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Environment, Planning and
Sustainable Development Directorate
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Planning and Design for Living Infrastructure as part of Residential Intensification in a Changing Climate

ACT Government

Version Control

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Planning and Design for Living Infrastructure as part of Residential Intensification in a Changing Climate.

Prepared by:

tait network.

On behalf of:
Environment, Planning, Sustainable and Development Directorate, ACT Government

Contents

Living Infrastructure Report

1.0 Executive Summary

Tait Network has been engaged by the Environment, Planning and Sustainable Development Directorate (EPSDD) to provide advice and recommendations on policy principles, strategies and mechanisms for establishing living infrastructure requirements as part of urban intensification in future urban renewal and greenfield development areas in the ACT.

Our focus was to embed living infrastructure considerations across statutory frameworks as an integrated planning approach. Our recommendations are presented across three scales; Block, Street and Suburb, as a means to structure an approach and ensure that change is achieved holistically.

These recommendations were based on the findings of a literature review and a spatial analysis study of existing conditions and future scenarios based on data projections. Recommendations are outcomes-oriented and utilise statutory controls, design guides and rating tools as mechanisms to bring about high-quality living infrastructure realities.

Seven major concerns are identified with twenty-six direct mechanisms suggested to support the change.

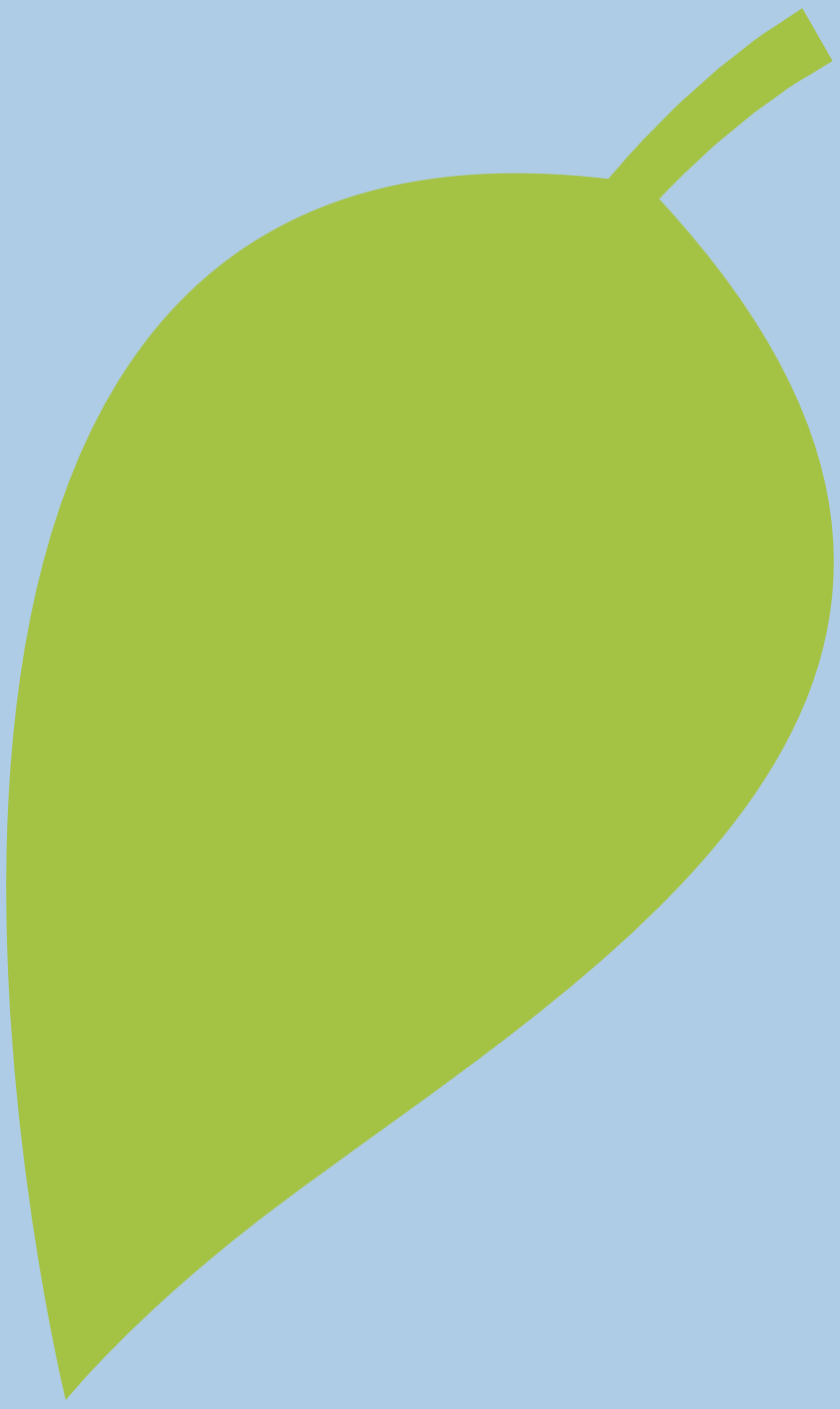
It was noted through study of the existing conditions that current controls were not producing intended living infrastructure outcomes. While compliant, current planning controls allow development approval through application of criteria that was felt to fail the intent of the Territory Plan Rule.

The preference would be to consider this document as a wholesale revision and implement changes as a suite. However, minor adjustments and the strengthening of existing rules through improved criteria, or rules being made mandatory where suitable, will make a significant difference to the lived experience of living infrastructure in new and significant rebuilds.

Living Infrastructure terminology is shown to be relatively consistent across jurisdictions. Deviations in approach appear in the minimum standards and percentages awarded to given definitions. Therefore, these recommendations focus on developing stronger minimum standards to promote high quality outcomes and recognise living infrastructure as an essential asset to be funded alongside other major asset priorities, such as roads and services.

A range of further studies are identified to develop and deepen the ideas presented in this report.

"...It [living infrastructure] protects and rejuvenates communities by providing essential services such as and air and water and healthy ecosystems... Communities who successfully maintain these assets are more likely to be resilient and able to adapt more effectively to future shocks and changes" (Green Infrastructure Economic Framework 2015)



2.0 Background

As Canberra becomes a more compact city with greater intensively developed urban areas, the need for making living infrastructure an integral part of the city's form and function increases. Living infrastructure refers to all interconnected ecosystems within urban areas and integrates and builds upon 'green infrastructure' and 'blue infrastructure' within the urban landscape. Balance must be achieved between urban intensification and amenity that can be best provided by living infrastructure.

Canberra's Living Infrastructure Information Paper (February 2018) outlines the ACT's commitment to developing a strategy, including targets for urban tree canopy cover as part of its integrated approach to climate change. This strategy will sit within the Land Use Sector of the *ACT Climate Strategy to a Net Zero Emissions Territory* policy being developed in 2018.

The EPSDD is considering the policy principles, strategies and mechanisms for establishing living infrastructure requirements as part of urban intensification in future urban renewal and greenfield development in the ACT. In particular, EPSDD is interested in how living infrastructure can be supported through the mechanisms in the Territory Plan, Government policies, design and technical guidelines.

Tait Network was engaged in 2018 by the Planning Policy Division of EPSDD to provide advice and recommendations to support the implementation of living infrastructure as part of residential development in urban renewal and greenfield development areas. The strategies and mechanisms provided will inform changes within the Territory Plan and ACT Planning policy including changes to street subdivision design, verge widths, zoning, plot ratio, building height, private open space and vegetated cover, with the objective to provide optimum living infrastructure outcomes.

A project steering group was established by EPSDD comprised of representatives across the ACT Government. The steering group took part in two workshops; the first to review early findings from the literature review and data analysis phases, and another to review the draft recommendations. Feedback was captured through meeting minutes, with each comment addressed.

This report is the culmination of a literature review process (undertaken in Stage 1 of the project) and analysis of data provided by EPSDD (undertaken in Stage 2 of the project). It sets down key findings and recommendations for improving urban infrastructure and living infrastructure outcomes in the ACT.

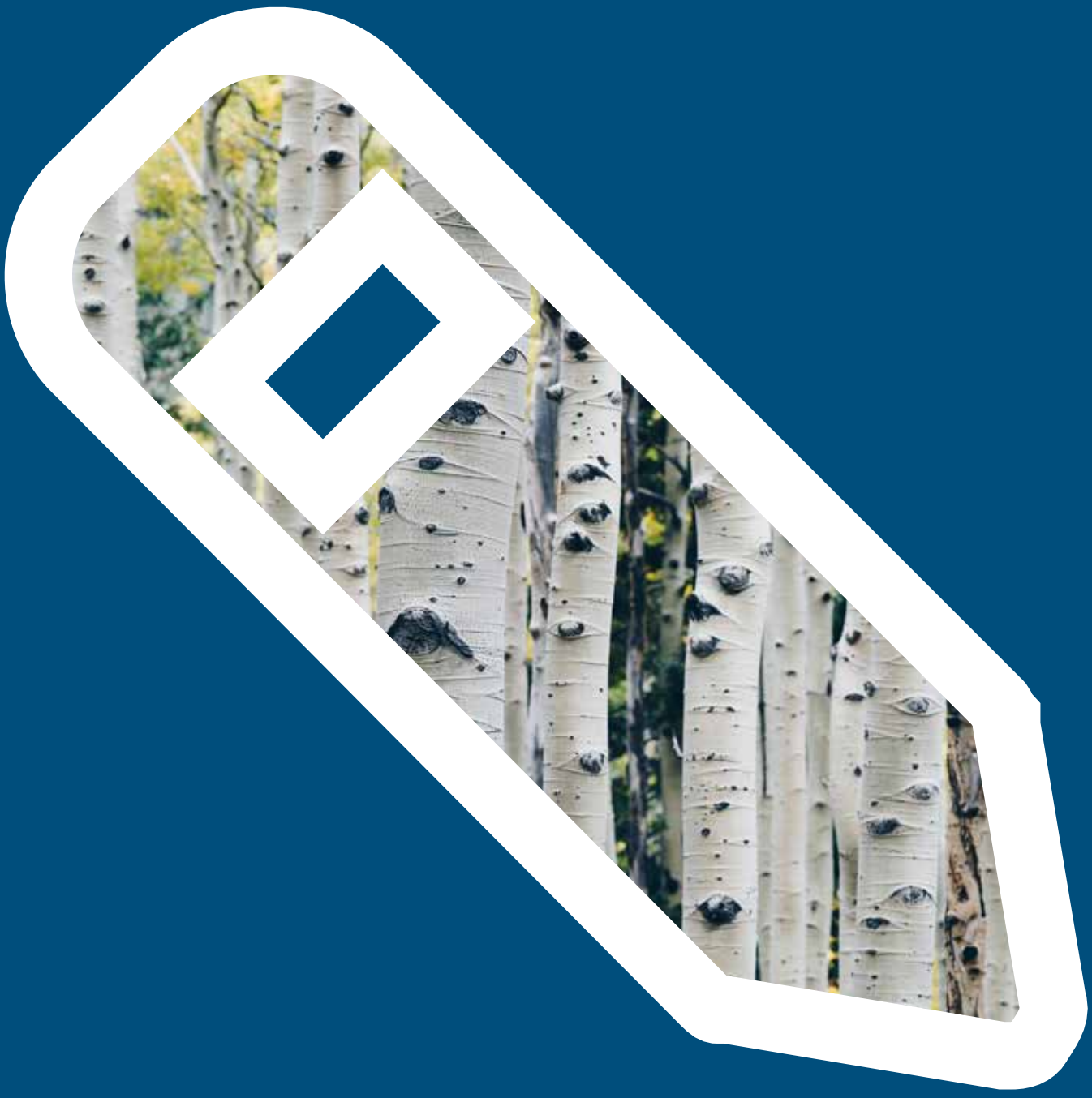
Project Focus

The key focus of the project is the application of living infrastructure under the Territory Plan and an assessment of the effectiveness of existing terminology and mechanisms for supporting living infrastructure, including requirements for site open space, private open space, principle private open space, and private planting area. Consideration has been given to the need for additional or replacement terminology and mechanisms in the Territory Plan. It makes recommendations for inclusion of effective provisions in the relevant ACT Government policies, design and technical guidelines and the Territory Plan.

Living Infrastructure Definition

In this project, living infrastructure refers to all interconnected ecosystems within an urban catchment. Living infrastructure integrates and builds upon the concepts of 'green infrastructure' (which focuses on vegetation) and 'blue infrastructure' (which focuses on water management) within urban landscapes. In the literature definitions of 'green infrastructure' vary and can be almost indistinguishable from living Infrastructure. They include, for example, vegetation and urban forests as well as water sensitive urban design and the environmental, social and economic benefits that accrue from these elements.

The full definition and benefits of living infrastructure provided by the EPSDD are set out in Attachment 1.



3.0 Literature Review

The desktop literature review concerns approaches to establishing requirements for living infrastructure (however named) under existing planning, development and sustainability frameworks in selected Australian and international jurisdictions. The primary focus is on planning policy and mechanisms designed to enhance green infrastructure drawing on various government documents, policies and legislation and academic papers.

Documents Reviewed

The list of documents reviewed covers statutory instruments, policy documents, design guidelines, design manuals/standards, other government documents (including those relating to good examples of living or green infrastructure) and academic papers. State and Territory statutory instruments for living infrastructure often defer to Local Environmental Plans (LEPs) and as such selective statutory instruments have been reviewed as examples of progressive living infrastructure outcomes. Notably, NSW 'Landscape Area' and Victoria Yarra Planning Scheme's 'Garden Area' are taken as valuable benchmark percentages for dwelling types and block sizes, presented in Table page 12.

The literature will be discussed in terms of policy, terminology, mechanisms and methods used to foster and deliver living infrastructure. While the focus is Australia, overseas programs, notably the Seattle Green Factor, is included as an example of successful implementation, now with ten years' experience of implementing green infrastructure in the private realm. Another international context, Rotterdam, The Netherlands, is referenced as it provides valuable policy insights about residents' views on green infrastructure adaption measures, and their willingness to pay for it.

The literature shows it is important to recognise that while 'Integrating Green infrastructure into ... Strategic and Statutory frameworks is considered essential ... this alone will not ensure delivery of outcomes. A collaborative and appropriately funded approach is needed' (GANSW).

Summaries of select documents are available at Attachment 2.

A full list of reviewed titles is available at Attachment 3.

3.1 Policy approach

A best practice policy approach, identified in the literature, is for evidence-based policy (Arundel) that includes measurable spatial policy standards that can be mapped to benchmark and monitor implementation and performance. Ambitious policies appear to produce better livability outcomes for residents, even if those targets are not met, than less ambitious ones.

The literature points to Living Infrastructure policy having the best prospects for success if it:

- is based on a whole-of-government approach and integrated with other urban policies and infrastructure
- is embedded into the planning system
- is evidenced based
- treats Living Infrastructure as an essential asset and combined with urban development and 'grey' infrastructure to create a multi-purpose infrastructure that mimics nature to deliver critical ecosystem services, health benefits and promote active lifestyles
- promotes a network of open spaces connected to 'blue infrastructure', residential and employment areas
- takes every opportunity to insert living infrastructure in development projects and upgrades of traditional infrastructure
- embeds consultation and participation in its processes
- focuses, at least initially, on key demonstration projects (eg maintaining and developing the urban forest) that will engage the public and demonstrate the benefits of living infrastructure
- is supported by clear design principles and guidelines and
- is appropriately funded, including for program maintenance and monitoring.

A commitment to continuing consultation and participatory planning methods is seen as central to successful urban strategies (Alexandra, Kendal, Melbourne Metro Rail). An integrated planning, or 'whole of Government', approach is considered to be a key factor in the success of green infrastructure strategies and should involve the public, professionals, relevant peak bodies, associations or institutions. Long-term success of living infrastructure depends on community involvement and a comprehension of its significance and positive impact. Effective synergies occur through integration of urban and conservation planning to deliver social, economic and environmental benefits (Alexandra, Meyers).

Consideration should be given to developing a more multipurpose infrastructure that mimics natural systems and how this might be expressed in the Territory Plan. Integration of green infrastructure and grey infrastructure as described by The City of Melbourne would improve the multi-functionality of our cities' urban greenery.

- Green infrastructure: the network of natural landscape assets which underpin the economic, socio-cultural and environmental functionality of our cities and towns; ie. The green spaces, water systems and built environment landscapes which intersperse and increase connectivity, multi-functionality and landscape performance in urban environments.
- Grey infrastructure: man-made, constructed assets...utilities and services distribution...and commercial infrastructure.

Living infrastructure assets should be recognised to be as essential as roads and storm water pipes and funded accordingly (GANSW) to initiate institutional and political commitment needed for long term success (Alexandra). This represents the need for a radical shift in thinking (GANSW) to ensure a viable living infrastructure.

Moving from single-purpose to multi-purpose infrastructure, integrating green infrastructure with more traditional grey infrastructure and urban development, would provide valuable ecosystem services. A policy focus on maintaining and developing the urban forest will contribute greatly to the quality of living infrastructure, including social and cultural services and equity. Key success factors include an integrated approach within government agencies and a commitment to engagement processes with the public and relevant industries (Kendal).

Literature concerning urban trees also highlights the importance of integrating urban forest policies with other urban policies (land use, planning, transport, health, ecology and open space management) as a factor in the success of urban forest policy (Kendal). This too needs to be supported by adequate funding and informed by research and improvements in practice (Kendal). The available evidence on urban heat islands in the ACT, for example, shows that trees provide extensive cooling benefits (Meyers). Research also points to the importance of establishing and maintaining reliable inventories (Kendal).

Both the City of Melbourne Council and the City of Sydney Council have prioritised development of their urban forests, adopting a 'whole-of-forest' approach to include trees in the public, institutional and private realms and their definitions of 'urban forest' include trees and vegetation. Both have a strong focus on soil.

Terminology

Statutory instruments

A review of relevant terminology in NSW and Victoria's statutory instruments revealed a considerable overlap with terminology in the Territory Plan. The meaningful differences come in reference to implementation of these terms through use of minimum percentages for each given mechanism. Perhaps most relevant are the terms 'minimum landscaped area' (NSW) and 'garden area' (Victoria). 'Minimum Landscaped Area' is an established term in NSW. 'Garden area' is a new requirement for a mandatory minimum 'Garden area', introduced in 2017 into the Neighbourhood Residential Zone and the General Residential Zone in the Victoria Planning Provisions. It should be noted that 'garden area', as defined in this context, may include elements such as paving or swimming pools and therefore does not equate to a permeable area. Its purpose is to protect the open garden character of the state's suburbs, towns and cities in the context of demand for different housing typology to meet future needs of the community. It is not restricted to ground level.

Design manuals and design standards

ACT

The ACT's Municipal Infrastructure and Standards contain comparable provisions for green infrastructure that would benefit from illustrations and images to clarify the intended outcomes. The ACT Statutory provisions and design standards have limited impact on green space in the private realm because landscape plans, or their equivalent, are not required for all developments or renovations.

Adelaide

The A*delaide Design Manual: Greening* emphasises the value of creating a web of interrelated natural systems across a range of scales and applications, with the intent of building a city that is sustainable, economically prosperous and resilient. This manual and the companion *Green Infrastructure Guidelines* are examples of best practice in support of green elements of living infrastructure. The Guidelines provide guidance for the public and private realms; the Manual focuses on the public realm. The Guidelines and the Greening Manual include drawings and photographs.

Key concepts:

- living architecture: the integration of plants with the built form e.g. green roofs, roof terraces, green walls and facades
- green streets: focuses on the pedestrian experience, a solid presence of trees, low plantings and rain gardens to maximise pedestrian amenity and activation of commercial spaces
- urban forest: the combined collection of trees in the urban area, including city streets, parks, reserves and individual properties within private gardens and public institutions
- urban food: provision for growing food in urban areas, communal spaces of institutions or apartment complexes. It ranges from edible plants in garden beds to organized community gardens

Principles:

- create a connected network of greening
- reinforce urban character
- harness multiple functions of greening
- create conditions for success and longevity of greening
- create value with welcoming spaces
- integrate tree planting strategies
- maximise the seasonal benefits of greening
- create continuous tree canopies across the city
- use greening to improve the human scale of streets
- harness storm water for healthier streets
- apply best practice

Water sensitive urban design is also included in the Adelaide Design Manual. It is not discussed here because it is established practice in the ACT and is being further developed by EPSDD.

NSW and Sydney

NSW's *Low Rise Medium Density Design Guide 2017* is a toolkit for improving the design of residential development. It contains design criteria that must be met in order to obtain a complying development certificate under the *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 NSW* (Note: an amended Code comes into force July 2018). It includes clear links to development standards in the enabling legislation, strategic context, clear objectives and design criteria supported by drawings and images. Terminology in this guide relevant to living infrastructure that is not covered in the Territory Plan includes:

- green roof
- green wall
- landscaped area
- public open space

Another best practice example is the *City of Sydney Landscape Code*, adopted in 2016, for the creation of high quality, sustainable landscape surfaces in the private realm. Volume 1 applies to single dwellings and volume 2 to all other development. The Code is part of the development approval process and clearly outlines what documentation is required for submission. Volume 1 outlines mandatory requirements for new, or modifications to, existing trees, front fences, front yards and green roofs/walls and provides design guidance for each type of space. Clear links are given to enabling legislation, planning documents and relevant guides. Volume 2 in particular provides a clear section on the relationship between this Code and other plans and policies. The Code includes excellent drawings and images to guide the user. The landscape requirements section provides a fine precedent for urban forest policy on trees, soils, green walls and roofs. The landscape guidance section ranges from best practice landscape design to utilities and maintenance. Terminology in this Code relevant to living infrastructure that is not covered in the Territory Plan includes:

- green roof
- local species
- public domain
- soft landscape
- urban canopy
- urban ecology

Water sensitive urban design is also included in the Code. It is not discussed here because it is established practice in the ACT and is being further developed by EPSDD.

3.2 Mechanisms

High quality design guidelines, manuals or standards are critical to the delivery of living infrastructure. The literature indicates a range of mechanisms to be used that support successful implementation of living or green infrastructure in urban development. Initiated through policy development, much of this implementation occurs within the various statutory frameworks, summarised in the table below but may be supplemented by supportive documentation such as Design Guides and Ratings Tools.

Statutory Frameworks

Mechanism	Statutory	Guideline	Education
Plot ratios, site cover, verge widths, private open space, principle private open space, site open space, pervious surfaces, garden or planting areas, communal open space	★		
Planning objectives	★		★
Rating schemes	★	★	
Design Standards	★		★
Design guidelines/best practice advice		★	★
Design Factsheets (can include statement about what is mandatory and what is not)		★	★

Rating Schemes

The use of rating schemes or score cards is supported by the literature (AILA, Seattle Green Factor, Yarra Council) and merit consideration where mandatory requirements exist. These can provide clarity and facilitate the design approval process with built-in incentives (eg bonus points for use of local plants and materials); see Sustainable Sites Initiative (SITES) http://www.sustainablesites.org/, the Seattle Green Factor http://www.seattle.gov/dpd/codesrules/codes/greenfactor/default.htm, or the Built Environment Sustainability Scorecard (BESS), as assessment tool created by local governments in Victoria http://www.bess.net.au/

Existing Statutory Provisions in the ACT

Territory Plan terms and definitions

Existing statutory provisions for principle private open space, private open space, site open space and private planting area, communal open space and site cover in the Territory Plan.

Term	Definition	Function
Principal Private Open Space	Private open space that is directly accessible from a habitable room other than a bedroom	Provides a functional area of open space by specifying minimum dimensions
Communal Open Space	Common outdoor open space for recreation and relaxation of residents of a housing development	Provides adequate open space for dwellings that have a shared open space
Planting Area	An area of land within a block that is not covered by buildings, vehicle parking and maneuvering areas or any other form of impermeable surface and that is available for landscape planting	Provides adequate on-site space for landscape planting
Plot Ratio	The gross floor area in a building divided by the area of the site	Provides limitation in the size of a dwelling
Private Open Space	An outdoor area within a block usable for outdoor living activities, and may include balconies, terraces or decks but does not include any area required to be provided for the parking of motor vehicles and any common driveways and common vehicle maneuvering areas. Up to 25 per cent of any part of private open space may be roofed over, except that a balcony may be entirely roofed over	Provides adequate outdoor area
Site Coverage	The proportion of the actual site covered by dwellings and all other buildings	Controls building footprint

Territory Plan References

A summary of related reference terms as they appear in the Territory Plan.

Territory Plan Part	Terms Used	Location
Precinct Codes	Principal Private Open Space	
	Communal Open Space	
	Private Open Space	
	Plot Ratio	
	Urban Open Space	
Residential Zones Development Code	Plot Ratio	R5, R10, Element 13.2 C54
Single Dwelling Housing Development Code	Principal Private Open Space	R41, C41, Table 8
	Planting area	R38, R39, R40
	Plot Ratio	R1, R22
	Private Open Space	R22, R38, C38, R39, C39, R40, C40
	Site Coverage	C38, C39, C40
Multi-Unit Housing Development Code	Principal Private Open Space	R61, C61, Table A9
	Communal Open Space	R39, R38
	Plot Ratio	R4, R6, R7, R8, R9, R16
	Private Open Space	R4, R38, C38, R39, C39
Estate Development Code	Street Tree	R22, R24, C24, R25, C25, C60, C65, R92, R116, Element 17 Table 2A & 2B
	Street Verge	C15, R60, C60, R92, R125,
	Street Medians	Element 17 Table 4
	Public Realm	C23, Element 17 Table 4

Summary of Existing Transport Canberra and City Services (TCCS) Standards

TCCS Design Standards are currently in the process of being updated from the Design Standards (DS) to the Municipal Infrastructure Standards (MIS) documents. The following eight standards have been reviewed to present a summary of existing elements which have relevance to Living Infrastructure policy

MIS 01: Street Planning And Design (Draft)
MIS 06: Verges (Draft)
MIS 08: Stormwater (Draft)
MIS 15: Urban Edges Management Zone (Draft)
DS 14: Urban Open Space
DS 16: Urban Wetlands Lakes And Ponds
MIS 24: Soft Landscape Design (Draft)
MIS 25: Plant Species For Urban Landscape Projects (Draft)

MIS 01: Street Planning and Design

- Environmental considerations
  - WSUD design standards
  - Street design for energy and water conservation
- Climate change considerations
  - Landscaped areas are designed to provide amenity and biodiversity, protect buildings and spaces from the elements and incorporate sustainable urban drainage systems.
  - Species selection that is appropriate to the Canberra climate and will require minimal watering or maintenance activities.

MIS 06: Verges

- Provision for appropriate and adequate landscaping
- Provision for buffer space for reduction in traffic noise level at dwellings
- The verge should be of sufficient width to allow space for all relevant services, landscaping, indented parking, future carriageway widening, paths and swale drains
- Provision of trees to the verge, consideration of the root zone, species selection of appropriate size
- Consideration of the surface treatment of verges
- Planting module requirements

MIS 08: Stormwater

- Provision of stormwater infrastructure which will enhance the urban environment by providing assets of social, environmental and economic value
- Provision of stormwater infrastructure which will protect and maximise the value of aquatic and terrestrial ecosystems within the stormwater system
- Consideration of WSUD
- Consideration to maximise natural habitat for fauna via indigenous riparian, floodplain, and foreshore vegetation
- Consideration of Ecology and Landscaping
- Consideration of impervious and pervious surface treatments
- Treatment of buffer strips and tree pits

MIS 15: Urban Edges Management Zone

- Provision of an appropriate interface between the urban area and surrounding public and unleased land.
- Consideration of the retention of existing trees and native vegetation while allowing for bushfire regulation requirements.
- Consideration of provision of appropriate canopy coverage for native fauna
- Provision of an adequate buffer between development and environmentally sensitive areas
- Consideration of vegetation coverage to allow for wildlife movement

DS 14: Urban Open Space

- Provisions for parks and open space
- Provision of urban wildlife and nature conservation

DS 16: Urban Wetlands Lakes and Ponds

- Provision of pollutant reduction in SW
- Provision of enhanced environmental amenity
- Consideration of appropriate species selection

MIS 24: Soft Landscape Design

- Consideration of appropriate species selection
- Consideration of maintenance requirements
- Consideration of appropriate soil provision
- Provision of structural soil and cells
- Provision of permeable paving
- Protection of existing trees
- Consideration of the retention of existing trees in the planning of residential estates
- Provision of urban tree planting including street trees and car parks
- Provision of appropriate shrub planting
- Provision of appropriate grassing including dryland and native species
- Consideration of the relationship between trees and infrastructure
- Specification of trees
- Provision of landscape within carparks
- Consideration of planting within medians

MIS 25: Plant Species for Urban Landscape Projects

- Provision of suitable plant species for Canberra and specific site conditions
- Consideration of the suitability of the species in specific situations
- Set back requirements:
  - Path
  - Kerb
  - Building
  - Driveways (Refer MIS 07)
  - Services (Refer MIS 06)
- Target Soil Volume requirements and site restrictions (Available Soil Volume)
- site restrictions (Available Soil Volume)

Comparative Living Infrastructure Controls

Mechanisms supporting implementation of green infrastructure in urban development across the ACT, NSW and Victoria Yarra Council.

ACT

Mechanism	**'Planting Area' within Private Open Space**		
Definition	**An area of land within a block that is not covered by buildings, vehicle parking and maneuvering areas or any other form of impermeable surface and that is available for landscape planting (ACT Planning and Land Authority Part B Definition of Terms)**		
Application of Planting Area	**3.3 Residential Zones Single Dwelling Housing Development Code**	R38 Large Block (>500m²)	50% minimum area in (minimum private open space area equal to 60% of the block area, less 50m²) is planting area
		R39 Mid Sized Block (>250m² ≤500m²)	50% minimum area in (minimum private open space area equal to 40% of the block area, less 50m²) is planting area
		R40 Compact Block (≤250m²)	50% minimum area in (minimum private open space area equal to 20% of the block area, less 50m²) is planting area
	3.4 Residential Zones Multi Unit Housing Development Code	R38 RZ1 (Suburban Zone), RZ2 (Suburban Core Zone)	Not less than 20% of the total site area is planting area
		R39 RZ3 (Urban Residential Zone), RZ4 (Medium Density Residential Zone), RZ5 (High Density Residential Zone), Commercial Zones	Not less than 10% of the total site area is planting area

VIC: Yarra Planning Scheme

Mechanism	**Garden Area**		
Definition	**An area on a lot with a minimum dimension of 1m that does not include:** **a) a dwelling or residential building, except for:** **- an eave, fascia or gutter that does not exceed a total width of 600mm;** **- a pergola;** **- unroofed terraces, patios, decks, steps or landings less than 800mm in height;** **- a basement that does not project above ground level;** **- any outbuilding that does not exceed a gross floor area of 10m²; and** **- domestic services normal to a dwelling or residential building;** **b) a driveway; or** **c) an area set aside for car parking**		
Application of Garden Area	**General Residential Zone: 32.08-4**	Lot Size 400-500m	25%
		Lot Size 501-650m	30%
	Neighbourhood Residential Zone: 32.09-4	Lot Size above 650m²	35%

'The minimum garden area requirement specifies the percentage of a lot that must be set aside to ensure the open garden character of suburbs is protected'

Source; Victoria Environment, Land, Water and Planning, Planning Practice Note 84.

NSW[1]

Mechanism	**Landscaped Area**		
Definition	**A part of a site used for growing plants, grasses and trees, but does not include any building, structure or hard paved area (Sydney Local Environment Plan 2012)**		
Application of Landscaped Area	**SEPP[2] Part 3C > Division 3 > Subdivision 3: for dwelling houses and attached development**	Lot Area 200m² - 300m²	10% of lot area
		Lot Area 300m² - 450m²	15% of lot area
		Lot Area 450m² - 600m²	20% of lot area
		Lot Area 600m² - 900m²	30% of lot area
		Lot Area 900m² - 1,500m²	40% of lot area
		Lot Area 1,500m²	45% of lot area
	Part 3B > Division 3 > Subdivision 3	Manor House	50% of lot area minus 100m² Minimum dimension of any area included in the landscaped area calculation is 1.5m At least 50% of the area forward of the building line is to be landscape area
	Part 3B > Division 2 > Subdivision 3	Dual Occupancy	50% of lot area minus 100m² Minimum dimension of any area included in the landscaped area calculation is 1.5m At least 25% of the area forward of the building line is to be landscape area
	Part 3B > Division 4 > Subdivision 3	Multi Dwelling (Terraces)	R1, R2 or RU5 zoned land 30% of lot area R3 zoned land 20% of lot area Minimum dimension of any area included in the landscaped area calculation is 1.5m At least 25% of the area forward of the building line is to be landscape area
	Additional control from NSW Low Rise Medium Density Design Guide: 2.4C-1	Multi Dwelling Housing	R1, R2 or RU5 zoned land 30% of lot area R3 zoned land 20% of lot area Minimum dimension of any area included in the landscaped area calculation is 1.5m At least 50% of the area forward of the building line is to be landscape area

1 Definition and parameters are from the State Environment Planning Policy (Exempt and Complying Development Codes) 2008 (NSW) that informs the Design Criteria in the Low Rise Medium Density Design Guide for development applications 2018.

2 State Environment Planning Policy (Exempt and Complying Development Codes) 2008 (NSW)


FRANKLIN
PAGE
DICKSON
TURNER
WRIGHT
MAWSON
Study area as proportion of study suburbs

4.0 Spatial Analysis

This section will expand on the analysis of data provided by EPSDD across six study suburbs in the ACT to identify the current state of living infrastructure across the Block, Street and Suburb scales. The Spatial Analysis provides possible future scenarios in light of proposed amendments to living infrastructure assets.

4.1 Methodology

The methodology undertaken for the Spatial Analysis Study follows the Proposed Methodology provided by EPSDD, set out in Attachment 4. It draws on data sets outlined on page 17 of this report and focuses on residential areas, data does not include commercial areas within the study suburbs. The suburbs selected for case studies were chosen to investigate living infrastructure across different eras of development, from traditional large Canberra blocks in 'old suburbs' to contemporary suburbs typified by dense dwelling typologies in 'new suburbs'. Data sets collected across suburbs allow for assessment and comparison across three scales: suburb level, street level, block level. Various measures explored within the data sets investigate living infrastructure and areas relating to it including tree canopy cover and permeable areas, which are pertinent to the understanding of living infrastructure.

A detailed Data Spread is provided for each scale of investigation and presented within its respective section of the Spatial Analysis.

Terminology

Terminology used throughout this section is defined below.

