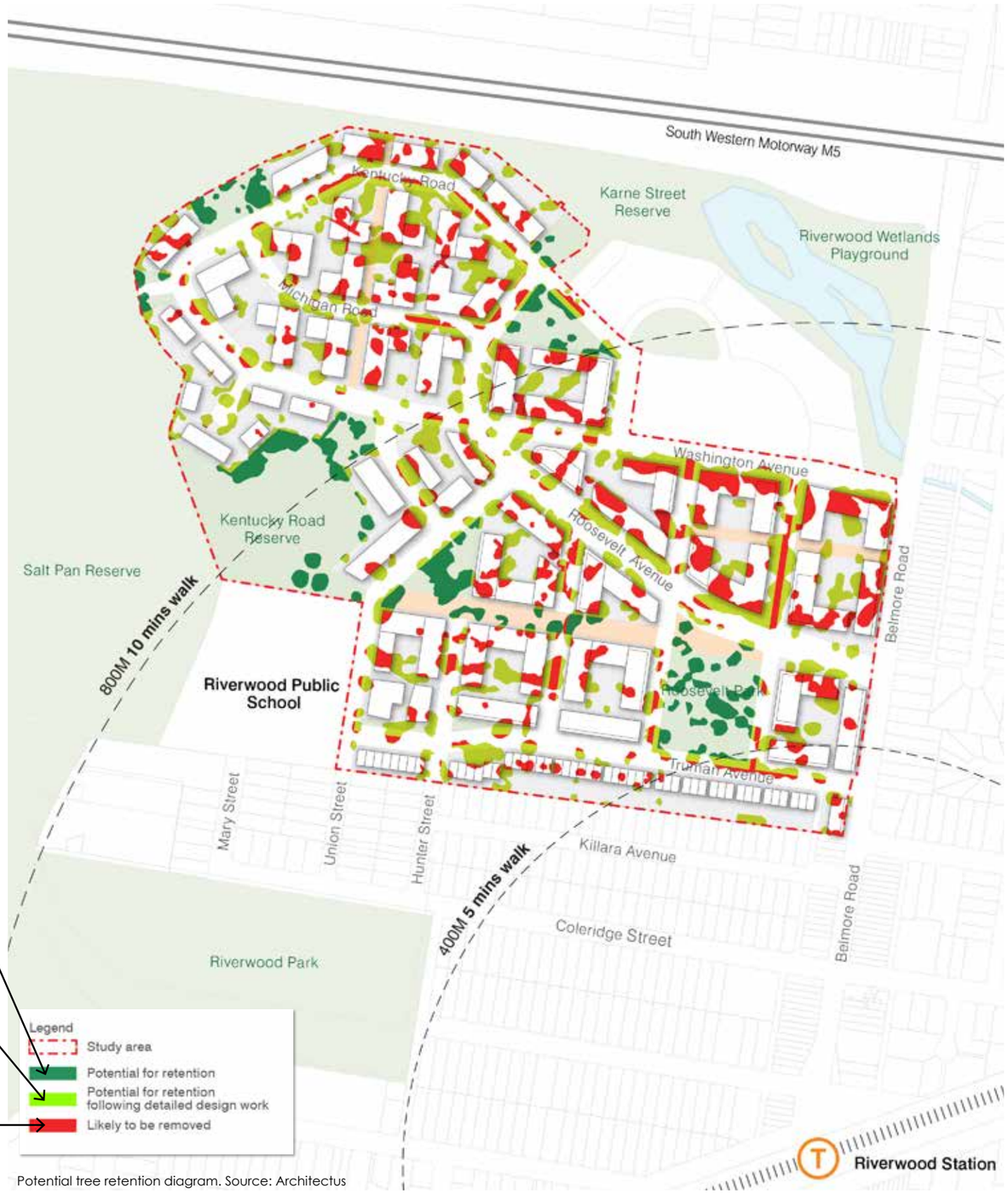
Tree Canopy	Area (ha)	% of existing tree canopy	Tree canopy %
Site Area	30.52		
Existing	7.95		26.0%
Potential for retention	1.18	14.8%	4%
Potential for retention following detailed design work	4.03	50.7%	13%
Likely to be removed	2.74	34.5%	9%

Potential tree retention table. Source: Architectus

The canopy areas shaded dark green are most easily retained as they are situated within existing or future parks.

The canopy areas shown light green will be reviewed for retention in the detailed design phase as they are typically located along future roads or in private deep soil zones.

The canopy areas shown red are most likely to be removed as they are situated within indicative building footprints.



Potential tree retention diagram. Source: Architectus

4.3.1 TREE CANOPY

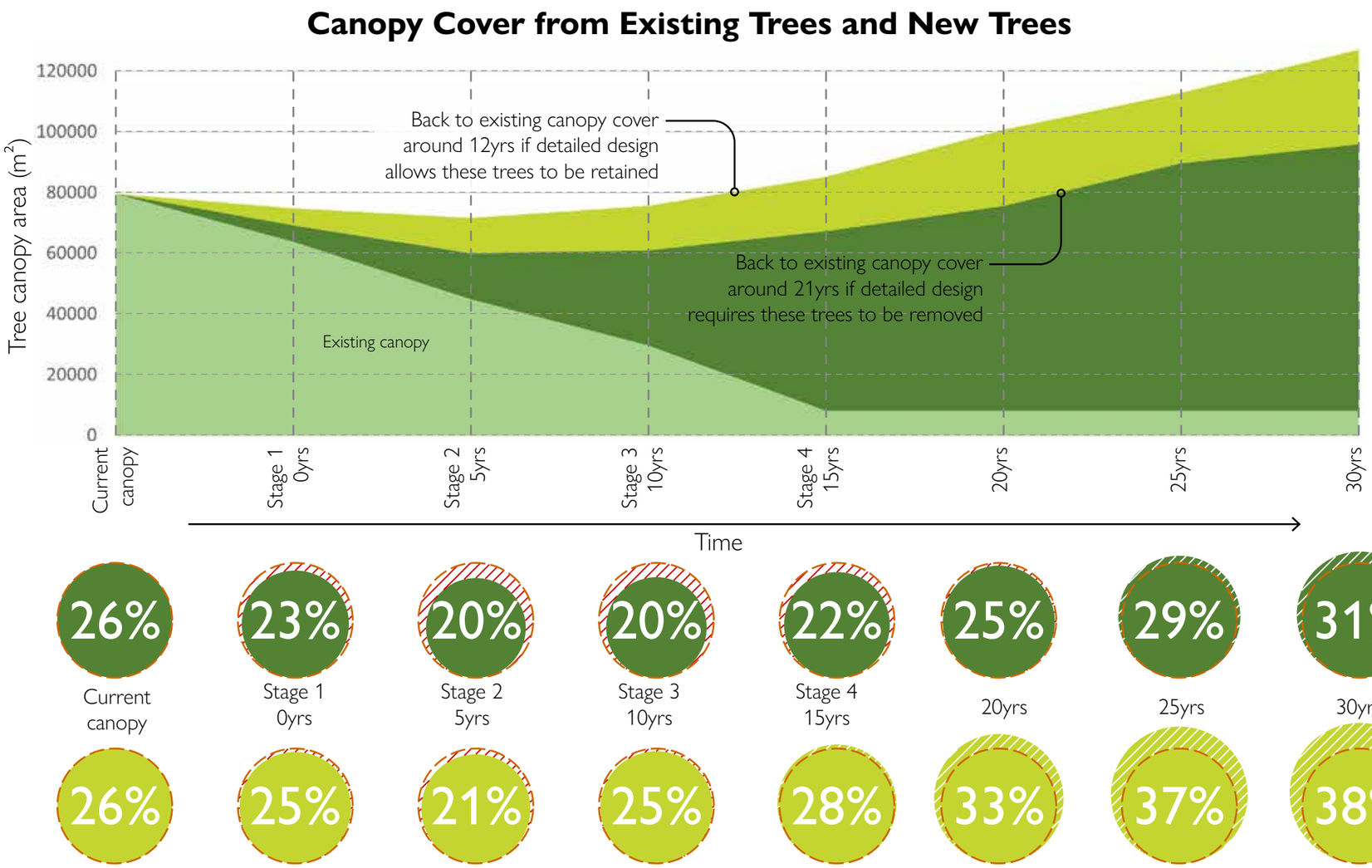
As the project will be delivered in stages over the course of approximately 20 years, the impact on existing tree canopy will be a gradual process.

As each stage is developed, the preceding stage will have had its impacted tree canopy replaced with new tree planting, reducing the overall tree canopy impact across the precinct.

During the renewal, and particularly during the first stage of redevelopment, there will be an initial loss of canopy. However, it is anticipated that new tree canopy cover will grow over time to reduce the impact across the precinct.

Although the existing tree canopy cover will be impacted by new development, and will take time to reach its current levels, it is expected that new tree canopy cover will boost overall canopy cover over time.

In order to minimise the overall impact on tree canopy across the precinct at any given time, it is important to plant new trees as early as possible at each development stage, as well as consideration to retaining as many trees as possible.



Top: Indicative diagram showing how new tree canopy cover boosts overall canopy cover over time following initial loss after removal of existing trees. Note: Does not allow for growth or death of existing remaining trees.

Above: Indicative diagram with scaled circles showing overall tree canopy cover as a percentage of the overall site area. Due to the staged nature of the development, canopy cover does not drop below 20%. Depending on how many existing trees are able to be retained following detailed design, expected tree canopy is expected to cover between 31% and 38% of the site area in 30 years.

Note: Figures used for the diagrams on this page are from the *Tree canopy analysis by stage* pages within the *Public Domain, Place and Urban Design Report* - Refer to that report for assumptions on calculations - Canopy areas calculated included streets and public spaces, and excluded new canopy in residential lots yet to be designed, so figures could be around 7-12% higher when deep soil areas within private lots are included - refer Deep soil section of above report.

4.3.1 TREE CANOPY

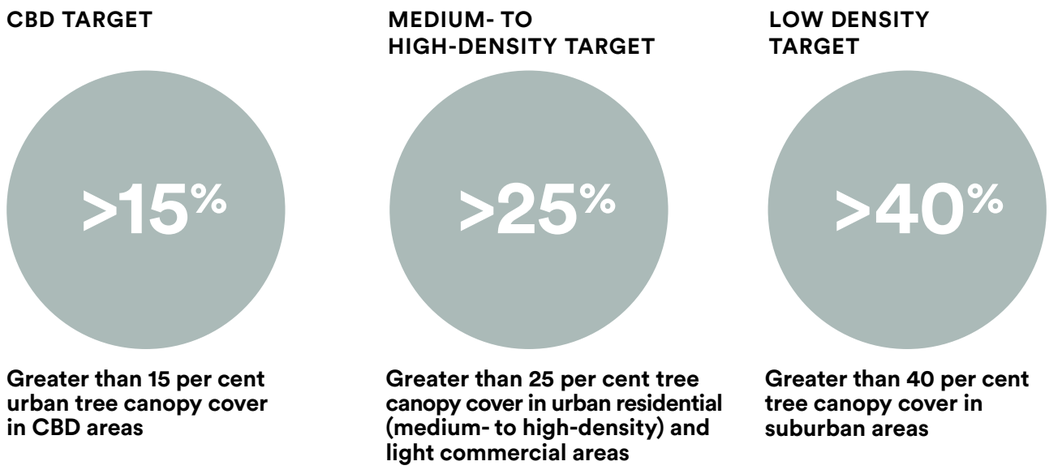
The target for the Greater Sydney Region is to achieve 40% urban tree canopy cover by 2056 (Draft Greener Places Design Guide). For medium-to-high density areas, the target is 25% canopy cover.

Following consideration it is recommended that Riverwood targets canopy cover of 30% across the renewal area. This is a more ambitious target than recommended in the Greener Places Design Guide, and an overall increase in canopy cover across the renewal area.

The target canopy cover will vary across streets, parks and residential lots.

The table opposite identifies the targets for each type of landscape setting within the renewal area. From the calculations in the table opposite, 30% cover in 30 years is achievable. In fact, the table indicates that 34% canopy cover across the whole site is possible if 60% of street areas have canopy cover, 40% of parks and 20% of private spaces within residential lots have canopy cover.

Indicative Canopy Cover Targets - Greater Sydney Region



Indicative tree canopy cover targets. Source: Draft Greener Places Design Guide

Riverwood Canopy Cover Target

Approximately 9.4ha of the 30.5ha renewal area needs to have tree canopy cover in 30 years to achieve the 30% overall target for Riverwood.

Indicative Achievable Canopy Cover - Riverwood

Landscape Setting	Area (hectares)	Area (% of site area)	Proposed Canopy Cover in 30 years (area of landscape setting)	Proposed Canopy Cover in 30 years (% of landscape setting)
Streets	8.0ha	26%	4.8ha	60%
Parks	4.9ha	16%	2.0ha	40%
Private (residential lots)	17.6ha	58%	3.5ha	20%
Overall	**30.5ha**	**100%**	**10.3ha**	**34%**

Refer to the *Indicative tree canopy cover targets* in the *Public Domain, Place and Urban Design Report* for more detail on the canopy breakdown between Streets, Parks and Private areas.

4.3.1 TREE CANOPY

The diagram below shows the areas that have been assumed as Street, Park and Private areas within the Riverwood renewal.

The tree canopy areas diagram, shown right, indicatively shows the extent of tree canopy that can be achieved in the Riverwood renewal. It shows tree canopy in streets, parks and some private areas, as well as key existing trees identified as to be retained. The diagram focuses on tree planting for streets and parks as designed by JMD Design (JMD).

Key	Landscape Setting	Area		Proposed canopy cover in 30 years			Analysis of proposed canopy cover against desired canopy cover target in Green Infrastructure Report
		ha	% of site area	Area of landscape setting	% of landscape setting	Target % of landscape setting (GI report)	
	Street	8ha	26%	6.2ha	78%	60%	The proposed canopy has the potential to reduce and meet the target with more detailed consideration of basement entries, servicing, lobby entries, on street parking, lighting and street furniture locations.
	Park	4.9ha	16%	1.3ha	27%	40%	Proposed does not meet target due to landscape design produced only for new open spaces not existing open spaces. Proposed canopy would reach target with future landscape design for both Kentucky Road Reserve and Salt Pan Gardens (2.5 of the 4.9ha)
	Private	17.6ha	58%	3.5ha	20%	20%	Inclusive of deep soil **and street trees**
	Overall	**30.5ha**	**100%**	**11**	**36%**	**30%**	**Proposal achieves above 30% canopy cover and would likely increase with additional planting in KentuckyRoad Reserve**

Tree canopy cover targets from the Public Domain, Place and Urban Design report. Source: Architectus

Tree canopy areas. Source: Architectus

Tree Retention

Existing trees provide a significant head start to achieve canopy cover.

To mitigate the cumulative impact of tree removal at the precinct level, it is recommended that compensatory or replacement trees are stipulated as a condition of approval for Riverwood.

A replacement ratio is a simple and targeted method to calculate compensatory tree planting. It can be easily quantified, shown in tables on drawings, traced, monitored and enforced on site.

Existing trees on site that need to be removed to accommodate development at Riverwood are required to be replaced as per the following ratios:

Tree replacement ratios are now commonplace in Councils across NSW. These vary between Councils, with some as high as 20:1 for old growth ecologically significant trees. In the Canterbury Bankstown Council area, proponents are required to plant replacement trees at a ratio of at least three trees for every one tree removed, which applies to all types of trees (not just high value trees).

Higher tree replacement numbers are consistent with the Premier's Priorities for Greening our City to increase canopy cover across Greater Sydney by planting five million trees by 2030, and the NSW Government's Net Zero Plan.

