SJB Architects

Pagewood Green (Stage 2)
Urban Design Report and Masterplan

128 & 130-150 Bunnerong Road
Pagewood

Prepared for
Meriton

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We create amazing places

At SJB we believe that the future of the city is in generating a rich urban experience through the delivery of density and activity, facilitated by land uses, at various scales, designed for everyone.

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Introduction

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Introduction

1.1 Purpose of the Report

This Urban Design Report (UDR) has been prepared for Meriton in support of the Planning Proposal and provide an indicative layout for a future Stage One Development Application of Pagewood Green Stage II. Outlined in this report is the design rationale that underpins the site layout, built form, public domain and future land uses.

A specialist consultant team has been brought together by Meriton to provide technical expertise for the Stage One Development Application that includes; Architecture and Urban Design by SJB; Landscape Architecture and Town Planning by Urbis; Traffic Engineering by ARUP; and Civil Engineering by AT&L. SJB has included the relevant information from each consultant in the UDR.

The Pagewood Green Stage II masterplan is located on the former British American Tobacco Australia (BATA) manufacturing facility on the corner of Heffron and Bunnerong Roads in Pagewood. The Site has an area of 8.95ha and is located within a broader site that comprises a parcel of land known as 128 and 130-150 Bunnerong Road Pagewood.

Pagewood Green Stage I consists of the remaining area of the site to the south and was subject to a separate development application. Stage I is currently under construction and consists of multiple high-density residential apartment buildings, associated retail, child care and a large open space. Principles established in the Stage 1 plan have been reflected in this UDR to maintain consistency and ensure the site is contextually appropriate.

The UDR is broken down into a process that is consistent with a 'design-led' approach to masterplanning. Design-led planning is an approach that is place based and people focused, creating a new neighbourhood where future residents can live, work and play. The UDR provides a legible public domain and active interface with the built form, that will form the bones of a vibrant community in the future.

The appropriate information to support the masterplan is contained in the report, and includes the following:

- An understanding of the planning policy, site and context analysis
- A Vision and Design Principles that will inform the future character, quality of development and underpin the design response
- A masterplan, that configures the built form and public open space for the site
- Calculation of yields, dwelling sizes, building types, floor areas and FSR
- An assessment of the scheme that quantifies solar access to the site

This UDR has consolidated the much of relevant information and context provided in previous masterplans prepared for the site by HASSELL (2016, 2017) and subsequent reviews by Hills Thalis (2016, 2017) at the request of council. SJB believe that the process of building upon existing work and the iterative process that has taken place, has led to a masterplan that has a highly refined and justified outcome.