Total Street Area: is the area of the street that includes carriageway and verges

Road: is the carriageway

Verge: is edge of carriageway to block boundary

Building footprint over block area: is the percentage of site coverage

Older (or old) suburbs refers to the following suburbs: Dickson, Mawson, Page, Turner

Newer (or new) suburbs refers to the following suburbs: Franklin and Wright

Permeable area: refers to the total area minus the building footprint, paving, hardstand and other impermeable surfaces

Impermeable area: refers to the total area of the building footprint, paving, hardstand and other impermeable surfaces

Hardstand area: refers to any area of impermeable paving including footpaths. Hardstand area includes driveways in study blocks. Driveways included separately in street areas

Access Street: where the residential environment is dominant, traffic is subservient, speed and traffic volumes are low and pedestrian and cycle movements are facilitated

Minor Collector: collects and distributes traffic from access streets, linking to major collector roads within the neighbourhood

Major Collector: forms the link between the primary network and the roads within local areas and should carry only traffic originating or terminating in the area

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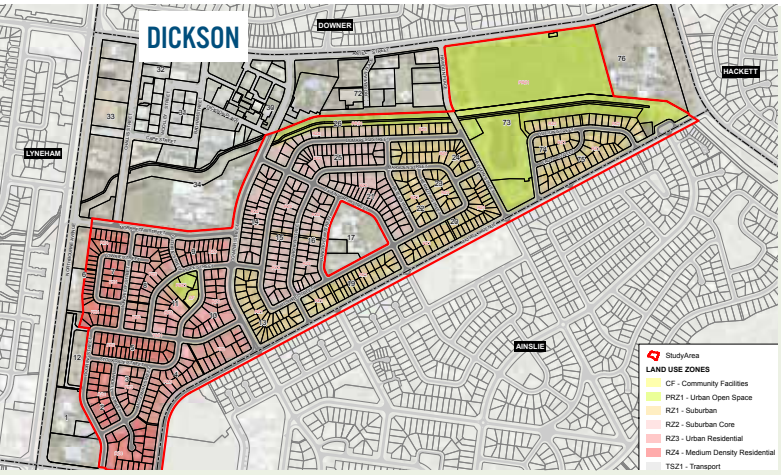
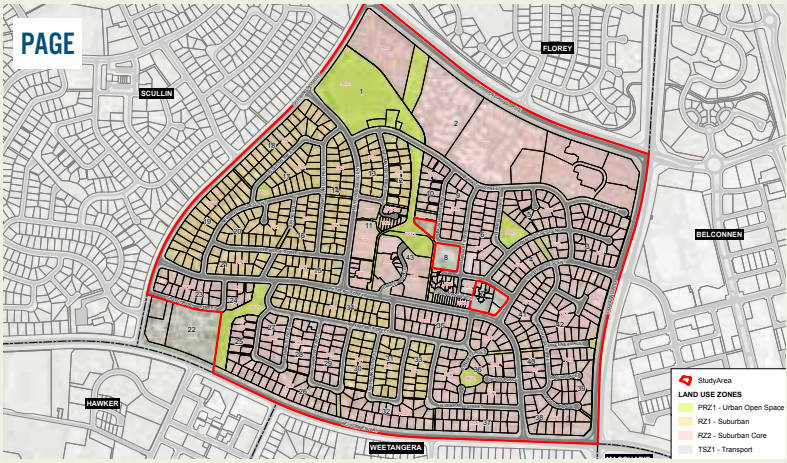
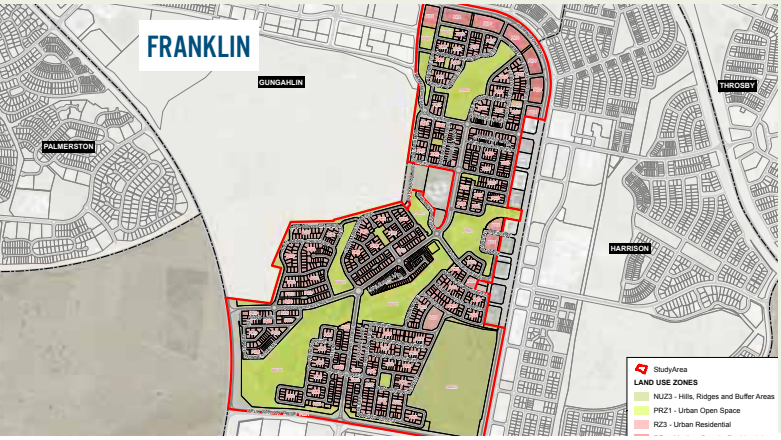






Detailed view of study area

Data Sets

The data provided by EPSDD is a combination of data sets derived from LiDAR and digitised data from aerial imagery sets, as well as data collected from ACTmapi, through the use of GIS mapping software.

Data was supplied as excel spreadsheets, shape files and aerial PDFs, visually mapping the study areas, inclusive of relevant areas and percentages of various ground treatments, building footprints and canopy areas.

Suburb level data was gathered from the following six study suburbs:

Dickson

Turner

Mawson

Page

Franklin

Wright

Street level data for the six study suburbs was gathered from 33 study streets:

Dickson – 5 streets

Turner – 6 streets

Mawson – 6 streets

Page – 6 streets

Franklin – 5 streets

Wright – 5 streets

Block level data for the six study suburbs was gathered from 91 study blocks:

Dickson – 20 blocks

Turner – 20 blocks

Mawson – 17 blocks

Page – 12 blocks

Franklin – 11 blocks

Wright – 11 blocks

General assumptions

While all calculations have been processed from the largest spread of data available, the absolute findings are limited to their respective study areas where an absolute figure has been provided. Where the data is calculated from averages, in the absence of absolute figures, it has been assumed that the respective study areas reflect a reliable spread of data.

Averages have been calculated for all data where applicable. Averages were only generated between like study suburbs, 'old suburbs' and 'new suburbs', so as to ensure relevance of cross comparison.

For example, absolute data has been provided for permeability of study blocks, not for all blocks within the study suburb. It has been assumed that the study blocks represent a reliable spread of data and that the average permeability of these study blocks can be applied to all blocks within the study area to calculate suburb permeability. This assumption has been made across all calculations where necessary. Specific assumptions are given where data is presented.

Additional calculations and averages created for the purpose of comparison are presented in Attachment 5 for further information.

Exclusions

Some exclusions have been made to data sets where the omission of particular study sites improves the reliability of the calculation. Specific exclusions are mentioned where it has effected the analysis.

4.2 Scenarios 1, 2 and 3

The spatial analysis was divided into three stages. Data was supplied under the following scenarios:

Scenario 1

Assessment of existing living infrastructure and built form

Scenario 2

Assessment of living infrastructure and built form under potential development yield within existing zoning

Scenario 3

Assessment of living infrastructure and built form under projected high development yield

Higher Yield data was collected from a range of suburbs in Canberra. *Higher Yield* provided for Scenario 2 & 3 was collected from a range of suburbs where blocks reflect what is provided in the current market in terms of dwelling types and building footprint and is allowable under the existing Territory Plan Zoning. This data set was extracted from ACTMapi and Development Application data to assess the impact of urban intensification on living infrastructure.

Existing Conditions

Existing conditions have been generated from data sets identified on page 17 of this document. Detailed methods for specific sections of data are described in each section where relevant.

4.3 Facts and Figures behind the data

Suburb

Suburb Data Spread

The data gathered at suburb level is made up of study areas from six suburbs containing residential zoning RZ1 to RZ5 and open space areas. Included was the number of dwellings and breakdown of land use areas within the total study area.

Suburb Data

The graphs below demonstrate the spread of total area at the suburb level. It shows that **total suburb area is predominantly made up of block area** in all study suburbs, except in Franklin where block area is the same as street area. In Wright block area only represents 4% more than street area to total study area.

	STUDY AREA (M²)	% OF OPEN SPACE AREA (INCLUDING NUZ3)	% OF STREET AREA TO STUDY AREA	% OF BLOCK AREA TO STUDY AREA
TURNER	1,179,933	27%	31%	42%
DICKSON	994,092	22%	28%	50%
MAWSON	1,818,248	23%	19%	57%
PAGE	1,272,425	8%	25%	66%
FRANKLIN	2,116,698	32%	34%	34%
WRIGHT	834,248	10%	43%	47%

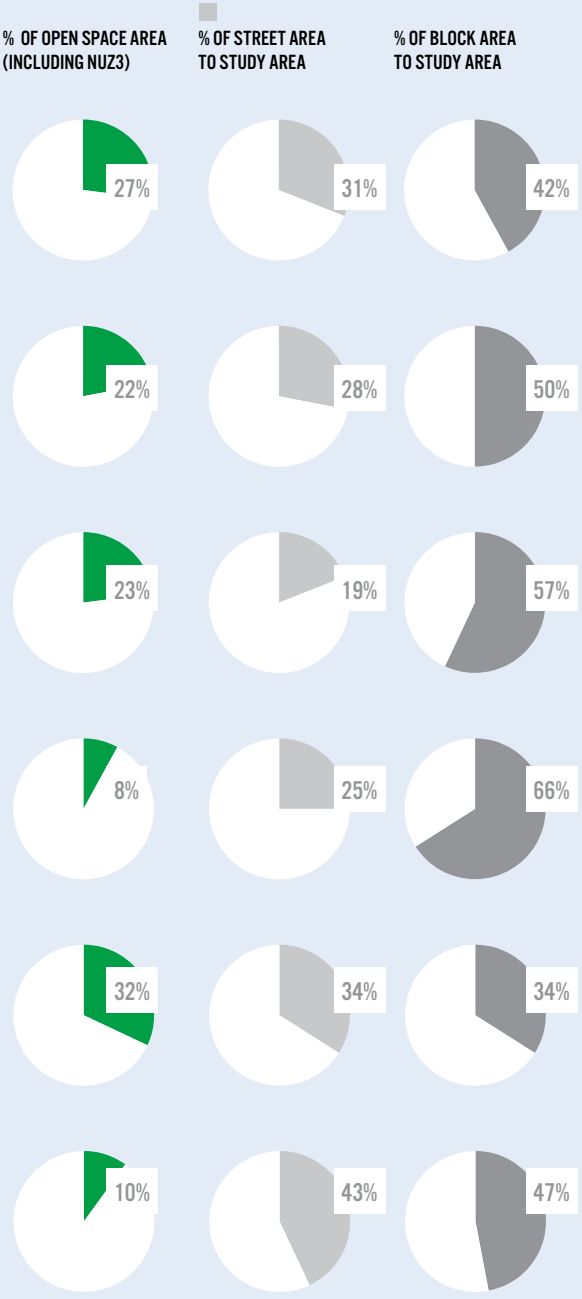


TABLE 4.3.1A

Street

Street Data Spread

The data for streets is made up of 5 to 6 study street sections for each study suburb, with 33 study street sections in total. Street sections generally represented a selected area of the street. The street sections collected for each suburb represent a spread of street types and street classifications. Data collected includes dimensions for road and verge widths and square metre area for roads, verges, hardstands, driveways, canopies, permeable area and impermeable area.

Street Data

Averages of street data for each suburb have been calculated by street type and street classification. Comparisons between suburb streets such as *Driveway Area to Verge Area, Verge Area to Total Street Area*, and *Verge Area over Total Street Area*. For consistency of comparisons, all street calculations have been separated by street classification or street type. Comparisons between suburbs show that the amount of Hardstand

TABLE 4.3.2A

TABLE 4.3.2B

Area to Verge Area in a Major Collector street has increased based on the era of the suburb. The average Hardstand Area to Verge Area in Mawson and Page is 25%, an 8% increase from the older suburbs Turner and Dickson where the average is 17%. Verge Area to Total Street Area also demonstrates a consistent change based on the era of the suburb. For major collectors in Mawson and Page, the verge makes up 53% of the total street, a 10% decrease from Turner and Dickson where the average is 63%. The data shows no correlations between Minor Collectors of the study suburbs. Where 0% is recorded for any category indicates the absence of that type within the given study area.

The comparison of streets was narrowed-down to only include streets classified as an access street. 'Modified access streets' investigates only areas interfacing residential blocks, removing areas of intersection and other anomalies from the calculation. As access streets interface predominantly single residential housing typologies, modified data reflects a more consistent comparison of streets. **The data demonstrates a general increase in hardstand area and driveway area in newer suburbs.**

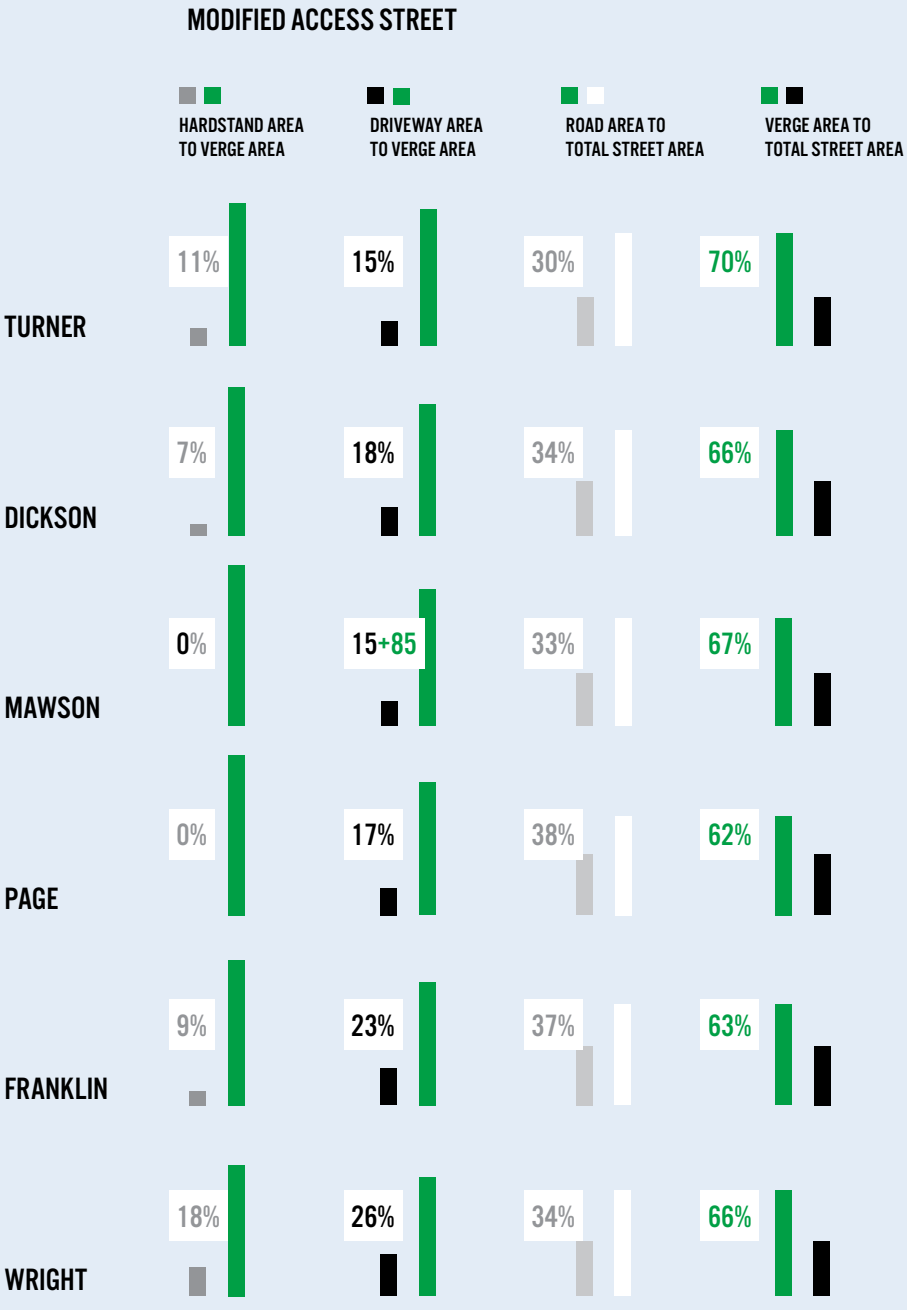


TABLE 4.3.2C

Study Blocks

Study Block Data Spread

A comprehensive set of data was collected for each study block including block type, land use zone, number of dwellings, block area, block width, building area, hardstand area, easement area, total permeable area, total impermeable area, Territory Plan private open space, Territory Plan planting area and canopy area.

Study Block Spread

The data for blocks is made up of eleven to twenty study blocks from each study suburb with 91 study blocks in total. The 11 to 20 study blocks collected for each suburb represents a spread of dwelling types and residential land use zones. Table 3.1.3 shows the spread of dwelling types per suburb.

STUDY BLOCKS

	Single dwelling	Townhouse	Terrace	Multiunit	Duplex	Dual occupancy	Total
T URNER	8	3	-	6	-	3	20
DICKSON	12	-	-	5	3	-	20
MAWSON	6	3	1	4	-	3	17
PAGE	8	1	2	-	-	1	12
FRANKLIN	5	1	2	2	1	-	11
WRIGHT	5	2	1	3	-	-	11

TABLE 4.3.3

The single dwelling typology had the largest range of sample sizes across all six suburbs and provides a consistent comparison for study blocks between suburbs. Because of this single dwellings form the focus of the building footprint analysis of study blocks.

Data from Attachment 5, Table 4.3.3A-D

Increasing Site Cover

Building footprint to block area, calculated for all study suburbs, has been sorted by both dwelling type and land use zone. **Calculations found that the newer suburbs of Franklin and Wright have a greater percentage of building footprint to block area** in contrast to the older suburbs. This finding is consistent across all calculations including all dwelling types and all land use zones.

BUILDING FOOTPRINT TO BLOCK AREA RATIO (%)

	Single dwelling	Townhouse	Terrace	Multiunit	Duplex	Dual occupancy
TURNER	24%	-	39%	-	38%	33%
DICKSON	30%	22%	-	-	35%	-
MAWSON	23%	-	36%	49%	21%	41%5
PAGE	31%	-	39%	55%	-	42%
FRANKLIN	54%	59%	52%	57%	41%	-
WRIGHT	53%	-	66%	58%	43%	-

TABLE 4.3.3C

All Blocks

All Blocks Data Spread

Data for All Blocks includes land use zone, block area, building area, and canopy area but not dwelling numbers or dwelling typologies. Dwelling numbers have not been identified in this data set and there is no differentiation between single residential blocks and other block types. While dwelling typologies of these blocks have not been identified for this data set, land use zones RZ1 and RZ3 can be assumed to be predominately single residential blocks. To enhance the reliability of this data, multiunit blocks, identified by their comparatively large block sizes, have been excluded from the calculations. Additionally, the calculations exclude empty or near empty blocks.

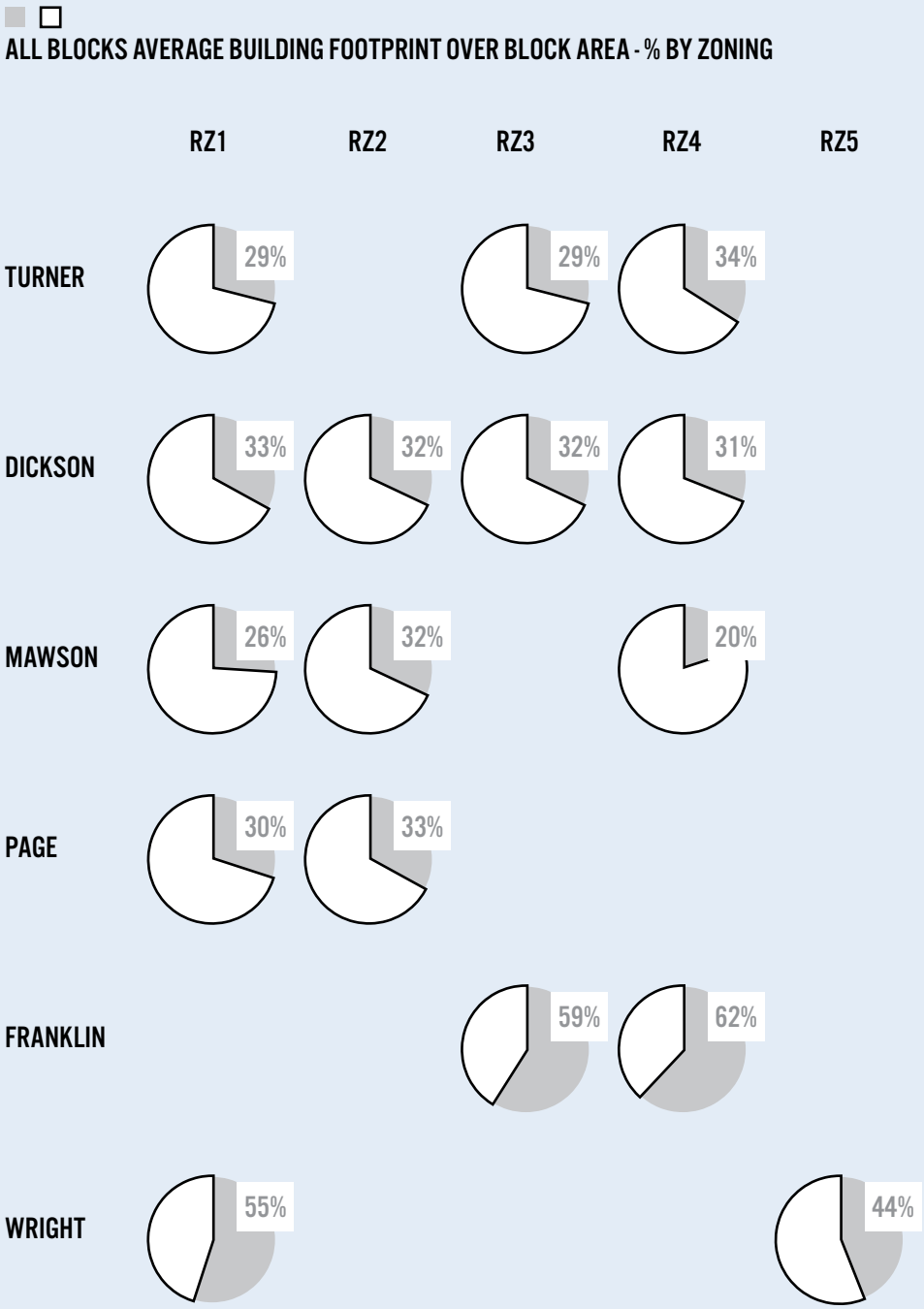


TABLE 4.3.4D

All Blocks Spread

Calculation for the spread of block typologies across land use zones was generated for comparison between suburbs. These calculations found that **Large Blocks are far more prevalent in older suburbs and Compact Blocks are only found in newer suburbs**, with the exception of Page where compact blocks represent 2% of total blocks.

- Compact block means a block with an area ≤ 250m²;
- Mid-sized block means a block with an area >250m2 ≤ 500m²;
- Large block means a block with an area >500m².

Data from Attachment 5, Table 4.3.4A-C

Increasing Site Cover

Building Footprint to Block Area was calculated for all study suburbs and sorted by block types and land use zones. These calculations found that **the newer suburbs of Franklin and Wright have a greater percentage of Building Footprint to BlockArea in contrast to the older suburbs.** This finding is consistent across all calculations including all block types and all land use zones. As illustrated below, even the comparison of large blocks demonstrates a significant increase in site cover.

Data from Attachment 5, Table 4.3.4E

RZ1 COMPARISION ACROSS STUDY SUBURBS

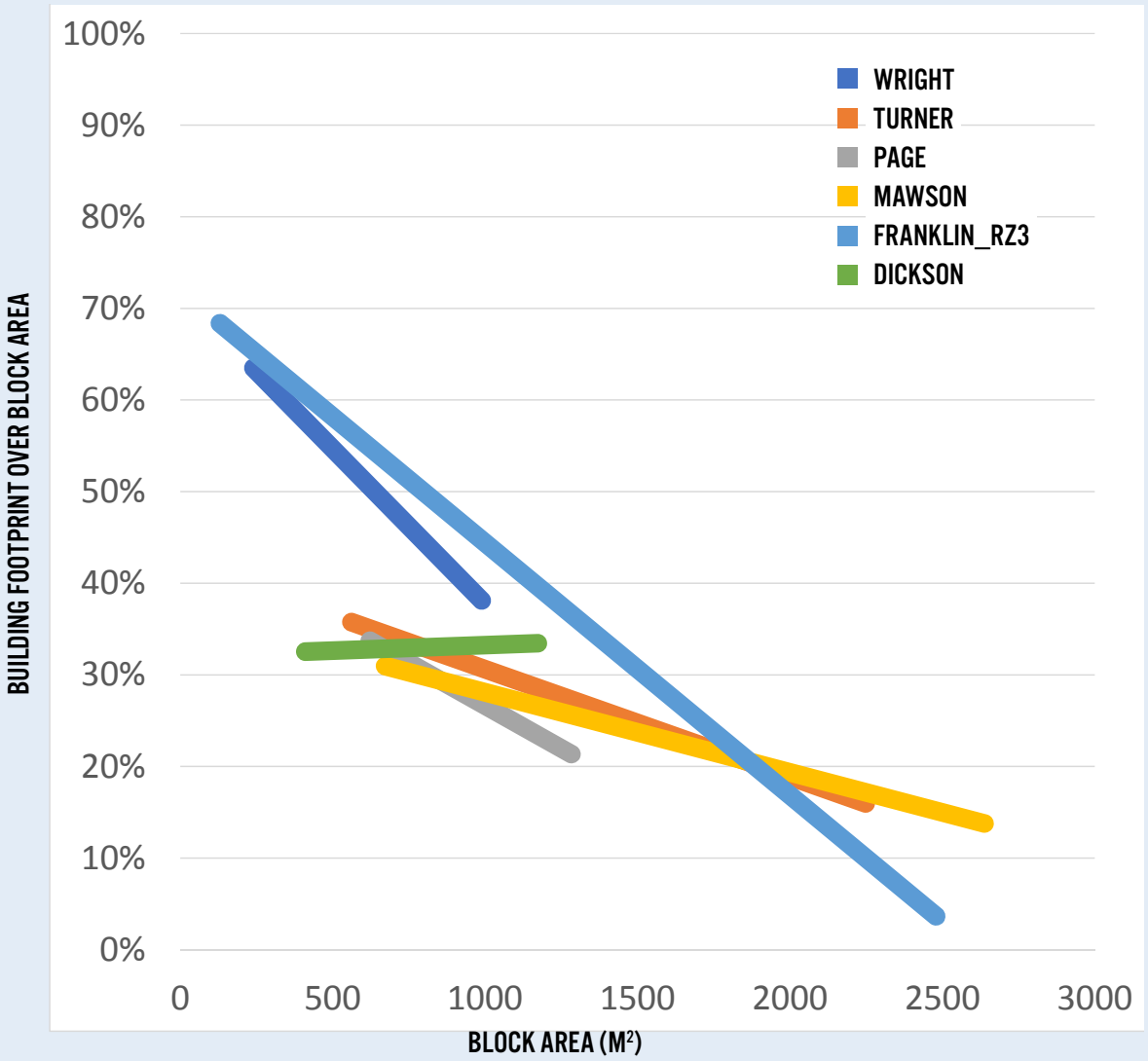


TABLE 4.3.4H, SEE ATTACHMENT 5 GRAPH 4.3.4H

Higher Yield Blocks

Higher Yield Blocks Data Spread

Data spread for Higher Yield blocks is identical to the spread of data collected for study blocks. The set of data includes block type, land use zone, number of dwellings, block area, block width, building area, hardstand area, easement area, total permeable area, total impermeable area, Territory Plan private open space, Territory Plan planting area and canopy area.

Higher Yield Blocks Data

The calculation of average block area, average number of dwellings per block, and *Average Building Footprint to Block Area* have been generated for the higher yield blocks.

These blocks are noted as Max Yield Blocks in the data. The higher yield blocks are sorted by block types and land use zones. The calculation for *Building Footprint to Block Area*

AVERAGE BUILDING FOOTPRINT OVER BLOCK AREA - % BY ZONING

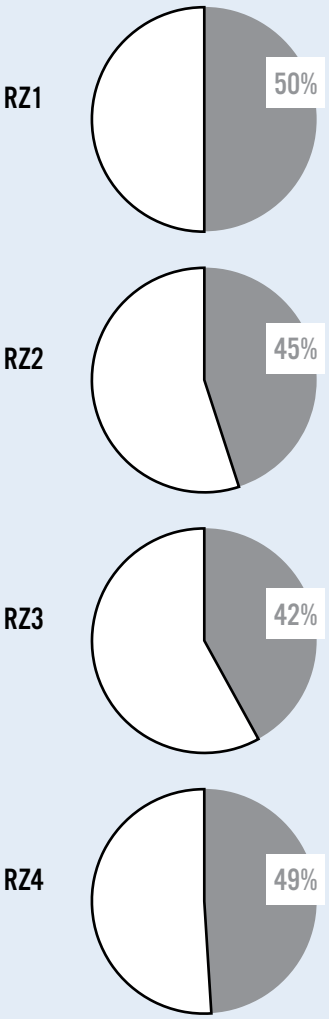
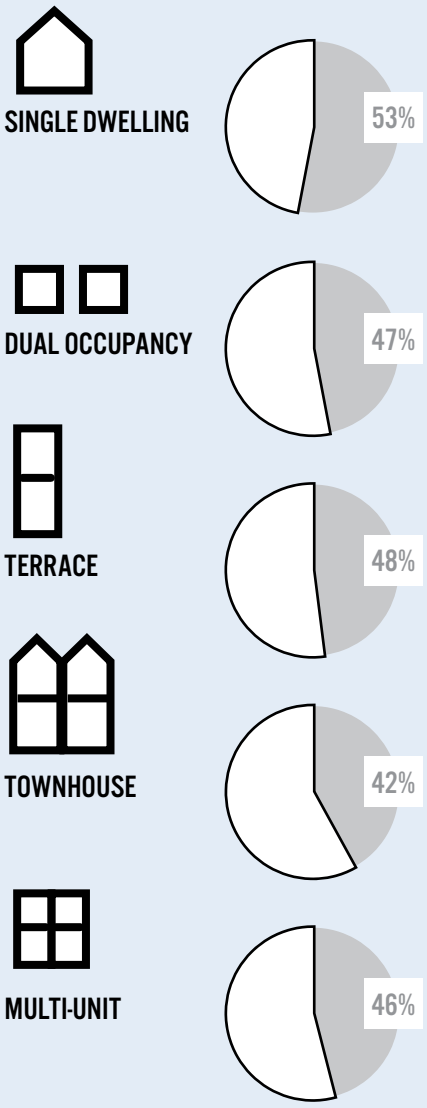


TABLE 4.3.5A

AVERAGE BUILDING FOOTPRINT OVER BLOCK AREA - % BY TYPOLOGY



GRAPH 4.3.5B

found Higher Yield block site coverage to be most similar to newer suburbs of Franklin and Wright.

Data from Attachment 5, Table 4.3.5A-D

Planting (Private Open Space (POS) and Principle Private Open Space (PPOS)

While we observe that a large number of blocks fulfill current Territory Plan planting requirements under the Private Open Space and Principal Private Open Space controls, it is compliant mostly through deference to Criteria **requirements and not implementation of the Rule.** As a result planting areas may not be in the spirit of the Rule and may not be adequately addressing urban heat gain and amenity.

ALL SUBURBS AVERAGES FOR PLANTING REQUIREMENTS BY TYPOLOGY

SINGLE DWELLING

87.5% of large blocks meet the current Territory Plan planting requirements.

87.5% of mid-size block examples meet the current Territory Plan planting requirements.

No compact block examples were given.

DUAL OCCUPANCY

100% Dual occupancy examples meet the current Territory Plan planting requirements

TERRACE

30% of townhouses meet the current Territory Plan planting requirements

TOWNHOUSE

30% of terrace houses on compact blocks meet the current Territory Plan planting requirements

MULTI-UNIT

100% of multi-unit examples meet the current Territory Plan planting requirements

4.4 Canopy and Permeability

Canopy Data Spread

The data gathered for canopy area is a comprehensive set of data which contains canopy area mapped using LiDAR at suburb, street, and block level. At suburb level, the canopy area data is sorted by suburb, land use zone, and between open space, streets, and blocks. At street and block level, the canopy data is provided for each study site and can be sorted correspondingly; street canopy can be sorted by street classification and street type; block canopy can be sorted by land use zone, block area, and dwelling type. Additionally, canopy data is supplied for all blocks individually.

Mature Canopy Data

Canopies in the newer suburbs of Franklin and Wright have not reached their mature size and thus may not accurately reflect the mature canopy areas found in other study suburbs. To increase accuracy, mature canopy areas for open space and street trees was gathered from DWG landscape drawings for Wright and these areas were added to existing LiDAR data. Investigation of study blocks for Wright and Franklin found areas of tree canopy not picked up by the LiDAR data, these have been mapped on top of the shape files and used as supplementary data. The investigation on study blocks for other suburbs found discrepancy between LiDAR data and actual canopy area found within the aerial.

For all canopy readings in Scenario 1 and for all further scenarios, some blocks have been omitted from analysis and calculations to enhance reliability of information.

Permeability Data Spread

The data for permeability was gathered from an investigation of study sites. The permeability data is provided for each study site at street and block level and can be sorted correspondingly; street permeability can be sorted by street classification and street type; block permeability can be sorted by land use zone, block area, and dwelling type. *Permeability at Street* takes into consideration hardstand area such as paths and driveway area but does not identify details such as permeable paving. *Permeability at Block* level considers hardstand area such as driveways, paths, and other paving, as well as building footprint areas.