The 5:1 ratio for Riverwood applies to the High Value Trees as assessed by the Riverwood High Retention Tree Report by EcoLogical - approximately a third of the trees on site.

The replacement ratios approach is based on the principles of Intergenerational Equity and net environmental gain.

The ratios selected for Riverwood need to also be appropriate for the later phases of the development in 15 years time when the existing trees being replaced will be even larger than they are currently.

A higher replacement ratio for high value trees increases the likelihood they are retained by encouraging these trees to be more thoroughly considered for retention and ideally designed in to the scheme.

Where replacement trees can't be accommodated on site, replacement trees should be provided as close as possible to the location of the removed tree/s.

Salt Pan Creek Reserve and Kentucky Road Reserve are locations nearby that could feasibly accept replacement planting. Failing this, an offsite location nearby that enhances the Sydney Green Grid should be determined with Council.

As individual development stages and building envelopes are refined, the tree retention and replacement strategy will be further developed.

Tree replacement ratios

Tree type	Replacement ratio (Replaced: removed)
High retention value trees	5:1
All other trees on site	3:1

Existing Tree Protection

To protect existing trees that are to be retained, the tree protection zone (TPZ) requires access restriction during the development. The structural root zone (STZ) must not be disturbed to prevent destabilisation of the tree.

The Preliminary Arboricultural Impact Assessment from Ecological outlines tree protection measures to be followed.

It is expected that as individual development parcels undertake detailed design, that:

1. At the outset, an arboricultural assessment of all trees on site is undertaken and distributed to the design team. Significant existing trees will be clearly identified within that document; and

2. The arborist's report needs to identify the structural root zone (SRZ) and tree protection zone (TPZ) that will ensure that built form does not impact tree health.

3. The design team, especially architects, engineers and landscape architects design the built form and other elements to accommodate the existing significant trees with adequate setting and soil volume.

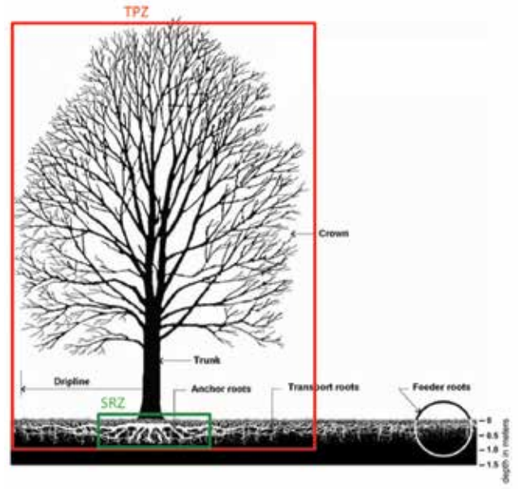
The appendix shows three Sydney examples of where existing significant trees have been accommodated into the design of dense residential developments.

During construction, existing trees to be retained must be protected in accordance with Australian Standard 4970 - 2009 Protection of Trees on Development Sites which describes encroachment into tree protection zones of existing trees and tree protection measures.

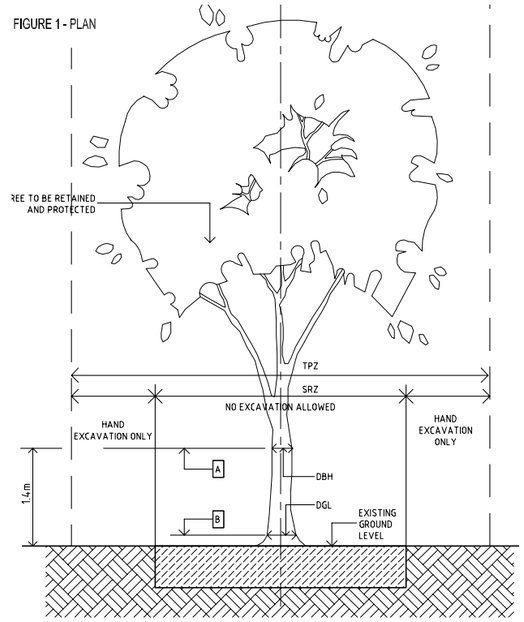
Canterbury Bankstown Council standard drawing S-210 Standard Tree Protection Zone around Existing Tree must also be adhered to.

Sometimes minor encroachment into the tree protection zone is unavoidable. The examples opposite show how to reduce the impact of such incursions.

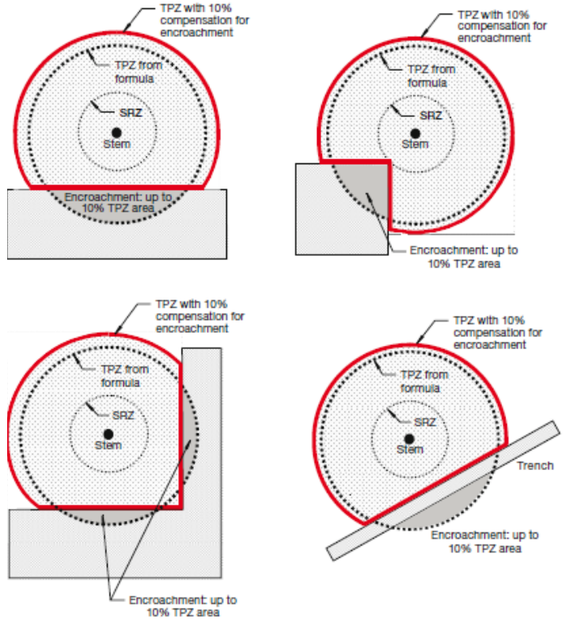
It is recommended that a maximum of 10% encroachment is allowed into the TPZs of existing trees.



Tree Protection Zones (TPZ) and Structural Root Zone (SRZ)
Source: Preliminary Arboricultural Impact Assessment, Ecological



Tree Protection Zone around Existing Tree
Source: Canterbury Bankstown Council



Example of a minor encroachment into TPZ
Source: Standards Australia

4.3.2 SOIL VOLUMES

Tree root growth is opportunistic, and often occupies irregularly shaped areas. Tree roots are much more extensive than commonly thought, and tend to extend outward from the tree trunk rather than downwards.

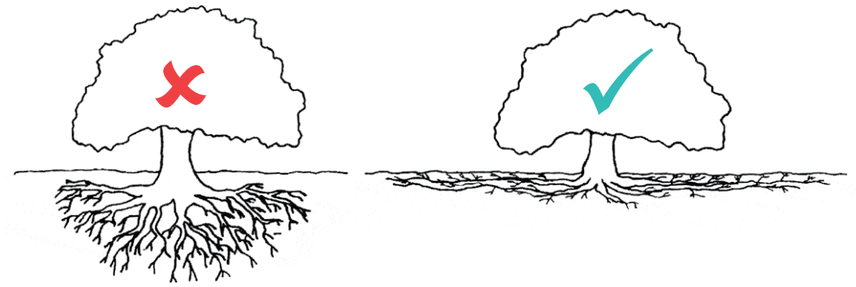
A healthy mature tree may have tree roots up to 7 times larger than the crown area of the tree.

Nutrients, water and oxygen exchange must all be available in the root zone for optimal tree health and growth.

To maximise tree growth for new and existing trees, large soil volumes need to be prioritised.

The notion of 'deep soil planting' for new trees should be replaced with 'adequate soil volume'. Typically, soil depth should be 1m. Slightly less (say 0.8m) is acceptable where on structure.

Soil types vary generally in their organic content, structure and water holding capacity, but in general there is little air available for roots deeper than around 1.6m. Therefore new growing media deeper than this is not normally required, and is unnecessary. A drainage layer below the soil would be required to prevent water logging.



Typical misconception is that tree roots mirror the canopy underground. The reality is that roots normally form a root 'plate' extending well beyond the canopy drip line predominantly in the top 800mm of soil.

Diagram adapted from Trees and Development: A Technical Guide to Preservation of Trees During Land Development by Nelda Matheny and James R. Clark, 1998. International Society of Arboriculture

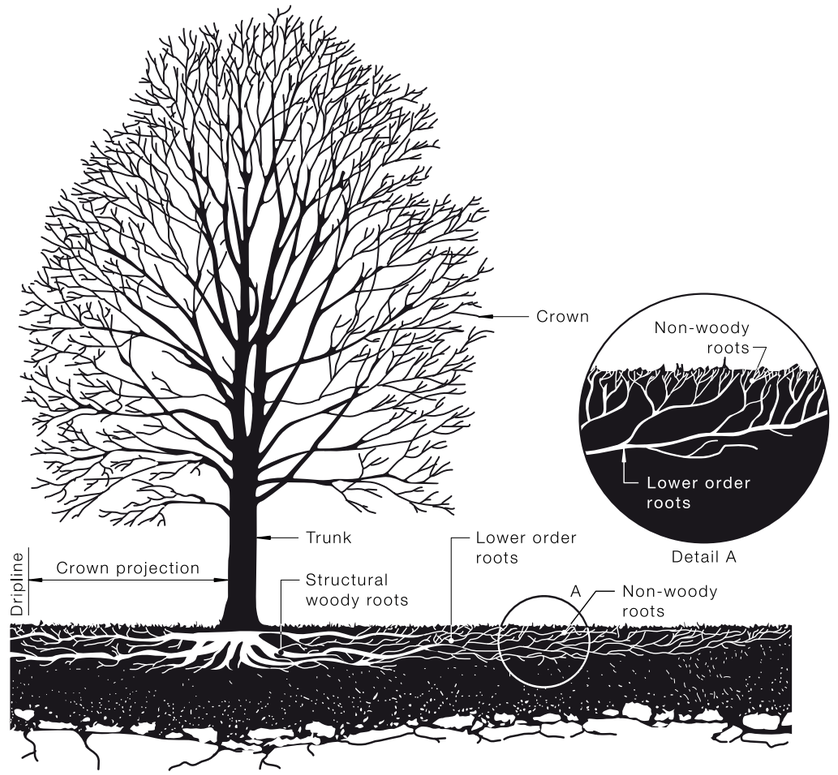


Figure B1 from Australian Standard 4970 - 2009 Protection of trees on development sites shows the typical structure of a tree in a normal growing environment. Most roots are very close to the surface so in an urban environment, adequate soil volume is required, but there is little point providing growing medium beyond 1.6m depth.

Soil volume calculations

To optimise tree growth and stability, adequate soil volume must be provided to allow establishment and perpetuation of the root plate.

Ideally the soil profile should be undisturbed and connected to the site's natural soil profile to promote connection to the groundwater system and maximise soil biota to aid the ongoing flourishing of the tree.

To maximise the growth and long term health of new and existing trees, large soil volumes in connected networks need to be prioritised.

To determine appropriate soil volume, the following method must be used:

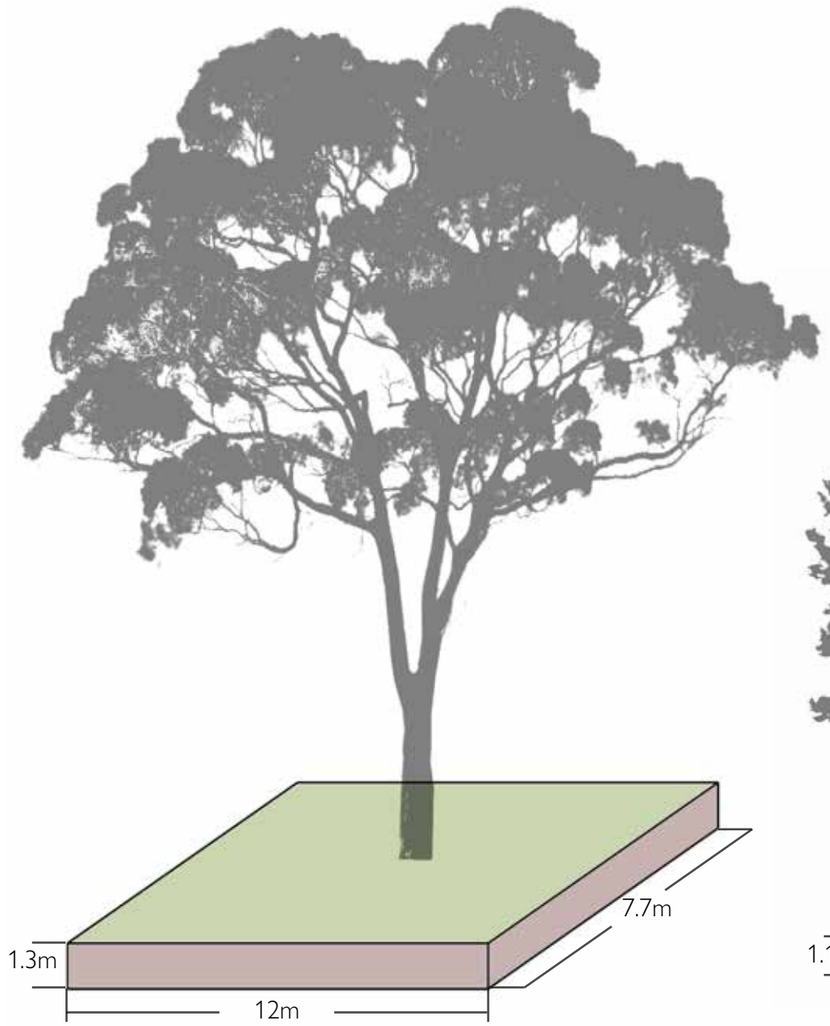
Crown Method

For every square metre of canopy at maturity allow 0.6m^3 volume of soil
Canopy area (m^2) x 0.6 = soil m^3

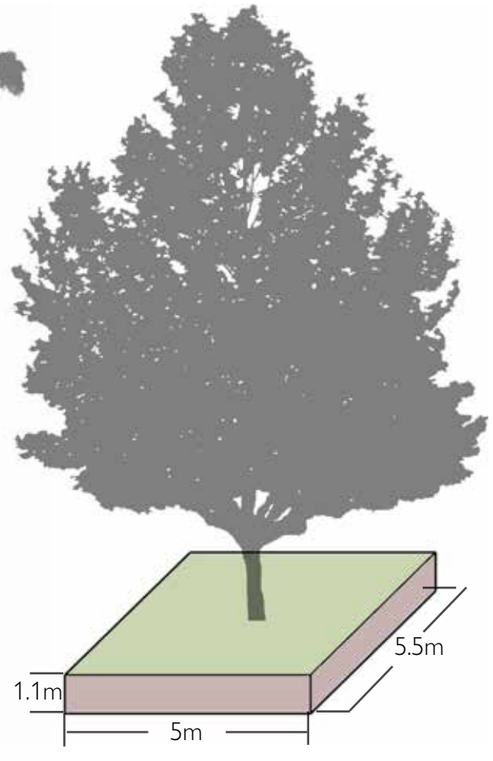
e.g. a tree with a projected crown diameter of 8m at maturity requires 30m^3 of soil ->
π x radius^2 x 0.6 = soil m^3
3.14 x 4 x 4 x 0.6 = 30m^3

Example soil volumes calculated using the Crown and Height method

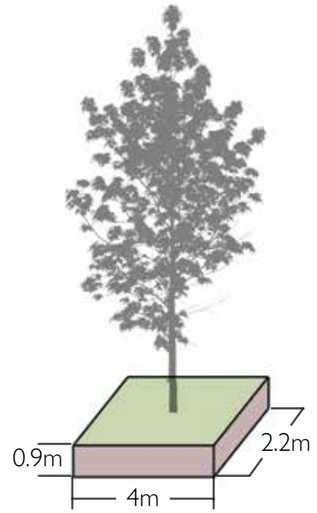
	Projected canopy diameter	Projected canopy area	Required soil volume
Large Tree	eg 16m	eg 200m^2	eg 120m^3
Medium Tree	eg 8m	eg 50m^2	eg 30m^3
Small Tree	eg 4m	eg 13m^2	eg 8m^3



Example Soil Volume (approx. 120m^3)
illustrated for **large tree**
with projected 16m canopy diameter



Example Soil Volume (approx. 30m^3)
illustrated for **medium tree**
with projected 16m canopy diameter



Example Soil Volume (approx. 8m^3)
illustrated for **small tree**
with projected 16m canopy diameter

Example indicative soil volumes expressed for new large, medium and small trees.