Stage I Masterplan approved by council

View accross Stage II site toward Sydney CBD

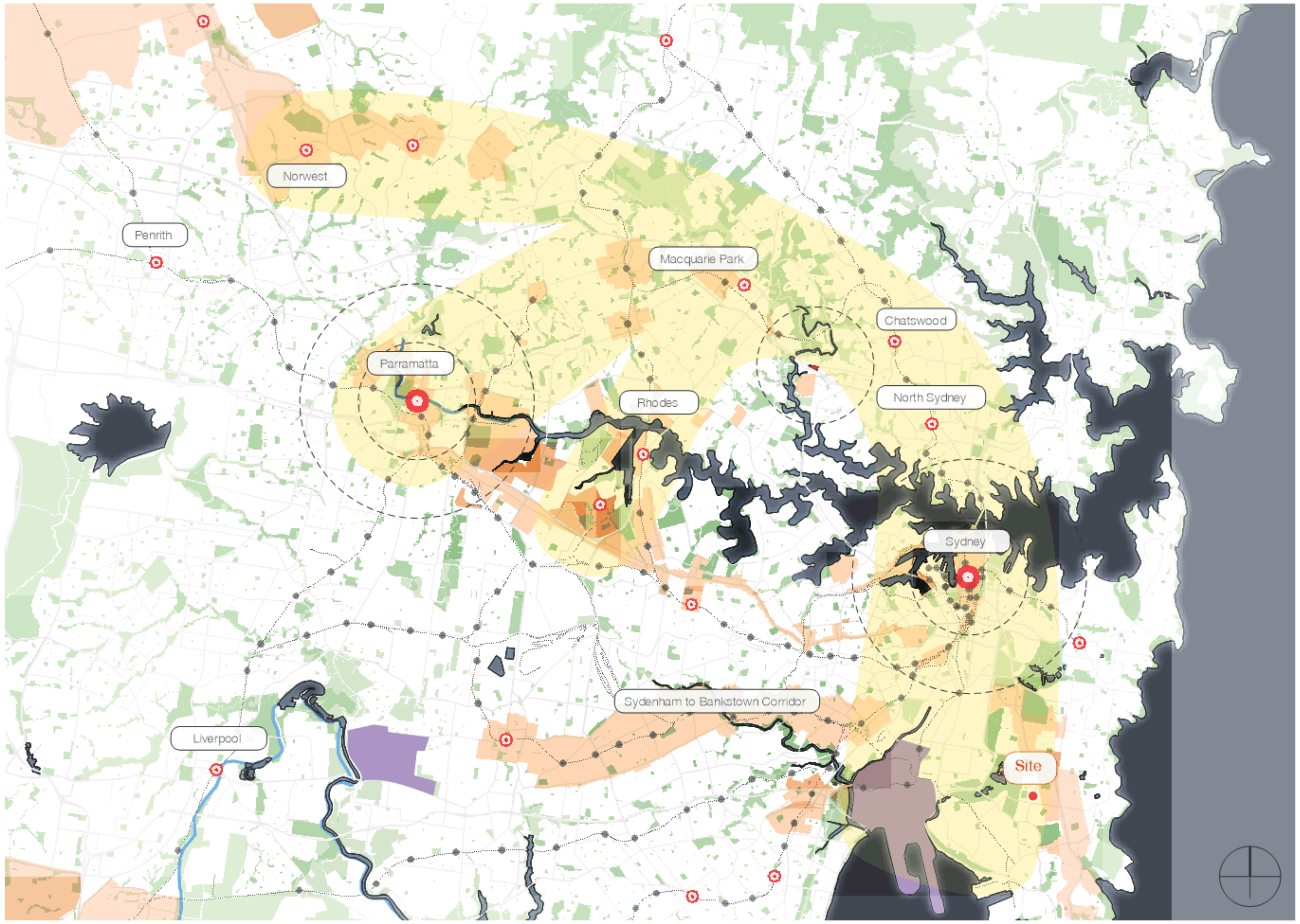
Stage I UB5W development

1.2 Regional Context

The Global Economic Corridor

The Pagewood Green Stage Two site is strategically located for redevelopment. It is recognised by past and current regional plans, including 'A Plan for Growing Sydney' and 'The Greater Sydney Regional Plan' as part of the Global Economic Corridor (GEC). The plans outline the importance of identifying opportunities for increased residential density and renewal in strategic locations.

The GEC extends from the surrounding vicinity of the site, which includes Port Botany and Sydney Airport, through Sydney CBD to the Norwest Business Park, and includes centres such as Chatswood and Bondi Junction, the Strategic Centres of St Leonards and Macquarie Park, four large universities and major health and entertainment precincts.



Introduction

1.3 Strategic Context

Greater Sydney Regional Plan

The subject site is situated within the scope of the Eastern City District Plan, which is part of the Eastern Harbour City as identified in the Greater Sydney Regional Plan (2018). The Eastern City District includes the local government areas of Bayside, Burwood, Canada Bay, Inner West, Randwick, Strathfield, Sydney, Waverly and Woollahra.