Suburb

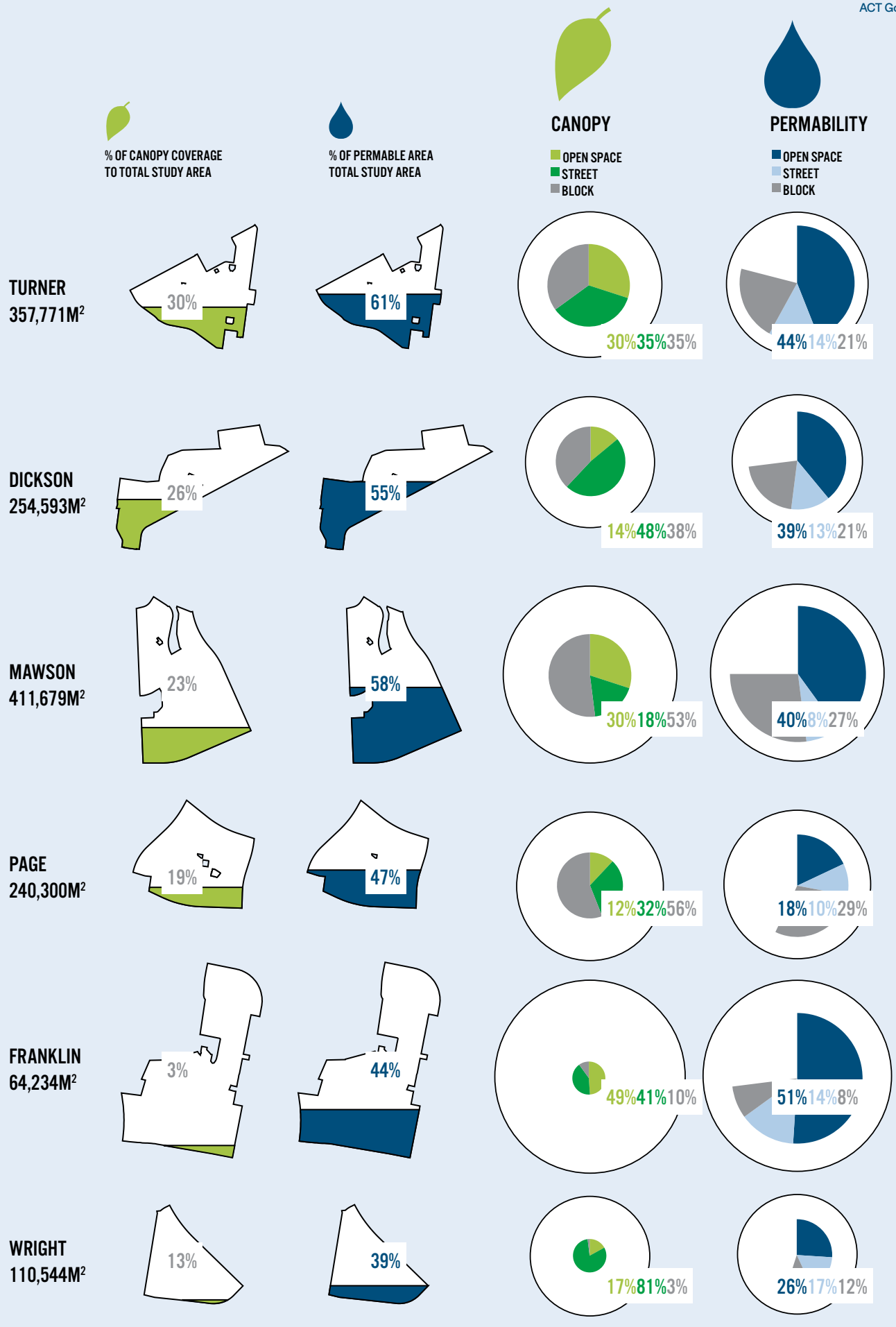
Suburb Level Permeability

The permeability data at suburb level is calculated using a combination of existing permeability data that exists for street and block level, and other suburb level data. To find suburb permeability, the calculation is separated into three main parts: open space permeability, street permeability and on block permeability. Firstly, all open space areas were assumed to be 100% permeable. Secondly, the street permeability was calculated by taking the average percentage of permeability for all study streets and applying the percentage to the total street area for the suburb to find the permeable street area per suburb. Thirdly, the block permeability was calculated by taking the average percentage of permeability for blocks by land use zone and applying the percentage to the corresponding total block area by land use zone. The sum of permeable areas for each land use zone provides the total permeable area for blocks. The suburb level permeability can be projected by adding open space, street, and block permeable areas together.

Suburb Level Canopy and Permeability Data

The data calculated for canopy at suburb level reveals that Turner has the most canopy coverage of all study suburbs at 30% coverage. The spread of canopy coverage over different areas largely varies between suburbs, the main commonality being that **canopy is predominately found on blocks and streets**. These canopy areas combined make up over 70% of all canopy cover in older suburbs. Turner is also identified as the suburb that has the most permeable area. Some consistencies have been identified in the spread of permeability over different areas. Open space area contributes the most to the permeability of a suburb in all study suburbs except Mawson, Page, and Wright. Blocks contribute more to the permeability of a suburb than streets in all study suburbs except Franklin and Wright.

Data from Attachment 5, Table 4.4.1A-E


% OF CANOPY COVERAGE
TO TOTAL STUDY AREA
% OF PERMABLE AREA
TOTAL STUDY AREA
CANOPY
OPEN SPACE
STREET
BLOCK
PERMABILITY
OPEN SPACE
STREET
BLOCK
TURNER
357,771M²
30%
61%
30%35%35%
44%14%21%
DICKSON
254,593M²
26%
55%
14%48%38%
39%13%21%
MAWSON
411,679M²
23%
58%
30%18%53%
40%8%27%
PAGE
240,300M²
19%
47%
12%32%56%
18%10%29%
FRANKLIN
64,234M²
3%
44%
49%41%10%
51%14%8%
WRIGHT
110,544M²
13%
39%
17%81%3%
26%17%12%

Street

Street Level Canopy and Permeability

The data calculated for canopy at street level reveals that Access Streets contribute the most to canopy coverage in all study suburbs except for Franklin and Turner. Access Streets are also identified as the street classification which has the most percentage of permeable area in all study suburbs except for Turner. Average percentages of canopy and permeability of streets per suburb have also been sorted by Street Type.

Data shows that Access Streets generally have the most canopy cover over total street area of all street classifications for all study suburbs except Turner where Major Collectors had 3% more coverage. Correspondingly, data shows that Access Streets are also generally the most permeable of all street classifications for all study suburbs except Turner where Major Collectors had 5% more permeable area. Access Streets for all study suburbs have a minimum of 40% permeable area to total street area.

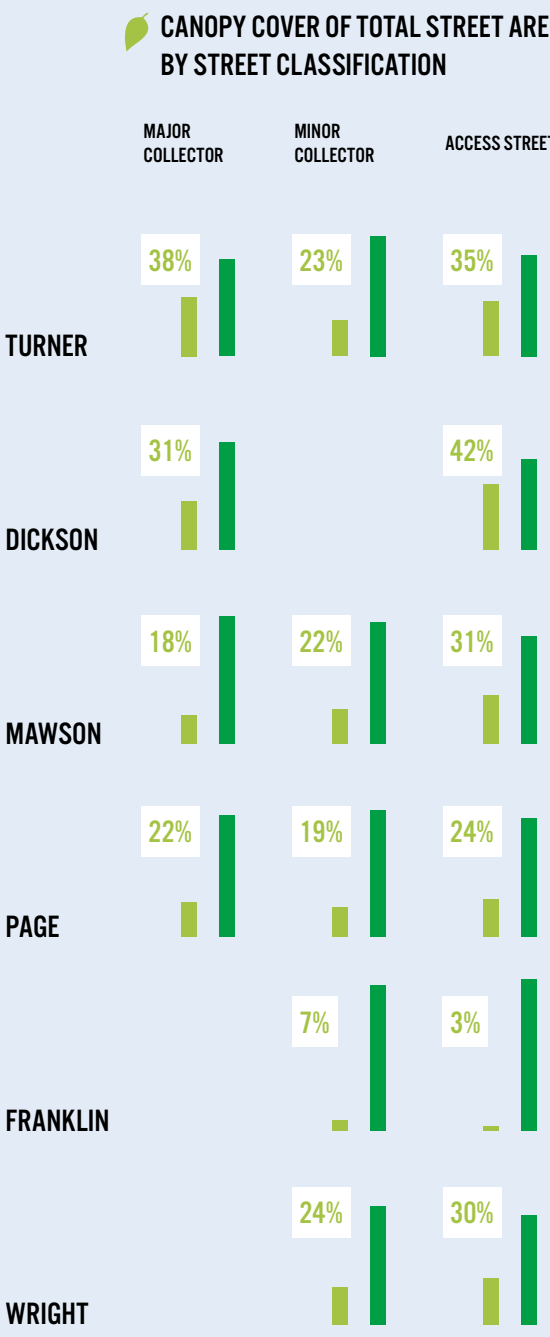


TABLE 4.4.2A

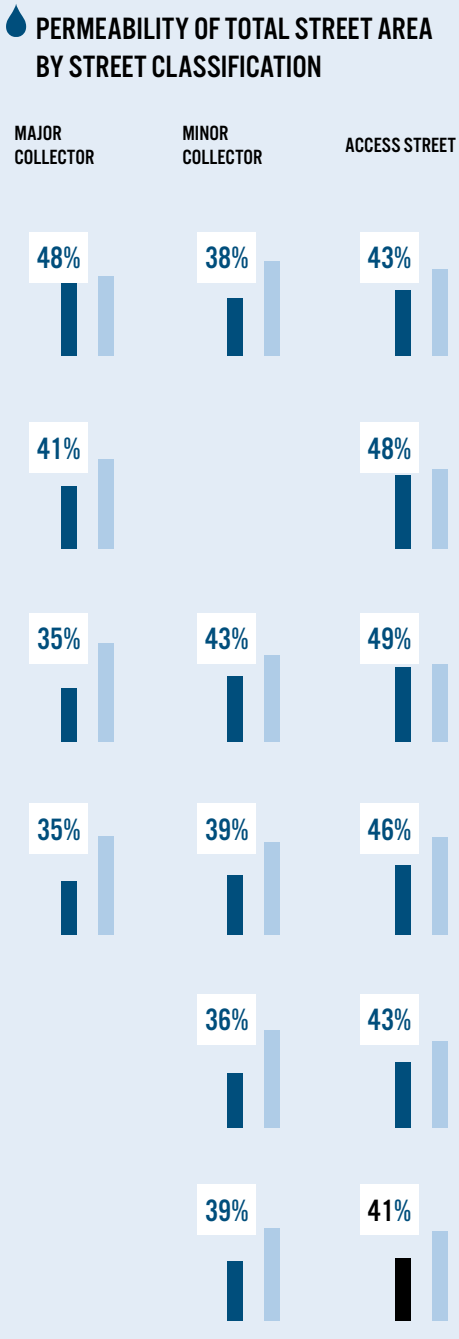


TABLE 4.4.2B

Modified Access Streets offer the most reliable insight on canopy and permeability data, it can also be expected that Access Streets account for the majority of streets found in a typical suburb. Modified Access Street data identifies Turner as the most canopy covered at 50% canopy area to total street, and Mawson as the most permeable at 57% permeable area to total street area.

Data from Attachemnt 5, Table 4.4.2A-D

MODIFIED ACCESS STREET

CANOPY AREA
TO TOTAL STREET AREA

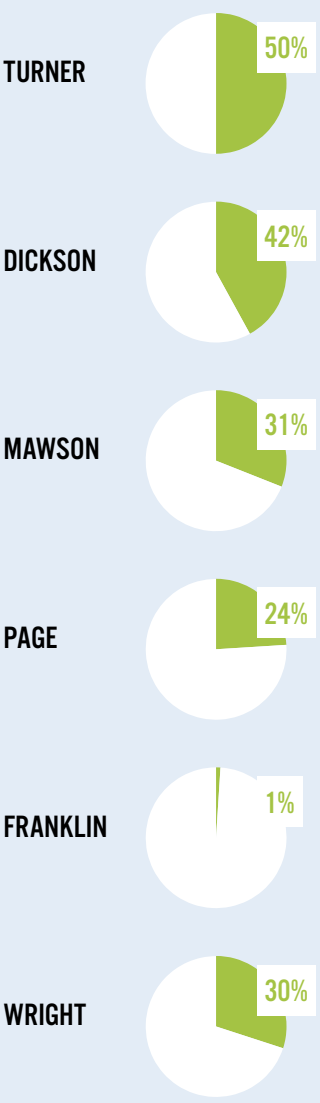


TABLE 4.4.2E

MODIFIED ACCESS STREET STATS

PERMEABLE AREA
TO VERGE AREA

IMPERMEABLE AREA
TO VERGE AREA

PERMEABLE AREA
TO TOTAL STREET AREA

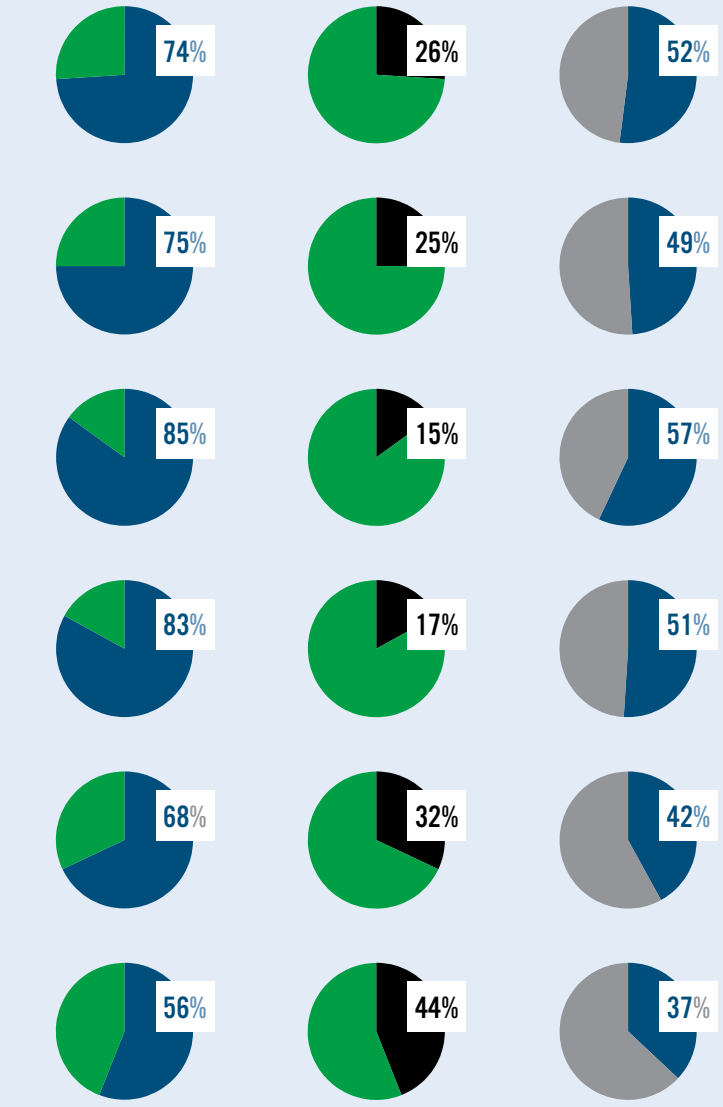


TABLE 4.4.2F

Street Trees On Block

From an assessment of the aerial photography and LiDAR information provided, it is clear that street trees provide a considerable area of canopy coverage on block in older suburbs. The LiDAR information gathered does not identify between street canopy and on Block canopy. In order to estimate the amount of coverage provided on block by street trees, the street tree canopy information was recalculated with a buffer zone extending over the existing street boundary to capture canopy in close proximity to streets that could be assumed to be provided by street trees. Two sets of this data are provided, one with a 3m buffer zone and another with a 5m buffer zone. From a visual assessment of the canopies and buffer zones, the 5m buffer zone appears to reflect the most accurate measure of street tree overlap with block. It should be noted that there are areas where on block canopy is captured within the buffer zone, and examples where on block canopy extends onto the street. However, most of the canopy area within the streets and buffer zone appear to be street trees so the data is assumed to be reliable.

The buffer zones were calculated at suburb level without differentiation between streets interfacing sections of open space and streets. In order to separate the open space buffer zone canopy from the rest, to determine residential block buffer zone canopy, the percentage of open space canopy over suburb was taken for each suburb and subtracted from the total buffer zone canopy. While this method of calculation relies on estimations rather than absolute data, it is the most reliable method using data supplied.

Calculations for 3m buffer zone found that street trees make up 16% of on block canopy cover on average for older suburbs. The same calculation using the 5m buffer zone found the average to be 25%.

STREET TREE CANOPY FOUND ON BLOCK %

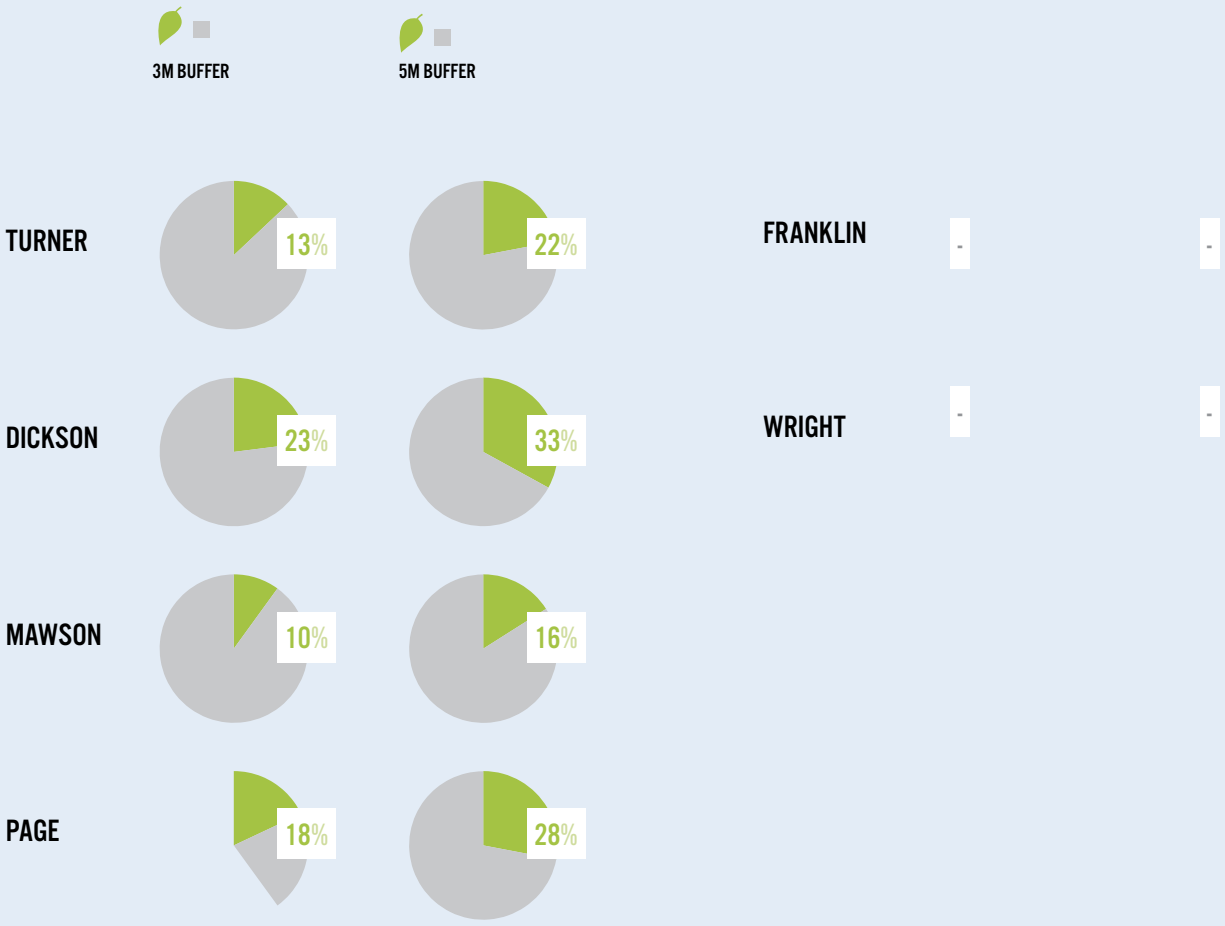


TABLE 4.4.1F

Study Blocks

Block Level Canopy and Permeability

Canopy data calculated for Single Residential dwelling typologies shows consistency between ***Canopy to Block*** coverage and the era of the suburb. The oldest suburbs, Turner and Mawson have a canopy to block coverage of 31% and 32% respectively. Dickson and Page have a canopy to block coverage of 15% and 19%, while Franklin and Wright both have 0% canopy on their Single Residential blocks. On average, dwelling typologies terrace, multi-unit, and dual occupancy offer less canopy coverage on block than single residential dwellings in all study suburbs.

The permeability data calculated for Single Residential dwelling typologies again shows a relatively consistent percentage to the era of the suburb. Turner and Mawson have 62% and 66% permeable area respectively, Dickson and Page both have 52% permeable area, Franklin and Wright have 23% and 32% permeable area for Single Residential blocks. On average, dwelling typologies townhouse, terrace, multi-unit, and dual occupancy, offer less permeable area on block than single residential dwellings in all study suburbs except Franklin.

CANOPY TO BLOCK (%)

	Single dwelling		Townhouse		Terrace	Multiunit	Duplex	Dual occupancy
TURNER	31%	-	11%	-	15%	15%		
DICKSON	15%	25%	-	-	4%	-		
MAWSON	32%	-	12%	18%	20%	7%		
PAGE	19%	-	22%	20%	-	2%		
FRANKLIN	0%	2%	0%	0%	1%	-		
WRIGHT	-	-	0%	0%	0%	-		

TABLE 4.4.3A

PERMEABLE AREA (%)

	Single dwelling		Townhouse		Terrace	Multiunit	Duplex	Dual occupancy
TURNER	62%	-	27%	-		38%	43%	
DICKSON	52%	62%	-	-		34%	-	
MAWSON	66%	-	34%	40%		60%	33%	
PAGE	52%	-	35%	25%	-		51%	
FRANKLIN	23%	30%	18%	21%		28%	-	
WRIGHT	32%	-	8%	26%		28%	-	

TABLE 4.4.3B

All Blocks

Block Level Canopy

The data was calculated from residential land use zones in lieu of dwelling typology information for this data set. The focus on single residential dwellings led to comparisons between RZ1 and RZ3 zoned blocks. The canopy data for all blocks closely corresponds with the Single Residential block findings for Study Blocks. The canopy data still shows consistency between canopy to block coverage and the era of the suburb. For RZ1 blocks, the oldest suburbs Turner and Mawson have a canopy to block coverage of 28% and 24% respectively. Dickson and Page have a canopy to block coverage of 19% and 17%, while Franklin (RZ3) and Wright have a canopy to block coverage of 1% and 0%.

Data from Attachment 5, Table 4.4.4A-F

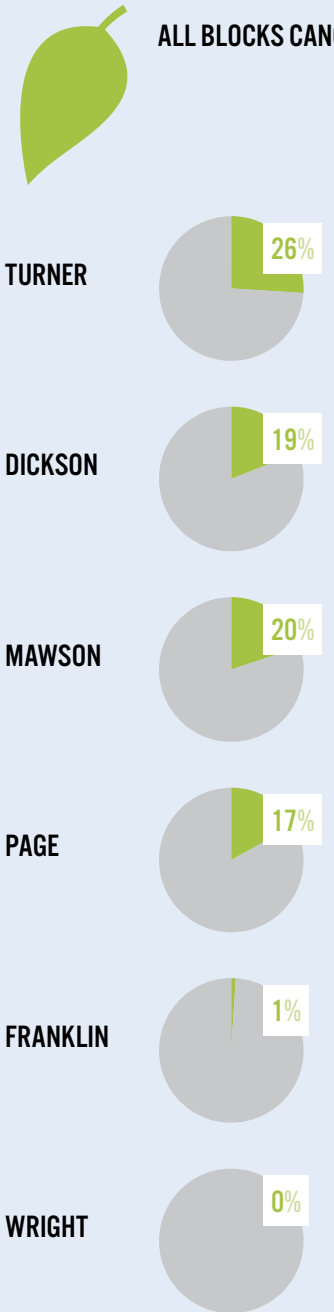


TABLE 4.4.4A

Higher Yield Blocks

Block Level Canopy and Permeability

Data shows that canopy coverage for Higher Yield Single Dwelling blocks is 30%, most similar to Turner at 31% coverage. Permeable area for Higher Yield Single Dwelling blocks is 21%, most similar to Franklin at 23% permeability.

Data from Attachmemt 5, Table 4.4.5A-B

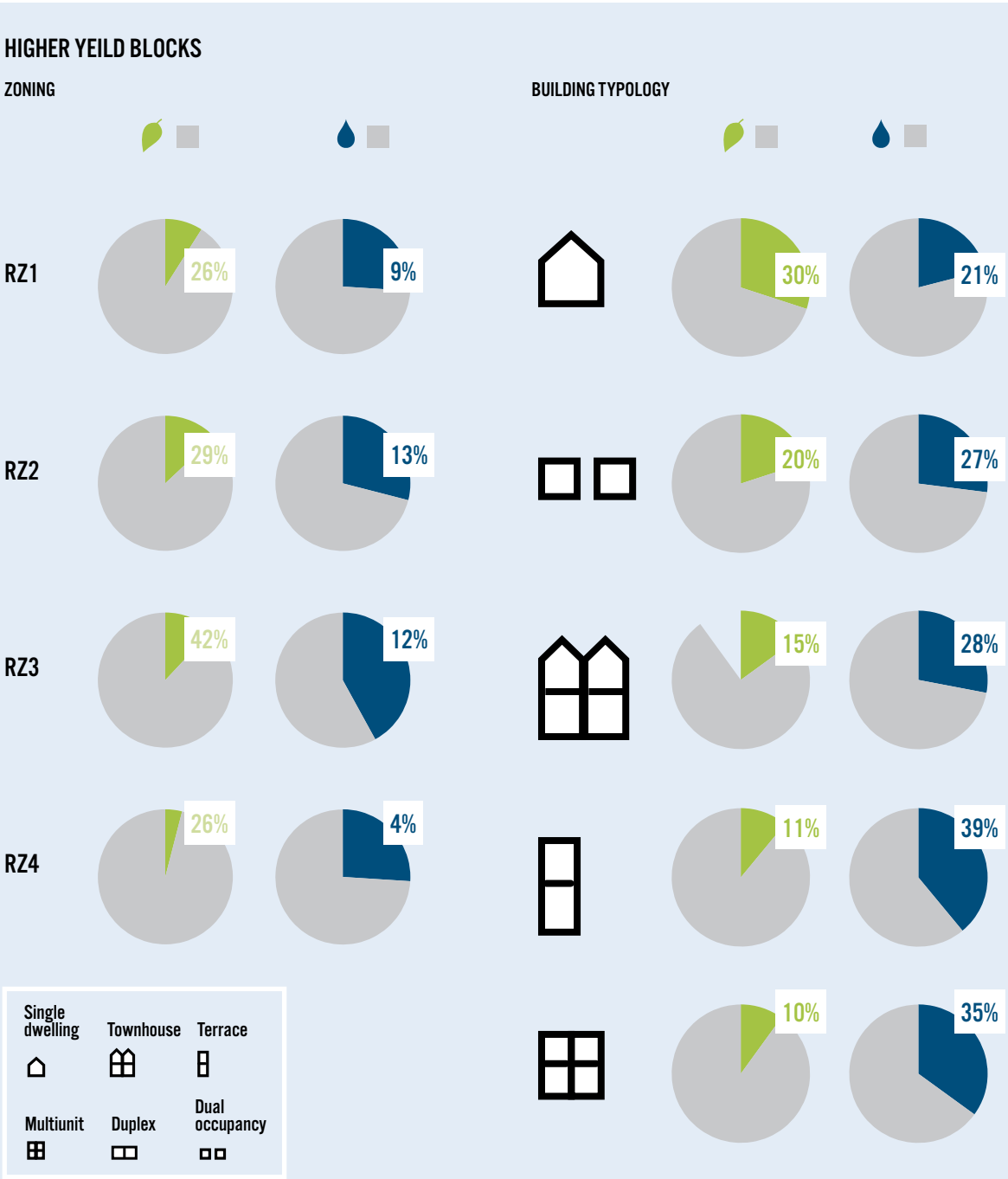


TABLE 4.4.5A

TABLE 4.4.5B

4.5 Possible Future Conditions

Scenario 2

Following EPSDD Proposed Methodology, Scenario 2 measures the effect of an increased yield within existing zoning. Building from the existing data, Scenario 2 uses Higher Yield case study blocks to calculate the change to canopy and permeability of study suburbs at block level. The change in canopy and permeability on block level was then combined with existing data for streets and open space to measure the impact at suburb level.

Scenario 2 does not measure impact to street trees, or permeability of streets which could be affected by an increased yield, changes to setbacks or building envelopes.

Data from Attachment 5, Table 4.6.1A-C

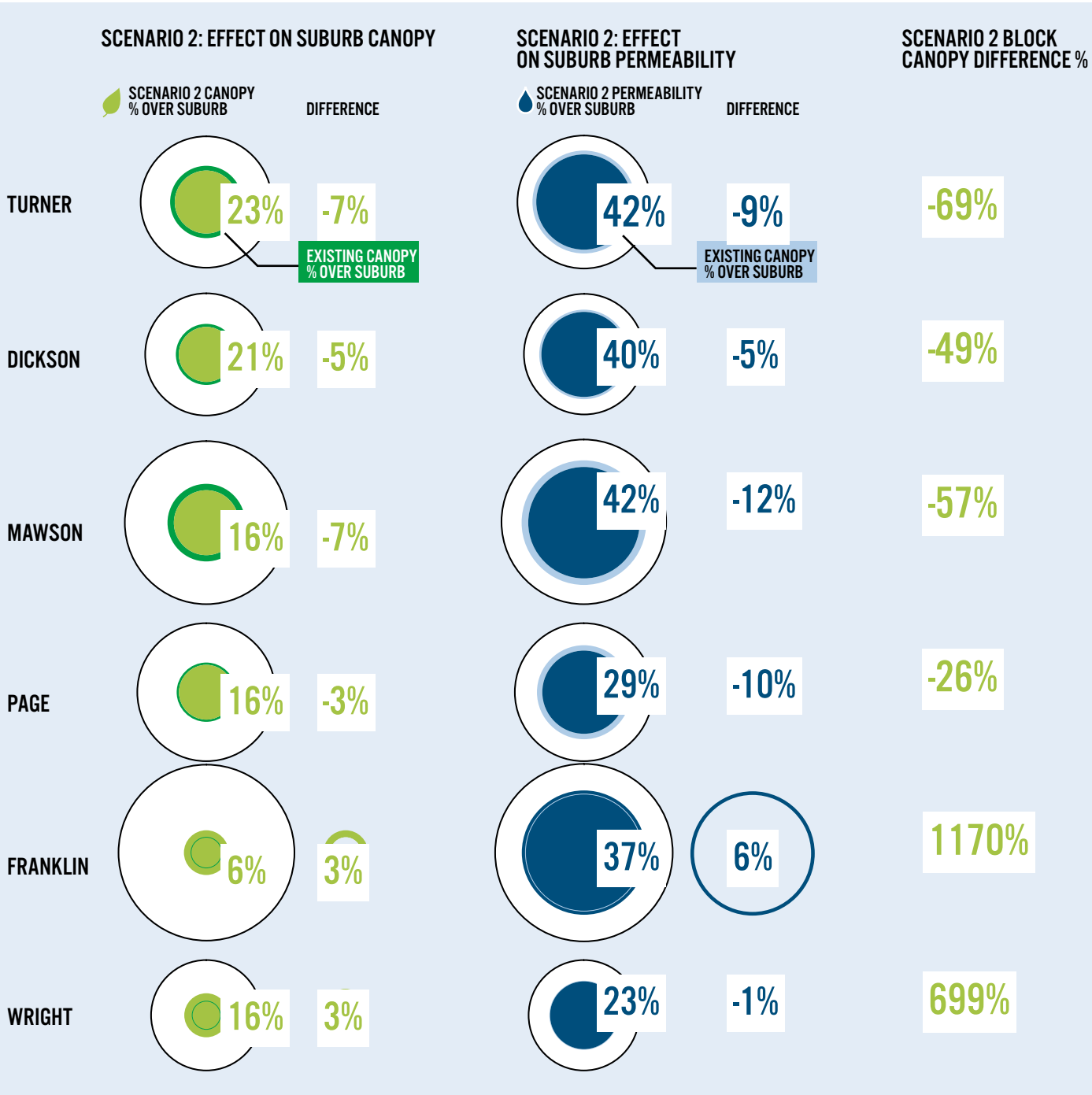


TABLE 4.6.1A

TABLE 4.6.1B

Scenario 3

Following EPSDD Proposed Methodology, Scenario 3 measures the effect of maximum development yield through higher possible zoning for blocks in proximity to commercial centers (600m), frequent rapid transit corridors (600m), and light rail transit corridors (800m). Building from the existing data, Scenario 3 uses Higher Yield case study blocks to calculate the change to yield and canopy of study suburbs within the higher zoned blocks. Only areas within the maximum development yield radii are affected by the change, the calculation retains the existing data for areas outside the Higher Yield catchment radii. This method applies to all Scenario 3 calculations including dwelling yields, canopy areas and permeable areas. Changes to canopy have been calculated on block level and do not account for increase in driveways affecting street tree coverage. Scenario 3 does not measure impact to street trees which could be affected by an increased yield.

Data from Attachment 5, Table 4.6.2A-C

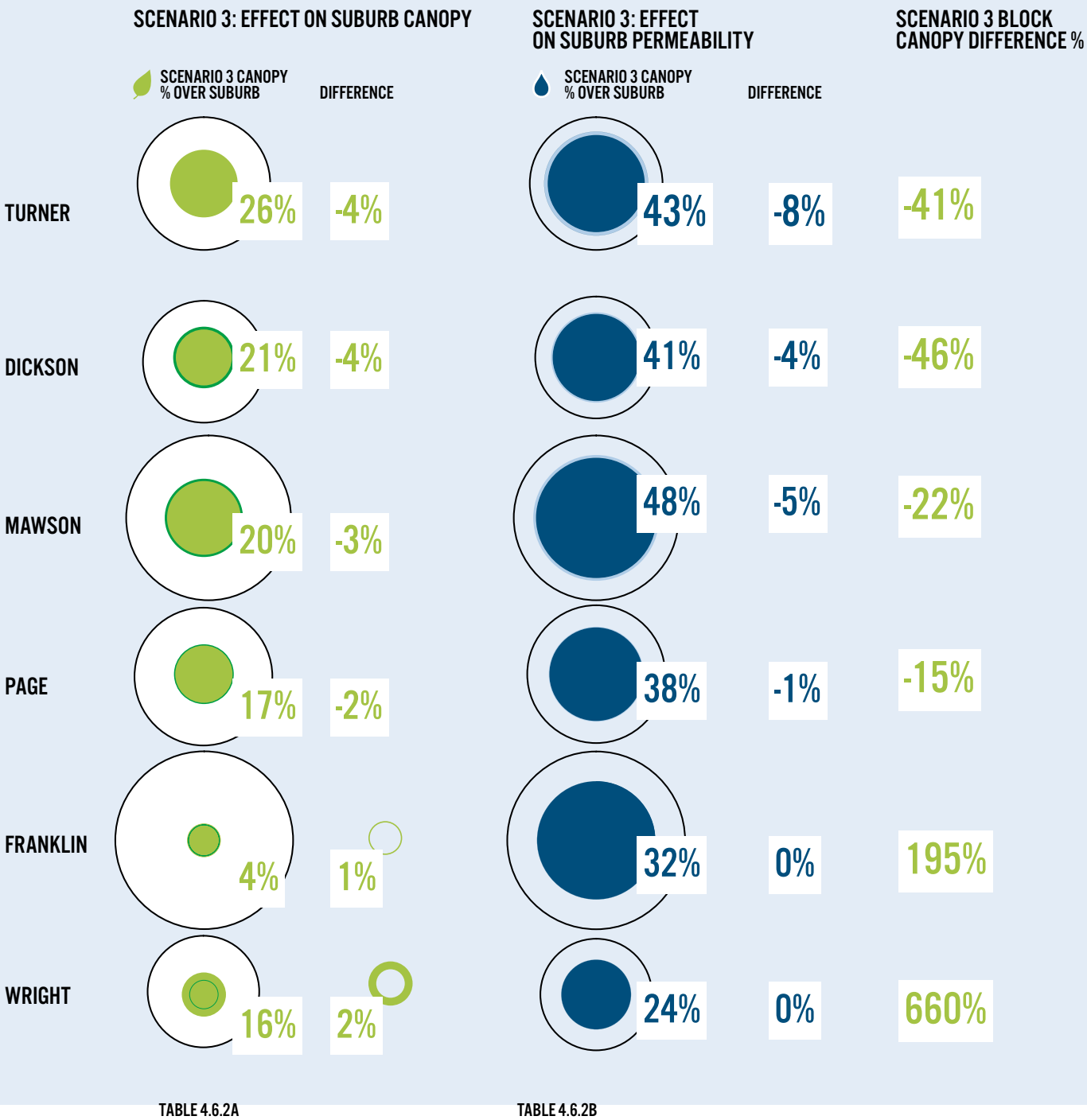


TABLE 4.6.2A

TABLE 4.6.2B

4.6 Findings from Data Analysis

Where is Existing Living Infrastructure found?