4.3.2 SOIL VOLUMES

Soil networks

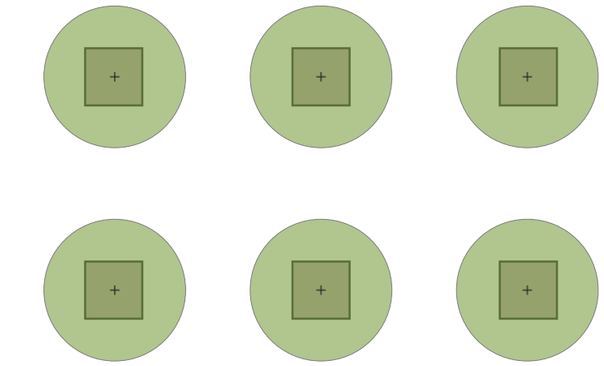
The configuration of the soil volume is important. Trees do much better in connected networks of soil rather than isolated tree pits.

Trees have been proven to communicate with each other in the soil zone using their roots and fungal associations (often in extended networks) that act as extended nervous systems, allowing the trees to do things like share nutrients when one tree is sick. A healthy soil biota is therefore essential to healthy tree growth.

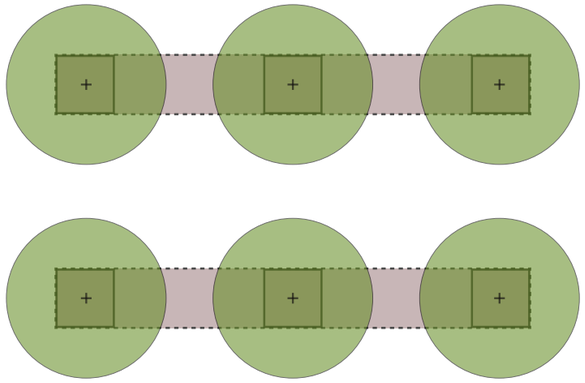
Planting on slab

Given the likely extensive basements throughout the Riverwood master plan area, much of the planting within the property boundaries will be on slab and it is more difficult to achieve soil networks on podiums.

Appropriate irrigation systems (passive or automatic) as well as drainage and soil mixes will be essential for tree and planting health.

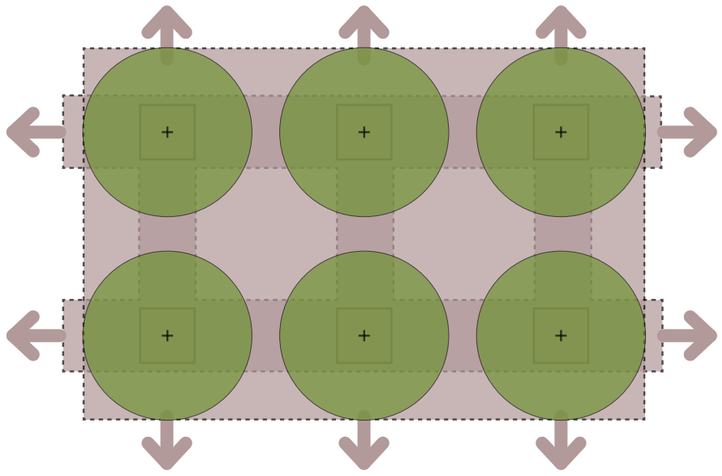


DISCONNECTED: Trees in urban environments have traditionally been planted in isolated tree pits surrounded by pavements, often with insufficient soil volume to provide healthy tree growth.



PART CONNECTED: Trees in urban environments have better health and growth when in continuous trenches of soil. This is typically how street tree planting is currently done in many main streets.

The evolution of structural soil systems and rigid soil cell devices that retain healthy soil profiles, even under road surfaces, have improved tree growth in streets.



FULLY CONNECTED: Trees in urban environments have best health and growth when in more extensive networks of soil and adequate volume is provided.

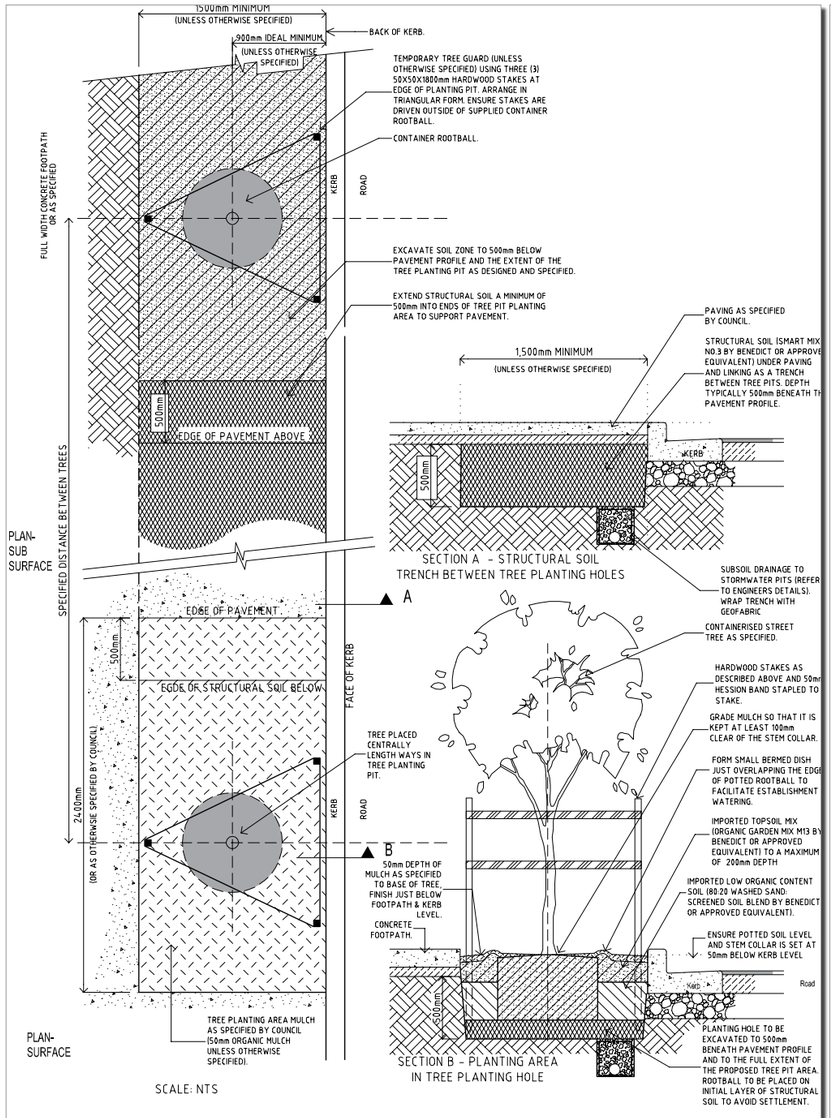
This more extensive soil configuration also reduces drying out and over-wetting around each tree.

Tree Planting

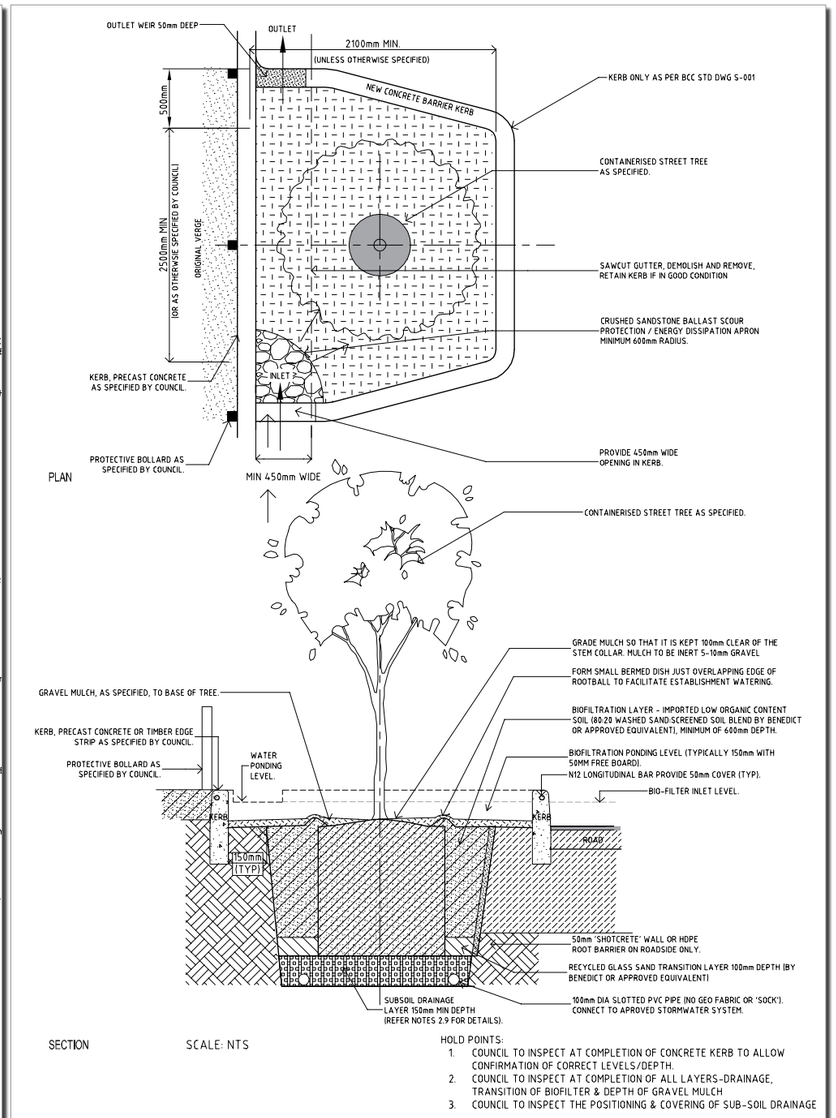
The details opposite show the City of Canturbury Bankstown's standards for street tree planting, and could form the basis for the project design details.

The detail adjacent includes a linked soil trench (which could be further improved by ensuring integration within a wider soil network). The utilisation of structural soil as in the detail versus soil cell products such as Stratavault will need to be further considered during detailed phases of design.

The detail opposite is for a rain garden in a kerb extension and includes an opening for passive street tree irrigation. Low level planting could be added to maximise green cover.



CITY OF CANTERBURY BANKSTOWN	STD DWG N°
STANDARD	S-205
TREE PLANTING (>100L) IN FULL WIDTH PAVEMENT WITH LINK TRENCH	Sheet N°: 1 of 2 / Revision: 1/05/2017
DETAILS	File Name: S-205-1 OF 2.dwg



HOLD POINTS:
1. COUNCIL TO INSPECT AT COMPLETION OF CONCRETE KERB TO ALLOW CONFIRMATION OF CORRECT LEVELS/DEPTH.
2. COUNCIL TO INSPECT AT COMPLETION OF ALL LAYERS-DRAINAGE, TRANSITION OF BIOFILTER & DEPTH OF GRAVEL MULCH
3. COUNCIL TO INSPECT THE POSITIONING & COVERING OF SUB-SOIL DRAINAGE

CITY OF CANTERBURY BANKSTOWN	STD DWG N°
STANDARD	S-208
RAINGARDEN TREE PLANTING IN KERB EXTENSION	Sheet N°: 1 of 2 / Revision: 1/05/2017
DETAILS	File Name: S-208-1 OF 2.dwg

4.3.3 PLANT SPECIES

The Riverwood master plan forms part of the green grid connecting the street network to Salt Pan Creek Reserve.

The streets of Riverwood are an important opportunity to maximise biodiversity and habitat. These green links form a network of biodiversity corridors, providing safe passages for animals to move through the urban landscape.

Different species of trees provide different shading and cooling benefits. Larger trees with greater structure and dense crowns provide greater cooling benefits than more open canopies.

All existing trees should prioritised for retention as much as possible, regardless of species unless they are weeds or unsuitable due to health. The proposal should also seek to enhance the existing Cumberland Plain Woodland community onsite and ensure that it is not negatively impacted by the proposal.

Choosing appropriate plant species for new trees is vital to creating a cool green city landscape and a connected street tree canopy.

Both endemic and exotic species will increase tree canopy shade, provide habitats for foraging and help to enhance the biodiversity within the Riverwood precinct .

Having said this, species selection for tree planting should prioritise locally indigenous species where they can fulfil the requirements of shade and amenity to ensure a net increase in native species.

A diversity of tree species should ensure resilience to droughts, pests, disease, climate change and the urban heat island effect. A 12-month flowering succession at Riverwood will also benefit the insect community.

Understorey planting provides another important ecological layer, with habitat for insects, small birds and small fauna.

For all new plantings, high quality ground preparation and passive irrigation should be prioritised over tree stock size.

Selection of trees for the public domain need to be big enough to withstand theft, vandalism and other damage, typically min. 100L-200L depending on availability.

The full indicative street tree plant schedule developed by JMD follows.

With the aim of maximum green cover on streets, on building podiums, in community gardens, parks and gardens, and on roof tops, these species are known to be more resilient to the effects of climate change whilst creating large shade canopy with the view of promoting a connected canopy over the streets.