Eastern City District Plan

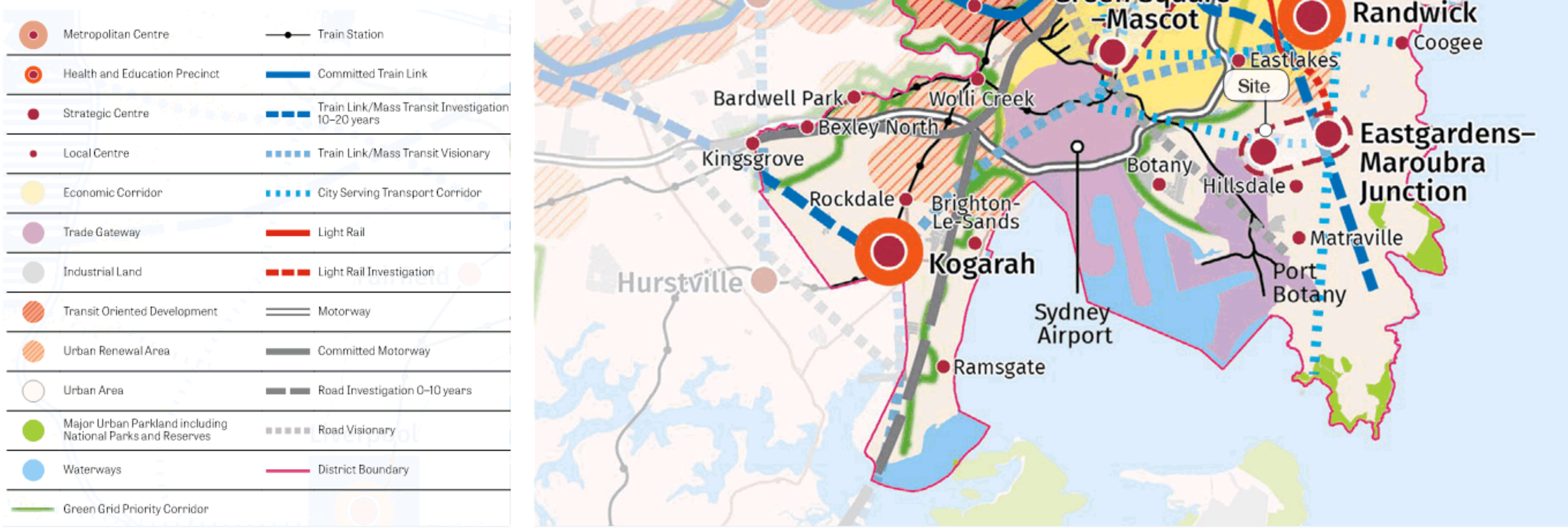
The District Plan is a guide for implementing the Greater Sydney Regional Plan at a district level over the next 20 years. The Plan identifies the Eastern City District's population is expected to grow significantly and residential densities must increase. The Plan will guide the growth and transition of the district focusing on the GEC and transport corridors.

There are investigations into a transport link from Harbour CBD to Malabar via Randwick and Eastgardens/Maroubra Junction. This will open up this wider district to improved active and sustainable transport modes, and pave the way for transport oriented growth.

The Eastern City District Plan also identifies a range of population trends and housing targets. Some of the trends and targets relevant to this proposal are:

- An additional 325,000 people are expected to be living in the District by 2036;
- Projected dwelling requirement of157,500 dwellings within the District by 2036;
- With a 64% increase in the 65-84 age group requiring appropriate accommodation solutions.

The proposal has already received gateway approval by the DPE as a delegate of the GSC confirming that it has planning merit.