Blocks

Existing canopy coverage is predominately found on blocks and streets. These canopy areas combined make up over 70% of all canopy cover in older suburbs. The larger spread of data for on-block canopy in land use zones indicates that canopy cover is largely found in RZ1 and RZ3 blocks, suggesting that single dwelling blocks contain the most canopy area. Study blocks indicate this to be correct in Mawson and Turner.

Streets and Open Space

When considering block and street canopy in the older suburbs, it should be noted that the coverage of block canopy is consistently provided by street trees. The 5m buffer zones used to estimate street tree coverage on block found that street trees contribute 25% of block canopy cover in older suburbs. Open space canopy cover is found to be variable between study suburbs, ranging from 16% cover in Dickson to 33% cover in Turner.

Where is Living Infrastructure lacking?

Streets

While canopy area for newer suburbs is largely unreliable as trees have not reached their mature sizes, it can be expected that trees in these suburbs will provide far less canopy coverage over blocks and streets due to various factors impacting newer suburbs. Trees within streets have a comparable verge area to old suburbs but could possess less soil volume for growth due to increase in services within the verge. The increased area of hardstand due to increase in size and frequency of paths, and increased area of driveway due to increasing block density and standard driveway sizes, greatly decreases street permeability. This decrease could detrimentally impact the heath of street trees, hindering their canopy sizes.

Trees over Blocks

Street trees in newer suburbs are subject to more clearances than those of older suburbs. Projected mature street tree canopies in newer suburbs typically do not overlap as found in older suburbs where street trees provide a consistent network of canopy coverage within a suburb, over streets and over blocks. Street trees which do not provide on-block cover will account for the potentially significant disparity between suburb canopy cover for older and newer suburbs.

Diminishing Block Sizes

In addition to losing on-block canopy cover offered by street trees, on-block canopy cover could be affected further by larger driveways, decreasing block sizes and increasing building areas. The decreasing block sizes are demonstrated in the shifting spread of block typologies found in each study suburb. This change is demonstrated in the considerable increase of compact blocks in newer suburbs. Apart from the 2% of compact blocks in Page, there are no compact blocks in older suburbs, whereas in Franklin and Wright, compact blocks make up 13% and 6% of blocks respectively. An example comparing average RZ1 blocks in Turner and Wright demonstrates the shift toward smaller blocks and a significant increase in block coverage by building footprints. The average RZ1 block in Turner is 1154m^2 whereas the average RZ1 block in Wright is less than half of this, at 499m^2 yet the difference in building sizes within these blocks are comparable, the average building footprint of an RZ1 dwelling in Turner is 334.66m^2 and the same building footprint in Wright is 274.45m^2.

As a result, it can be observed that building areas are not reducing in size proportionally to the reduction in block size rather the building's footprint is not considerably affected by the reduction of block size. Instead it is the space for canopy area and permeable area on block that is significantly reduced.

Further, when comparing large block typologies (which are a more direct comparison sharing similar block areas), it is clear that buildings in newer suburbs are covering more block area than in older suburbs. Large blocks follow the trend of smaller, compact and mid-sized blocks in the same suburbs, where the percentage of building footprint to block area is much higher than older suburbs. The average percentage of building footprint to block area in large blocks within RZ1 is over 50%, whereas in all older suburbs the same percentage does not exceed 33%.

The effects of these factors impacting canopy coverage cannot be accurately projected at this time however, it can be expected that newer suburbs will have substantially less canopy coverage than older suburbs.

Expected Impact

Projections

The impact of increasing density is a significant consideration for older suburbs where the canopy cover may be integral to the character of the suburb. General impacts of an increasing density can be observed in the existing conditions of the newer suburbs. It can be anticipated that the same impacts will affect older suburbs as density increases. These general impacts include a trend toward an increase in building footprint area over block and an increase in impermeable area as paths and driveways increase in size and frequency. The effect of these conditions to canopy area will become apparent as trees in newer suburbs reach their mature sizes.

Block Canopy

We recognise that the primary constraint facing living infrastructure on block is the increase in building footprint to block density and the resulting lack of available permeable space. Scenario 2 and 3 investigates change to on block canopy brought on by increasing density. The output of calculations measured from block level data indicates a considerable loss of on block canopy. For Scenario 2, Mawson and Turner will lose over half of the existing on block canopy. For Scenario 3, Dickson and Turner lose over 40% of the existing on block canopy. When analysed at suburb level and looking at the difference in percentage of *Canopy Cover over Suburb*, the impact appears significantly less. Older suburbs in Scenario 2 lose 3% - 7% canopy cover over suburb area, and older suburbs in Scenario 3 lose 2% - 4% canopy cover over suburb area. The reason for this difference is that the impact has been mitigated by the unchanged canopy area of open space and street trees.

Street Canopy

While it can be assumed that there will be no change to the open space canopy cover from the increasing density of these scenarios, it is the impact to street trees which becomes the critical determining factor when measuring the impact of increasing density on canopy. In understanding that street trees contribute to a larger proportion of canopy cover than open space streets, and also that street trees provide a significant portion of on block canopy, then the impact of increasing density can be largely determined by the impact on street trees. A percentage of on-block canopy could potentially be protected by safeguarding the health of existing street trees. Factors concerning the heath of street trees include the permeability of street area, the permeability of block area, space on block for canopy area, and soil volume among many others. An example of detrimental impact could be the increase in services within the verge area to service the increase in yield that may decrease the available soil volume for street trees or affect the existing root zone of established street trees. Should the impact on street trees be detrimental, then the impact will reflect at suburb level canopy correspondingly.

Open Space Canopy

Open space canopy provides a significant portion to the overall canopy area of a suburb. The data does not indicate that open space area provides consistent canopy coverage over the study area. However, it can be expected that existing canopy coverage would be undisturbed by increased density and will represent a larger portion of the overall canopy cover of the suburb as on block canopy cover is lost to increased density. Open space area has potential for further planting to increase canopy coverage. Additionally, the area of open space provided contributes greatly to the overall permeability of a suburb.

Shifting Nature of Streets Trees

The planting of street trees has changed over time. Between older and newer suburbs there is an observed difference in the planting patterns of street trees, from a consistent density of canopy coverage to a more scattered planting.

Planting in new suburbs has become limited due to parking bays, paths and driveways.

Older suburbs should prioritise street tree canopy retention while newer suburbs should seek to increase available canopy cover to meet satisfactory standards or a standard similar to other suburbs in Canberra.

5.0 Recommendations

These recommendations are based on the findings of the literature review and spatial analysis study of existing condition and future scenarios based on data projections. Recommendations are outcomes-oriented and utilise statutory controls, design guides and rating tools as mechanisms to bring about high-quality living infrastructure realities. Our recommendations are presented across three scales; Block, Street and Suburb, as a means to structure an approach and ensure that change is achieved holistically.

Seven overarching recommendations are identified with twenty-six direct mechanisms suggested to support the change.

Overview

These recommendations support embedding living infrastructure across statutory frameworks.

The recommendations are presented as

Key Finding: This defines the issue presented to maintain and enhance living infrastructure in our built environment.

Policy Objective: This sets out the proposed policy objective to be achieved.

Proposed Planning Policy and Mechanisms: This nominates the mechanism or other planning instruments to implement the proposed principles.

This structure provides an outline of the issues, the guiding principles for addressing issues, and suggests proposed mechanisms to meet that change.

High-level recommendations grouped at the Block, Street and Suburb level provide a recommendation for the underlying principle for change and then look at broader policy context through resourcing and education.

5.1 Block Level

In newer suburbs, building footprints are increasing and block sizes are decreasing, resulting in a significant reduction in permeable surfaces. This has implications for the amount of planting area and water infiltration possible at the block level and prevents trees from reaching their nature canopy.

Key Finding

The effectiveness of key rules in the Single Dwelling Housing Development Code and the Multi Unit Housing Development Code are currently undermined by associated criteria that can result in compliant development that does not meet the intent or spirit of the rule.

Policy Objective

Control the footprint of the dwelling on the site to ensure sufficient permeable area for planting.

Proposed Planning Policy and Mechanisms:

- Site Cover control
- Planting area minimums
- Rating tool

Block Level Recommendations

Review existing Territory Plan controls applying to building footprint, including plot-ratio and private open space, and introduce spatial controls for maximum building footprint and minimum required planting area across all residential zonings. Preliminary investigation of the interaction between Site Coverage and Plot Ratio are expressed through diagrams in Attachment 6, however, further investigation is needed to comprehensively model the relationship including requirements for solar access, building envelope and setbacks. Additional modeling is required to understand the unintended social and economic consequences of the given recommendations in relation to accessibility, housing affordability and cost of build.

Plot Ratio Revision

The current Territory Plan utilises different controlling mechanisms to restrict housing footprint, such as Private Open Space and Plot Ratio. The affective variable differs between dwelling type and block size. The following Site Cover mechanism attempts to simplify and streamline, while strengthening, the approach so that at each instance it is the Site Coverage control that mitigates the building footprint. Therefore, consider removing plot ratio in the Single Dwelling Housing Code. Initial modeling has shown plot ratio to be made irrelevant with the creation of a strong Site Coverage control.

Site Cover Definition;

Expand the site cover definition to ensure roofed elements that impact permeability are captured and limited by site coverage maximums.

Site Coverage: "the proportion of the actual site covered by dwellings and all other buildings including roofed: terraces, pergolas, patios or decks".

Rating Tool

Introduce a rating tool to replace and strengthen criteria pertaining to Site Coverage rules across the Single Dwelling Housing Development Code and Multi Unit Housing Development Code. The rating tool is to be developed as an exercise of further study. It is anticipated the rating tool be based on examples explored in the literature review process. The rating tool is to be designed to take into consideration pre-existing conditions on block.

Elements to be taken into consideration include, but are not confined to:

- Planting area
- Site coverage
- Water infiltration
- Landscape quality
- Deep root planting area
- Tree canopy
- Green roofs
- Green walls

In the event the development of the rating tool is delayed a strengthened criteria should be implemented in the short term to avoid loop holes that are currently diminishing living infrastructure outcomes. Potential criteria to consider may include:

- Ensures all non-essential hardstand areas are built with permeable materials that allow water filtration that facilitates on-site infiltration of stormwater run-off
- Provide vegetation as the desired permeable surface to support cooling microclimates and improve soil health
- Provide deep soil zones suitable for planting and vegetation growth of deep rooted plants, particularly canopy trees
- Contribute to the dwellings energy efficiency by ameliorating extreme weather, by providing shade in summer, especially to west-facing windows, and admitting winter sunlight to living areas
- Incorporate trees, shrubs and ground covers that are local to the area and will attract local wildlife

SDHDC Site Coverage and Planting Area Controls

In Single Dwelling Housing Development Code, to streamline the controlling entity on building footprint and to enhance space available to planting, replace section 5.2 Private Open Space with Site Coverage and Planting Area controls as presented in Rule 38, 39, 40.

MUHDC Site Coverage and Planting Area Controls

In the Multi Unit Housing Development Code, to streamline the controlling entity on building footprint and to enhance space available to planting, replace section 4.2 and 4.3 Site Open Space with Living Infrastructure Controls presented in newly proposed Rule 38, 39.

- Relocate content pertaining to amenity, current content R38 a), b) and R39 a), b) to Element 6 Amenity

NOTE: Figures are derived from spatial analysis with modelling of existing controls across various typologies and proposed controls. Typology specific site coverage was explored, however, recommendations support retaining a zoned based approach to site cover percentages.

SINGLE DWELLING HOUSING DEVELOPMENT CODE CONTROLS

RULE 38 LARGE BLOCKS

Site Coverage: maximum 40% of block area

Planting Area: minimum 30% of block area

The minimum dimension of any area included in the planting area calculation is 2.5m to support larger vegetation

Trees on block: minimum of two canopy trees with mature height of greater than or equal to five metres

CRITERIA 38

Use of Rating Tool to achieve minimum standard score (to be determined through design of rating tool system)

RULE 39 MEDIUM BLOCKS

Site Coverage: maximum 50% of block area

Planting Area: minimum 25% of block area

The minimum dimension of any area included in the planting area calculation is 2.5m to support larger vegetation

Trees on block: minimum of two canopy trees with mature height of greater than or equal to five metres

CRITERIA 39

Use of Rating Tool to achieve minimum standard score (to be determined through design of rating tool system)

RULE 40 COMPACT BLOCKS

Site Coverage for rear loading blocks: maximum 70% of block area

Site Coverage for front loading blocks: maximum 50% of block area

Planting Area: minimum 20% of block area

The minimum dimension of any area included in the planting area calculation is 2.5m to support larger vegetation

Trees on block: minimum of one canopy trees with mature height of greater than or equal to five metres

CRITERIA 40

Use of Rating Tool to achieve minimum standard score (to be determined through design of rating tool system)

MULTI UNIT HOUSING DEVELOPMENT CODE CONTROLS

RULE 38 – RZ1 AND RZ2

Site Coverage: maximum 40% of block area

Planting Area: minimum 35% of block area

The minimum dimension of any area included in the planting area calculation is 2.5m to support larger vegetation

CRITERIA 38

Use of Rating Tool to achieve minimum standard score (to be determined through design of rating tool system)

RULE 39 – RZ3, RZ4, RZ5 AND COMMERCIAL ZONE

Site Coverage: maximum 45% of block area

Planting Area: minimum 25% of block area

The minimum dimension of any area included in the planting area calculation is 2.5m to support larger vegetation

CRITERIA 39

Use of Rating Tool to achieve minimum standard score (to be determined through design of rating tool system)

5.1 Block Level - Quality

Key Finding

Data shows that the apartment typology is relatively self-regulating due to plot ratio and basement form restrictions. Consequently, site cover controls were considered less pertinent for this housing type with improvement to living infrastructure outcomes to be captured by landscape design controls.

Policy Objective

Overlay site coverage controls with design controls to ensure commitment to high quality living infrastructure

Proposed Planning Policy and Mechanisms

- Landscape design controls

Block Level – Quality Recommendations

Incorporate site landscaping requirements into the development assessment process. Consider mechanisms that require landscape plans to be submitted as a requirement for Development Application for new development and significant redevelopment along with mechanisms to ensure implementation of the designs.

Landscape Quality Control

In the Multi Unit Housing Development Code introduce R40 to section 4.4 *Landscape Design*. Content and figures proposed are drawn from examples explored in the literature review as best practice design controls.

RULE 40 LANDSCAPE DESIGN	CRITERIA 40
The landscape design is to provide for a combination of tree planting – for shade, mid height shrubs, lawn and ground covers	**Use of Rating Tool to achieve minimum standard score (to be determined through design of rating tool system)**
Planting of trees of semi-mature stock	
Planting of trees with a minimum mature height of 5m	

Landscape Plans

Single Dwelling and Multi Unit developments to require:

- Landscape plans to be submitted as a requirement for Development Application
- Implementation of approved landscape plans prior to certificate of occupancy

MUHDC Landscape Plan Approval

For Multi-Unit developments landscape plans must be prepared and signed off by a registered Landscape Architect.

5.2 Street Level

Changes in design standards relating to footpaths, driveways and verge planting over time have had negative implications for living infrastructure. Increased footpath widths and driveway frequency have reduced the permeable area in verges and available soil volume for tree planting. A requirement that tree canopies cannot overlap block boundaries now restricts street tree size, reduces shade and the beneficial impact trees may have on reducing urban heat island effects.

Key Finding

Related controls are contained across a myriad of documents, such as the Estate Development Code, Design Standards for Urban Infrastructure and Utility Provider controls. These documents should be reviewed to ensure living infrastructure and tree assets are given equal consideration alongside other assets.

Policy Objective

Ensure that the tree asset is prioritised in street configurations to increase shade and cooling effects on streets and neighbouring blocks.

Proposed Planning Policy and Mechanisms

- Verge design
- Street tree planting
- Education
- Driveway standards

Street Level Recommendations

Improve the microclimate of urban areas to offset urban heat gain through prioritising and maximising street trees and permeable surface areas. Review relevant ACT statutory requirements, municipal design and technical standards with a view to improving implementation of living infrastructure and increasing available planting area in street verges. As part of this review include consideration of minimum road corridor widths, minimum verge widths, tree clearance requirements, deep root planting requirements, utilities corridor provisions, active travel (pedestrian and cycle) path provisions, and driveway and parking requirements for all street types.

Location of Services

Reviewing street configuration to allow more efficient location of services that result in an increase of soil volume. Measures may include location of services in shared corridors and under footpaths.

Permeable Verge Control

Review the Estate Development Code to improve permeability in the verge with a maximum impermeable area. This is a benchmark recommendation, reflective of the better performing older suburbs from the spatial analysis study. Further investigation would be needed to determine a percentage better suited to a denser urban form.

Estate Development Code section 9.2 Street Verge:

R60	C60
No more than 30% of the finished street verge surface is impervious	*unchanged*

Tree Clearances

Review current tree clearances, modifying the current approach to support the specification of large trees in street planting.

Verge Parking

Implement community education programs on the negative impact of parking on verges to living infrastructure.

Trees in Median

Review street configuration in larger streets creating opportunities for large trees to be planted in a median and to enable WSUD treatment.

Permeable Materials

Implement incentives to use permeable materials in construction, including the use of permeable pavers, permeable concrete, and permeable asphalt.

Design Standards for Driveways

Review design standards for driveways. For dual occupancy proposals within the established suburbs, a single verge crossing for both dwellings should be encouraged. The width requirement for verge crossings could be reduced for single dwelling verge crossings, consider Standard B14, 55.03-9 of the Yarra Council Planning Scheme.

5.3 Suburb Level

A significant proportion of trees at the suburb level are located in the public realm within public open space. The current Estate Development Code specifies areas per population for district parks and areas for neighbourhood parks but not for town parks or broad scale open space, which tend to be defined by adjacent development areas or existing topography. Functions for Town parks may have shrub or flower beds but no mention is made of trees. Similarly, trees are not specifically listed as a feature of broad scale open space which may include remnant and planted native vegetation.

> **"...Tree planting, helps to clean the air, reduces urban heat, offers shade, provides habitat for wildlife and adds aesthetic appeal to the urban landscape. It can also assist the infiltration of rain water to the water table and reduce storm-water runoff" (NSW Low Rise Medium Density Design Guide)**

Key Finding

Within the Estate Development Code there is currently no requirement for a minimum provision of broad scale open space or minimum canopy cover for suburbs.

Policy Objective

Improve the liveability of the microclimate through the design of the public realm.

Proposed Planning Policy and Mechanisms

- Minimum open space in estates
- Trees in public realm controls

Suburb Level Recommendations

Review statutory mechanisms under the Territory Plan establishing minimum requirements for tree provision, canopy cover and open space area in estate developments and precincts to improve the microclimate of the public realm to minimise urban heat gain.

Open Space Control

Implement a new rule in the Estate Development Code to allocate a minimum percentage of neighbourhood to open space. The rule is to be applied to developments greater than or equal to twenty hectares. Where specific site conditions such as creek lines, areas of environmental significance etc. exist, protection would be afforded through the Precinct Code. Twenty hectares is nominated because it would not apply to an individual development, such as an apartment complex, but would come into force for developments of a significant scale. The proposed percentage has been adopted from the best performing study suburb in the spatial analysis and is noted for further study.

RX – OPEN SPACE PROVISION	CX – OPEN SPACE PROVISION
A minimum of 30% of development boundary is zoned PRZ1 or NUZ3 for developments 20ha or greater	**Proximity to existing or proposed PRZ1 or NUZ3 zoning must be able to demonstrate the 30% open space is met at the neighbourhood level**

Street Tree Controls

Allocate a minimum street tree coverage by street type to Table 2A of the Estate Development Code, as a referenced table in Mandatory Rules. Percentages are drawn from findings of the Spatial Analysis where street trees are shown to fluctuate according to the street category and related conditions. These figures are preliminary, they are to be confirmed through further study.

Estate Development Code – Table 2A

FACILITY TYPE	REAR LANE	SHARED USE ACCESS STREET 'WOONERF' STYLE	ACCESS STREET A	ACCESS STREET B	MINOR COLLECTOR	MAJOR COLLECTOR
Minimum Street Tree Requirement	No trees required and not to be planted unless sufficient space is provided	>40% street trees to be provided	40% street trees to be provided	40% street trees to be provided	25% street trees to be provided	30% street trees to be provided

Public Realm Canopy Cover Control

Implement an additional Rule, following from Rule 27 of the Estate Development Code, to create a minimum canopy cover for parks and open space:

R28	
A minimum 40% of canopy cover is provided in the public realm. **This rule applies to all public realm spaces except for the following:** **i) street verges** **ii) street medians** **iii) access ways (as defined in table 4)** **iv) pedestrian lanes (as defined in table 4)**	*unchanged*

Remnant Trees

Implement provision in the Estate Development Code regarding the retention of remnant trees to give instant shade while landscaping matures and provide habitat

Shading of Footpaths

Revise Rule 25 of the Estate Development Code to make the rule mandatory ensuring the comfort and liveability of the public realm is addressed.

5.4 Living Infrastructure in the Statutory Framework

Living infrastructure is not well described in planning documents, indicating it is not a priority for development in Canberra. Similarly, raising community awareness of the importance of fostering living infrastructure through development does not appear to be a priority.

Key Findings

Existing planning and development provisions that support living infrastructure lack focus and are dispersed in various documents.

Policy Objective

Consider living infrastructure as essential infrastructure for development design.

Proposed Planning Policy and Mechanisms

- TCCS Standards
- Design Guides
- Legislation

Statutory Level Recommendations

Review and update the policy and statutory framework for planning and development in the ACT with the aim of supporting best-practice living infrastructure delivery with effective regulatory requirements.

TCSS Standards

Review of relevant municipal infrastructure standards administered would provide an opportunity to ensure consistency of terminology and technical requirements to ensure delivery of complimentary living infrastructure outcomes in the public realm.

Design Guidelines

Develop statutory Living Infrastructure Design Guidelines as a best practice reference document to support the implementation of mandatory minimum standards and encourage high quality in the implementation of living infrastructure in the ACT. Design Guidelines will assist the consistency and standardisation for projects of all scales.

Government Legislation

To embed the practice across all stakeholders, consideration should be given to include living infrastructure Territory Plan strategic direction, structure plans, concept plans, precinct codes and development codes

5.5 Resources and maintenance

With urban intensification and future climate change, the importance of public realm living infrastructure to the Canberra community will continue to increase. The current level of resources allocated to landscape maintenance presents challenges for the continued delivery and maintenance of high-quality living infrastructure.

Key Issue

Current level of funding does not support the implementation or maintenance of high quality living infrastructure

Policy Objective

Identify funding to embed living infrastructure as essential infrastructure in the planning framework.

Proposed Planning Policy and Mechanisms

- Funding streams
- Maintenance minimisation

Resource and Maintainence Level Recommendation

With recognition of the increasingly important role living infrastructure plays in the public realm, review the conditions for long-term funding to support ongoing delivery and maintenance of living infrastructure in the ACT. Identify new funding streams in collaboration with relevant departments and undertake pilot urban canopy and greenspace linkage projects.

Capital Works

Integrate consideration of living infrastructure as a standard component of planning and design processes for relevant capital works projects such as roads, public transport infrastructure, pedestrian and cycle paths and public spaces.

Government Funding

Identify key existing government funding programs which may support living infrastructure.

Maintenance

Identify opportunities for passive irrigation of street trees and priority public open spaces to minimise maintenance demands. Develop policy, technical standards and design guidelines to support stormwater irrigation of public realm living infrastructure, such as street trees, verges and priority public open spaces.

5.6 Education

A lack of public awareness regarding the importance and impact of living infrastructure on wellbeing, comfort and as an essential community asset has consequences for maintenance and prioritisation of these assets, particularly on block.

Key finding

On Block conditions show poor living infrastructure outcomes.

Policy Objective

Normalise conversation about the positive impact of living infrastructure in the community and among practitioners and officials.

Proposed Planning Policy and Mechanisms

- Education campaigns

Education Level Recommendations

Implement public education programs which emphasise the value of Living Infrastructure on:

a. Healthy cities
b. Biodiversity
c. Urban heat island effect
d. Mental health and wellbeing
e. Water infiltration and storm water management

6.0 Conclusion of Key Policy Approaches

Key policy approaches to embed living infrastructure across statutory frameworks are informed by a spatial analysis of the current condition.

Reflecting on the application of Territory Plan controls for building footprint it was observed the rule was often coupled with weak and indirect criteria controls. The spatial analysis suggests many developments defer to application of the criteria, creating a condition where the intent of the rule is watered down and becomes ineffectual.

Recommendations at the Block level seek to simplify the process of and strengthen restrictions of building footprint by introducing a Site Coverage Control and an affiliated Rating Tool criteria.

It was considered important to legislate minimum tree planting and open space provision as the core elements controllable through the design and development phase. In this capacity Street Tree and Open Space recommendations seek to assure a suitable suburb level canopy cover to mitigate against heat island effects, ensure habitat links, shade amenity etc.

7.0 Further Studies

The scope of this project is limited and has identified a range of further studies that could be undertaken to support the ongoing development of living infrastructure in the ACT. Many of the recommendations will require additional research and development.

Further investigation is required into the integration of living infrastructure for urban intensification in residential and commercial development including mixed use.

Improving and building the data set

Scenario 1 data facilitated valuable insight into how living infrastructure exists in Canberra. Scenario 2 and 3 built on this existing data to understand how living infrastructure will look in tomorrow's Canberra. From all of these data sets provided, reliable findings about living infrastructure have been established. To further the understanding of living infrastructure, data sets for future studies can build on and refine these data sets.

The continual observation of the blocks experiencing increasing density and measuring impact to living infrastructure on these blocks will allow us to better understand how our older suburbs will look going into the future. The continual observation of living infrastructure in newer suburbs is also important to understand how canopy is affected by the many factors impacting newer suburbs. For relevant suburbs, the mature canopy should be measured against projected mature canopy of landscape plans to understand how accurate these projections are. Some other suggestions on improvements to data:

- As with any data set, a larger spread of data will yield a more reliable result. A larger spread of data could involve:
  - More study suburbs
  - More study streets
  - More study blocks
- Mature canopy data could be sourced for newer suburbs, this will give a more reliable comparison between suburbs
- For street level data, the study suburbs could include data about how much of each street classification accounts for the total street area. This will allow for study street data to be projected up to suburb level with much greater accuracy, rather than needing to take an average of all street classifications at suburb level.

Rating tools

One of the key recommendations is the development of a rating tool to take the place of key criteria in the Territory Plan. Further study of rating tools is required to understand their complexity and success in driving the desired outcomes. An ACT specific tool should be developed based on this additional research. Discussions should be held with jurisdictions using rating tools, such as Seattle, to gain an understanding of the impact the Seattle Green Factor has had on tree canopy and vegetation after ten years.

Understanding the interdependencies in the Territory Plan at the block level

The proposed introduction of a site coverage and planting area control to replace the private open space control also overlaps with the plot ratio controls. Further study is required to model the interdependencies between these controls and better understand their effect on each other. It is likely that the plot ratio controls could be removed all together from the Territory Plan.

Comprehensive review of controls affecting street trees

The controls affecting the delivery of street trees that provide shade and cooling are spread across a range of documents. A study mapping the impact of these controls in section and plan for different street types and adjacent block typologies is required to identify how controls need to be modified. Service providers must be part of this discussion.

Percentage of canopy coverage by street type in Estate Development Code

Further studies are required to improve percentage of canopy coverage, by street type, in Estate Development Code and other statutory provisions, guidelines and standards.

Percentage of canopy coverage in Open Space in Estate Development Code

Further studies are required to improve percentage of canopy coverage, in open space, in Estate Development Code and other statutory provisions, guidelines and standards.

Percentage of open space in new estates

A study of the wider Canberra urban form beyond the six suburbs studied for this project, plus additional research into this topic, are required to inform the proposed rule. The control could be based around area per hectare, area per head of population or area per district.

Design standards for driveways

A study of alternative configurations for reduced driveway widths and configurations is required.

Living Infrastructure Design Guidelines

The preparation of Living Infrastructure Design Guidelines as a best practice design guide for practitioners, government and citizens across all scales of development.

Inclusion of Living Infrastructure across all statutory documents

Further work is needed around how and where living infrastructure can be embedded across statutory documents.

Funding mechanisms

Strategic policy on how the current economic model in the ACT can be augmented to allow for the ongoing maintenance of living infrastructure.

Education Campaign

Development of an education campaign on living infrastructure.

8.0 Attachments

1. Definition and Benefits of Living Infrastructure, Excerpt from Brief;
2. Literature Review Summaries
3. Literature Review References
4. EPSDD Proposed Methodology
5. Additional Data Tables
6. Block Diagram Templates

Attachment 1
Definition and Benefits of Living Infrastructure
Excerpt from Brief

STATEMENT OF REQUIREMENTS (CONSULTANCY SERVICES)

Planning and Design for Living Infrastructure as Part of Residential Intensification in a Changing Climate.

Definition of Living Infrastructure

At a broad scale, Living Infrastructure refers to all interconnected ecosystems within an urban catchment. Living Infrastructure integrates and builds upon the concepts of 'green infrastructure' (which focusses on vegetation) and 'blue infrastructure' (which focuses on water management) within urban landscapes.

Within the ACT policy context, four basic components of living infrastructure have been identified as:

- plants (native and exotic vegetation)
- open spaces (parks, pathways, verges)
- lakes, ponds, and waterways (stormwater treatments)
- soils and surfaces.

Living infrastructure is an essential component of the urban environment that occurs on and applies to:

- Public land: parks open spaces and reserves, waterways and wetlands, streets and transport corridors, squares and plazas, sports and playing fields
- Private land: front gardens and backyards, building roofs and building facades and walls

Living infrastructure is supported by:

- stormwater management, capture and reuse
- ground water recharge
- urban runoff quality and quantity
- capacity of stormwater systems.

Benefits of Living Infrastructure

Living infrastructure provides a range of beneficial ecosystem services in the urban environment, including:

- reducing urban heat and improving resilience to climate change
- reducing urban stormwater run-off, improving water quality and groundwater infiltration
- increasing urban biodiversity and habitat connectivity
- reducing urban air pollution
- reducing energy usage in the built environment
- increasing property values
- increasing urban amenity, community health and wellbeing.

Attachment 2
Literature Review References

Australian Institute of Landscape Architects. Smart Cities Plan. ACT: Australian Institute of Landscape Architects; 2016.

This paper is a submission in response the Commonwealth Government's Smart Cities Plan (March 2016). It emphasises the value of living infrastructure as being able to enhance and regenerate natural resources rather than simply minimise damage to environmental systems. This regenerative capacity is increased through strategic connectivity of landscape assets. AILA proposes living infrastructure be recognised as an asset class thus enabling broader economic objectives to be realised.

Terminology: Living infrastructure, green infrastructure assets

Mechanisms: recognition of living infrastructure as an asset class; embracing living infrastructure metrics, creative living infrastructure funding and implementation strategies. Sustainable Sites Initiative (SITES) http://www.sustainablesites.org rating system via Commonwealth funded City Deals https://cities.infrastructure.gov.au/city-deals delivered via local government.

Adelaide City Council. Adelaide Design Manual: Green Infrastructure Guidelines: Adelaide City Council, Adelaide; 2014.

Green infrastructure is defined in this document as the web of interrelated natural systems that underpin and are integrated with the urban fabric. These include living architecture, the urban forest, green streets and water sensitive urban design. Eight guiding principles provide a high level framework for the implementation of Green Infrastructure initiatives to achieve real and lasting benefit.

These guidelines, prepared by Aspect Studios, are set out in four sections: Context, Applications, Elements, and Implementation with four appendices including Best Practice Examples, Policy and Background Research, Workshop Summary and Examples of Maintenance strategies. It covers both public and private realms. This structure ensures guidelines which draw on a wide body of knowledge and focused on Adelaide and the issues it faces to become a healthy, resilient city. Further details are attached at Attachment 2. The document is supported by excellent photographs and technical illustrations.

The importance of embedding green infrastructure in the city's urban design framework and of working across a range of scales and a range of levels is emphasised. Scales include regional, city, and individual; levels include policy and planning, city design and city assets. Benefits of green infrastructure, its design and maintenance are key elements in the guidelines.

Successful implementation of green infrastructure depends on (1) an integrated design approach requiring prioritisation of greening equal to, or more important than, other infrastructure; (2) collaboration with a diverse group of professionals such as landscape architects, engineers, policy makers, asset managers, architects, ecologists, soil scientists, horticulturalists and authorities; and (3) collaboration between Council, developers, building owners, privates residents, design consultants , contractors, operations and maintenance personnel and utility providers responsible for a range of city assets.