4.3.3 PLANT SPECIES

Proposed Urban Structure

Indicative Plant Schedule - North-south street trees

Large native trees


Agathis robusta


Corymbia maculata

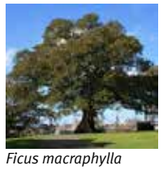

Eucalyptus fibrosa


Eucalyptus microcorys


Eucalyptus paniculata


Eucalyptus sideroxylon


Eucalyptus saligna


Ficus macraphylla


Lophostemon confertus


Syncarpia glomulifera


Waterhousea floribunda

Medium native trees


Angophora costata


Angophora floribunda


Corymbia eximia


Cupaniopsis anacardioides


Melaleuca styphelioides


Tristaniopsis laurina

Small trees/Shrubs/Ground Covers


Backhousia citriodora


Callistemon citrinus


Callistemon viminalis


Baeckea virgata


Elaeocarpus reticulatus


Hibbertia obtusifolia


Melaleuca linarifolia


Synoum glandulosum


Westringia fruticosa

Small exotic trees


Fraxinus griffithii

Native

Botanical name	Common name	Origin	Regionally Indigenous	Type	Street Type
Large trees					
Agathis robusta	**Queensland Kauri Pine**	Native		Evergreen	N/S
Corymbia maculata	**Spotted gum**	Native	Yes	Evergreen	N/S
Eucalyptus microcorys	**Tallowwood**	Native	Yes	Evergreen	N/S
Eucalyptus fibrosa	**Red Ironbark**	Native	Yes	Evergreen	N/S
Eucalyptus paniculata	**Grey Ironbark**	Native	Yes	Evergreen	N/S
Eucalyptus saligna	**Sydney Blue Gum**	Native	**Yes**	**Evergreen**	**N/S**
Eucalyptus sideroxylon	**Mugga Ironbark**	Native	Yes	Evergreen	N/S
Ficus macrophylla	**Large-leaved Fig**	Native	**Yes**	Evergreen	N/S
Lophostemon confertus	**Brush Box**	Native	No	Evergreen	N/S
Syncarpia glomulifera	**Turpentine**	Native	Yes	Evergreen	N/S
Medium trees					
Angophora costata	**Dwarf Apple**	Native	Yes	Evergreen	N/S
Angophora floribunda	**Rough-barked Apple**	Native	Yes	Evergreen	N/S
Corymbia eximia	**Yellow Bloodwood**	Native	Yes	Evergreen	N/S
Corymbia maculata	**Spotted Gum**	Native	Yes	Evergreen	N/S
Cupaniopsis anacardioides	**Tuckeroo**	Native	Yes	Evergreen	N/S
Melaleuca styphelioides	**Pricky Paperbark**	Native	Yes	Evergreen	N/S
Tristaniopsis laurina	**Water Gum**	Native	Yes	Evergreen	N/S
Small trees					
Backhousia citriodora	**Lemon Scented Myrtle**	Native		Evergreen	N/S
Callistemon citrinus	**Crimson Bottlebrush**	Native	Yes	Evergreen	N/S
Callistemon viminalis	**Bottlebrush**	Native		Evergreen	N/S
Elaeocarpus reticulatus	**Blueberry Ash**	Native	Yes	Evergreen	N/S
Melaleuca linarifolia	**Snow In Summer**	Native	Yes	Evergreen	N/S
Synoum glandulosum	**Sentless Rosewood**	Native	Yes	Evergreen	N/S
Shrub/Ground cover					
Baeckea virgata	**Dwarf Baeckea**	Native	No	Evergreen	N/S
Hibbertia obtusilfolia	**Hoary Guinea Flower**	Native	Yes	Evergreen	N/S
Westringia Fructicosa	**Coastal Rosemary**	Native	Yes	Evergreen	N/S

Exotic

Botanical name	Common name	Origin	Regionally Indigenous	Type	Street Type
Small tree					
Fraxinus griffithii	**Evergreen Ash**	Exotic	No	Evergreen	N/S

JMD Landscape Report Indicative Plant Schedule

4.3.3 PLANT SPECIES

Proposed Urban Structure

Small native trees


Brachychiton acerifolius

Large exotic trees


Koelreuteria bipinnata


Platanus digitata


Ulmus glabra


Ulmus parvifolia

Medium exotic trees


Caesalpinia ferrea


Fraxinus pennsylvanica


Jacaranda mimosifolia


Liriodendron tulipifera


Nyssa sylvatica


Pistacia chinensis


Pyrus ussuriensis


Robinia pseudoacacia


Zelkova serrata

Small exotic trees


Lagerstroemia indica

Indicative Plant Schedule - East-west street trees

Native

Botanical name	Common name	Origin	Regionally Indigenous	Type	Street Type
Small tree					
Brachychiton acerifolius	**Illawarra Flame Tree**	Native	Yes	Deciduous	N/W

Exotic

Botanical name	Common name	Origin	Regionally Indigenous	Type	Street Type
Large trees					
Koelreuteria bipinnata	**Pride of China**	Exotic	No	Deciduous	E/W
Platanus digitata	**Syrian Plane**	Exotic	No	Deciduous	E/W
Ulmus glabra 'Lutenscens'	**Golden Elm**	Exotic	No	Deciduous	E/W
Ulmus parvifolia	**Chinese Elm**	Exotic	No	Deciduous	E/W
Medium trees					
Caesalpinia ferrea	**Leopard Tree**	Exotic	No	Deciduous	E/W
Fraxinus pennsylvanica	**Green Ash**	Exotic	No	Deciduous	E/W
Jacaranda mimosifolia	**Jacaranda**	Exotic	No	Deciduous	E/W
Liriodendron tulipifera	**Tulip Tree**	Exotic	No	Deciduous	E/W
Nyssa sylvatica	**Black Tupelo**	Exotic	No	Deciduous	E/W
Pistacia chinensis	**Chinese Pistachio**	Exotic	No	Deciduous	E/W
Pyrus ussuriensis	**Manchurian Pear**	Exotic	No	Deciduous	E/W
Robinia pseudoacacia 'Frisia'	**Golden Robina**	Exotic	No	Deciduous	E/W
Zelkova serrata	**Green Vase Zelkova**	Exotic	No	Deciduous	E/W
Small trees					
Lagerstroemia indica	**Crepe Myrtle**	Exotic	No	Deciduous	E/W

JMD Landscape Report Indicative Plant Schedule

4.3.3 PLANT SPECIES

Site Soils

The existing soil profile In Riverwood from the *Soil Landscapes of the Sydney 1:100 000* sheet show that the residual soil landscapes on the site are:

- BLACKTOWN and
- BIRRONG

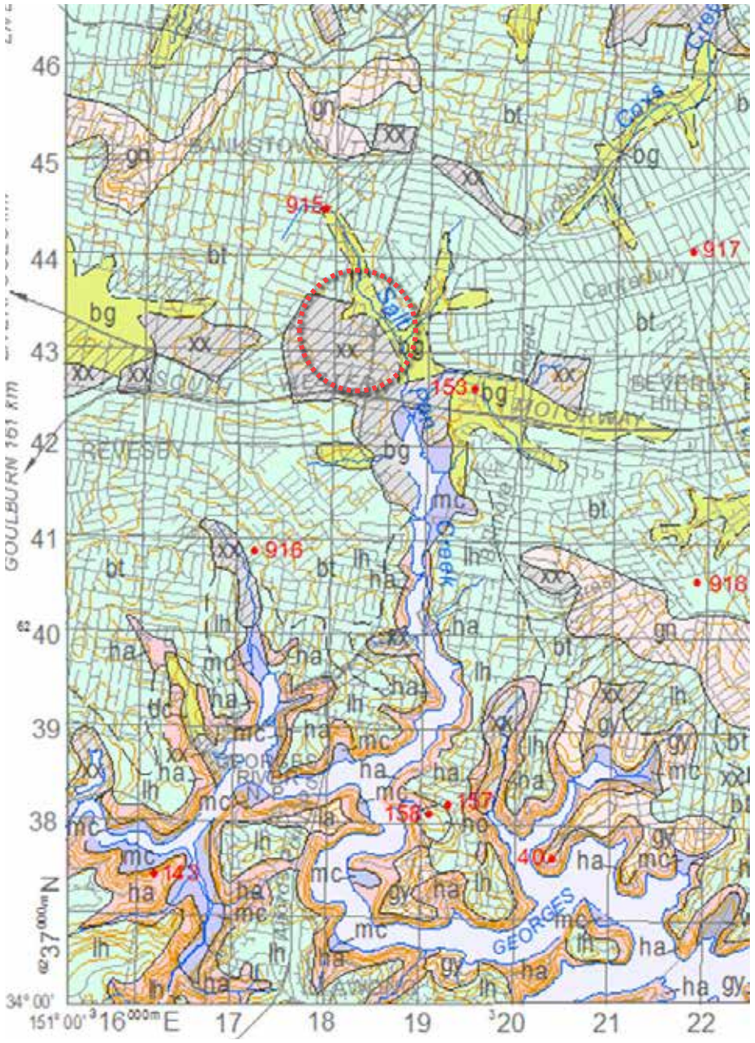
and around Salt Pan Creek residual soil types are:

- MANGROVE CREEK
- DISTURBED TERRAIN

The Ecological Biodiversity Development Assessment Report shows that the western portion of the site is on the Georges River Alluvial Plain, and the eastern portion is on Ashfield Plains.

Whilst much of the site may have disturbed soil types due to the nature and timing of the original development, the characteristics of the underlying soils should be understood and conserved. A connected soil network integrating existing site soils retained in place should be developed as optimum.

Tree species should be selected based on those that can thrive in these soils.



Extract from the *Soil Landscapes of the Sydney 1:100,000 Sheet*, with site indicated on the plan and key soil landscapes from the key reproduced.

Site map. Source: Biodiversity Development Assessment Report, Ecological

4.3.4 BIODIVERSITY

Biodiversity loss is one of the greatest environmental threats worldwide and it is our responsibility to prioritise how we will address these issues.

Green infrastructure at Riverwood should help conserve and enhance ecological and biological functions across a range of urban scales.

Salt Pan Creek, and Salt Pan Creek Riverwood Wetlands are home to a range of species, and it is imperative that this habitat is protected and managed.

The Riverwood study area features a small area of native remnant vegetation - *Grey Box Forest Red Gum grassy woodland on flats of the Cumberland Plain* - and a large area of planted native and exotic trees.

Connectivity to large tracts of habitat is suitable for mobile species such as mammals, birds and bats. Connectivity within the study area is provided to a limited extent by roadside planted trees.

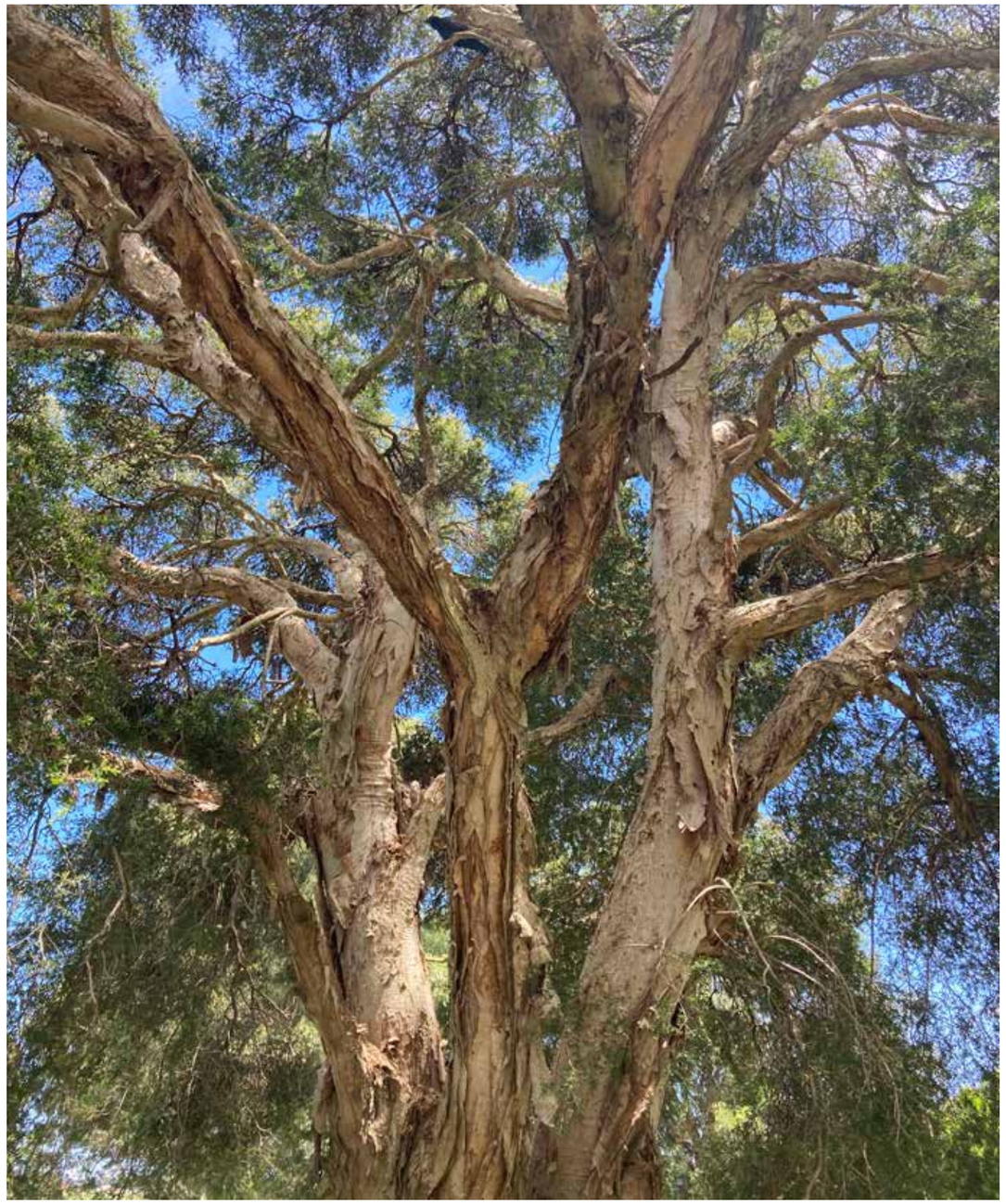
Although the proposal is likely to result in significant impact on the existing vegetation, the master plan has been developed to avoid impacts on remnant native vegetation.

The Ecological Australia Biodiversity Development Assessment Report indicates that the *Pteropus poliocephalus* (Grey-headed flying fox), *Chalinolobus dwyeri* (Large-eared pied bat) and *Lathamus discolor* (Swift parrot) could be adversely affected by the proposed works. Application of the Commonwealth Significant Impact Criteria was undertaken for these species and concluded that the project is unlikely to have a significant impact.

Despite the impacts of urban development, Riverwood offers opportunities for the area to continue to be home to a significant number of species.

Green infrastructure planning and design can contribute to local habitat conservation by providing habitats for foraging and establishing green connections between urban neighbourhoods and these habitats.

Direct and indirect biodiversity impacts from the master plan development and mitigation measures are outlined in the Ecological Biodiversity Development Assessment Report, and summarised in the following table.



Mellaleuca tree on site provides habitat for local wildlife.