Introduction

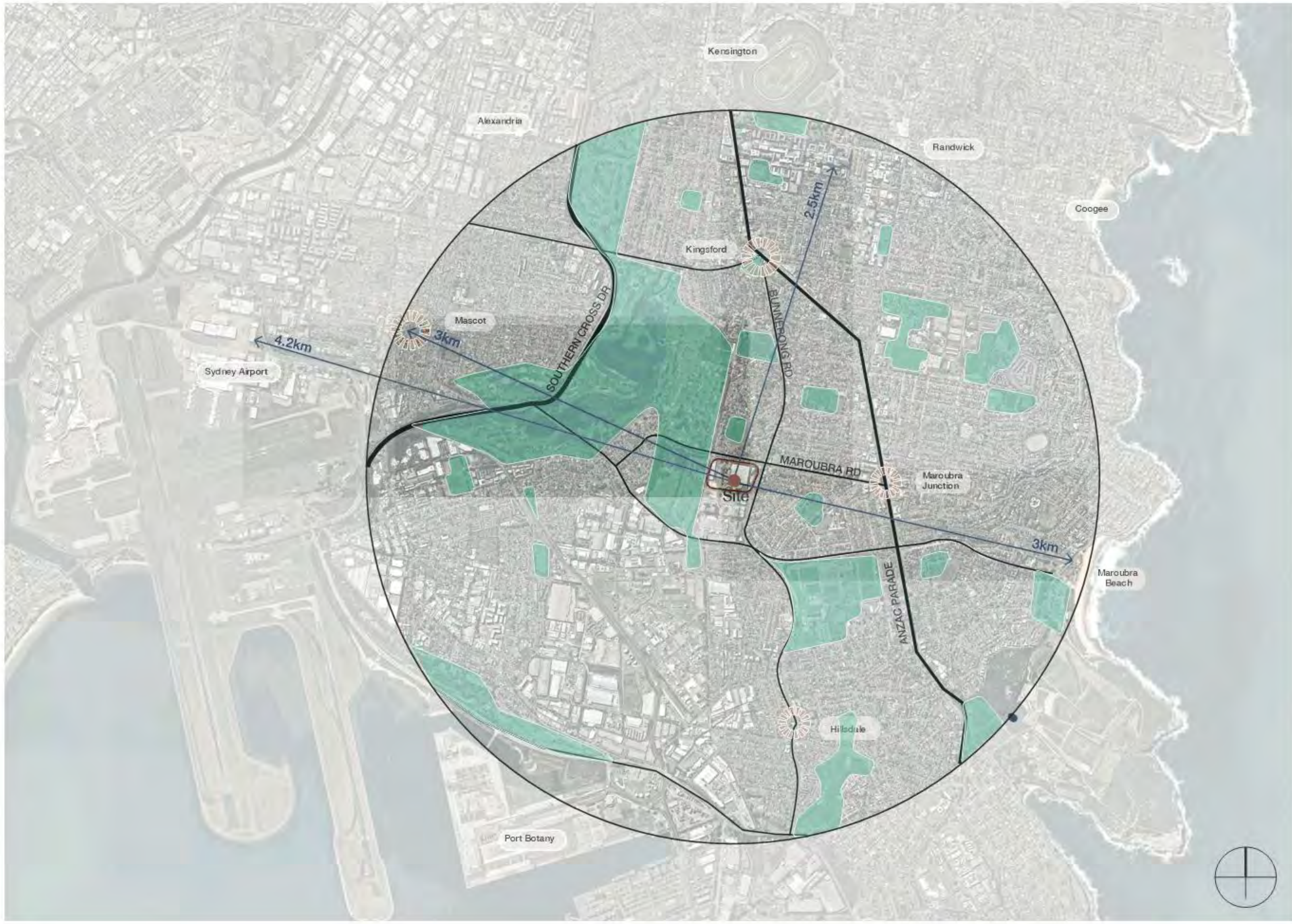
1.4 Local Context

The site is located on the former British American Tobacco Australia (BATA) manufacturing facility. Prior to this it was used as the General Motors Holden Factory.

The site has an area of 8.95ha and is located within a broader site that that already has an approved master planned and is under development.

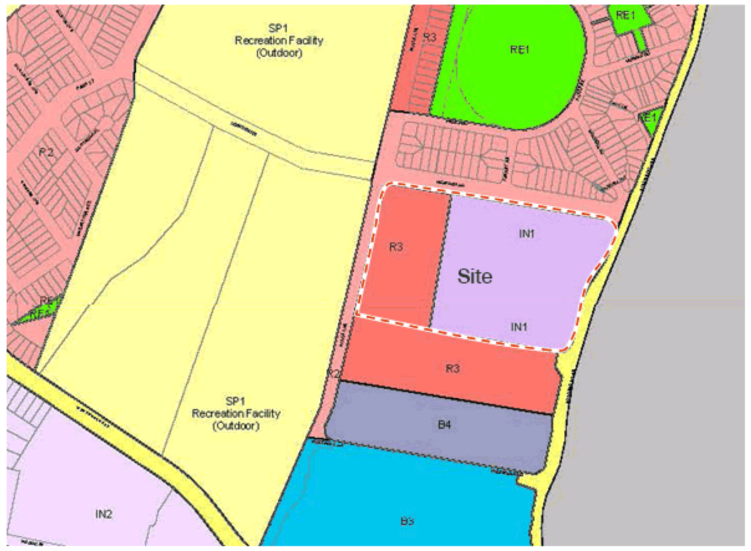
The site is located 8km from the CBD and within 6km of major employment centres, such as Sydney Airport, Port Botany, Randwick, UNSW, Centennial and Moore Parks.