Terminology: Green infrastructure, Urban Design Framework, Improved water management, Human Health and Wellbeing, Increased Livability, Climate modification Economic Prosperity, Improved Urban Ecology, whole-of-life-cycle-cost analysis, Living Architecture, Green Streets, Water Sensitive Urban Design, Urban Forest, Urban Food, Soft Engineering, Hard Engineering.

Mechanisms: recognition of green infrastructure as an asset, policy that includes incentives and contributions (from Council and or developers), use of a rating tool. Green Infrastructure Rating Tool (GIRT), evidenced passed design, staged implementation, capacity building, and illustration of opportunities via example.

Adelaide City Council. Adelaide Design Manual: Greening: Adelaide City Council, Adelaide; 2016. A companion document, Greening: Technical Specifications, is currently under development.

This document is part five or seven in the Adelaide Design Manual and emphasises the value of creating a web of interrelated natural systems across a range of scales and applications in the city with the intent of building a city that is sustainable, economically prosperous and resilient. It refers to and draws heavily upon the Green Infrastructure Guidelines above. This 'greening' approach stresses the benefits, doing more with less money, looking beyond the public realm, educating (seen as critical) users, developers, designers engineers contractors and maintenance staff about sustainable urban design approaches and their implementation. Its focus is the public realm.

Eleven greening principles 'outline the implementation of green infrastructure initiatives to achieve real and lasting benefits for the City of Adelaide'. The Greening Approaches set out are intended to be used as a toolkit for green infrastructure approaches in conjunction with the Green Infrastructure Guidelines. The approaches area organised under five headings: 1. Living Architecture; 2. Green Streets; 3. The Urban Forest; 4. Water sensitive Urban Design; and 5. Urban Food. The five approaches are elaborated as to their purpose, elements and significance for the city.

A significant part of the document is devoted to Street trees and planting, both seen as important in moderating the city's climate, helping to meet future climate challenges and creating a more climate resilient city. The approach adopted seeks to achieve planting that is environmentally and contextually appropriate for the character and heritage of Adelaide. Five themed planting palettes, including related street tree and planting groups, provide design intent for themes and desirable physical characteristics (should be referenced to the Street Types section in the Adelaide Design Manual). Each palette theme and approach is further elaborated (precinct use and approaches intended to achieve design, environmental and social outcomes) and located on a map. Minimum Design Standards to be adhered to for all projects set out street tree and planting palettes. These palettes and the Green Infrastructure Guidelines must be used when implementing greening approaches throughout the city's public realm. Species for planting palettes (as opposed to tree palettes) are not provided and are determined on a case by case basis with Adelaide City Council. Greening of Squares is determined by individual Master Plans.

The document provides a coherent approach to greening the City's streets, supported by excellent images, maps and illustrations.

Terminology: Green Infrastructure, Water Sensitive Urban Design, Greening Principles, Living Architecture, Green Streets, Urban Forest, Urban Food, Planting Palettes, Design Standards.

Mechanisms: Planting palettes; plant selection that is environmentally and contextually appropriate, principles designed to enhance ecological, social and economic values, design manual defines parameters, Design intent approach, precinct based planting design, creation of connected network of greening. Foster best practice.

Kendal D, Farrar A, Plant L, Threlfall C G, Bush J, Baumann J (2017). Risks to Australia's urban forest from climate change and urban heat. Clean Air and Urban Landscapes Hub. Australia.

This paper documents a study of public trees in Australia's cities and provides analysis of risk under two scenarios: limited climate change and 'business as usual'. Several strategies are offered for urban forest managers to adapt to increasing temperatures including building resistance (irrigation, pest control, mulching, improving abiotic conditions) resilience (irrigation, soil improvement, improved stock selection, planting techniques, longer establishment maintenance) and selection of species better able to adapt to future climates (consult with Nursery industry about better lead times etc and diversity of selection). Meaningful engagement with the community and industry will help to create successful urban forests of the future. The report provides useful data for planning and policy development and illustrates the importance of establishing and maintaining reliable tree inventories. Key factors for success with urban forest policy and governance include building a shared vision of the urban forest and broad based partnerships across government departments and non-government stakeholders as well as sharing information across jurisdictional boundaries and between Australian cities. Integration of urban forest policies with other urban policies (land use, planning, transport, health, ecology and open space management) is also a factor in the success of transitions in urban forest policy. Adequate funding, resources, availably of technical expertise together with monitoring and evaluation to support adaptations to species composition and to governance, management and engagement processes is another key success factor. The importance of the urban forest to social and cultural services and equity is emphasised as is the need to engage with the community.

Terminology: Urban forest diversity, ecosystem services, biodiversity, social and cultural services, resistance, resilience.

Mechanisms: build resistance, resilience, improved tree planting and selection techniques, continuing consultation/engagement with industry and community, fostering urban forest 'champions, whole of government approach including policy integration, adequate funding for resources, maintenance and technical expertise, monitoring, sharing information across jurisdictions (State and National).

Alexandra J, Norman B, Steffen W and Maher W (2017) Planning and Implementing Living Infrastructure in the Australian Capital Territory – Final Report, Canberra Urban and Regional Futures, University of Canberra, Canberra.

This document is a literature review to support delivery of innovative, high quality living infrastructure as part of Canberra's urban renewal and development processes. A number of key themes and issues relevant

to Canberra are identified. Of these the following are relevant to Stage 1 of this project: an integrated government approach, institutional and political commitment, capacity for integrated planning across all levels and functions of government and active community involvement, an emphasis on cultural aspects of innovation, and research and development. Consultation and participatory planning methods are central to successful urban strategies – a wider process that mobilises citizens, civic institutions, communities and practitioners. Techniques such as scenario planning help to build capacity and build support. Good practice in water sensitive design should be integrated into living infrastructure planning and policy and risk reduction should be a key design element. Urban forests and biodiversity conservation are integral to living infrastructure. Good use should be made of outcome-focused guidelines and design principles to enhance the quality of planning decisions. It is also important to be able to broadly quantify ecosystem service benefits for options under consideration.

Well-designed living infrastructure is an essential component of effective climate mitigation and adaption strategies for cities. There is a strong rationale for integrated planning focused on achieving multiple benefits. Living infrastructure needs to be understood in terms of transitions towards meeting societal needs for sustainability as well technical and material aspects and it is important to distinguish between incremental and transformational adaptation. Cities face a range of constraints to transformative change, including institutional complexity and incremental planning. Responsiveness to new challenges, circumstances, knowledge and climate change is critical to adaptive and transformative capacity.

Strong case is made for green infrastructure in urban renewal projects in Canberra especially along the transit corridors. Several types of living infrastructure are commonly used in urban development: tree plantings, WUSD, green roofs and walls, community gardens and green connectors. Living infrastructure is best implemented not as individual elements but as a broad, interconnected green infrastructure network that provides multiple ecosystem services to urban populations. Two other important strategies contribute to successful living infrastructure: enhancing sense of place and providing financial incentives for installation of living infrastructure, for example Vancouver requires five percent of the value of development be directed into social infrastructure. Several examples of implementation of this type of infrastructure are provided.

The paper proposes five ideas for Canberra – a design competition along light rail corridor; integrated planning across several scales from pocket parks and walking corridors between light rail stops, to larger scale connectivity between the transit corridor and nature reserves and existing parks (Haig Park a good example); blue infrastructure - Sullivan's Creek offers opportunities); challenge to private sector developers along the corridor to give high priority to living infrastructure and a climate scorecard for three main metrics to be achieved - storing carbon, heat adaptation and managing WSUD.

Waste water in Canberra, especially stormwater, needs to be treated as a resource to be managed and reused. Transformation of water systems includes both technological innovation and the broader challenges of governance and institutional reform. There is the possibility of creating of micro-pockets of urban 'floodplain forest' where run-off is concentrated to mimic say, River Oak forests.

The literature is split on usefulness of defining living infrastructure as an asset which may obfuscate wider role of government as protector of the public's long term interests. Rather than focus on assets it may be better to focus on understanding how policy decisions are made and effect change that way. Also, having guiding design principles focused on outcomes may be more effective than investing in valuation studies.

Seattle Green Factor http://www.seattle.gov/dpd/codesrules/codes/greenfactor/default.htm

Adopted in 2007, the Seattle Green Factor (SGF) is a weighted, score-based code requirement for specified developments in Seattle. It was based on the Berlin Biotope Area Factor https://www.berlin.de/senuvk/umwelt/landschaftsplanung/bff/index_en.shtml and modified to suit the Seattle context. Currently SGF does not apply to single residential development. SGF is a response to concerns about balancing urban density with liveability and the need to support ecosystem function especially in relation to stormwater and the heat island effect. It was also a response to LEED provisions at the time which focussed on buildings rather than landscape. SGF does not apply to all development in Seattle and currently does not apply to single residential zones.

GSF aims to increase the amount and quality of landscaping in urban areas while allowing flexibility for developers and designers to use property efficiently. As a mandated system it provides flexibility for developer to meet the code and rewards:

- low water use
- layered planting with site appropriate plants
- tree preservation
- large canopy street trees

- permeable paving
- green roofs and walls
- bioretention areas

Bonuses points are achievable by including drought tolerant or native plant species, irrigation with harvested rainwater, landscape features that are visible to passers-by and Food cultivation.

SGF scores required are typically tied to zones: The city of Seattle requires the equivalent of 30% of a block in commercial zones to be vegetated using the SGF

Zone	Minimum Score
Commercial and neighbourhood commercial	0.30
Industrial Commercial (in urban villages)	0.30
Midrise and highrise residential	0.50
Lowrise multifamily residential	0.60
South Downtown	0.30
South Lake Union	0.30

Lots of unusual configuration may be assessed based on project impact area rather than total area, giving developers flexibility to use the site efficiently. A worksheet and score sheet are attached.

A completed green factor scoresheet and landscape plans must be included as part of the plan set submitted for development/building approval. Minimum designer qualifications apply to preparation of the landscape plans, depending on the size of the development together with detailed requirements for information and standards to be provided on the landscape plan. Maintenance is given high priority and a Landscape Management Plan is also required as part of the project. It is not submitted with the development application, instead the designer certifies one has been prepared and handed to building owner.

A Landscape Improvement Checklist must be signed by the project's landscape professional and submitted to the building inspector and landscaping must be installed in accordance with the approved plans prior to issue for final Certificate of Occupancy. except in special circumstances – for example, severe drought. Critically, because SGF is embedded in the statutory framework, building owners may be subject to legal action if the landscape elements are not installed as per the approved plans.

Director's Rule 30-2015 Page 15 of 16 http://www.seattle.gov/dpd/codes/dr/DR2015-30.pdf

Revised 4/8/09

Green Factor Worksheet*

SEATTLE×green factor

		Planting Area						TOTAL**
		1	2	3	keep adding columns as needed			
A1	square feet							0
A2	square feet							0
A3	square feet							0
B1	square feet							0
B2	# of plants							0
B3	# of trees							0
B4	# of trees							0
B5	# of trees							0
B6	# of trees							0
B7	# of trees							0
C1	square feet							0
C2	square feet							0
D	square feet							0
E	square feet							0
F1	square feet							0
F2	square feet							0
G	square feet							0
H1	square feet							0
H2	square feet							0
H3	square feet							0
H4	square feet							0

* See Green Factor score sheet for category definitions
** Enter totals on the Green Factor score sheet

The interactive Excel version of this worksheet is available at www.seattle.gov/dpd/greenfactor.

Director's Rule 30-2015 Page 16 of 16 http://www.seattle.gov/dpd/codes/dr/DR2015-30.pdf

Revised 12/28/10

Green Factor Score Sheet

SEATTLE×*green factor*

Project title:

		enter sq ft of parcel			
	Parcel size (enter this value first) *	5,000		SCORE	-
	Landscape Elements**	Totals from GF worksheet		Factor	Total
A	**Landscaped areas (select one of the following for each area)**				
1	Landscaped areas with a soil depth of less than 24"	enter sq ft: 0		0.1	-
2	Landscaped areas with a soil depth of 24" or greater	enter sq ft: 0		0.6	-
3	Bioretention facilities	enter sq ft: 0		1.0	-
B	**Plantings (credit for plants in landscaped areas from Section A)**				
1	Mulch, ground covers, or other plants less than 2' tall at maturity	enter sq ft: 0		0.1	-
2	Shrubs or perennials 2'+ at maturity - calculated at 12 sq ft per plant (typically planted no closer than 10" on center)	enter number of plants: 0	0	0.3	-
3	Tree canopy for "small trees" or equivalent (canopy spread 8' to 15') - calculated at 75 sq ft per tree	enter number of plants: 0	0	0.3	-
4	Tree canopy for "small/medium trees" or equivalent (canopy spread 16' to 20') - calculated at 150 sq ft per tree	enter number of plants: 0	0	0.3	-
5	Tree canopy for "medium/large trees" or equivalent (canopy spread of 21' to 25') - calculated at 250 sq ft per tree	enter number of plants: 0	0	0.4	-
6	Tree canopy for "large trees" or equivalent (canopy spread of 26' to 30') - calculated at 350 sq ft per tree	enter number of plants: 0	0	0.4	
7	Tree canopy for preservation of large existing trees with trunks 6"+ in diameter - calculated at 20 sq ft per inch diameter	enter inches DBH: 0	0	0.8	
C	**Green roofs**				
1	Over at least 2" and less than 4" of growth medium	enter sq ft: 0		0.4	
2	Over at least 4" of growth medium	enter sq ft: 0		0.7	
D	**Vegetated walls**	enter sq ft: 0		0.7	
E	**Approved water features**	enter sq ft: 0		0.7	-
F	**Permeable paving**				
1	Permeable paving over at least 6" and less than 24" of soil or gravel	enter sq ft: 0		0.2	
2	Permeable paving over at least 24" of soil or gravel	enter sq ft: 0		0.5	
G	**Structural soil systems**	enter sq ft: 0		0.2	
		sub total of sq ft =	0		
H	**Bonuses**				
1	Drought tolerant or native plant species	enter sq ft: 0		0.1	
2	Landscaped areas where at least 50% of annual irrigation needs are met through the use of harvested rainwater	enter sq ft: 0		0.2	
3	Landscaping visible to passersby from adjacent public right of way or public open spaces	enter sq ft: 0		0.1	
4	Landscaping in food cultivation	enter sq ft: 0		0.1	-
				Green Factor numeric =	-

* *Do not count public rights-of-way in parcel size calculation.*

** *You may count landscape improvements in rights-of-way contiguous with the parcel. All landscaping on private and public property must comply with the Landscape Standards Director's Rule (DR 6-2009)*

The interactive Excel version of this score sheet is available at www.seattle.gov/dpd/greenfactor.

Green Business Certification Inc (2014) SITES v2 Rating System for sustainable land design and development - The SITES v2 Rating System is owned by Green Business Certification Inc. The material on which the SITES v.2 Rating System is based was developed through a collaborative, interdisciplinary effort of the American Society of Landscape Architects Fund, The Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the United States Botanic Garden

http://www.sustainablesites.org/

SITES is a US based, independent landscape-focussed rating system applicable to projects across the scales from single blocks to a large subdivisions, brownfield and greenfield sites. It is a system that can be used world-wide. SITES is administered by the Green Business Certification Inc (GNCI) and is not tied to a specific development approval process. There is a fee for registration and a separate fee for certification of a project. Because SITES provides performance benchmarks rather than prescriptive practices, it can support the unique conditions of a site, encouraging flexibility and creativity appropriate to site context and intended use.

Central to SITES is the idea that ecosystem services through sustainable landscapes create resilient communities better able to recover from catastrophic events (eg floods, drought, wildfire s) and benefit property owners, local and regional communities and economies. Since its inception in 2007, SITES has been extensively field tested in a two year pilot program involving more than 160 projects. As at March 20187, some 120 projects across 35 US States and eight countries have registered or certified with SITES.

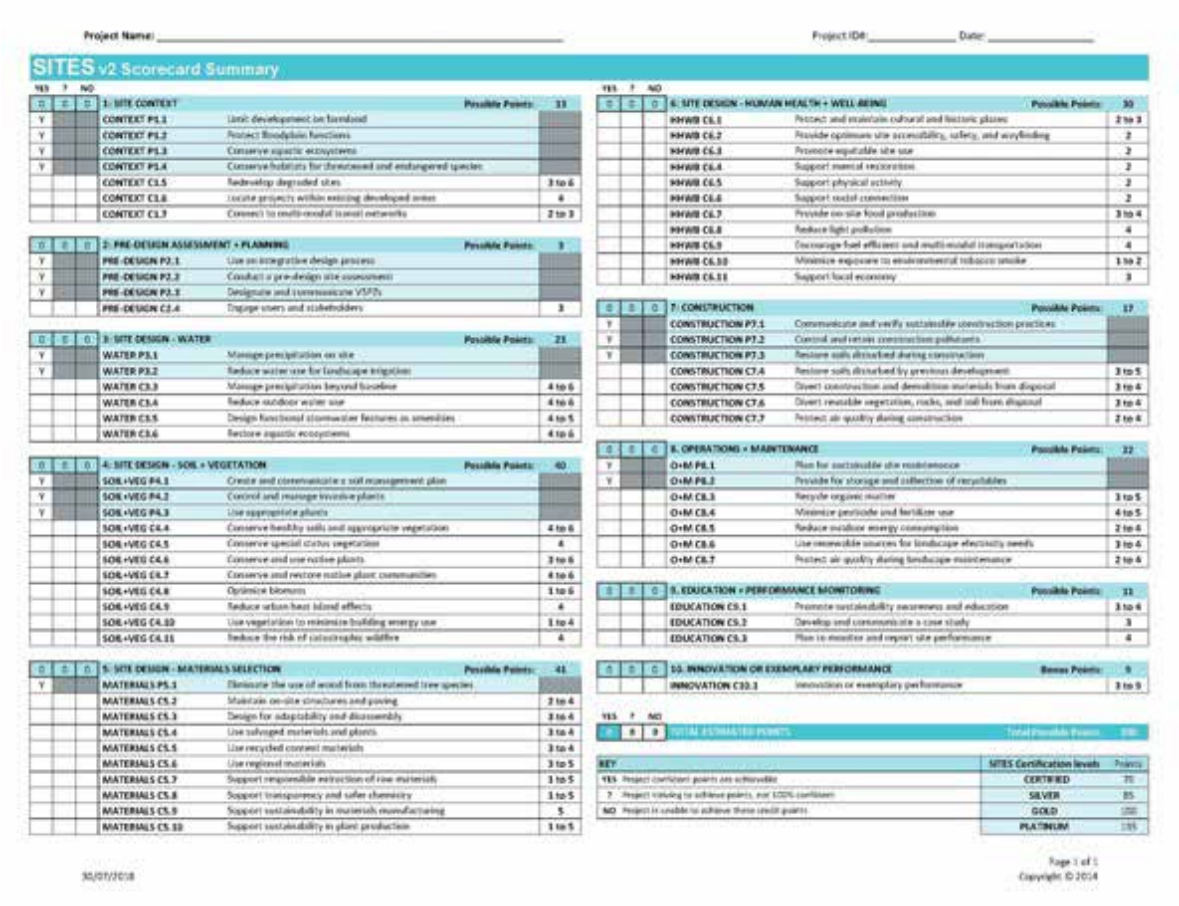
By aligning design and development practices with the functions of healthy ecosystems, ... SITES offers several significant benefits and values: 1) it advances best practices in landscape architecture and other environmental design professions, 2) it may help design professionals fulfil their health, safety, and welfare responsibilities for licensure, 3) clients can be assured that their project has achieved rigorous, field-tested standards for sustainability, 4) clients can market the SITES certification of their projects (as many do for the LEED® green building program), and 5) it is ethically responsible, protects natural systems for present-day use and appreciation, and preserves ecosystems and their essential services for future generations. (GBCI, SITES v2 Rating System for sustainable land design and development 2014)

The site-specific benchmarks are organised by development phases:

- Site context
- Predesign assessment and planning
- Site design – water
- Construction
- Operations and Maintenance
- Education and performance monitoring
- Innovation and exemplary performance

Each phase includes prerequisites, which must be achieved and are not scored, and potential credits which are scored and count towards the final rating and level of certification. For example, under Site Context the prerequisites include conservation of aquatic ecosystems, and habitats for threatened and endangered species while credits can be achieved for redevelopment of degraded site, location of projects within existing developed areas and connection to multi-modal transit networks. A sample summary scorecard is attached.

SITES offers professional accreditation on successful completion of an exam appropriate training and experience. http://www.sustainablesites.org/education-listing?field_education_type_value_1=SITES+rating+system+specific+courses . There is also a free webinar series about sustainable landscape design and development.



Project Name: _____ Project ID#: _____ Date: _____

SITES v2 Scorecard Summary

Y	?	NO			Possible Points
			1: SITE CONTEXT		33
Y			CONTEXT P1.1	Limit development on farmland	
Y			CONTEXT P1.2	Protect floodplain functions	
Y			CONTEXT P1.3	Conserve aquatic ecosystems	
Y			CONTEXT P1.4	Conserve habitats for threatened and endangered species	
			CONTEXT C1.5	Redevelop degraded sites	3 to 6
			CONTEXT C1.6	Locate projects within existing developed areas	4
			CONTEXT C1.7	Connect to multi-modal transit networks	2 to 3
			2: PRE-DESIGN ASSESSMENT + PLANNING		3
Y			PRE-DESIGN P2.1	Use an integrative design process	
Y			PRE-DESIGN P2.2	Conduct a pre-design site assessment	
Y			PRE-DESIGN P2.3	Designate and communicate VSPZs	
			PRE-DESIGN C2.4	Engage users and stakeholders	3
			3: SITE DESIGN - WATER		23
Y			WATER P3.1	Manage precipitation on site	
Y			WATER P3.2	Reduce water use for landscape irrigation	
			WATER C3.3	Manage precipitation beyond baseline	4 to 6
			WATER C3.4	Reduce outdoor water use	4 to 6
			WATER C3.5	Design functional stormwater features as amenities	4 to 5
			WATER C3.6	Restore aquatic ecosystems	4 to 6
			4: SITE DESIGN - SOIL + VEGETATION		40
Y			SOIL+VEG P4.1	Create and communicate a soil management plan	
Y			SOIL+VEG P4.2	Control and manage invasive plants	
Y			SOIL+VEG P4.3	Use appropriate plants	
			SOIL+VEG C4.4	Conserve healthy soils and appropriate vegetation	4 to 6
			SOIL+VEG C4.5	Conserve special status vegetation	4
			SOIL+VEG C4.6	Conserve and use native plants	3 to 6
			SOIL+VEG C4.7	Conserve and restore native plant communities	4 to 6
			SOIL+VEG C4.8	Optimize biomass	1 to 6
			SOIL+VEG C4.9	Reduce urban heat island effects	4
			SOIL+VEG C4.10	Use vegetation to minimize building energy use	1 to 4
			SOIL+VEG C4.11	Reduce the risk of catastrophic wildfire	4
			5: SITE DESIGN - MATERIALS SELECTION		41
Y			MATERIALS P5.1	Eliminate the use of wood from threatened tree species	
			MATERIALS C5.2	Maximize on-site structures and paving	2 to 4
			MATERIALS C5.3	Design for adaptability and disassembly	3 to 4
			MATERIALS C5.4	Use salvaged materials and plants	3 to 4
			MATERIALS C5.5	Use recycled content materials	3 to 4
			MATERIALS C5.6	Use regional materials	3 to 5
			MATERIALS C5.7	Support responsible extraction of raw materials	1 to 5
			MATERIALS C5.8	Support transparency and safer chemistry	1 to 5
			MATERIALS C5.9	Support sustainability in materials manufacturing	5
			MATERIALS C5.10	Support sustainability in plant production	1 to 5
			6: SITE DESIGN - HUMAN HEALTH + WELL-BEING		30
			HHWB C6.1	Protect and maintain cultural and historic places	2 to 3
			HHWB C6.2	Provide optimum site accessibility, safety, and wayfinding	2
			HHWB C6.3	Promote equitable site use	2
			HHWB C6.4	Support mental restoration	2
			HHWB C6.5	Support physical activity	2
			HHWB C6.6	Support social connection	2
			HHWB C6.7	Provide on-site food production	3 to 4
			HHWB C6.8	Reduce light pollution	4
			HHWB C6.9	Encourage fuel efficient and multi-modal transportation	4
			HHWB C6.10	Minimize exposure to environmental tobacco smoke	1 to 2
			HHWB C6.11	Support local economy	3
			7: CONSTRUCTION		17
Y			CONSTRUCTION P7.1	Communicate and verify sustainable construction practices	
Y			CONSTRUCTION P7.2	Control and retain construction pollutants	
Y			CONSTRUCTION P7.3	Restore soils disturbed during construction	
			CONSTRUCTION C7.4	Restore soils disturbed by previous development	3 to 5
			CONSTRUCTION C7.5	Divert construction and demolition materials from disposal	3 to 4
			CONSTRUCTION C7.6	Divert rewildable vegetation, rocks, and soil from disposal	3 to 4
			CONSTRUCTION C7.7	Protect air quality during construction	2 to 4
			8: OPERATIONS + MAINTENANCE		12
Y			O+M P8.1	Plan for sustainable site maintenance	
Y			O+M P8.2	Provide for storage and collection of recyclables	
			O+M C8.3	Recycle organic matter	3 to 5
			O+M C8.4	Minimize pesticide and fertilizer use	4 to 5
			O+M C8.5	Reduce outdoor energy consumption	2 to 4
			O+M C8.6	Use renewable sources for landscape electricity needs	3 to 4
			O+M C8.7	Protect air quality during landscape maintenance	2 to 4
			9: EDUCATION + PERFORMANCE MONITORING		11
			EDUCATION C9.1	Promote sustainability awareness and education	3 to 4
			EDUCATION C9.2	Develop and communicate a case study	3
			EDUCATION C9.3	Plan to monitor and report site performance	4
			10: INNOVATION OR EXEMPLARY PERFORMANCE		Bonus Points: 9
			INNOVATION C10.1	Innovation or exemplary performance	3 to 9

YES	?	NO

TOTAL ESTIMATED POINTS — Total Possible Points: 330

KEY	SITES Certification levels	Points
YES Project confident points are achievable	CERTIFIED	70
? Project striving to achieve points, not 100% confident	SILVER	85
NO Project is unable to achieve these credit points	GOLD	100
	PLATINUM	135

30/07/2018

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Jacobs, B., Mikhailovich, N., and Delaney, C. (2014) Benchmarking Australia's Urban Tree Canopy: An i-Tree Assessment, prepared for Horticulture Australia Limited by the Institute for Sustainable Futures, University of Technology Sydney.

This paper provides, at a high level, an estimate of land surface cover for 139 Local Governments across Australia. Metrics (i-Tree https://www.itreetools.org/) used in the report offer an opportunity to benchmark green cover to inform green infrastructure development at low cost. The report is presented as a first step in 'strengthening and understanding of the composition of land cover and how urban greening strategies can be maximised in urban areas of Australia [and act as a catalyst] for 'a process of social change through benchmarking.'

Land cover is categorised to enable analysis of ecological function and identification of opportunities for creating green cover:

- Tree cover
- Shrub cover
- Grass and /or bare ground
- Hard surfaces

Distinguishing between tree and shrub cover provides information about laying of existing green cover. Distinguishing between hard surfaces and grass/bare ground potentially reveals what is potentially plantable and area that may offer innovative solutions such as green roofs on 'hard surfaces'. I-Tree in this project draws on Google Earth imagery overlaid with shape file boundaries. The data reveals the ACT to have the highest proportion of tree cover (56%) in the local government areas studied. This provides a useful benchmark of combined private and public green cover when setting future green cover targets across a range of scales in the ACT.

This report may have been overtaken by more recent and detailed data for the ACT, and its high level nature limits its use, nevertheless the categorization of land cover provides valuable insights for policy and project development. A three-stage research process is recommended:

- quantitative analysis: high level land surface mapping of land cover by area, percentages of cover by category

- quantitative analysis: refinement of land surface mapping - essentially to distinguish between public and private ownership, how is bare grass used, where are the areas of opportunity (bare grass and hard surfaces) located etc, overlap with socioeconomic indexes (most useful when overlaid with mapped urban heat island effects)
- qualitative analysis: understanding quality: building on the quantitative data, undertake qualitative analysis to maximise human and environmental benefits of urban greening (targeted intervention). Questions to ask include:
  - which plant species would best suit
  - what are human engagement patterns with new or existing vegetation
  - where are priority areas for native vegetation
  - what are broader social impacts of urban greening

The report recommends undertaking a Social Return on Investment (SROI) analysis to attribute a dollar value to and long and short term outcomes for further urban greening.

Terminology: Tree cover, shrub cover, grass/bare ground, hard surfaces, potentially plantable, currently non-plantable, urban greening,

Mechanisms: strategic policy based research.

Government Architect NSW (GANSW) (2017). Greener Places, Establishing an urban green infrastructure policy for New South Wales. NSW Government, Sydney.

http://www.governmentarchitect.nsw.gov.au/policies/greener-places

GANSW sets out a draft policy guide for design, planning, design and delivery of green infrastructure in urban NSW. Green infrastructure is defined as

The network of green spaces, natural systems and semi-natural systems including parks, rivers, bushland and private gardens that are strategically planned, designed and maned to support a good quality of life in an urban environment.

This concept of landscape as green infrastructure creates a collaborative framework of designers, planners, developers and policy makers seeking to achieve local and state goals related to liveability, quality of life and wellbeing. In this context green infrastructure is seen as crucial to a city as transport, cultural and communications infrastructure, complementing other types of infrastructure projects. Its elements range from 'residential gardens to local parks and housing estates, streetscapes and highway verges, services and communications corridors, waterways and regional recreation areas'. Page 13 of this document includes a diagram illustrating how these elements can be utilised in a green infrastructure network.

Well-designed green infrastructure should respond to the following key principles:

- Integration – combine with urban development and grey infrastructure
- Connectivity – create an interconnected network of open space
- Multifunctionality – deliver multiple ecosystem services simultaneously
- Participation – involve stakeholders in development and implementation

A strong case is made for green infrastructure as an essential asset, promoting multifunctional design delivering a range of benefits to a single area. 'Well-designed and planned green infrastructure will help absorb flood water, cool the urban environment, clean the air, provide space for local food production and ensure the survival of Sydney's fauna and flora as well as providing space for recreation, sport and leisure.' Green infrastructure is seen to deliver key environmental, economic and social benefits.

The document offers a vision of what an integrated, connected and multifunctional green infrastructure network would look like. It would provide for:

- Conservation of the natural environment
- Increased access to open space
- Improved connectivity to promote active living
- Increased urban greening to ameliorate climate extremes

Effective implementation of green infrastructure requires:

- appropriate statutory measures at state and local government levels – inclusion of green infrastructure as essential infrastructure in strategic planning outcomes and requirements in regional and district plans; inclusion of green infrastructure in land use and infrastructure plans, priority precincts etc; issue of manuals, toolkits, practice notes about open space strategies, urban bushland and waterway strategies and urban canopy cover strategies; monitoring and reporting of outcomes; development of model council

Development Control Plan clauses to provide guidance to councils.

- collaborative action between the government, stakeholders and local communities through a series of workshops to finalise key actions for implementation; assign measurable outcomes for each action; assign lead agencies to instigate policy ; identify partners to work lead agencies.
- enacting key principles of integration, connectivity, multifunctionality and participation.
- funding at a level required to deliver the desired outcomes. Identifying the funding will require an audit of all existing funding programs, embedding green infrastructure as essential infrastructure in the planning framework; identifying new funding streams; in collaboration with relevant departments undertake pilot urban canopy and greenspace linkage projects; identifying funding stakeholders (eg State government agencies, councils, industry peak bodies and private sector); and identifying key existing government funding programs.

Importantly, 'Greener Places' is not a one-size-fits-all approach and publically available mandatory monitoring and reporting on policy outcomes is essential. Data should be made available to the community: examples could include live green grid mapping, known urban canopy coverage, information on priority projects and monitoring and reporting on grant allocations from the various green infrastructure funding programs.

Key elements in the delivery of green infrastructure include:

- Establishing a green infrastructure design policy
- Establishing design standards, design guidance and design manuals to support good practice and outcomes for green infrastructure
- Working across government to embed policy principles in all relevant areas
- Consult with a range of stakeholders prior to finalising policy.

Key mechanism: policy and design guidance (manuals, standards etc) embedded in statutory framework.

Verburg, P., van Teeffelen, A. and Derkzen, M. (2018). Green infrastructure for urban climate adaptation: How do residents' views on climate impacts and green infrastructure shape adaptation preferences? Landscape and urban planning, 157, pp.106-130.

https://www.sciencedirect.com/science/article/pii/S0169204616300949#!

Abstract

Cities are particularly prone to the effects of climate change. One way for cities to adapt is by enhancing their green infrastructure (GI) to mitigate the impacts of heat waves and flooding. While alternative GI design options exist, there are many unknowns regarding public support for the various options. This study aims to fill this gap by performing a socio-cultural valuation of urban GI for climate adaptation that encompasses multiple dimensions: people's notion of and concerns about climate impacts, the degree to which people acknowledge the benefits of GI to alleviate such impacts, and people's preferences for different GI measures, including their willingness to pay (WTP). Data were collected through photo-assisted face-to-face surveys (n = 200) with residents in Rotterdam, the Netherlands, and linked to GI GIS data. Respondents had a notion of and concerns about climate impacts, but did not necessarily acknowledge that GI may help tackle these issues. Yet, when residents were informed about the adaptation capacity of different GI measures, their preferences shifted towards the most effective options. There was no information effect, however, on people's WTP for GI, which was mostly related to income and ethnicity. Our study shows that economic valuation alone would miss nuances that socio-cultural valuation as applied in this paper can reveal. The method revealed preferences for particular adaptation designs, and assists in detecting why policy for climate adaptation may be hampered. Understanding people's views on climate impacts and adaptation options is crucial for prioritizing effective policy responses in the face of climate change.

This statistically rigorous study addressed:

- Notions of and concerns about climate impacts – concerns about urban heat were significantly more frequent among respondents who noticed temperature differences within the city and concerns about future heat impacts were more common among people who currently experienced it as a problem. Concerns about flooding were similar except that concerns about urban flooding were more common among respondents living in streets with little green infrastructure.
- Rating of green infrastructure benefits – respondents did not fully acknowledge the capacity of green infrastructure to mitigate local climate change effects. Overall, respondents acknowledged green infrastructure's capacity to mitigate local flooding but its ability to regulate temperature was less acknowledged.

- Preferences for green infrastructure measures - respondents showed a preference for green infrastructure that is diverse, aesthetically attractive and familiar over the simple and unfamiliar.

Home level: preference for gardens followed by green roofs (especially for those with children)

Neighborhood level: most preferred streets with shrubs or trees over grass strips. Local squares were preferably turned in to pocket parks with grass, shrubs and trees.