Table 16: Measures proposed to mitigate and manage impacts

Measure	Risk before mitigation	Risk after mitigation	Action	Outcome	Timing	Responsibility
Instigating clearing protocols including pre-clearing surveys, daily surveys and staged clearing, the presence of a trained ecological or licensed wildlife handler during clearing events	Moderate	Minor	Pre-clearance survey of trees to be removed and identification/location of habitat trees by a suitably qualified ecologist. Avoid clearing of habitat trees in later winter/spring during breeding/nesting period for birds Trees identified for retention should be clearly delineated as a 'No Go' zone with high visibility bunting. Supervision by a qualified ecologist/licensed wildlife handler during habitat tree removal in accordance with best practise methods. Any habitat tree removal is to be undertaken by a contractor under the supervision of a suitably qualified project arborist.	Any fauna utilising habitat within the development site will be identified and managed to ensure clearing works minimise the likelihood of injuring resident fauna	During clearing works	Project Manager / Ecologist
Installing artificial habitats for fauna in adjacent retained vegetation and habitat or human made structures to replace the habitat resources lost and encourage animals to move from the impacted site, e.g. nest boxes	Minor	Negligible	Any trees removed that have hollows/hollow trunks/fissures should be retained as ground fauna habitat and/or used as replacement hollows and attached to trees within or in vegetation adjacent to the development site. If it is impractical to use salvaged hollows as replacement tree hollows, compensatory nest boxes should be installed where practical.	Replacement of habitat features removed	Prior to and during clearing works	Project Manager/ Ecologist
Clearing protocols that identify vegetation to be retained, prevent inadvertent damage and reduce soil disturbance; for example, removal of native vegetation by chain-saw, rather than heavy machinery, is preferable in situations where partial clearing is proposed	Moderate	Minor	Vegetation identified for retention should be clearly delineated as a 'No Go' zone with high visibility bunting. No temporary facilities i.e. site offices/toilets/soil stockpiling is to occur within tree protection zone.	Vegetation to be retained outside of the development site boundary will not be disturbed/impacted	Demarcation of vegetation to be set up prior to any works occurring on site and to remain throughout duration of construction works	Project Manager
Sediment barriers or sedimentation ponds to control the quality of water released from the site into the receiving environment	Moderate	Minor	Appropriate controls are to be utilised to manage exposed soil surfaces and stockpiles to prevent sediment discharge into waterways. Soil and erosion measures such as sediment fencing, clean water diversion must be in place prior the commencement of the construction work and must be regularly inspected and	Erosion and sedimentation will be controlled	For the duration of construction works	Project Manager

Ecological: Measures proposed to mitigate and manage impacts, Biodiversity Development Application Report

Lighting needs to be designed to minimise impacts to nocturnal and diurnal fauna.	Moderate	Minor	Light pollution can be reduced by limiting the duration of spotlight illumination, reducing the brightness of lights where possible, installing shield fixtures to reduce light scattering, and using narrow-spectrum light sources to reduce the wavelengths likely to interfere with animal behaviour (Gaston et al 2012). High priority areas where the implementation of measures to reduce light pollution should be considered would be located adjacent to important habitat. Wildlife friendly lighting (i.e. filtered yellow-green and amber LEDs wavelength of 590 nm with light shield protection controlling light spill) should be considered in the retained bushland areas.	Lighting impacts on nocturnal and diurnal fauna is minimised.	During clearing works and post construction (i.e. design).	Project Manager/ Landscape Designer/ Ecologist
Hygiene protocols to prevent the spread of weeds or pathogens between infected areas and uninfected areas	High	Minor	Phytophthora control measures must be undertaken from the commencement of the project to minimise the risk of spread and to the site. The following guidelines should be followed: https://www.rbgsyd.nsw.gov.au/science/plants/pests-diseases/phytophthora-dieback/disinfection-procedures http://www.environment.gov.au/biodiversity/invasive-species/publications/management-phytophthora-cinnamomi-biodiversity-conservation Vehicles, machinery and building refuse should remain only within the development site. Weed management to be undertaken where required.	Spread of weeds and pathogens prevented	For the duration of construction works and post-construction	Project Manager
Staff training and site briefing to communicate environmental features to be protected and measures to be implemented	Minor	Negligible	Construction staff to be briefed prior to work commencing to be made aware of any sensitive biodiversity values present and environmental procedures such as: • Site environmental procedures (vegetation management, sediment and erosion control, exclusion fencing and weeds) • What to do in case of environmental emergency (chemical spills, fire, injured fauna) Key contacts in case of environmental emergency	All staff entering the development site are fully aware of all the ecological values present within the Lot and environmental aspects relating to the development and know what to do in case of any environmental emergencies	To occur for all staff entering/ working at the development site. Site briefings should be updated based on phase of the work and when environmental issues become apparent.	Project Manager
Making provision for the ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat adjacent to the master plan development site	Moderate	Minor	Landscaping in the development site is to use locality derived native species and those found within the PCT present.	Areas within the development site will be landscaped using appropriate species	Throughout construction and following completion of construction activities.	Project Manager

Ecological: Measures proposed to mitigate and manage impacts, Biodiversity Development Application Report

Use it or lose it
Increased housing density at Riverwood will lead to more intensive site use, generating more stormwater than in its current form. Any untreated run-off can have a detrimental impact on the overall water quality in Salt Pan Creek.

Riverwood averages approximately 750mm of rainfall each year. There is a huge opportunity for the new neighbourhood to be seen as a water supply catchment. As a 'sponge city' it can retain, adapt, slow down and re-use the rainfall resource.

The objective should be to mimic pre-urban run off reaching Salt Pan Creek, and minimise stream erosion.

Riverwood should encourage the use of the following alternative water source options:

- Rainwater– collected from roof areas and lawns and stored in a rainwater tank
- Stormwater– collected from trafficable surfaces such as streets and pavements and stored in a stormwater tank
- Greywater– diversion and treatment systems can be used to collect and re-use wastewater from the bathroom and laundry
- Reticulated recycled water– recycled wastewater supplied by a water authority or central authority via a reticulated system to individual lots for non-potable use
- Central on-site recycled water systems (multi-dwelling developments only)– for toilet flushing, laundry, air conditioner and clothes dryer condensate, garden irrigation; and
- Hot water recirculation and diversion– collecting water from hot water fittings until the water reaches the desired temperature

Captured water can then be re-used to irrigate

- street trees
- community gardens
- lawn areas in Roosevelt and Kentucky Road Reserve
- high water demand sports fields planned at Salt Pan Creek Reserve.

4.3.5 WATER

Irrigation leads to a noticeable difference in street tree size, helping achieve better overall tree canopy cover.

By designing tree pits to passively receive stormwater runoff from nearby hard surfaces such as footpaths and roads, the health and vigour of trees and the extent of their canopy cover will be significantly improved.

For Riverwood, parking areas that use porous paving to allow stormwater to soak in should also be incorporated.

Excess flows can go to rain gardens, the 'heavy lifters' for water quality. The Mott MacDonald Water Cycle Management Report recommends tree bays or swales located within road reserves and parks.

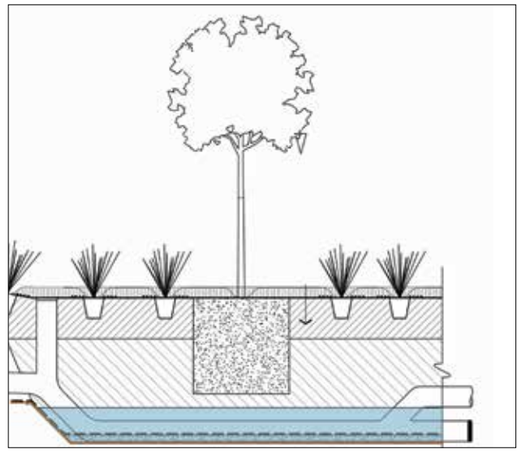
Rain garden design needs early consideration as they can't readily be retrofitted later on. There is variability in design, media and execution, and they are living systems, so still vulnerable to siltation and drying out.

Wicking bed storage should also be incorporated. These reservoirs at the base of planting beds water plants from below rather than above. Moisture is drawn up through the soil and evenly distributed

Passive street tree irrigation: Healthy and vigorous street tree planting on nearby Maryland Street benefiting from pits collecting stormwater runoff and supplying each tree. Other streets nearby where these techniques have not been used have trees that are much smaller.

Porous paving: Permeable paving helps stormwater soak into the ground and street trees to thrive.

Raingardens: A central swale captures runoff and provides passive irrigation to central median trees and groundcover plants.



Wicking beds: Water storage in the soil zone helps irrigate plants during dry periods.

4.3.6 CLIMATE CHANGE ADAPTATION

Climate change is one of the most pressing issues of our time and we are responsible for good design that mitigates the effects.

Climate change will see everyday temperatures rising, an increase in the amount and extent of droughts and threats to native species and ecosystems. Increasing frequency and ferocity of storms will also impact green infrastructure.

The community of Riverwood requires a targeted response to mitigate climate change, starting with the design of the neighbourhood. Good design can reduce its exposure to natural and urban hazards, so it is able to withstand the stresses associated with climate change.

Good design requires practices such as planting the right kind of trees and vegetation that will thrive in a changing climate and protect local habitat that will improve air quality in Riverwood.

The *Riverwood Climate Change Adaptation (CCA) Report* prepared by Mott MacDonald provides additional information on climate change adaptation.

4.3.7 CLIMATE POSITIVE DESIGN

With no action on climate change, there will be a catastrophic three to five degree warming of the planet from anthropogenic greenhouse gases by 2100.

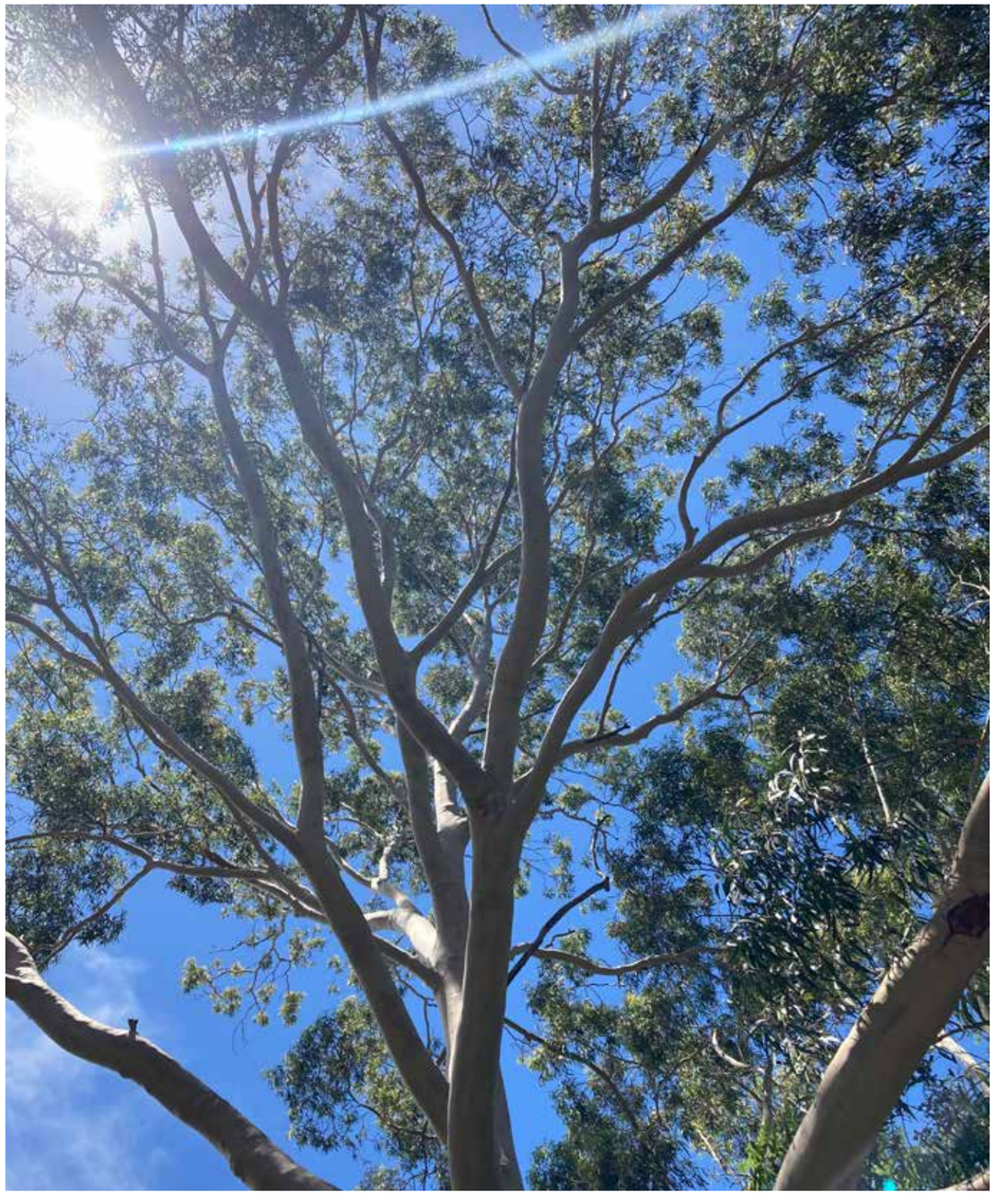
Climate Positive Design seeks to sequester more green house gases than are emitted by a project over its entire lifetime. Every project designed needs to be carbon neutral by 2050 to meet the Paris Agreement.

Climate positive design draws upon good design practices associated with climate adaptation and mitigation techniques, including green infrastructure and cooling cities.

In order to achieve a climate positive design for Riverwood, there are four key things that can be done to help avoid increased emissions and provide longer time for CO_2 sequestration:

1. Reduce the extent of high carbon elements
   - minimise tree removal
   - reduce extent of hard paved surfaces
   - reduce extent of concrete
   - design out the need for steel
   - reduce intensively managed lawns
2. Specify low carbon substitutes
   - specify low carbon concrete/polymer concrete
   - specify green steel
   - replace steel deck framing with fibreglass reinforced panels (FRP)
   - Specify electric maintenance equipment
   - Use biodynamic/probiotic fertiliser not ammonium nitrate based products
3. Plant as many large trees as possible
   - retain existing trees and their connected soil networks
   - plant new trees as early as possible
   - prioritise high-quality ground preparation over tree stock size
   - maximise soil networks, soil volumes and root plate area
   - use passive irrigation
4. Educate and advocate for climate positive design
   - raise awareness of the project's carbon footprint with the community, local businesses and government
   - consider biodiverse offsets where it is not possible on site.

The Mott Macdonald Climate Change Adaptation Report further explores impacts and adaptation measures to mitigate climate change risk.



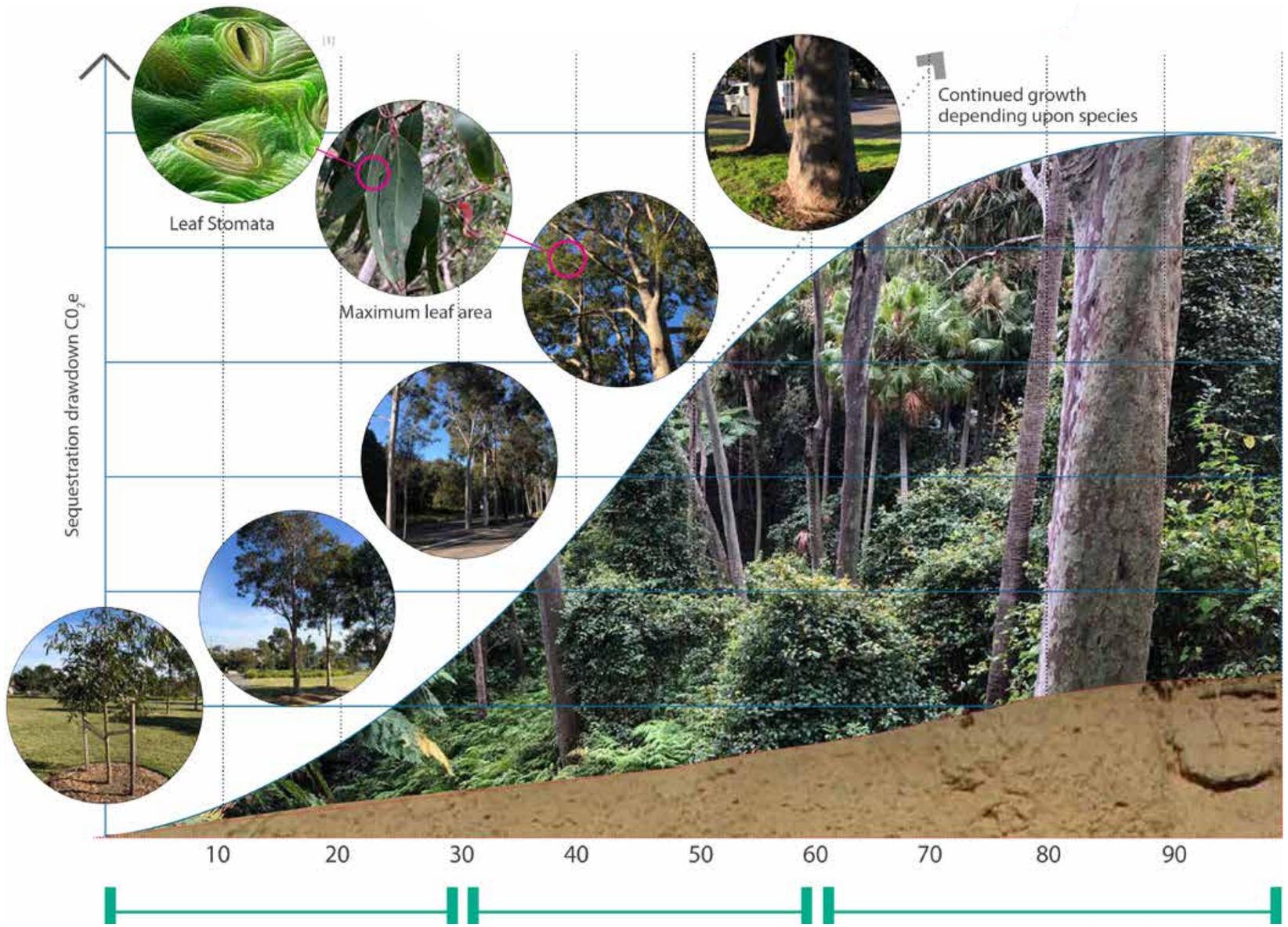
Trees take time to store carbon
Trees are a key green infrastructure tool to help draw down and sequester carbon.