City level: people preferred canals and trees over grass strips along main roads. Wooded parks were preferred as city parks, possibly because of their suitability for a combination of uses – sport, play, rest and enjoying nature. Spatial analysis revealed that people living in an area with greater green infrastructure cover more often preferred water rich parks over wooded parks.

At all levels, preferences shifted to more effective green infrastructure measures after respondents had been provided with more information about climate (impacts). Measures were primarily chosen because of their attractiveness and usefulness. There was a preference for large-scale green infrastructure over small-scale.

- Willingness to pay for green infrastructure measures – about two thirds of respondents were willing to pay for green infrastructure measures, mostly via an annual household tax.

Discussion

In general people were aware of the impact of urban heat and flooding and considered these to be serious future challenges. The study shows that providing information about the benefits of green infrastructure can increase support for adaptation measures indicating that environmental education has the potential to create public support for adaptation measures. 'Acceptability can increase when green infrastructure designs are promoted on a neighbourhood level to influence neighborhood norms so the residents do not feel like an outsider when they install a rain garden or green roof.'

Residents in green infrastructure poor areas preferred new trees being planted over shrubbery suggesting that urban planning should prioritise tree planting in new suburbs.

Conclusions

- People's awareness of climate impacts and understanding of green infrastructure benefits shapes their preferences for green infrastructure measures. Understanding this helps planners to identify more effective policy responses.
- In general, people are willing to support climate adaptation through green infrastructure as long as it is multifunctional.
- It is advisable to create public support for green infrastructure by making people aware of climate change impacts and by providing information about the multiple benefits of green infrastructure and tailor the choice to local preferences.

Attachment 3
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Attachment 4
Proposed Methodology

Planning and Design for Living Infrastructure as Part of Residential Intensification in a Changing Climate

Stage 2 – Spatial Analysis Study – Methodology

This proposed methodology for Stage 2 outlines the methodology undertaken for the data for Stage 2 Spatial Analysis Study. The data for Stage 2 is undertaken by EPSDD and provided to the consultant.

Utilising spatial data from the ACT Government's data sets and project experience EPSDD have mapped the living infrastructure and built form for the existing situation for six case study areas (suburbs). The spatial data sets include:

- Road infrastructure
- ACT Cadastre /Territory Plan based on blocks
- Hardstand areas including footpaths and driveways
- Building Footprints
- Tree Canopy Lidar data
- Tree Canopy Raster including heights
- Tree Canopy data including areas and attribution for tree types, age, dominant species in the road verge only)

The case study areas are examples of areas within greenfield development, existing older areas in Canberra and areas which could be subject to urban intensification. The spatial analysis study will assess the impact of development on living infrastructure at three levels or scales for six case study areas:

- the suburb level
- the street level (5-6 streets in each suburb)
- the individual block level (3-5 blocks in each zone)

The spatial analysis study has considered the impact of development on living infrastructure cover for three scenarios.

- Scenario 1 - assessment of existing living infrastructure and built form
- Scenario 2 - assessment and built form coverage under potential development yield within the existing zoning and its impact on living infrastructure
- Scenario 3 - assessment and built form coverage under projected high development yield and its impact on living infrastructure.

Case studies

- A minimum of six ACT specific case studies (suburbs) have been investigated.
- These case studies comprise a representative range of ACT developments and residential densities within RZ1 to RZ5 zoning in both greenfield and future possible urban infill locations in older parts of Canberra and the more recently developed areas. The case studies include a range of development and dwelling types.
- The study area include suburbs planned:
  - Suburbs designed for Griffin's plan for Canberra
  - Suburbs designed as part of the Garden City movement
  - Suburbs designed by the NCDC
  - Suburbs designed by ACT Government
- Suburbs / Case study areas
  - Dickson
  - Turner
  - Page
  - Mawson
  - Wright
  - Franklin

Scenarios

For the purpose of this study the scenarios has been undertaken as follows:

Scenario 1 – Existing Situation

- Mapping of data spatially for the case studies which are then extracted into excel spreadsheets in order to assess the amount of living infrastructure at suburb, street and block levels as a series of areas (m2) and percentages.
- The block types for the Spatial Analysis Study have been selected for:
  - Mix of zoning within residential zoning (RZ1 to RZ5)
  - Diversity of block size
  - Dwelling type

Scenario 2 – Potential development Yield Existing Zoning

- The potential development yield under the existing zoning is estimated at block level.
- Scenario 2 is representative of what the market is currently providing in terms of dwelling types and building footprint and is allowable under the existing Territory Plan zoning.
- Examples of dwellings have been utilised to estimate the impact of living infrastructure if the existing zoning was realised on the case study blocks. This has been drawn from ACTMapi and Development Application (DA) data and are identified as max yield blocks in the spreadsheets.
- At block level, case study data from Scenario 1 is compared to the examples of dwellings (max yield blocks). The potential development yield is estimated in terms of:
  - existing zoning
  - possible dwelling types permitted in the existing zoning
  - size of the block
  - site coverage
- Dwelling types for Scenario 2
  - RZ1 – maximum coverage (large houses)
  - RZ2 – dual occupancies (Block equal or > 700m2)
  - RZ3 – townhouses
  - RZ4 – multi-unit
  - RZ5 – multi unit
- Not taken into consideration
  - setbacks
  - plot ratio
  - building height

Scenario 3 - High development Yield

- The high development yield is estimated at block level.
- This scenario is a projection of higher zoning which could be considered in order to meet the demand for urban intensification in line with ACT Government policy.
- Examples of dwellings and blocks have been utilised to estimate the impact of living infrastructure if the higher development potential was realised through up zoning. This has been drawn from ACTMapi and Development Application (DA) data.
- The maximum development yield is estimated in terms of:
  - higher possible zoning:
    - blocks in proximity to commercial centres (600m)
    - blocks in proximity to frequent rapid transit corridors (600m)
    - blocks in proximity to light rail transit corridors (800m)
  - higher possible zone changes:
    - RZ1 to RZ2 – to allow dual occupancy (equal or > 700m2)
    - RZ2 to RZ3 – to allow townhouses
    - RZ3 to RZ4 – to allow multi-unit
    - RZ4 to RZ5 – to allow multi-unit
- possible dwelling types permitted in the higher zoning
- site coverage i.e. the amount of built form covering the block

  - size of the block
- Not taken into consideration
  - setbacks
  - plot ratio
  - building height

Testing Private Open Space Provisions and Planting area in the Territory Plan

- The Spatial Analysis study will test the existing private open Space provisions including the Planting Area provision from the Single Dwelling Code and the Multi Unit Code of the Territory Plan.
- For this study the rule will apply. The criteria will not apply.
- For this study the site open space for the multi-unit code is not calculated.

The following assumptions for calculating private open space and planting area have been drawn from the Territory Plan.

Single dwelling code

Large blocks >500m2 (R38)

- Private open space
  - Private open space has a minimum area equal to 60% of the block minus 50m2
- Planting area
  - 50% of the minimum area is planting area

Mid-size blocks >250m2 < or = to 500m2 (R39)

- Private open space
  - Private open space has a minimum area equal to 40% of the block minus 50m2
- Planting area
  - 50% of the minimum area is planting area

Compact blocks <250m2 (R40)

- Private open space
  - Private open space has a minimum area not less than 20% of the block
- Planting area
  - 50% of the minimum area is planting area

Multi Unit Code

RZ1 and RZ2 (R38)

- Site open space
  - NA for this study
- Planting area
  - 20% min of total site area is planting area

RZ3 and RZ4 and RZ5 (R39)

- Site open space
  - NA for this study
- Planting area
  - 10% min of total site area is planting area

Mapping of data in detail

The mapping for the Spatial Analysis Study for the Scenario 1 – the existing situation, includes the following data at suburb, street level and block level as outlined in the brief.

Suburb

- Zoning RZ1- RZ5
- dwelling density within RZ1 to RZ5
- access to public open green space and recreation space
- the amount of public open green space and recreation space as a percent of the suburb
- tree canopy cover as a percent of the suburb
- tree canopy cover for the RZ1-5 zonings

- tree canopy height including the range of heights and an average height
- permeable surface area as a percent of the suburb
- impermeable cover as a percent of the suburb

Street Level

- Segments of street types are mapped and analysed in each suburb including the tree canopy and the verge
- Zoning and adjacent land use
- street easement width and road corridor
- verge width for street types identified
- tree canopy cover as a percent of street and public realm
- tree canopy height including the range of heights and an average height
- permeable surface area as a percent of the street level and public realm
- impermeable cover as a percent of the street easement

Individual block level:

- zoning for RZ1 to RZ5 (provide a representative selection for a minimum of 3 blocks for each zoning for each of the study areas)
- block size and block width
- building footprint area as a percent of the block
- building height/storeys
- tree canopy cover as a percent of the block
- tree canopy height
- permeable surface area as a percent of the block
- impermeable cover as a percent of the block
- identification of underground services easement that might restrict canopy planting

Assumptions

Zoning

For the purpose of this study the areas that are being assessed are:

- Residential zoning within the RZ1 to RZ5 zonings
- Recreation and open space in PRZ1 and PRZ2
- Street Easements and Road corridors TSZ1 TSZ2

As the commercial and community areas are not being analysed for this study areas are mapped to exclude:

- Commercial zoning CZ zoning
- Community zoning CFZ zoning

Canopy Data

- For the purpose of this study where the canopy of a street tree is partly over a private block, that part of the canopy is considered in the canopy data of the private block. i.e. the canopy is clipped to the block boundaries.
- There is included in the data an option where the block boundary is indented 3 metres or 5 metres to allow the canopy of large trees in the street to be assessed within the street easement. This can impact on the percent of tree canopy whether it is in the public or private areas.

Permeable area

- All hardstand area including driveways and pathways are considered impermeable in the scenarios.
- Permeable area is the block area minus the building footprint and the hardstand area.

Glossary

Permeable cover - The area that is assessed as permeable surface area i.e. the reverse of impermeable

Impermeable cover- The area that is assessed as impermeable surface area, hardstand area including roads, driveways, pathways

Building footprint – The area that is contained by the building

Vegetated cover (landscape cover) – That area which is permeable, and can be vegetated including deep rooted planting areas for trees.

Private open space (Territory Plan definition) means an outdoor area within a block useable for outdoor living activities, and may include balconies, terraces or decks but does not include any area required to be provided for the parking of motor vehicles and any common driveways and common vehicle manoeuvring areas. Up to 25 per cent of any part of private open space may be roofed over, except that a balcony may be entirely roofed over.

Plot ratio (Territory Plan definition)means the gross floor area in a building divided by the area of the site.

Planting area (Territory Plan definition) means an area of land within a block that is not covered by buildings, vehicle parking and manoeuvring areas or any other form of impermeable surface and that is available for landscape planting.

Site coverage (Territory Plan definition) the proportion of the actual site covered by dwellings and all other building

Attachment 5
Additional Data Tables

4.3 Suburb

4.3.1A

	Study area (m^2)	% of open space area (including nuz3)	% of street area to study area	% of block area to study area
TURNER	1,179,933	27%	31%	42%
DICKSON	994,092	22%	28%	50%
MAWSON	1,818,248	23%	19%	57%
PAGE	1,272,425	8%	25%	66%
FRANKLIN	2,116,698	32%	34%	34%
WRIGHT	834,248	10%	43%	47%

4.3 Street

4.3.2A Major collector street

	Hardstand area to verge area	Driveway area to verge area	Verge area over total street area
TURNER	14%	11%	64%
DICKSON	20%	13%	61%
MAWSON	26%	8%	53%
PAGE	24%	10%	52%
FRANKLIN	N/A	N/A	N/A
WRIGHT	N/A	N/A	N/A

4.3.2B Minor collector street

	Hardstand area to verge area	Driveway area to verge area	Verge area over total street area
TURNER	20%	14%	57%
DICKSON	N/A	N/A	N/A
MAWSON	15%	12%	58%
PAGE	19%	12%	56%
FRANKLIN	29%	0%	50%
WRIGHT	19%	15%	59%

4.3.2C Modified access street

	Hardstand area to verge area	Driveway area to verge area	Road area to total street area	Verge area to total street area
TURNER	11%	15%	30%	70%
DICKSON	7%	18%	34%	66%
MAWSON	0%	15%	33%	67%
PAGE	0%	17%	38%	62%
FRANKLIN	9%	23%	37%	63%
WRIGHT	18%	26%	34%	66%

4.3 Study Blocks

4.3.3A Average building footprint (m²)

	Single dwelling	Duplex	Townhouse	Terrace	Multi-unit	Dual occupancy
TURNER	261		1847		1437	438
DICKSON	226	114			543	
MAWSON	264		3447	170	1734	394
PAGE	248		2050	118		340
FRANKLIN	278	125	3491	101	4367	
WRIGHT	246		1435	145	6562	

4.3.3B Average block area (m²)

	Single dwelling	Duplex	Townhouse	Terrace	Multi-unit	Dual occupancy
TURNER	1127		5577		3529	1338
DICKSON	752	636			1511	
MAWSON	1234		12634	345	8126	959
PAGE	840		5200	217		818
FRANKLIN	534	212	6714	175	10621	
WRIGHT	475		2099	250	15770	

4.3.3C Building footprint to block area ratio (%)

	Single dwelling	Duplex	Townhouse	Terrace	Multi-unit	Dual occupancy
TURNER	24%		39%		38%	33%
DICKSON	30%	22%			35%	
MAWSON	23%		36%	49%	21%	41%
PAGE	31%		39%	55%		42%
FRANKLIN	54%	59%	52%	57%	41%	
WRIGHT	53%		66%	58%	43%	

4.3.3D Building footprint to block area ratio (%)

	RZ1	RZ2	RZ3	RZ4	RZ5
TURNER	23%	-	37%	39%	-
DICKSON	34%	30%	29%	28%	-
MAWSON	28%	35%	-	21%	-
PAGE	30%	43%	-	-	-
FRANKLIN	-	-	55%	45%	-
WRIGHT	54%	-	-	-	53%

4.3 All Blocks

4.3.4A Compact blocks - %

	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	0%	0%	0%	0%	0%	6%
RZ2	0%	0%	0%	2%	0%	0%
RZ3	0%	0%	0%	0%	7%	0%
RZ4	0%	0%	0%	0%	6%	0%
RZ5	0%	0%	0%	0%	0%	0%

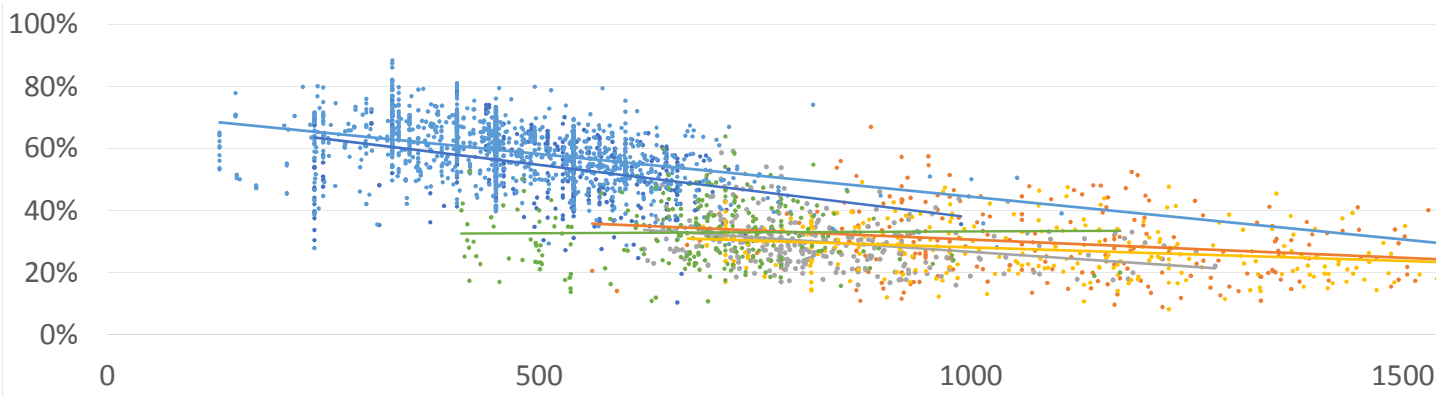
34.3.4B Mid sized blocks - %

	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	0%	4%	0%	0%	0%	41%
RZ2	0%	2%	6%	4%	0%	0%
RZ3	0%	1%	0%	0%	52%	0%
RZ4	0%	3%	0%	0%	0%	0%
RZ5	0%	0%	0%	0%	0%	0%

4.3.4C Large blocks - %

	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	64%	32%	46%	37%	0%	52%
RZ2	0%	25%	47%	57%	0%	0%
RZ3	13%	20%	0%	0%	34%	0%
RZ4	23%	14%	1%	0%	1%	0%
RZ5	0%	0%	0%	0%	0%	2%

RZ1 % OF Building Footrpint Over Block Area
GRAPH 4.3.4H



4.3.4D Average building footprint over block area - %

	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	29%	33%	26%	30%		55%
RZ2		32%	32%	33%		
RZ3	29%	32%			59%	
RZ4	34%	31%	20%		62%	
RZ5						44%

4.3.4E Average building footprint of large blocks over block area - %

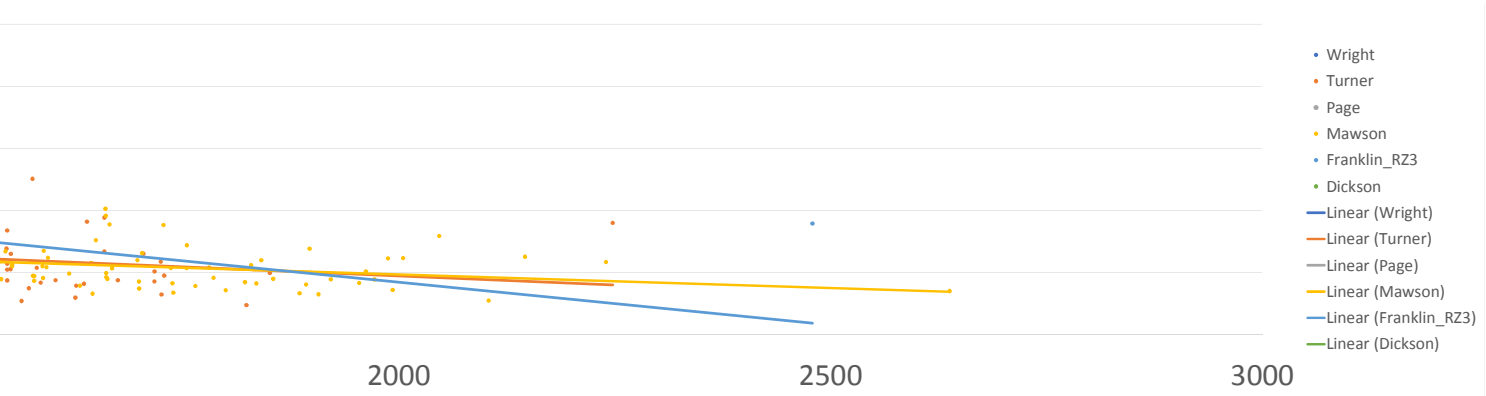
	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	29%	33%	26%	30%		53%
RZ3	28%	32%			54%	

4.3.4F Average block area - m²

	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	1154	682	1199	821		499
RZ3	1361	810			464	

4.3.4G Average building footprint area - m²

	TURNER	DICKSON	MAWSON	PAGE	FRANKLIN	WRIGHT
RZ1	324	224	305	243		269
RZ3	426	260			269	



4.3 Higher Yield Blocks

4.3.5A Average building footprint over block area - %

RZ1	50%
RZ2	45%
RZ3	42%
RZ4	49%

4.3.5B Average building footprint over block area - %

SINGLE DWELLING	53%
DUAL OCCUPANCY	47%
TERRACE	48%
TOWNHOUSE	42%
MULTI-UNIT	46%

4.3.5C Maxyield blocks

	Dwellings	Block area (m^2)
RZ1	1.3	1225
RZ2	13.8	4787
RZ3	12.3	2745
RZ4	23.2	3214

4.3.5D Maxyield blocks

	Dwellings	Block area (m^2)
SINGLE DWELLING	1.0	955
DUAL OCCUPANCY	2.0	1327
TERRACE	1.0	250
TOWNHOUSE	25.5	8088
MULTI-UNIT	22.7	2315

4.4 Suburb

4.4.1A

DIVISION	CANOPY AREA (m^2)
DICKSON	254,593
FRANKLIN	64,234
MAWSON	411,679
PAGE	240,300
TURNER	357,771
WRIGHT	110,544

4.4.1B

	% of canopy coverage to total study area	Open space canopy to total canopy area (including nuz3)	Street canopy to total canopy area	Block canopy to total canopy area
TURNER	30%	30%	35%	35%
DICKSON	26%	14%	48%	38%
MAWSON	23%	30%	18%	53%
PAGE	19%	12%	32%	56%
FRANKLIN	3%	49%	41%	10%
WRIGHT	13%	17%	81%	3%

4.4.1C

	Percentage of permable area	Open space permeability over total permeable area	Street permeability over total permeable area	On block permeability over total permeable area
TURNER	61%	44%	14%	21%
DICKSON	55%	39%	13%	21%
MAWSON	58%	40%	8%	27%
PAGE	47%	18%	10%	29%
FRANKLIN	44%	51%	14%	8%
WRIGHT	39%	26%	17%	12%

4.4.1D

	% of canopy coverage to total study area	% Of open space canopy to open space area (including nuz3)	% Of street canopy to total street area	% Of canopy to block area
TURNER	30%	33%	34%	25%
DICKSON	26%	16%	44%	19%
MAWSON	23%	29%	21%	21%
PAGE	19%	28%	24%	16%
FRANKLIN	3%	5%	4%	1%
WRIGHT	13%	21%	25%	1%

4.4.1E

	Percentage of permable area	Open space permeability to total open space area	Street permeability to total street area	On block permeability to total block area
TURNER	61%	100%	44%	49%
DICKSON	55%	100%	45%	41%
MAWSON	58%	100%	40%	48%
PAGE	47%	100%	40%	44%
FRANKLIN	44%	100%	41%	23%
WRIGHT	39%	100%	40%	25%

4.4.1F

	% of street tree canopy on block (3m buffer)	% Of street tree canopy on block (5m buffer)
TURNER	13%	22%
DICKSON	23%	33%
MAWSON	10%	16%
PAGE	18%	28%
FRANKLIN	-	-
WRIGHT	-	-

4.4 Street

4.4.2A Canopy cover of total street area by street classification

	Major Collector	Minor Collector	Access Street
TURNER	38%	23%	35%
DICKSON	31%		42%
MAWSON	18%	22%	31%
PAGE	22%	19%	24%
FRANKLIN		7%	3%
WRIGHT		24%	30%

4.4.2B Permeability of total street area by street classification

	Major Collector	Minor Collector	Access Street
TURNER	48%	38%	43%
DICKSON	41%		48%
MAWSON	35%	43%	49%
PAGE	35%	39%	46%
FRANKLIN		36%	43%
WRIGHT		39%	41%

4.4.2C Canopy cover of total street area by street type

	Urban residential 1	Urban residential 2	Urban residential 3	Urban arterial	Urban distributor
TURNER	37%	39%	10%		39%
DICKSON	32%	42%			31%
MAWSON	20%	22%	31%		16%
PAGE	22%	22%	24%		19%
FRANKLIN	7%	4%	0%		4%
WRIGHT	33%	27%		26%	25%

4.4.2D Permeability of total street area by street type

	Urban residential 1	Urban residential 2	Urban residential 3	Urban arterial	Urban distributor
TURNER	50%	45%	32%		47%
DICKSON	44%	48%			38%
MAWSON	33%	43%	49%		39%
PAGE	31%	49%	41%		40%
FRANKLIN	36%	44%	35%		47%
WRIGHT	40%	37%		41%	40%

4.4.2E Modified access street

	Canopy Area to Total Street Area
TURNER	50%
DICKSON	42%
MAWSON	31%
PAGE	24%
FRANKLIN	1%
WRIGHT	30%

4.4.2F Modified access street stats

	Permeable Area to Verge Area	Impermeable Area to Verge Area	Permeable Area to Total Street Area
TURNER	74%	26%	52%
DICKSON	75%	25%	49%
MAWSON	85%	15%	57%
PAGE	83%	17%	51%
FRANKLIN	68%	32%	42%
WRIGHT	56%	44%	37%

4.4 Study Blocks

4.4.3A Canopy to block (%)

	Single dwelling	Duplex	Townhouse	Terrace	Multi-unit	Dual occupancy
TURNER	31%		11%		15%	15%
DICKSON	15%	25%			4%	
MAWSON	32%		12%	18%	20%	7%
PAGE	19%		22%	20%		2%
FRANKLIN	0%	2%	0%	0%	1%	
WRIGHT	0%		0%	0%	0%	

4.4.3B Permeable area (%)

	Single dwelling	Duplex	Townhouse	Terrace	Multi-unit	Dual occupancy
TURNER	62%		27%		38%	43%
DICKSON	52%	62%			34%	
MAWSON	66%		34%	40%	60%	33%
PAGE	52%		35%	25%		51%
FRANKLIN	23%	30%	18%	21%	28%	
WRIGHT	32%		8%	26%	28%	

4.4 All Blocks

4.4.4A Turner

BLOCK TYPOLOGY	Average canopy cover			
	Compact block	Mid sized block	Large block	Total blocks
RZ1			28%	28%
RZ2				
RZ3			30%	30%
RZ4			19%	19%
RZ5				
TOTAL AVERAGE				26%

4.4.4B Dickson

BLOCK TYPOLOGY	Average canopy cover			
	Compact block	Mid sized block	Large block	Total blocks
RZ1		19%	19%	19%
RZ2		30%	24%	25%
RZ3		13%	17%	17%
RZ4		17%	17%	17%
RZ5				
TOTAL AVERAGE				19%

4.4.4C Mawson

BLOCK TYPOLOGY	Average canopy cover			
	Compact block	Mid sized block	Large block	Total blocks
RZ1			24%	24%
RZ2		11%	19%	18%
RZ3				
RZ4			19%	19%
RZ5				
TOTAL AVERAGE				20%

4.4.4D Page

Block typology	Average canopy cover			
	Compact block	Mid sized block	Large block	Total blocks
RZ1			17%	17%
RZ2	12%	17%	17%	17%
RZ3				
RZ4				
RZ5				
TOTAL AVERAGE				17%

4.4.4E Franklin

Block typology	Average canopy cover			
	Compact block	Mid sized block	Large block	Total blocks
RZ1				
RZ2				
RZ3	1%	1%	1%	1%
RZ4	1%	0%	1%	1%
RZ5				
TOTAL AVERAGE				1%

4.4.4F Wright

Block typology	Average canopy cover			
	Compact block	Mid sized block	Large block	Total blocks
RZ1	0%	0%	0%	0%
RZ2				
RZ3				
RZ4				
RZ5			0%	0%
TOTAL AVERAGE				0%

4.4 Higher Yield Blocks

4.4.5A Maxyield blocks

	Permeable %	Canopy %
RZ1	26%	9%
RZ2	29%	13%
RZ3	42%	12%
RZ4	26%	4%

4.4.5B Maxyield blocks

	Permeable %	Canopy %
SINGLE DWELLING	21%	30%
DUAL OCCUPANCY	27%	20%
TERRACE	39%	11%
TOWNHOUSE	28%	15%
MULTI-UNIT	35%	10%

4.5 Scenario 2

4.5.1A Scenario 2: Effect on suburb canopy

	Existing canopy % over suburb	Scenario 2 canopy % over suburb	Difference
TURNER	30%	23%	-7%
DICKSON	26%	21%	-5%
MAWSON	23%	16%	-7%
PAGE	19%	16%	-3%
FRANKLIN	3%	6%	3%
WRIGHT	13%	16%	3%

4.5.1B Scenario 2: Effect on suburb permeability

	Existing permeable area % over suburb	Scenario 2 permeable area % over suburb	Difference
TURNER	51%	42%	-9%
DICKSON	45%	40%	-5%
MAWSON	53%	42%	-12%
PAGE	40%	29%	-10%
FRANKLIN	32%	37%	6%
WRIGHT	24%	23%	-1%

4.5.1C Scenario 2: Block Canopy Difference %

TURNER	-69%
DICKSON	-49%
MAWSON	-57%
PAGE	-26%
FRANKLIN	1170%
WRIGHT	699%

4.5 Scenario 3

4.5.2A Scenario 3: Effect on suburb canopy

	Existing canopy % over suburb	Scenario 3 canopy % over suburb	Difference
TURNER	30%	26%	-4%
DICKSON	26%	21%	-4%
MAWSON	23%	20%	-3%
PAGE	19%	17%	-2%
FRANKLIN	3%	4%	1%
WRIGHT	13%	16%	2%

4.5.2B Scenario 3: Effect on suburb permeability

	Existing permeable area % over suburb	Scenario 3 permeable area % over suburb	Difference
TURNER	51%	43%	-8%
DICKSON	45%	41%	-4%
MAWSON	53%	48%	-5%
PAGE	40%	38%	-1%
FRANKLIN	32%	32%	0%
WRIGHT	24%	24%	0%

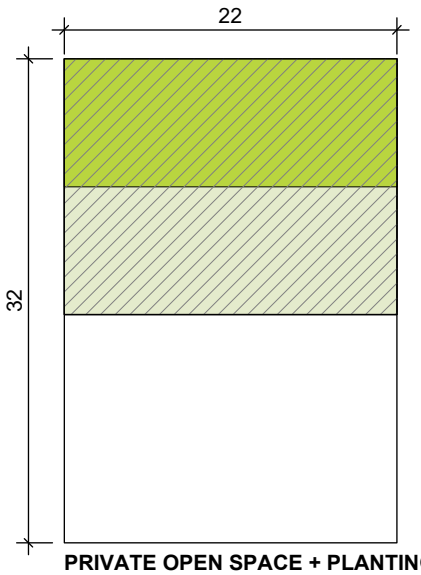
4.5.2C

	Scenario 3 Block Canopy Difference %
TURNER	-41%
DICKSON	-46%
MAWSON	-22%
PAGE	-15%
FRANKLIN	195%
WRIGHT	660%

Attachment 6
Block Diagram Templates

LARGE BLOCKS OVER 700M2

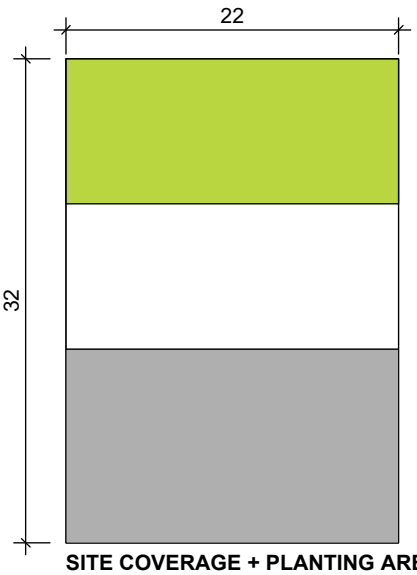
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 704M²

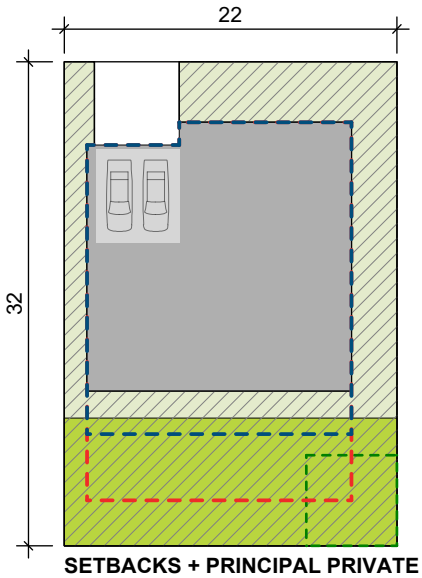
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	332M²	47%
PRIVATE OPEN SPACE:	60% - 50M²	372M²	53%
PLANTING AREA:	50% OF POS	186M²	26%

PROPOSED RECOMMENDATIONS



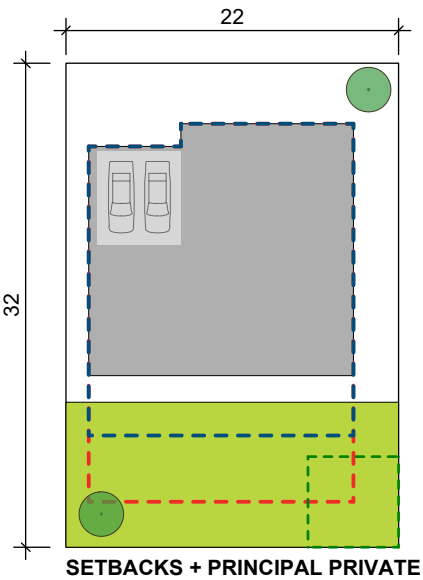
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 704M²

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	282M2	40%
OPEN SPACE:	N/A	422M2	60%
PLANTING AREA:	30%	211M²	30%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 704M²

	CONTROL	OUTCOME	
PLOT RATIO:	50%		
SITE COVERAGE:	N/A	302M²	43%
PRIVATE OPEN SPACE:	60% - 50M²	372M²	53%
PLANTING AREA:	50% OF POS	186M²	26%

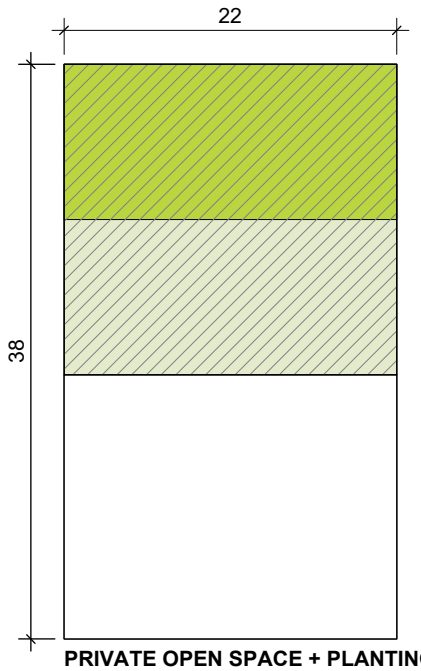


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 704M2

	CONTROL	OUTCOME	
PLOT RATIO:	50%		
SITE COVERAGE:	40%	282M2	40%
OPEN SPACE:	N/A	422M2	60%
PLANTING AREA:	30%	211M²	30%

LARGE BLOCKS OVER 800M2

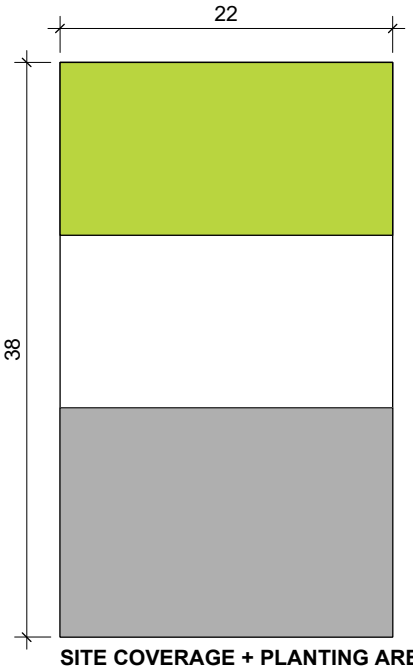
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 836M²

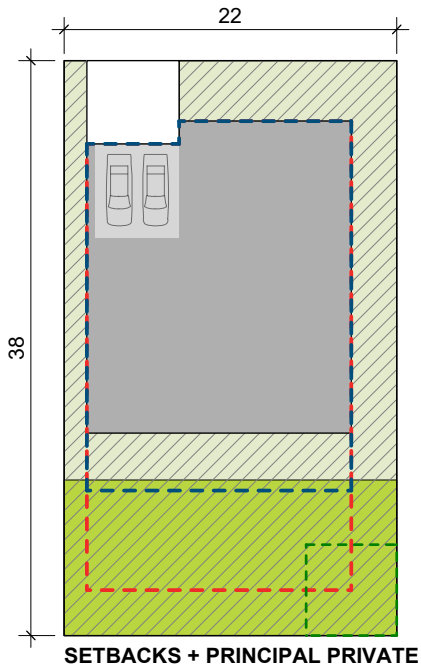
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	384M²	46%
PRIVATE OPEN SPACE:	60% - 50M²	452M²	54%
PLANTING AREA:	50% OF POS	226M²	27%

PROPOSED RECOMMENDATIONS



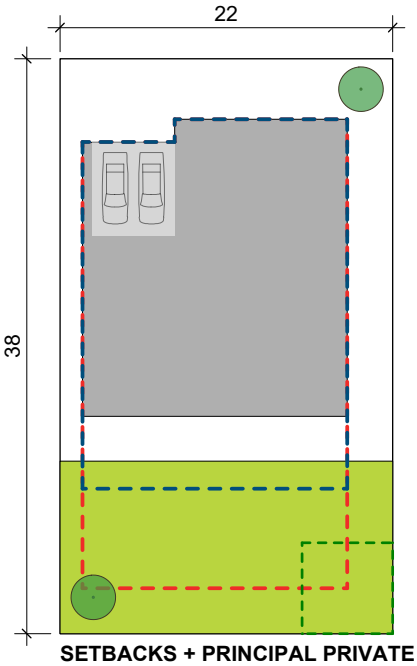
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 836M²

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	334M²	40%
OPEN SPACE:	N/A	502M²	60%
PLANTING AREA:	30%	251M²	30%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 836M²

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	351M²	42%
PRIVATE OPEN SPACE:	60% - 50M²	452M²	54%
PLANTING AREA:	50% OF POS	226M²	27%

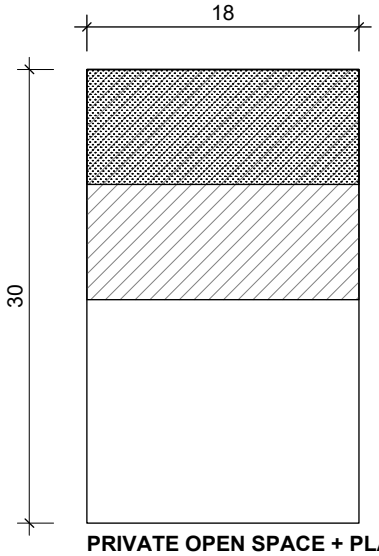


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 836M²

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	334M²	40%
OPEN SPACE:	N/A	502M²	60%
PLANTING AREA:	30%	251M²	30%

SECONDARY RESIDENCE

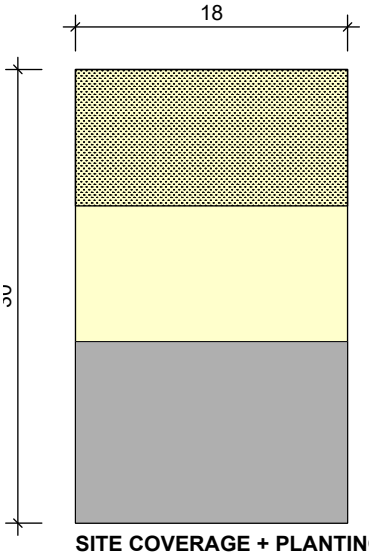
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 540M²

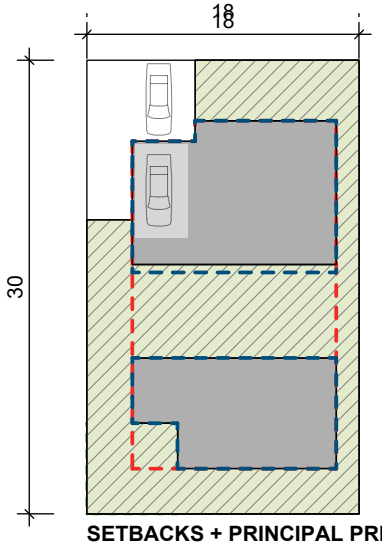
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	270M²	50%
PRIVATE OPEN SPACE:	60% - 50M²	274M²	51%
PLANTING AREA:	50% OF POS	137M²	25%

PROPOSED RECOMMENDATIONS



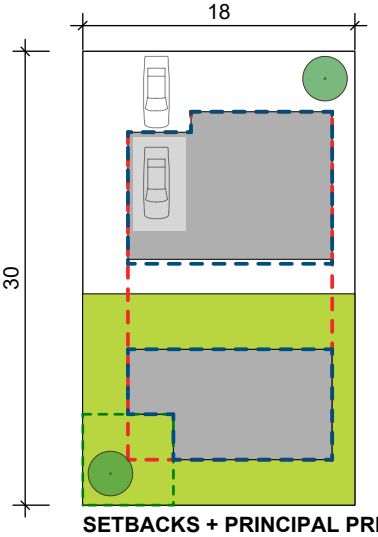
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 540M²

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	216M²	40%
OPEN SPACE:	N/A	274M²	51%
PLANTING AREA:	30%	162M²	30%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 540M²

	CONTROL	OUTCOME	
PLOT RATIO:	50%		
SITE COVERAGE:	N/A	212M²	39%
PRIVATE OPEN SPACE:	60% - 50M²	274M²	51%
PLANTING AREA:	50% OF POS	137M²	25%

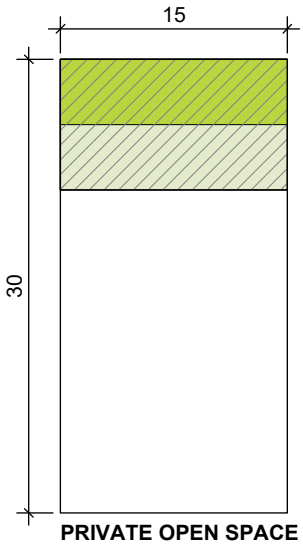


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 540M2

	CONTROL	OUTCOME	
PLOT RATIO:	50%		
SITE COVERAGE:	40%	216M²	40%
OPEN SPACE:	N/A	274M²	51%
PLANTING AREA:	30%	162M²	30%

MIDSIZE BLOCKS

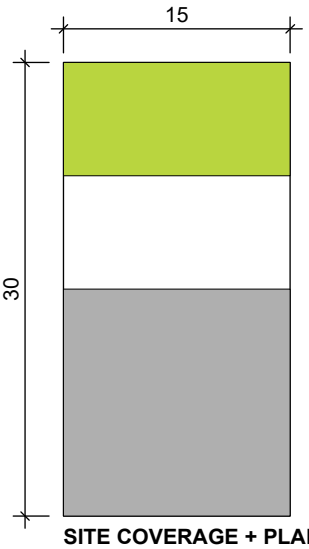
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 450M²

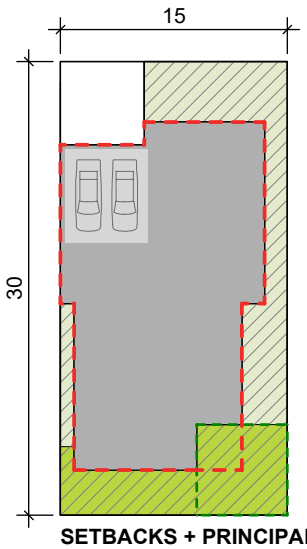
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	320M²	71%
PRIVATE OPEN SPACE:	40% - 50M²	130M²	29%
PLANTING AREA:	50% OF POS	65M²	14%

PROPOSED RECOMMENDATIONS



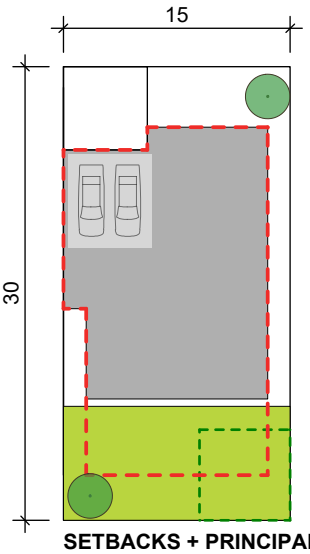
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 450M²

	CONTROL	OUTCOME	
SITE COVERAGE:	50%	225M²	50%
OPEN SPACE:	N/A	225M²	50%
PLANTING AREA:	25%	112.5M²	25%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 450M2

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	267M²	59%
PRIVATE OPEN SPACE:	40% - 50M²	153M²	33%
PLANTING AREA:	50% OF POS	65M²	14%

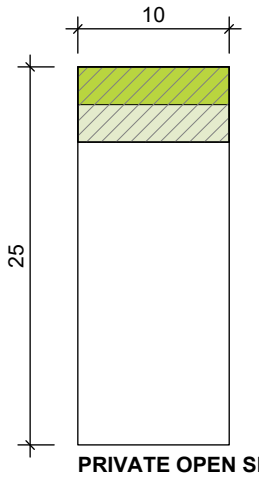


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 450M²

	CONTROL	OUTCOME	
SITE COVERAGE:	50%	225M²	50%
OPEN SPACE:	N/A	225M²	50%
PLANTING AREA:	25%	112.5M²	25%

COMPACT BLOCKS

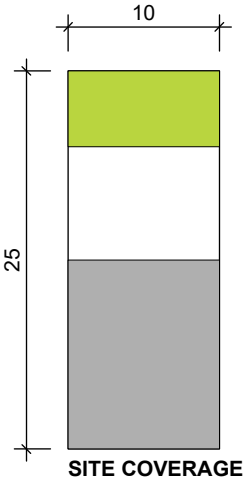
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 250M²

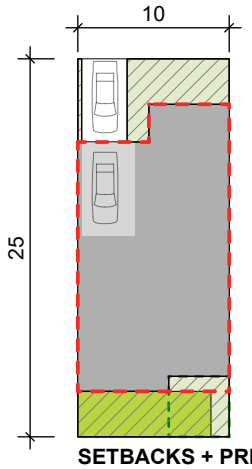
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	200M²	80%
PRIVATE OPEN SPACE:	20%	50M²	20%
PLANTING AREA:	50% OF POS	25M²	10%

PROPOSED RECOMMENDATIONS



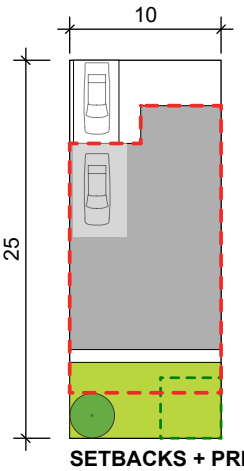
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 250M²

	CONTROL	OUTCOME	
SITE COVERAGE:	50%	125M²	50%
OPEN SPACE:	N/A	125M²	50%
PLANTING AREA:	20%	50M²	20%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 250M²

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	174M²	70%
PRIVATE OPEN SPACE:	20%	59M²	24%
PLANTING AREA:	50% OF POS	25M²	10%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 250M²

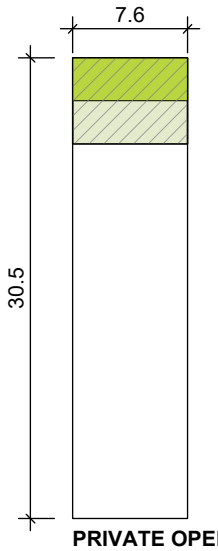
	CONTROL	OUTCOME	
SITE COVERAGE:	50%	125M²	50%
OPEN SPACE:	N/A	125M²	50%
PLANTING AREA:	20%	50M²	20%

LEGEND

- Private Open Space
- Planting Area
- Site Coverage
- Setbacks
- Plot Ratio
- Principal Private Open Space

COMPACT BLOCKS - REAR LOADING

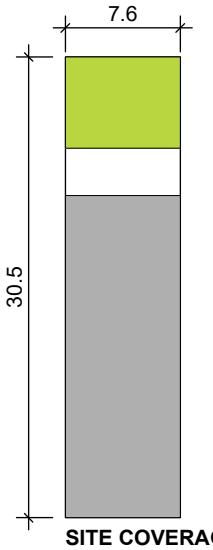
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 232M²

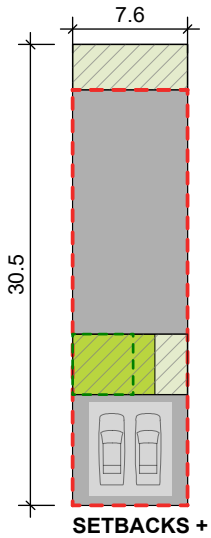
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	188M²	81%
PRIVATE OPEN SPACE:	40% - 50M²	43M²	19%
PLANTING AREA:	50% OF POS	22M²	9%

PROPOSED RECOMMENDATIONS



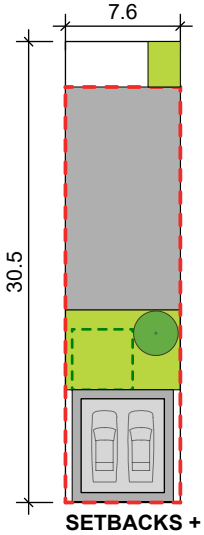
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 232M²

	CONTROL	OUTCOME	
SITE COVERAGE:	70%	162M²	70%
OPEN SPACE:	N/A	70M²	30%
PLANTING AREA:	20%	46M²	20%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 232M²

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	178M²	77%
PRIVATE OPEN SPACE:	40% - 50M²	53M²	23%
PLANTING AREA:	50% OF POS	22M²	9%

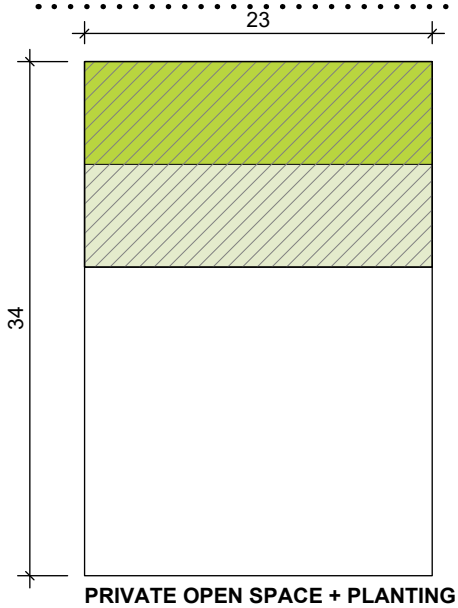


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 232M²

	CONTROL	OUTCOME	
SITE COVERAGE:	70%	162M²	70%
OPEN SPACE:	N/A	70M²	30%
PLANTING AREA:	20%	46M²	20%

DUAL OCCUPANCY

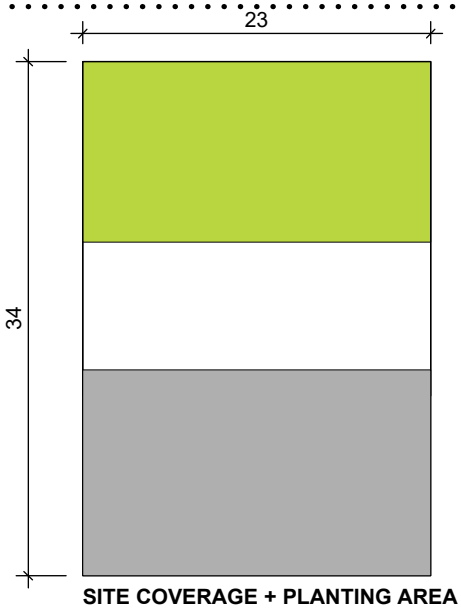
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 782M²

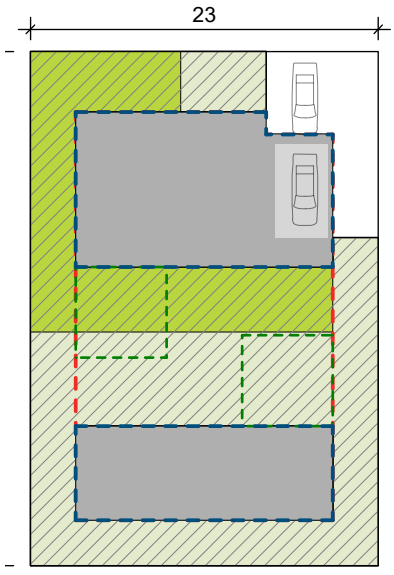
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	469M²	60%
PRIVATE OPEN SPACE:	40%	313M²	40%
PLANTING AREA:	50% OF POS	156M²	20%

PROPOSED RECOMMENDATIONS



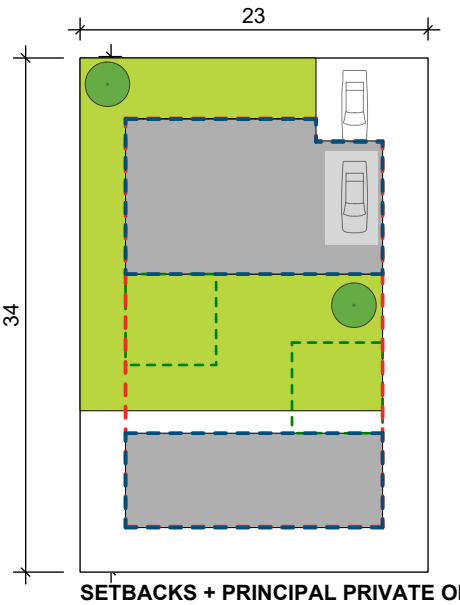
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 782M²

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	313M²	40%
OPEN SPACE:	N/A	469M²	60%
PLANTING AREA:	35%	274M²	35%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 782M² (RZ1 / RZ2)

	CONTROL	OUTCOME	
PLOT RATIO:	35%	274M²	35%
SITE COVERAGE:	N/A	274M²	35%
PRIVATE OPEN SPACE:	40%	447M²	57%
PLANTING AREA:	50% OF POS156M²		20%

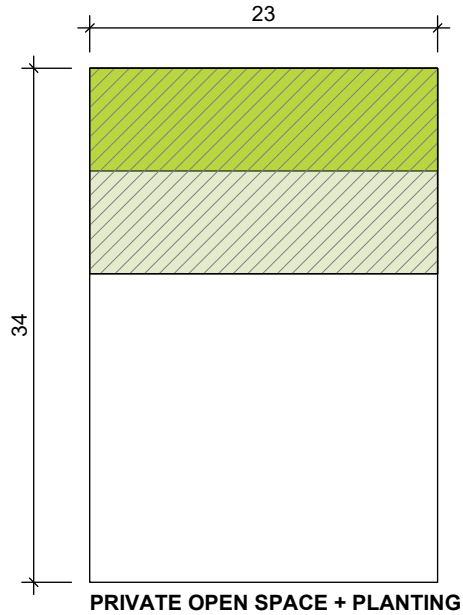


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO
BLOCK SIZE: 782M² (RZ1 / RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	35%	274M²	35%
SITE COVERAGE:	40%	274M²	35%
OPEN SPACE:	N/A	508M²	65%
PLANTING AREA:	35%	274M²	35%

DUAL OCCUPANCY

TERRITORY PLAN

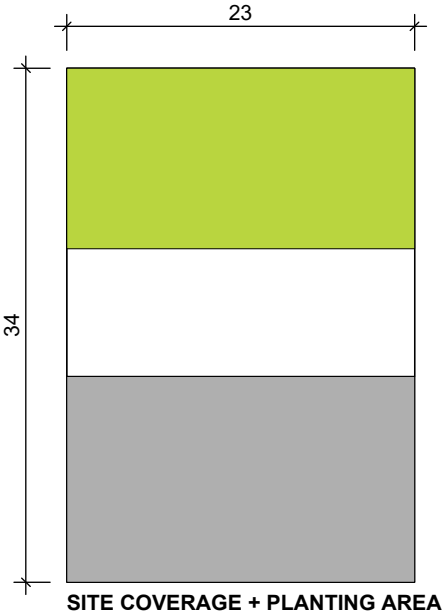


PRIVATE OPEN SPACE + PLANTING AREA

BLOCK SIZE: 782M²

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	469M²	60%
PRIVATE OPEN SPACE:	40%	313M²	40%
PLANTING AREA:	50% OF POS	156M²	20%

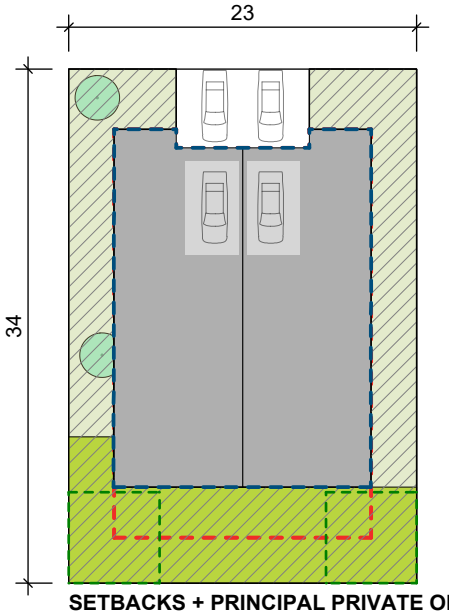
PROPOSED RECOMMENDATIONS



SITE COVERAGE + PLANTING AREA

BLOCK SIZE: 782M²

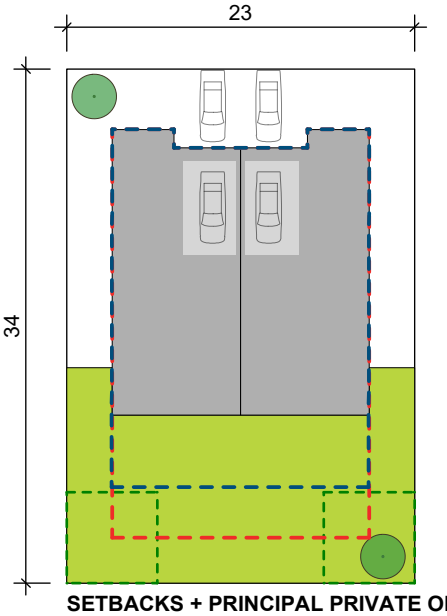
	CONTROL	OUTCOME	
SITE COVERAGE:	40%	313M²	40%
OPEN SPACE:	N/A	469M²	60%
PLANTING AREA:	35%	274M²	35%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO

BLOCK SIZE: 782M² (RZ1 / RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%	391M²	50%
SITE COVERAGE:	N/A	391M2	50%
PRIVATE OPEN SPACE:	40%	345M²	44%
PLANTING AREA:	50% OF POS	156M²	20%



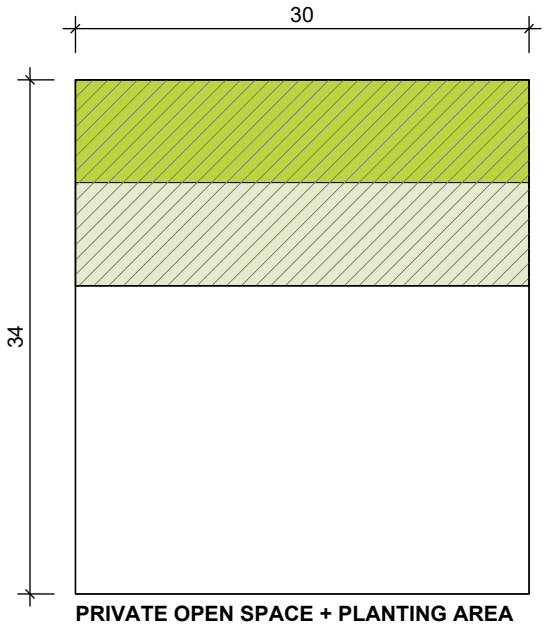
SETBACKS + PRINCIPAL PRIVATE OPEN SPACE + PLOT RATIO

BLOCK SIZE: 782M² (RZ1 / RZ2)

	CONTROL	OUTCOME	
PLOT RATIO:	50%		
SITE COVERAGE:	40%	313M²	40%
OPEN SPACE:	N/A	469M²	60%
PLANTING AREA:	35%	274M²	35%

ADAPTABLE TOWNHOUSE.PDF

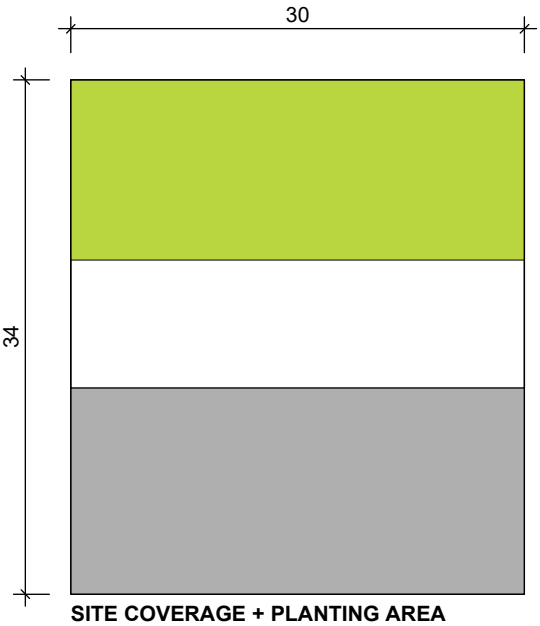
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 1020M² (RZ2)

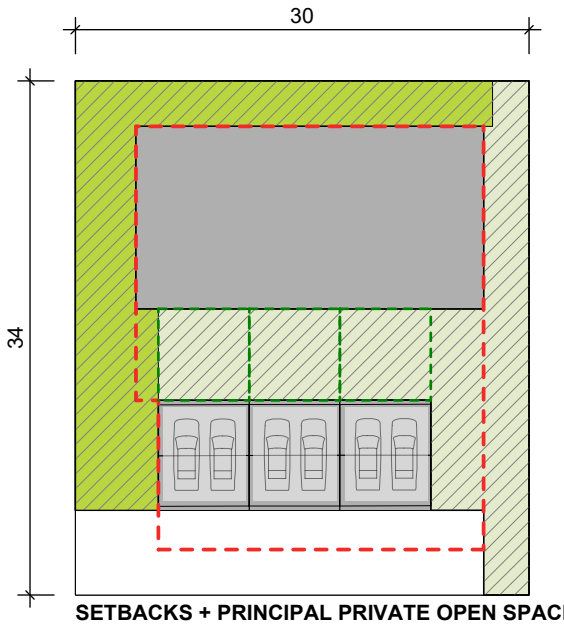
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	612M²	60%
SITE OPEN SPACE:	40%	408M²	40%
PLANTING AREA:	20%	204M²	20%

PROPOSED RECOMMENDATIONS



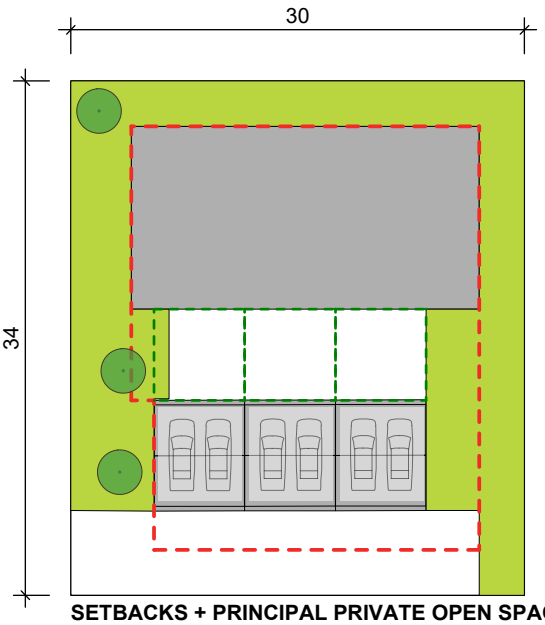
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 1020M² (RZ2)

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	408M²	40%
OPEN SPACE:	N/A	612M²	60%
PLANTING AREA:	35%	357M²	35%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 1020M² (RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%		
SITE COVERAGE:	N/A	409M²	40%
SITE OPEN SPACE:	40%	460M²	45%
PLANTING AREA:	20%	204M²	20%

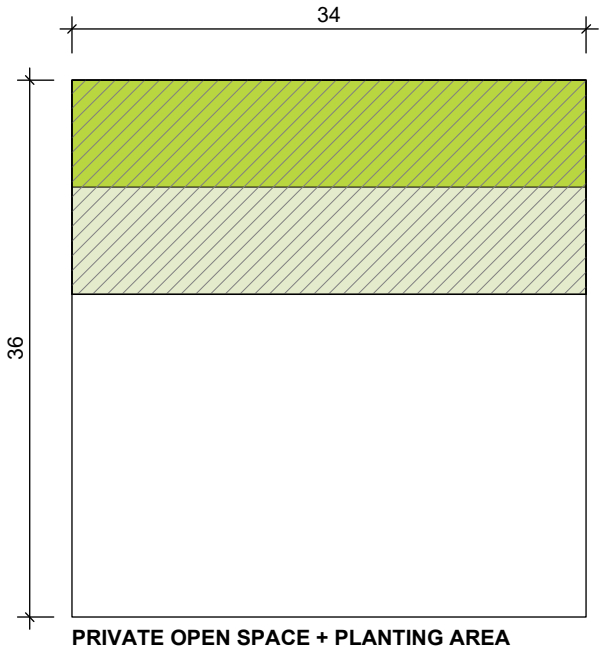


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 1020M² (RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%		
SITE COVERAGE:	40%	409M²	40%
OPEN SPACE:	N/A	611M²	60%
PLANTING AREA:	35%	357M²	35%

ADAPTABLE TOWNHOUSE.PDF

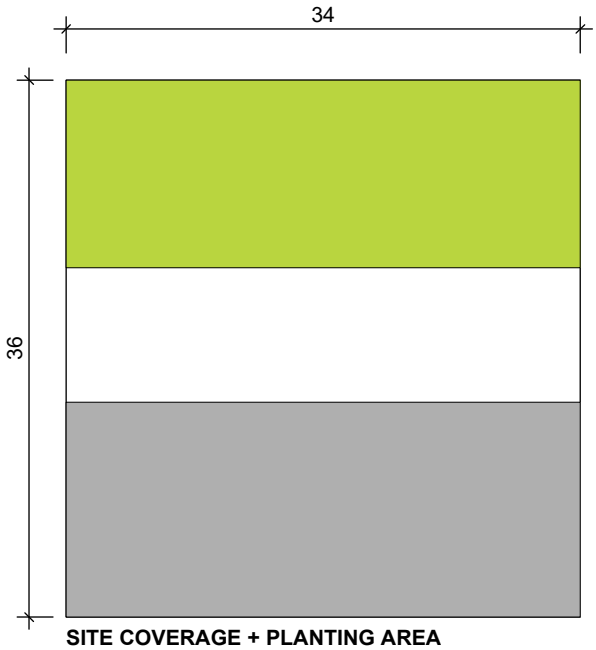
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 1207M² (RZ2)

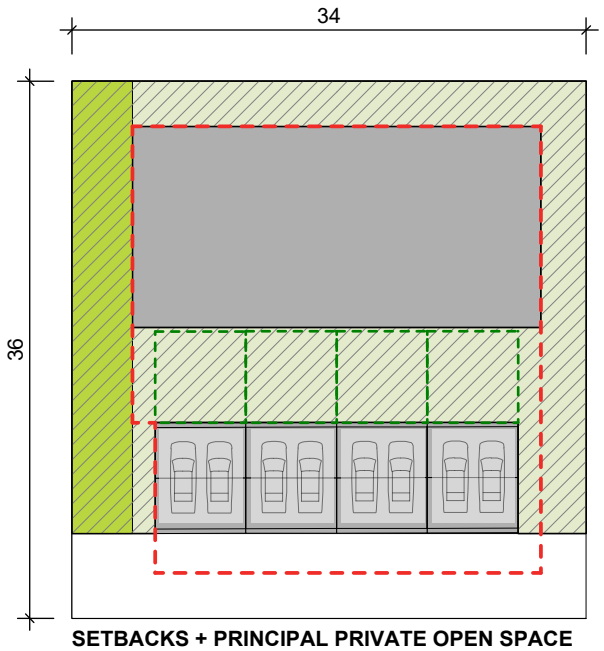
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	726M²	60%
SITE OPEN SPACE:	40%	482M²	40%
PLANTING AREA:	20%	242M²	20%

PROPOSED RECOMMENDATIONS



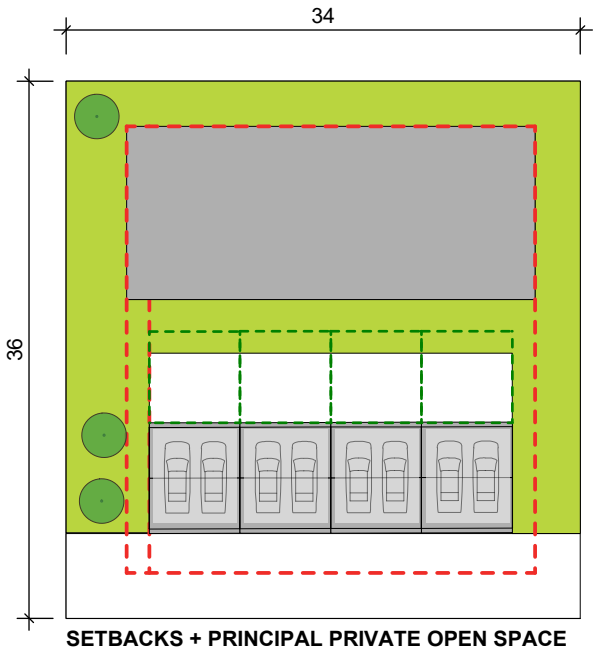
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 1207M² (RZ2)