In urban trees, carbon is stored in above ground biomass, and below the ground in the root biomass and soil. Soil networks and ecosystems play a very large part in the sequestration.

As carbon dioxide is drawn in through the leaves, a tree will increase in sequestration capability as its canopy cover grows.

It may take 20-30 years to reach maximum canopy size, and sequestration potential.

Trees take time to grow, so it's imperative to plant new trees early, and ensure good growing conditions for long term benefit



Cumulative carbon sequestered above and below ground

Starting early matters
Starting new tree planting early makes a difference.

The images opposite show indicative growth of a Corymbia maculata (Spotted Gum) over 30 years, and the corresponding carbon sequestration.

Carbon sequestration is as little as 8kg/year carbon dioxide equivalent (CO2e) in the first year, and potentially up to 420kg/year after 30 years.

1 year (2021)

50mm diameter x 2m high
8.8kg CO_2e
0.009 tCO_2e
8kg/yr*

5 years (2025)

150mm diameter x 6m high
236kg CO_2e
0.23 tCO_2e
47kg/yr*

15 years (2035)

450mm diameter x12m high
1,892kg CO_2e
1.8 tCO_2e
126kg/yr*

30 years (2050)

600mm diameter x 20m high
12,618kg CO_2e
12.6 tCO_2e
420kg/yr*

Illustration source: O'Dea, M. 2020. Climate Positive Design. AILA Victoria presentation. 10th September 2020.

Based on:
- Volume of the tree estimated to be solid cylinder of timber the height of the tree with a constant diameter from chest height.
- Below ground mass is calculated at 28% of the aboveground mass based on research by Husch et al. 2003, Tritton and Hornbeck 1982, Wenger 1984
- Volume multiplied by dry density (as there is no carbon in water) Dry density assumed as 950kg/m3
- Carbon then assumed to be 50% of the weight based on research by Robert Clifford.
- Carbon dioxide equivalent calculated by multiplying resultant carbon x 3.67 to account for the additional weight of the two oxygen atoms.

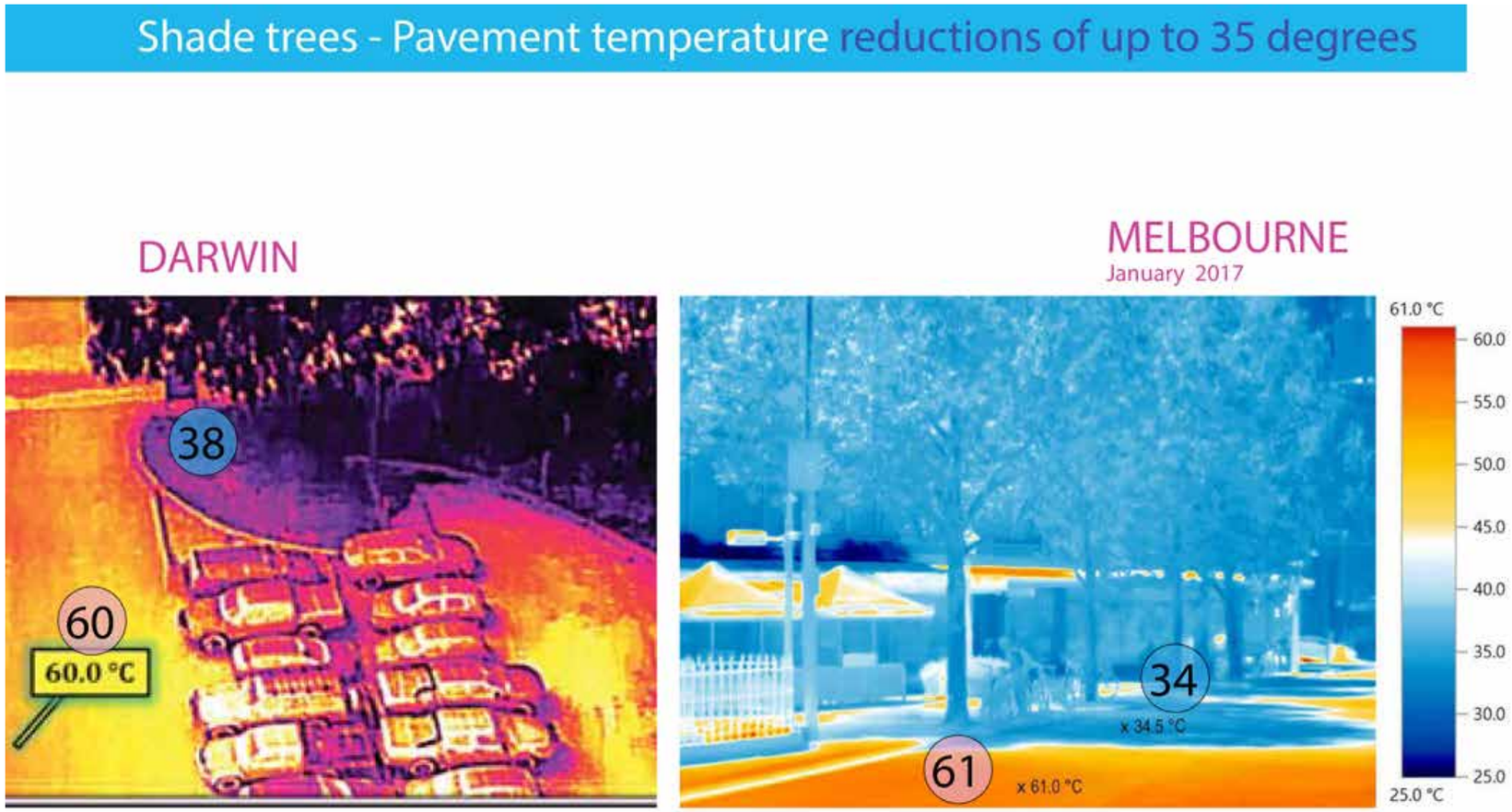
Formula used.
- π R2 x height to get above ground volume in m3
- Above ground volume x 1.28 to get total volume
- Total Volume x dry density of 950kg/m3 to get dry mass
- Dry mass x 50% to get total Carbon
- Carbon x 3.67 to get carbon dioxide equivalent.
- Carbon per year is a straight line extrapolation of CO2e / estimated age

The Riverwood master plan aims to maximise tree canopy coverage to maximise shade for reduction in urban heat island effect

Shade street trees
Shade from trees can reduce pavement temperatures by up to 35 degrees. Trees also create cooler spaces through evapotranspiration.

Urban stormwater
Urban stormwater should be one of the initiatives to cooling Riverwood. Ground moisture and irrigated lawns dramatically reduce urban heat. They lead to greener, cooler, more inviting lawns that are not hard to play or fall on.

Passive irrigation
Passive irrigation also promotes faster tree growth, leading to greater canopy cover and more shade, and increased rates of carbon capture.



Darwin thermocamera measurements via Unmanned Aerial Vehicle (drone)
source: Heat Mitigation Program, Darwin, UNSW study.

Thermal image taken in Melbourne during the Jan 2017 heatwave
source: City of Melbourne

4.3.9 HEALTH AND WELLBEING

There is a growing recognition of the correlation between local green spaces and community health, as made very apparent during the pandemic. It is evident that having access to a green space has a wide range of benefits towards well-being and mental and physical health.

Green infrastructure can benefit mental health and wellbeing by creative calming spaces for meditation and reflection.

High quality public realm helps build social cohesion in a community. Central to nurturing social engagement are the opportunities for clear lines of sight, loop path circuits, frequency of path crossings, places to sit in shade in summer and sun in winter, and places to observe others without committing to engagement.

Well designed night-lighting (minimising shadows and hidden spaces) also helps promote safe social engagement during the evenings.

The Riverwood master plan aims to have well-designed greener places with large, connected tree canopies that provide shade to encourage locals to be more physically and socially active.

All residences will be within walking distance of open space (400m for medium density and 200m for high density dwellings).

The master plan provides for community gardens and productive landscapes, encouraging production and consumption of fresh produce, increasing awareness of healthy eating and general wellbeing.

The Salt Pan Creek Reserve masterplan, in development by City of Canterbury Bankstown, proposes pedestrian cycle loops, multi-purpose playing fields, a skate facility, mountain biking circuit and adventure playground.

These formal and informal recreation areas will provide greater outcomes for the health and wellbeing of Riverwood residents.

4.3.10 LIFE CYCLE APPROACH AND CIRCULAR ECONOMY

Life cycle thinking is an approach that allows for an understanding of how everyday life affects the environment.

It is an ecological method that looks at the full life cycle of materials and buildings, through selecting safe and appropriate materials to maximise the utility of specific materials.

The design method enables new thinking about the life cycle of built form from the availability of natural resources, through to the processing and manufacturing, to on-site use and the eventual recycling of material.

By responding to climatic, physical and cultural environments, this approach creates communities that allows for a diverse range of economic, social and ecological value giving the opportunity to view materials as a nutrient cycle that supports other life.

The Riverwood master plan should encourage allow for a more direct approach to sustainability whilst creating a reciprocal relationship between humans and non-human material.

5. URBAN FOREST AND GREENING STRATEGY

5.1 LANDSCAPE SETTINGS AT RIVERWOOD

The master plan for the Riverwood Renewal has been developed to deliver an integrated mixed community supported by improved public domain, pedestrian and cycling connections and open space networks.

The urban design framework includes retaining as much of the existing street network as possible, while creating a legible street grid.

A permeable edge to Salt Pan Creek Reserve will provide better connections and clear views of the regional open space. New local parks and playgrounds will complement existing green open spaces.

The different landscape settings in the Riverwood master plan include:

- Streets - large boulevards such as Roosevelt Ave, and smaller local streets
- Parks such as Kentucky Road Reserve and Roosevelt Park and the Community Greenway
- High and medium density residential dwellings with communal courtyards

Riverwood master plan. Source: Architectus.

5.2 POSSIBLE STRATEGIES FOR STREETS - ROOSEVELT AVE

Streets are public spaces in their own right, and in Riverwood public streets make up 27% of the site.

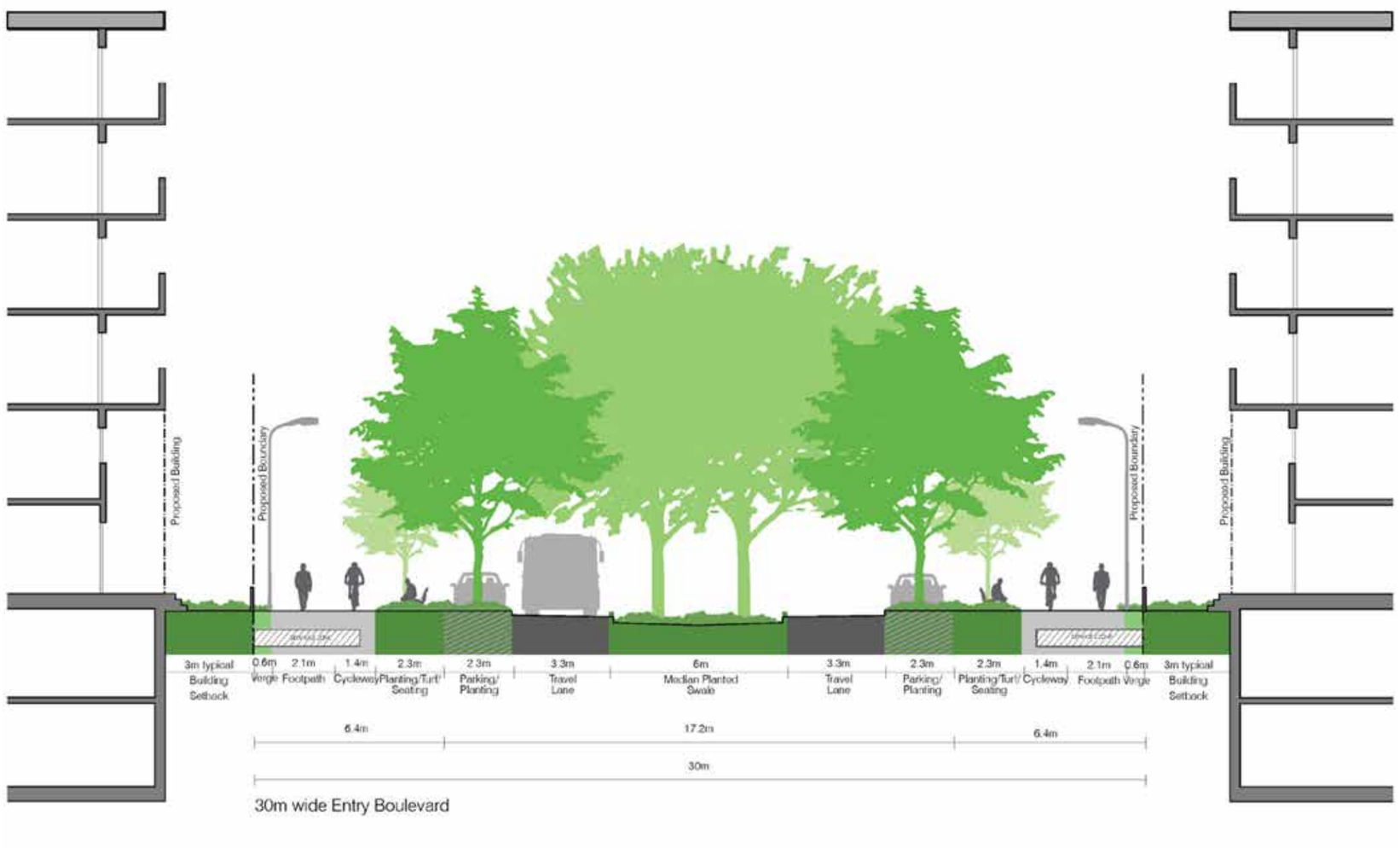
Streets are a key landscape setting to achieve good tree canopy cover. The aim should be for continuous canopy cover on both sides of every street, reducing urban heating and improving health outcomes for the community.

Undergrounding power lines will provide space for urban tree canopy. Integrating Water Sensitive Urban Design into every street will treat water where it falls, alleviating pressure on Salt Pan Creek.

The streets should be seen as a stormwater catchment area to passively irrigate street trees, giving them a chance to thrive in an urban environment.