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	483M²	40%
OPEN SPACE:	N/A	724M²	60%
PLANTING AREA:	35%	422M²	35%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 1207M² (RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%		
SITE COVERAGE:	N/A	534M²	44%
SITE OPEN SPACE:	40%	482M²	40%
PLANTING AREA:	20%	242M2	20%

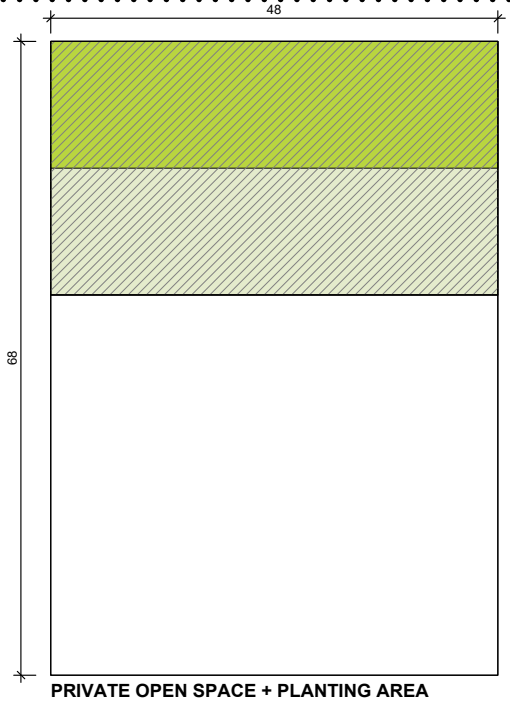


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 1207M2 (RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%		
SITE COVERAGE:	40%	483M²	40%
OPEN SPACE:	N/A	666M²	55%
PLANTING AREA:	35%	422M²	35%

TOWNHOUSE IN A MULTI-UNIT BLOCK

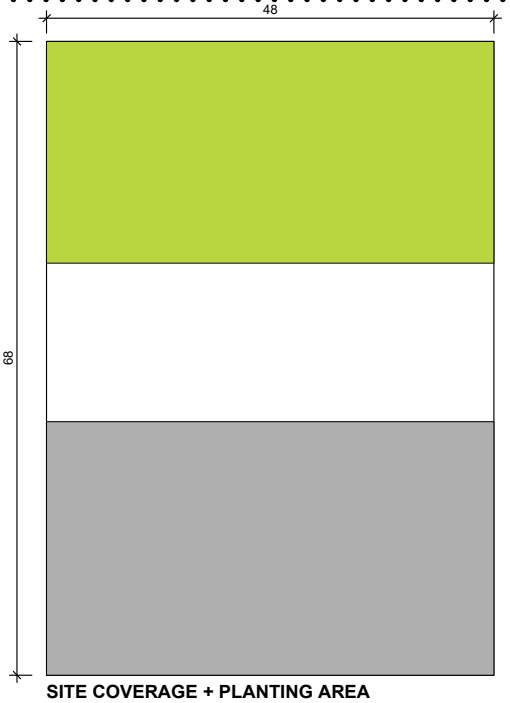
TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 3264M² (RZ2)

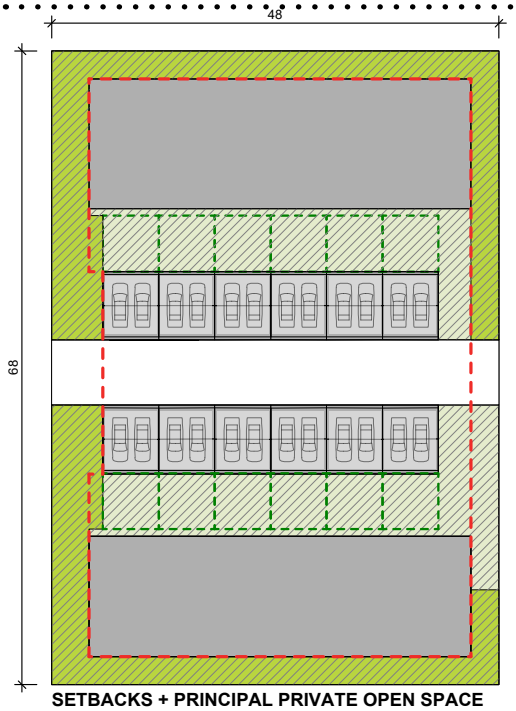
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	1959M²	60%
SITE OPEN SPACE:	40%	1305M²	40%
PLANTING AREA:	20%	653M²	20%

PROPOSED RECOMMENDATIONS



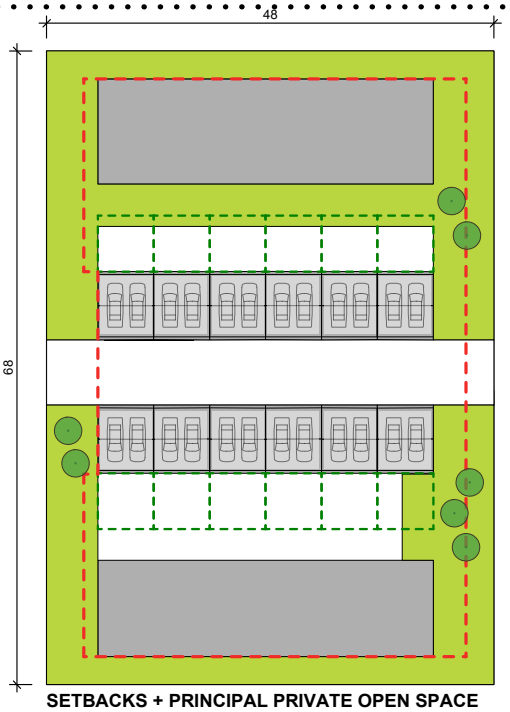
SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 3264M2 (RZ2)

	CONTROL	OUTCOME	
SITE COVERAGE:	40%	1305M²	40%
OPEN SPACE:	N/A	1959M2	60%
PLANTING AREA:	35%	1142M²	35%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 3264M² (RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%		
SITE COVERAGE:	N/A	1632M²	50%
SITE OPEN SPACE:	40%	1296M2	40%
PLANTING AREA:	20%	653M2	20%

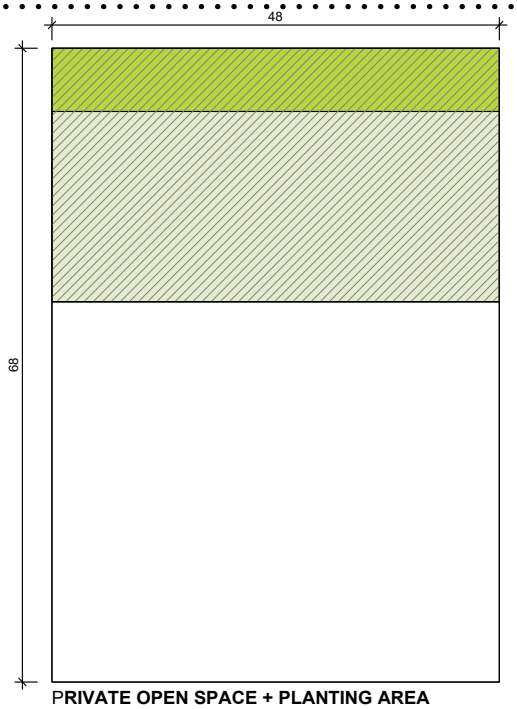


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 3264M² (RZ2)

	CONTROL	OUTCOME	
PLOT RATIO	50%		
SITE COVERAGE:	40%	1305M²	40%
OPEN SPACE:	N/A	1959M²	60%
PLANTING AREA:	35%	1142M²	35%

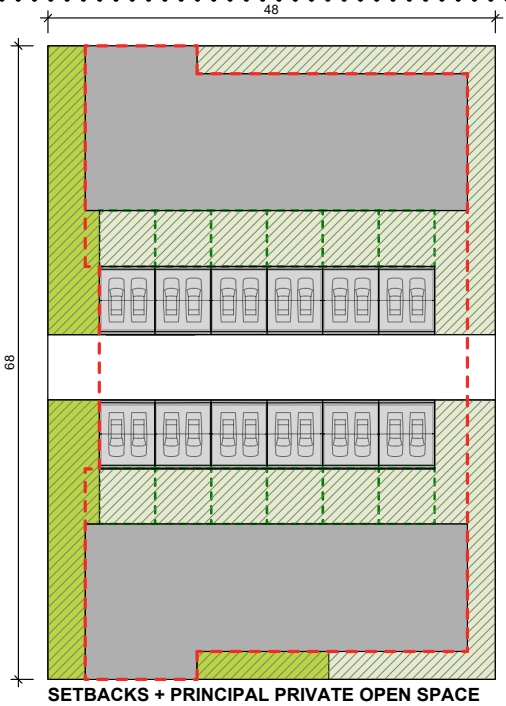
TOWNHOUSE IN A MULTI-UNIT BLOCK

TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 3264M² (RZ4)

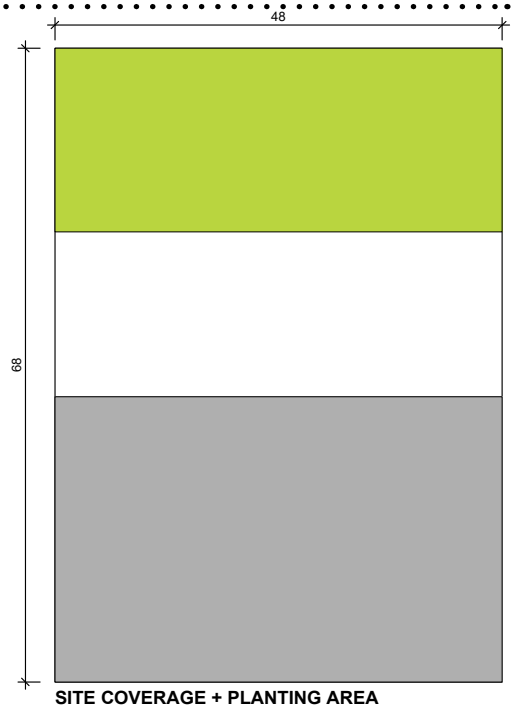
	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	1959M²	60%
SITE OPEN SPACE:	20%	1305M²	40%
PLANTING AREA:	10%	326M²	10%



SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 3264M² (RZ4)

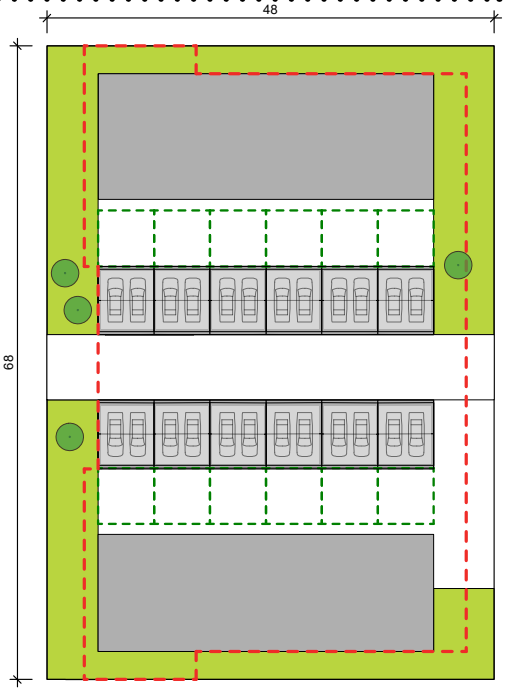
	CONTROL	OUTCOME	
PLOT RATIO	80%		
SITE COVERAGE:	N/A	1766M²	54%
SITE OPEN SPACE:	20%	1162M²	36%
PLANTING AREA:	10%	326M²	10%

PROPOSED RECOMMENDATIONS



SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 3264M² (RZ4)

	CONTROL	OUTCOME	
SITE COVERAGE:	45%	1469M²	45%
OPEN SPACE:	N/A	1795M²	55%
PLANTING AREA:	25%	816M²	25%

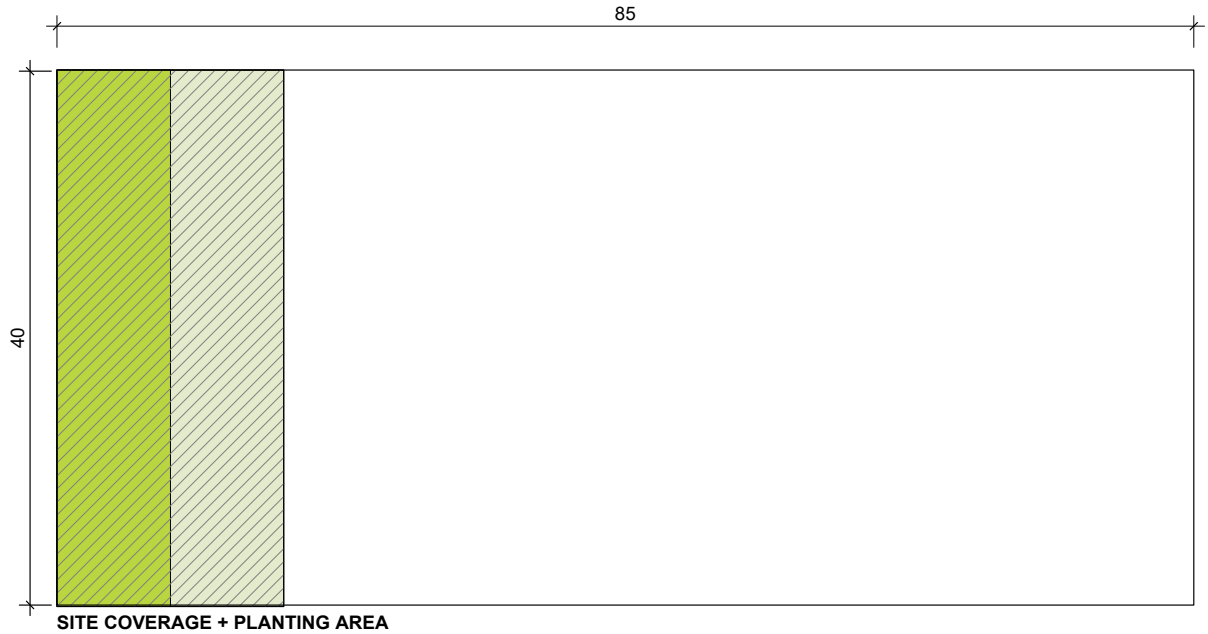


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 3264M2 (RZ4)

	CONTROL	OUTCOME	
PLOT RATIO	80%		
SITE COVERAGE:	45%	1469M²	45%
OPEN SPACE:	N/A	1795M²	55%
PLANTING AREA:	25%	816M²	25%

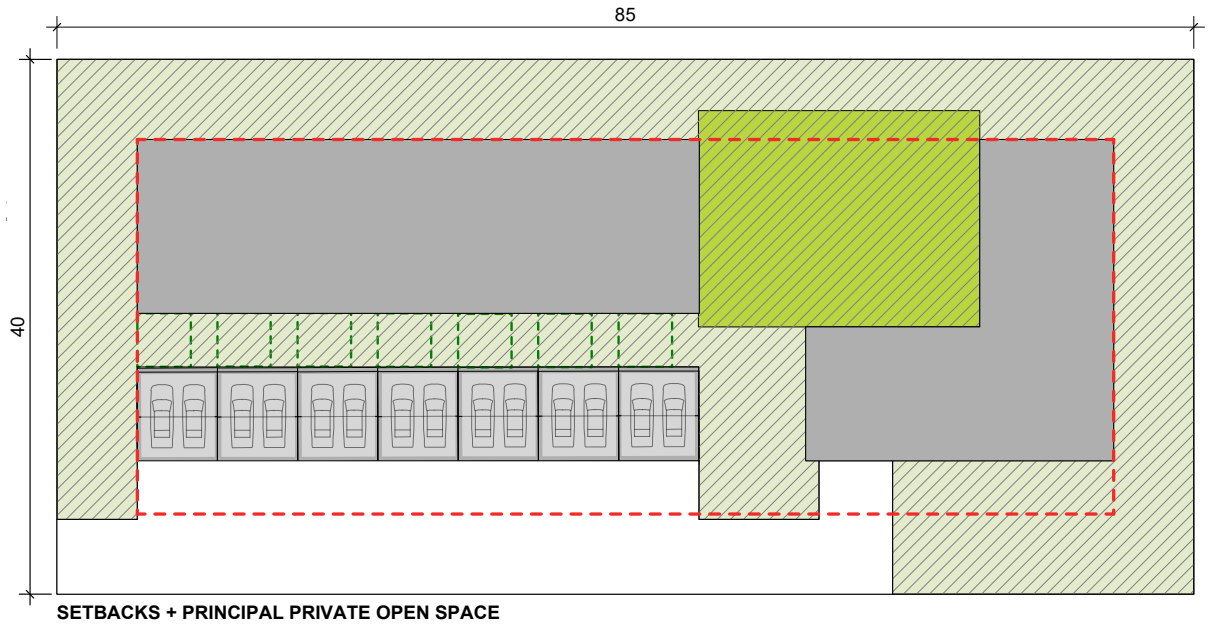
MULTIUNIT AND TOWNHOUSE

TERRITORY PLAN



SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 3400M² (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	2720M²	80%
SITE OPEN SPACE:	20%	680M²	20%
PLANTING AREA:	10%	340M²	10%

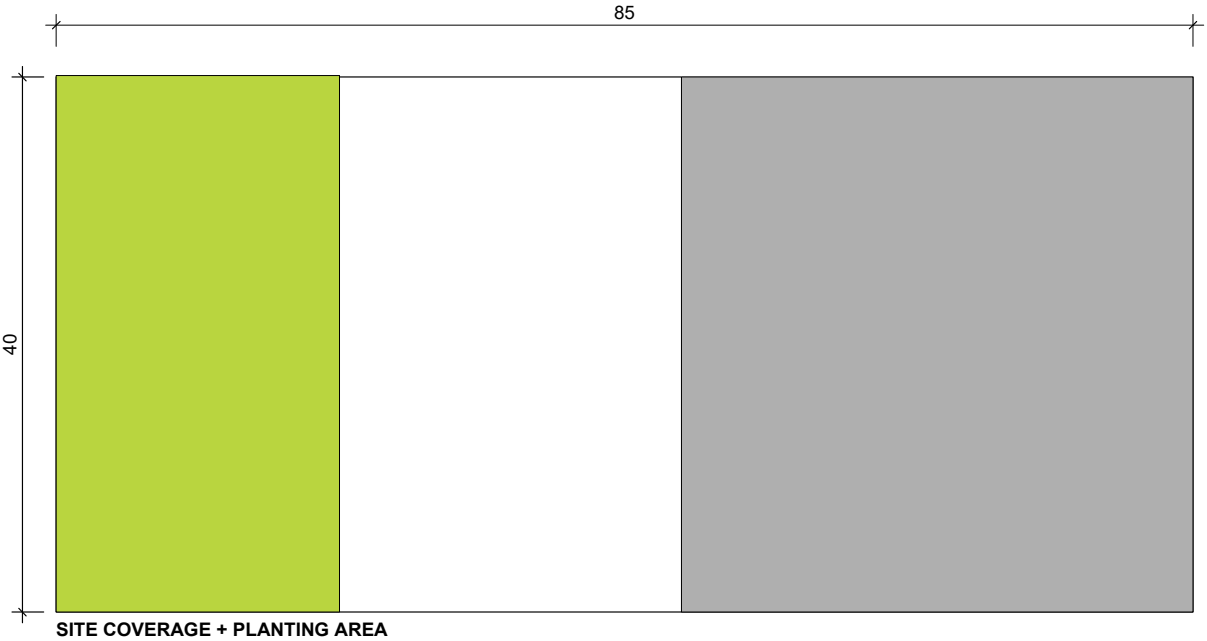


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 3400M2 (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
PLOT RATIO:	65-80%		
SITE COVERAGE:	N/A	1211M²	36%
SITE OPEN SPACE:	20%	1631M²	48%
PLANTING AREA:	10%	340M²	10%

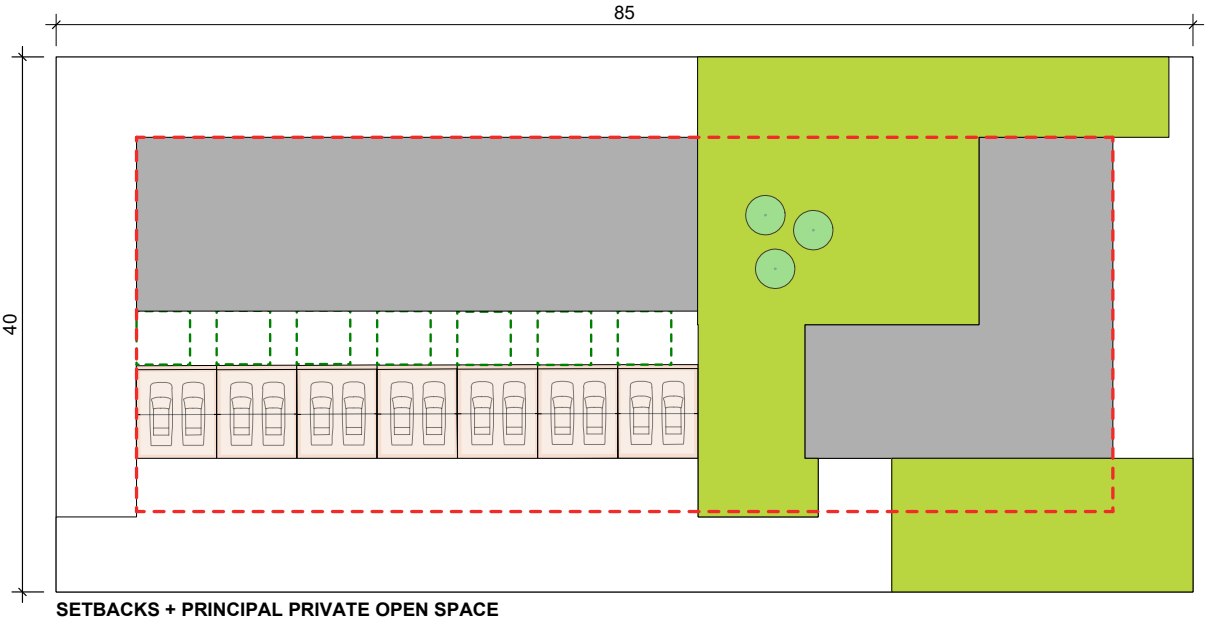
MULTIUNIT AND TOWNHOUSE

PROPOSED RECOMMENDATIONS



SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 3400M^2 (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
SITE COVERAGE:	45%	1530M^2	45%
OPEN SPACE:	N/A	1020M^2	30%
PLANTING AREA:	25%	850M2	25%

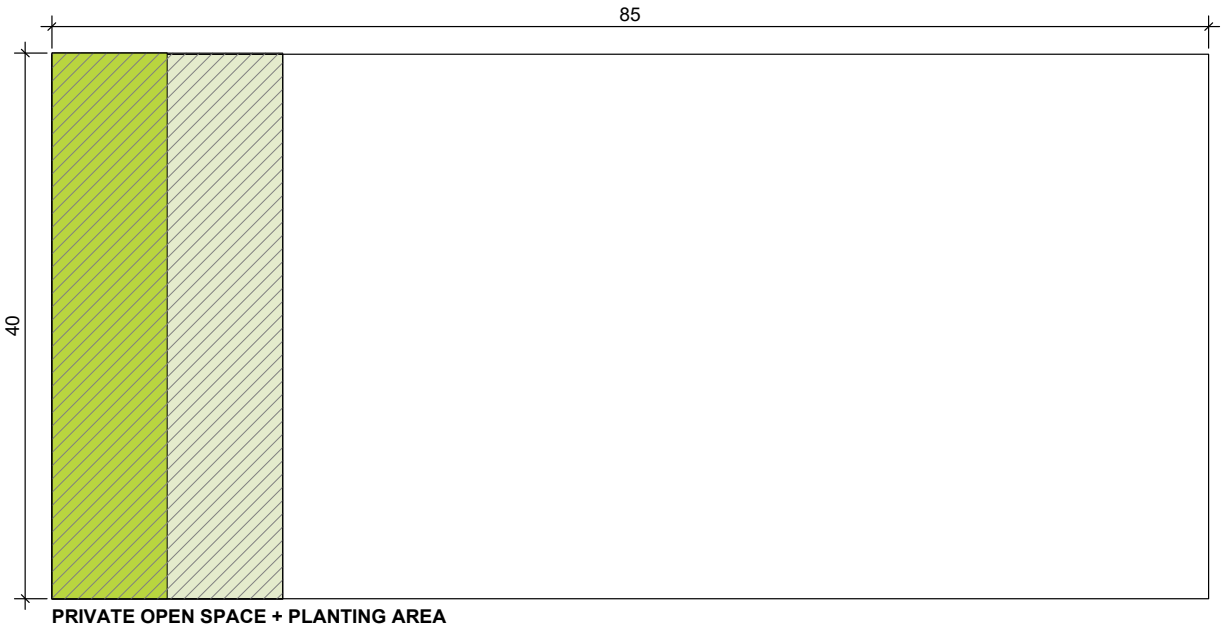


SETBACKS + PRINCIPAL PRIVATE OPEN SPACE
BLOCK SIZE: 3400M^2 (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
PLOT RATIO:	65-80%		
SITE COVERAGE:	45%	1211M^2	36%
OPEN SPACE:	N/A	2189M^2	64%
PLANTING AREA:	25%	850M2	25%

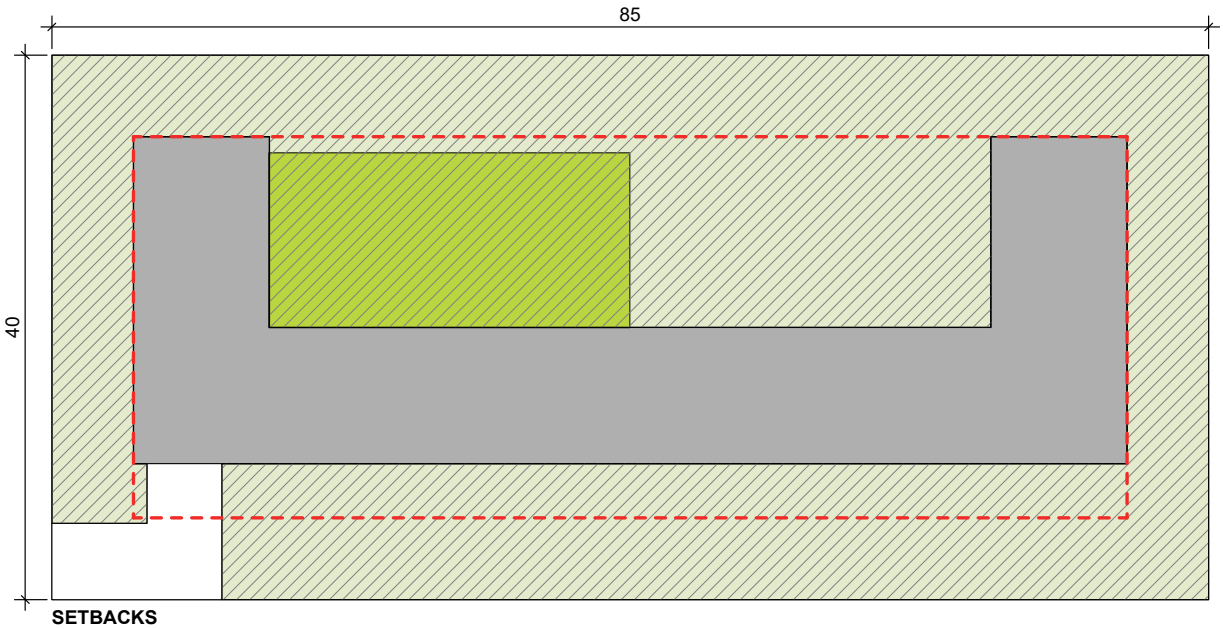
MULTI UNIT

TERRITORY PLAN



PRIVATE OPEN SPACE + PLANTING AREA
BLOCK SIZE: 3400M² (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
SITE COVERAGE:	N/A	2720M²	80%
SITE OPEN SPACE:	20%	680M²	20%
PLANTING AREA:	10%	340M²	10%

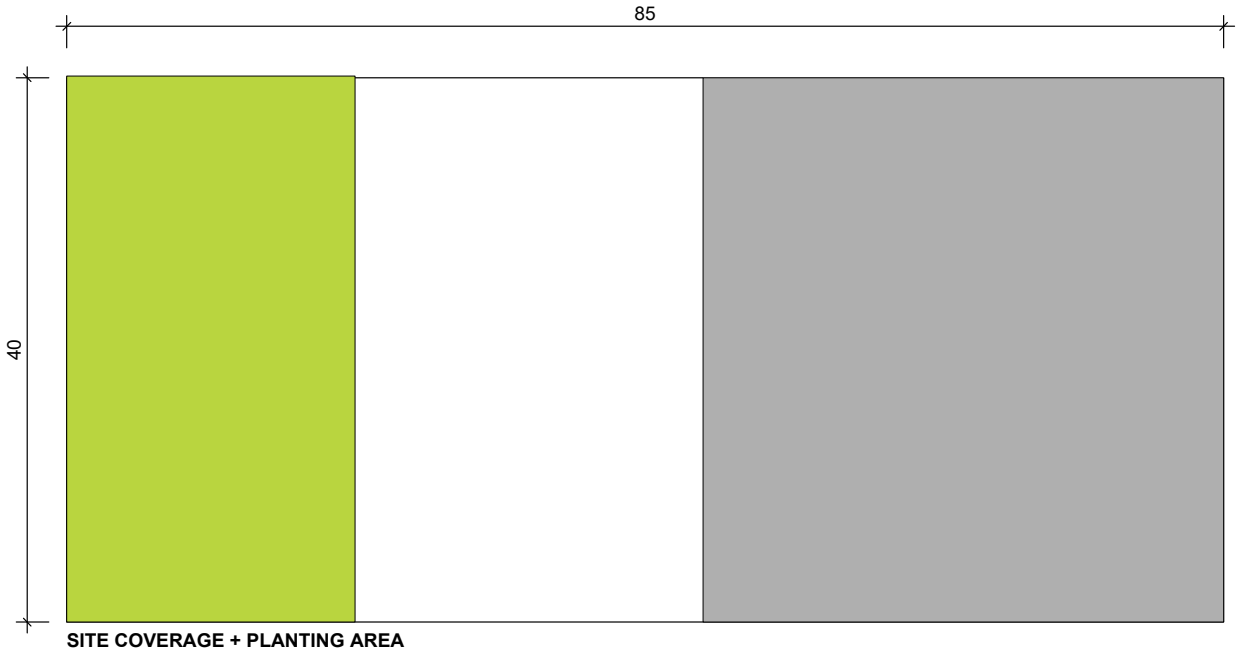


SETBACKS
BLOCK SIZE: 3400M² (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
PLOT RATIO:	65-80%		
SITE COVERAGE:	N/A	1010M²	30%
SITE OPEN SPACE:	20%	2296M²	68%
PLANTING AREA:	10%	340M²	10%

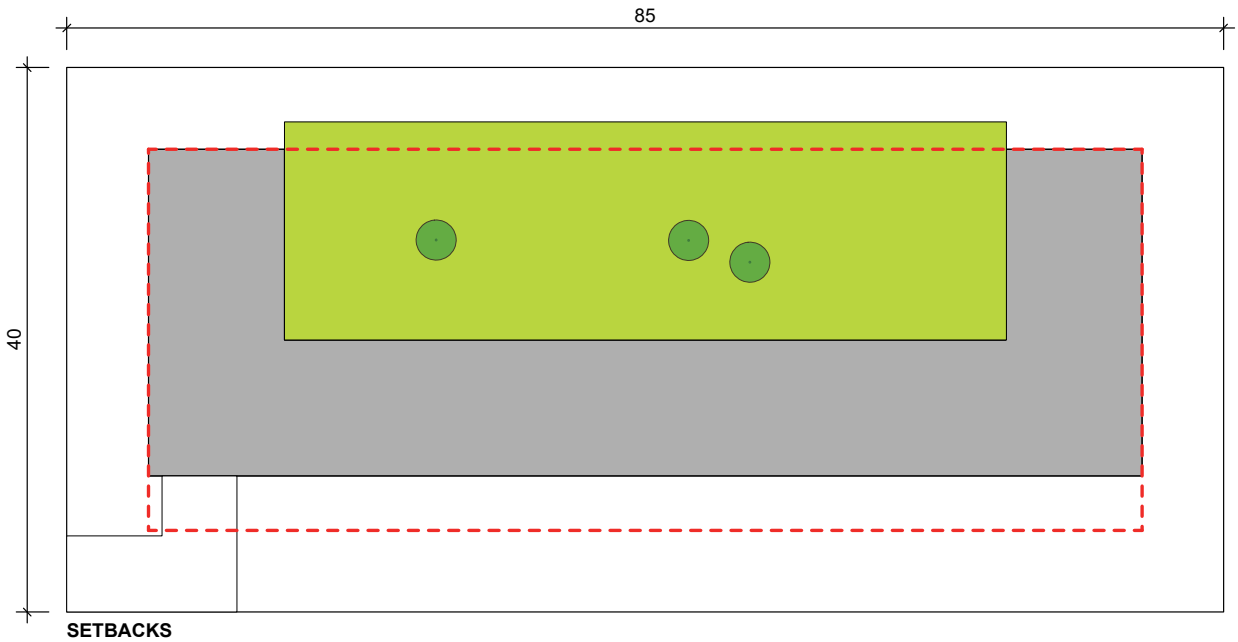
MULTI UNIT

PROPOSED RECOMMENDATIONS



SITE COVERAGE + PLANTING AREA
BLOCK SIZE: 3400M² (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
SITE COVERAGE:	45%	1530M²	45%
OPEN SPACE:	N/A	1020M²	30%
PLANTING AREA:	25%	850M2	25%



SETBACKS
BLOCK SIZE: 3400M² (RZ3 / RZ4 / RZ5)

	CONTROL	OUTCOME	
PLOT RATIO:	65-80%		
SITE COVERAGE:	45%	1010M²	30%
SITE OPEN SPACE:	N/A	2390M²	70%
PLANTING AREA:	25%	850M²	25%