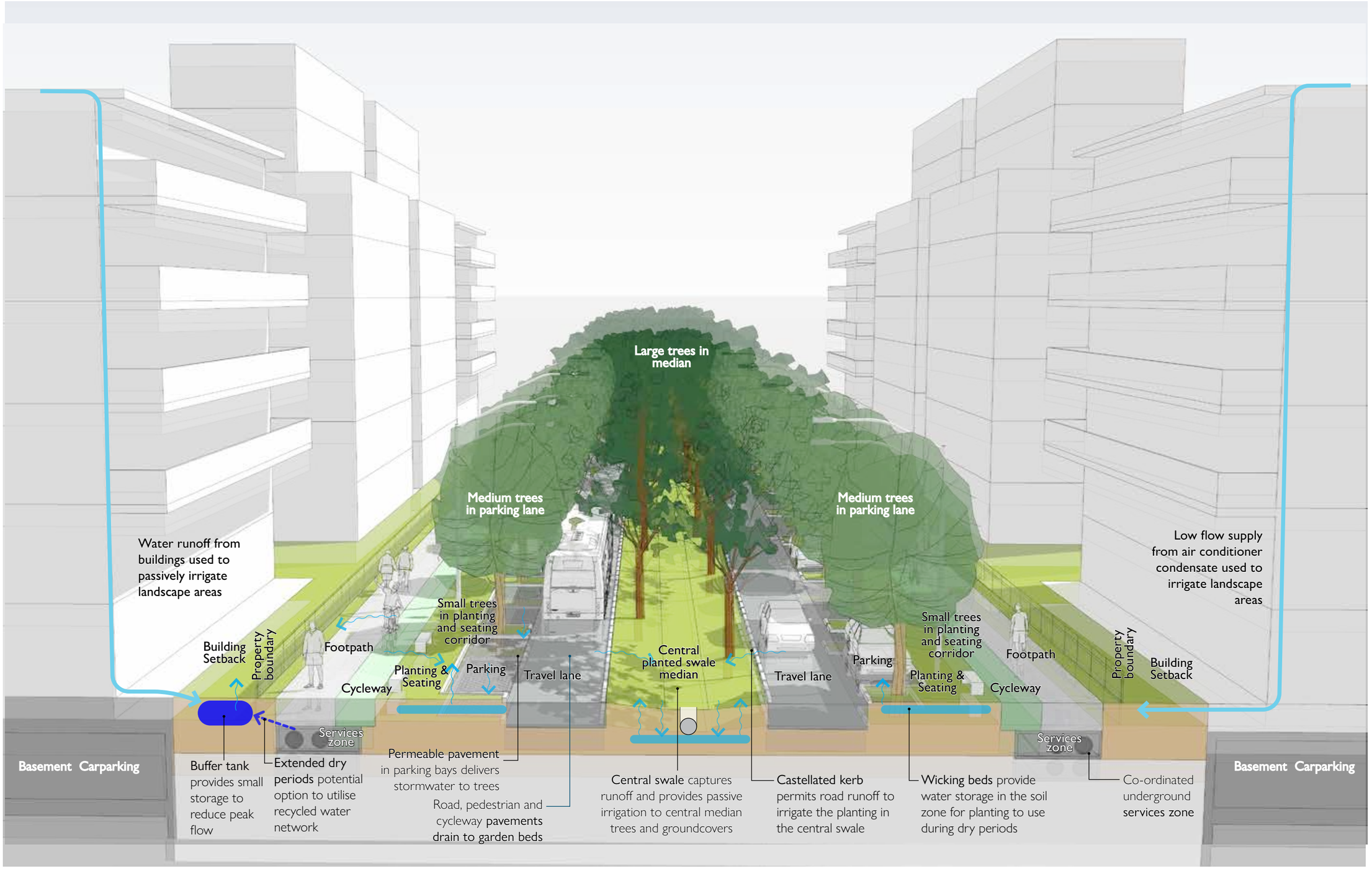
The proposed upgrade of Roosevelt Ave, as shown in the street section shown opposite, identifies locations for opportunities to incorporate green infrastructure - these have been indicated on the diagram on the following page.

These strategies should be further investigated during detailed design and subsequent planning application phases.



Source: *JMD Design / Architectus* section through Roosevelt Ave

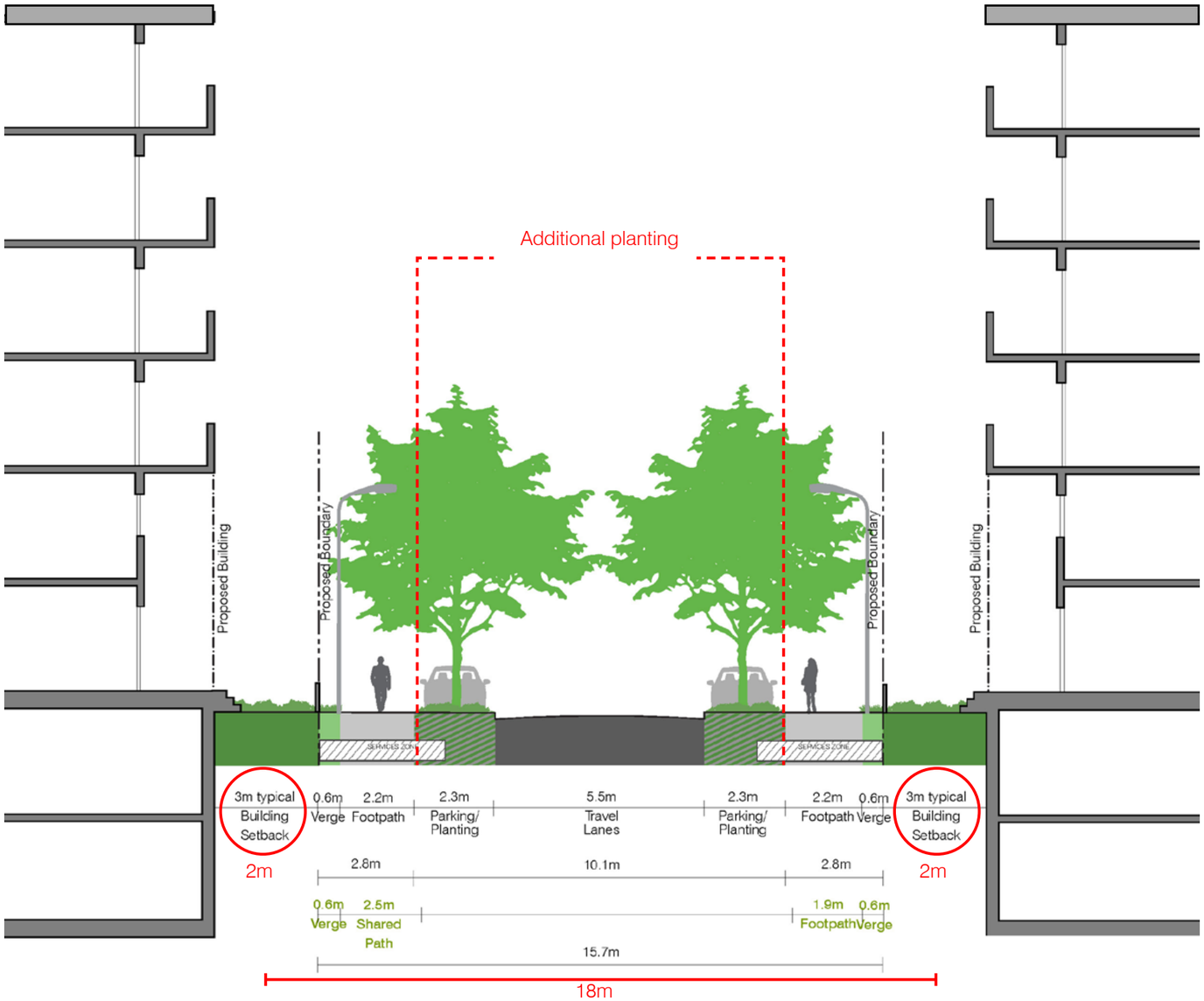
5.2 POSSIBLE STRATEGIES FOR STREETS - ROOSEVELT AVE



5.2 POSSIBLE STRATEGIES FOR STREETS - LOCAL STREETS

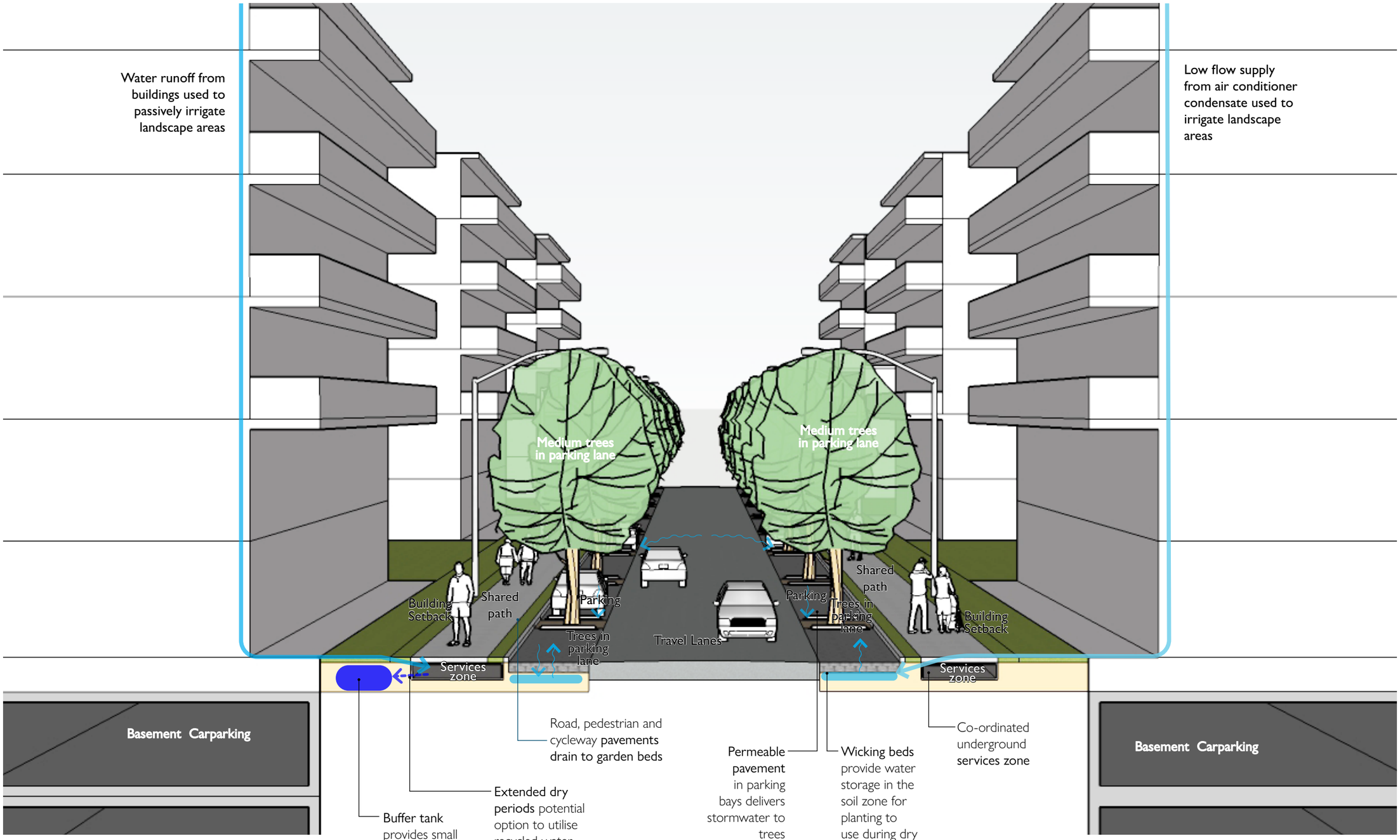
The proposed upgrade of local streets, as shown in the street section shown opposite, identifies locations for opportunities to incorporate green infrastructure - these have been indicated on the diagram on the following page.

These strategies should be further investigated during detailed design and subsequent planning application.



Source: *JMD Design / Architectus* section through Local Street / Service Street

5.2 POSSIBLE STRATEGIES FOR STREETS - LOCAL STREETS



5.3 POSSIBLE STRATEGIES FOR PUBLIC OPEN SPACE

The network of open spaces at Riverwood are a crucial component of green infrastructure. They broaden residents' sense of home to encompass shared outdoor spaces, particularly due to the higher housing densities.

Key considerations for public open space are quantity, quality, connectivity and distribution.

The masterplan provides for around 5ha of parks (including the Community Greenway) on the site, making up 16% of the total site area. The parks are a vital area to achieve good tree canopy cover, reducing urban heat and improving amenity.

Considerations for planning open space
Source: Greater Sydney Region Plan

It is worth noting that the City of Sydney has proposed 46% tree canopy cover for all parks as part of their Greening Sydney Plan.

All residential dwellings will be within 400m of open space. High density areas will be within 200m of open space.

The public open spaces within Riverwood will be well linked to surrounding areas, such as the town centre.

There could also be opportunities to share sports and recreation facilities with Riverwood Public School.

The 'borrowed landscape' of green (ie trees in private of communal spaces visible from public space) extends the perception of a green community. This is particularly relevant in communal courtyard design.

Like streets, the parks at Riverwood should be viewed as a stormwater catchment area, with passive irrigation for the trees and shrub plantings.

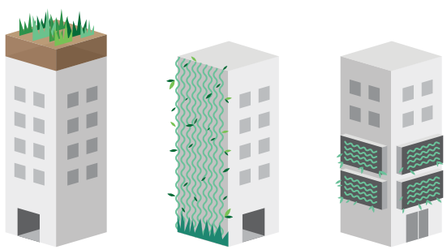
The small areas of native vegetation that remains within two parks must be protected.

5.4 POSSIBLE STRATEGIES FOR RESIDENTIAL DWELLINGS

Consideration should be given to the communal courtyards of the residential dwellings, to determine how they can help achieve good tree canopy coverage, including integrating significant existing trees into building and courtyard designs.

Green roofs will help to increase tree canopy and cool the buildings. Green walls and facades are appropriate where space is limited. There is also potential rooftop food production.

These strategies should be further investigated during detailed design and subsequent planning application.



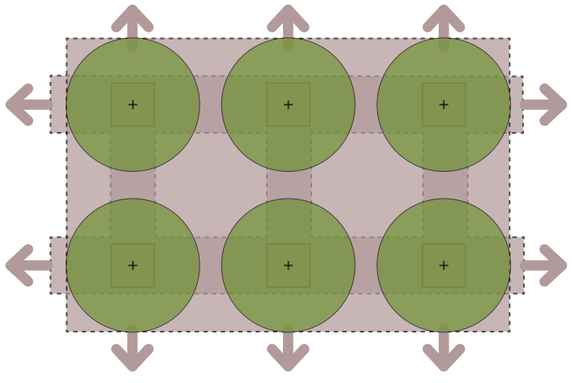
Green roofs, green facades and green walls all form part of the high density residential options for green infrastructure. Image source: *City of Melbourne, Green Our City Strategic Action Plan 2017-2021*

6.0 RECOMMENDATIONS

6.1 RECOMMENDATIONS

The following green infrastructure recommendations should be factored into the Riverwood Development Control Plan:

Target Outcomes	Recommendations
1. 30% of the study area covered with tree canopy in 30 years	• Each development parcel must contribute towards delivering the overall 30% tree canopy coverage target. • Where this cannot be achieved, compensatory tree planting is to be provided along the street frontage and in open spaces to contribute to the overall tree canopy target. • Existing trees are to be retained wherever possible and protected during construction phases. • High-significance and/or hollow-bearing trees are to be retained as a priority. • The following controls are to be considered in the Development Control Plan: – A minimum of 50% of high value trees are to be retained across the study area. Investigations into the retention of additional high value tress are to be conducted and a report justifying their removal submitted with any development application – For removal of trees of high retention value, compensatory tree planting is to be provided at a minimum replacement ratio of 5:1 (5 replacement trees for every 1 high value tree removed) – For removal of all other trees (that are not of high retention value), compensatory tree planting is to be provided at a minimum replacement ratio of 1:1 • Power lines are to be located underground to enable space for urban tree canopy.
2. Big shade trees lining both sides of every street	• The street design is to allow adequate space for provision of large trees on both sides of the street. Adequate connected soil volume is to be provided to support healthy tree growth.

Target Outcomes	Recommendations
3. Extensive ground cover plants to enhance habitat and biodiversity	• The public domain landscape design is to include extensive ground cover plants to enhance habitat diversity.
4. Connected soil networks with ample soil volume for trees to thrive	• Soil volumes for small, medium and large trees need to be large enough to support healthy tree growth. • Soil volumes are to be provided in accordance with the Crown Method: For every square metre of canopy at maturity allow 0.6m^3 volume of soil Canopy area (m^2) x 0.6 = soil m^3 e.g. tree with projected crown diameter of 8m at maturity requires 30m^3 of soil π x $radius^2$ x 0.6 = soil m^3 3.14 x 4 x 4 x 0.6 = 30m^3 • Prioritise connected soil networks between trees. • Where possible, the soil profile for new tree plantings should be undisturbed and connected to the sites natural soil profile. • Soil depth should be a minimum of 1m or 0.8m minimum, if on structure.  FULLY CONNECTED: Trees in urban environments have best health and growth when in more extensive networks of soil and adequate volume is provided. This more extensive soil configuration also reduces drying out and over-wetting around each tree.

Target Outcomes	Recommendations
5. Green infrastructure on roofs and podium	• Green roofs should be investigated and provided on buildings, where practical. This is to reduce urban heat, reduce stormwater runoff and encourage biodiversity.
6. Continuous green links to Salt Pan Creek Reserve and Corridor	• Ensure continuous green links to Salt Pan Creek Reserve and Corridor are delivered in accordance with the master plan and concept landscape design. This promotes biodiversity, reduces urban heat and has mental and physical benefits for the community.
7. Street trees planted early in each development stage	• Street trees are to be planted as early as possible at each stage of development. This allows time for them to establish and provide canopy cover as soon as possible.
8. Water cycle expressed on site through stormwater capture and reuse	• Prioritise stormwater capture and reuse from roofs, streets, pavements and lawns. • Integrate Water Sensitive Urban Design to treat water where it falls including street tree pits and central swale rain gardens. • Prioritise porous paving for on-street parking. • Prioritise wicking beds for water storage in soil zones to help irrigate plants during dry periods • Where possible use ground moisture and irrigated lawns to reduce urban heat. • Rainwater harvesting should be included for buildings without a green roof, to minimise stormwater runoff
9. Passive irrigation for all street trees, lawns and parks	• Passive irrigation should be prioritised for all street trees, lawns and parks to encourage healthy plant growth.

6.2 MANAGEMENT AND FUNDING

It is proposed that the City of Canterbury Bankstown will manage the public open spaces at Riverwood in the same way as any other public open space within the local government area.

The following options are worth exploration as potential funding contributions for the green infrastructure at Riverwood:

Metropolitan Greenspace grant
The Metropolitan Greenspace Program is an annual grants program helping deliver the Green Grid in Greater Sydney and the Central Coast. In 2020-21, $4 million has been allocated to the program.

Councils are required to match the funding granted on a dollar for dollar basis. Funding is available for the projects such as new or improved parks and open spaces.

NSW Environmental Trust Environmental Restoration and Rehabilitation grant
This assists community and government organisations contribute to the ongoing sustainable management and stewardship of significant environmental assets and services in NSW.

Projects contribute to delivering one or both of the following funding priorities from the NSW Environmental Trust Strategic Plan 2020-24: supporting threatened species recovery addressing climate change impacts on the natural environment – both mitigation and adaptation.

Section 7.11 Plans (previously Section 94)
Section 7.11 of the Environmental Planning & Assessment Act, 1979 (EP&A Act) enables consent authorities (usually local councils) to levy developer contributions, as a condition of development consent, towards the cost of providing local public infrastructure and facilities required as a consequence of development.

Voluntary Planning Agreements (VPAs)
Council may consider an offer from a developer to enter into a voluntary planning agreement under Section 7.4 of the Environmental Planning and Assessment Act 1979.

Works-In-Kind Agreements
Section 7.11 of the Environmental Planning & Assessment Act 1979 authorises councils when determining a development application, to grant development consent subject to a Section 7.11 Condition directed towards the provision, extension or augmentation of public amenities and public services, provided that the condition is authorised by a contributions plan.

7.0 APPENDIX

7.1 CASE STUDY - GARRAMILLA BOULEVARD GREEN STREET, DARWIN NT

CLOUSTON Associates developed the concept design for the Garramilla Boulevard, with a vision for a continuous, joined up tree canopy spanning the road in 15 years.

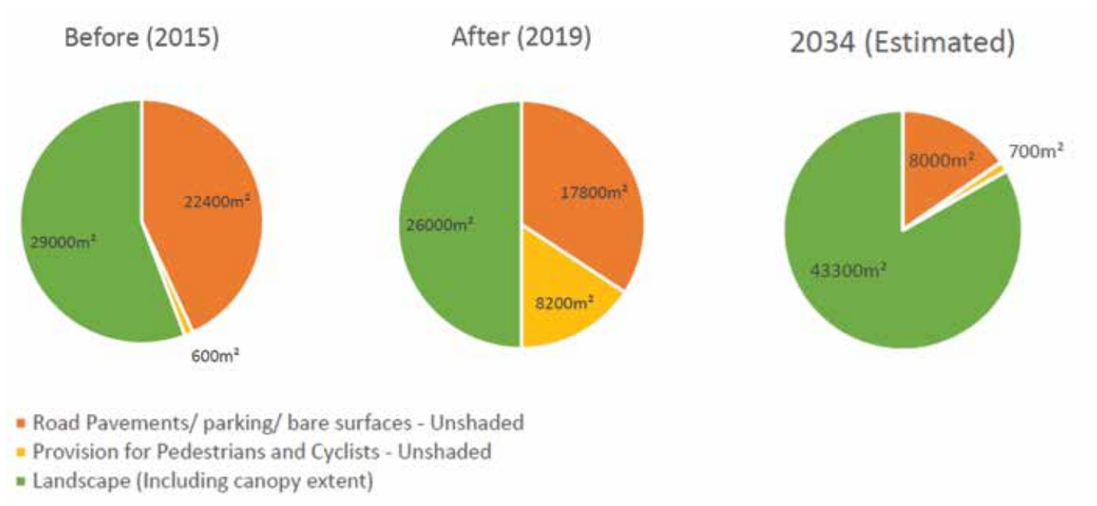
It was a process of rethinking how street space is allocated, ensuring that there is enough space for active modes of transport, space for landscape, and volume for trees - both in above ground and the soil below the ground.

Completed in 2019, the new Garramilla Boulevard road corridor dedicates 60% of space to landscape, pedestrian and bike paths.

The project places a major emphasis on supporting tree growth, with large tree pits and structural soil systems using rigid cell structures to promote generous soil volume:

- Large trees: 50 - 80m^3 soil volume
- Medium trees: 20 - 40m^3 soil volume
- Small trees: 5 - 15m^3 soil volume

The structural soil systems give trees what they need to survive - soil volume and nutrients, air, water and drainage. They also protect underground services.



Predictive shading as a result of street tree planting

Relevance to Riverwood

To maximise tree growth for new trees at Riverwood, the ground preparation needs to be prioritised with large soil volumes.

The configuration of the soil volume is also important. As seen at Garramilla Boulevard, trees do much better in connected networks of soil rather than isolated tree pits. This allows the trees to share nutrients and communicate with each other in the soil zone using their roots and fungal associations.

There is also a chance to implement structured soil systems in the new streets of Riverwood. Structured soil cells protect the trees in cyclone-prone Darwin, and can likewise protect trees in Riverwood when faced with increasing weather events due to climate change. It helps give the street tree canopy the greatest chance of success.

It is also imperative to select hardy, shady species that offer significant shade cover and can withstand the impacts of climate change. As seen in Garamilla Boulevard, larger trees with greater structure and dense crowns provide greater cooling benefits than more open canopies.

7.1 CASE STUDY - THE PONDS WSUD, BLACKTOWN NSW

CLOUSTON Associates developed the master plan and concept design for The Ponds, which is an 88ha open space network built around Second Ponds Creek within the Blacktown LGA.

The large residential community of 3000 medium density dwellings benefits from the rehabilitation of the creek and bushland, connecting residents with quality district community parkland and recreation facilities.

The Ponds is a benchmark Water Sensitive Urban Design (WSUD) project that put liveability and water at the centre of the community. Much of the connectivity and open space is associated or directly connected to the creek corridor and raises the community's awareness of the role of water in their landscape.

The multi-layered approach to managing water includes strategic use of the open space lawn to limit irrigation demand and stormwater capture and re-use for sports fields.

A system of grass swales, creek systems, constructed rain gardens, wetlands and ponds clean urban stormwater run-off.

The Ponds, Source: CLOUSTON Associates

Relevance to Riverwood

The application of a natural systems creek management approach may be difficult at Riverwood, but the fundamental principle remains the same. Every effort should be made to slow down, harvest, capture and re-use stormwater on site. Treating water where it falls will alleviate pressure on Salt Pan Creek.

The streets of Riverwood should be seen as stormwater catchment areas that can passively irrigate street trees, giving them a chance to thrive in an urban environment.

Constructed raingardens have capacity to capture and retain water in the bottom 200-300mm of the soil profile to promote long term resiliency of planting as a buffer to extended periods of dry weather.

The Mott MacDonald Water Cycle Management Report suggests co-locating water retention systems and ponds within Salt Pan Creek Reserve to reduce stormwater run-off, and reuse water for irrigation of parks/open space, and community gardens. This will also assist reduce potable water usage.

7.1 CASE STUDY - ONE CENTRAL WATER REUSE, SYDNEY CBD

One Central is a high rise residential tower complex on Broadway in the Sydney CBD.

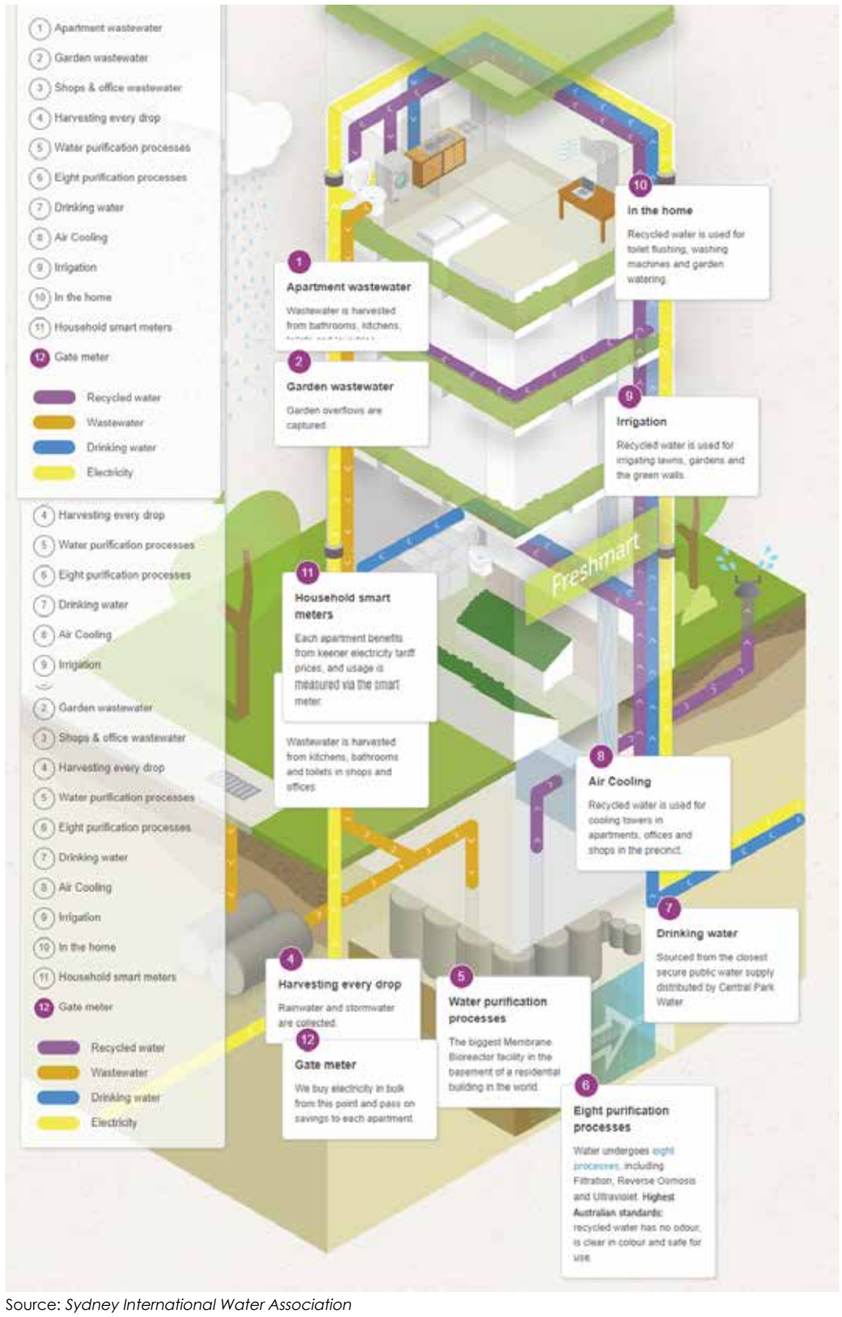
It sets a benchmark for wastewater treatment and re-use, using a decentralised recycled water system within a 5.8ha mixed use high density infill development site in Sydney.

Wastewater is treated to the highest Australian standards for recycled water using a membrane bioreactor (MBR) and reverse osmosis (RO). The recycled water is distributed within the precinct to supply water for cooling towers, irrigation, toilet flushing and washing machines. It is also used in the nearby UTS campus.

Relevance to Riverwood

This model would be highly applicable to the high density built form of Riverwood, given the projected population. This strategy works towards a circular economy with a zero ocean outfall goal.

One of the key beneficiaries of the water throughput for Riverwood would be the irrigation network for the adjacent parklands and future sports fields, cooling the local environment and reducing urban heat.



Source: *Sydney International Water Association*

Tree Retention Precedent - Putney Hill, Victoria Road, Ryde

Built form embraces existing tree and creates entry space

Aerial photograph showing building envelopes designed around existing trees Image source: Nearmap

Development accommodates existing large eucalypt

View looking southeast along Lardelli Dr Image source: Google StreetView

Oblique aerial looking southwest showing building envelopes designed around existing eucalypt on Lardelli Dr Image source: Nearmap

View looking northeast along Lardelli Dr Image source: Google StreetView

Tree Retention Precedent - Somerville Point, Elliott St, Balmain

Buildings accommodate existing tree

Aerial photograph showing building envelopes designed around existing trees Image source: Nearmap

Built form embraces existing tree. Entry space and street address created with pedestrian and view axis set up via other large tree retained

View looking northwest along Elliott St Image source: Google StreetView

Oblique aerial looking southwest showing building envelopes designed around existing fig on Elliott St and large tree closer to water's edge Image source: Nearmap

View looking southeast along Elliott St Image source: Google StreetView

Tree Retention Precedent - O'Dea Ave, Zetland

Building envelope and awning steps in and around the existing fig tree

Aerial photograph showing building envelope designed around existing fig — Image source: Nearmap

Oblique aerial showing building envelope designed around existing fig — Image source: Nearmap

Timber decking allows air and water exchange to the soil

View looking west along O'Dea Ave — Image source: Google StreetView

View looking east along O'Dea Ave — Image source: Google StreetView

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