It is located within 4.5 kilometres of Mascot Station and 2 kilometres to the future Kingsford Light Rail Station, with existing and future bus services providing direct access to and from the the site.



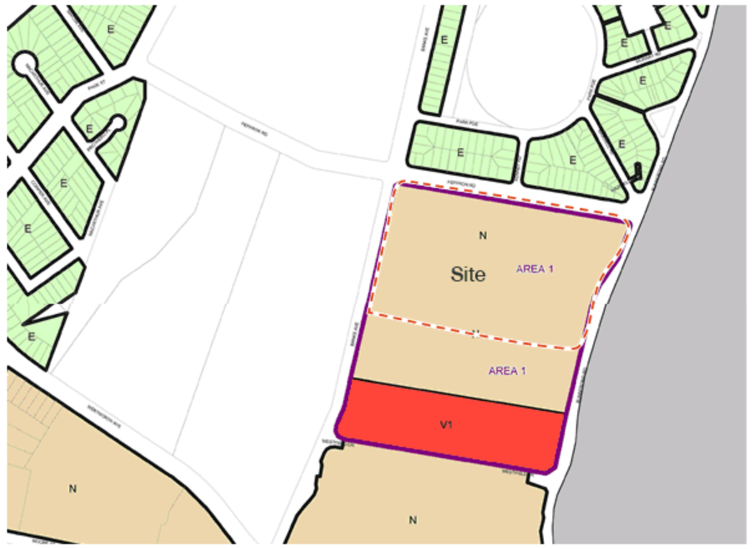
Introduction

1.5 Existing Controls - Bays Council LEP



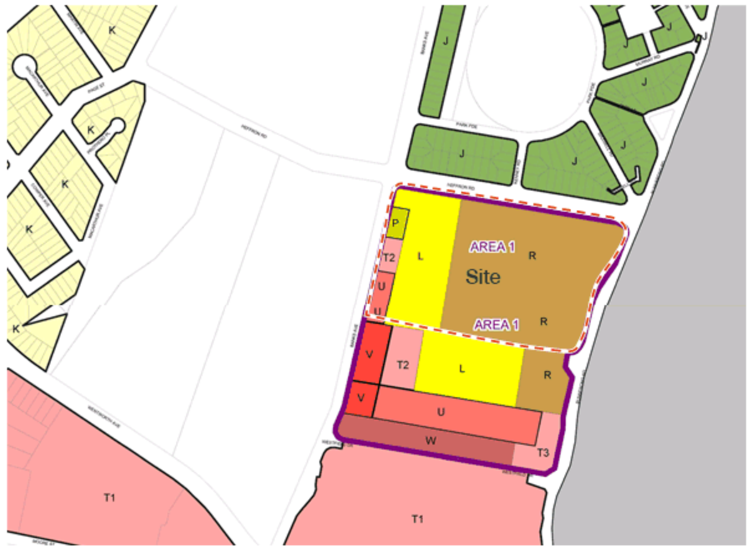
Land Zoning, 2015

The subject site is zoned R3 Medium Density Residential and IN1 General Industrial



Floor Space Ratio, 2013

The subject site currently has an allowable floor space ratio of 1:1



Height of Buildings, 2015

The subject site currently has an allowable building height of 11 - 32m

Key

B1	Neighbourhood Centre	R2	Low Density Residential
B2	Local Centre	R3	Medium Density Residential
B3	Commercial Core	R4	High Density Residential
B4	Mixed Use	RE1	Public Recreation
B5	Business Development	RE2	Private Recreation
B7	Business Park	SP1	Special Activities
IN1	General Industrial	SP2	Infrastructure
IN2	Light Industrial	W3	Working Waterways

Key

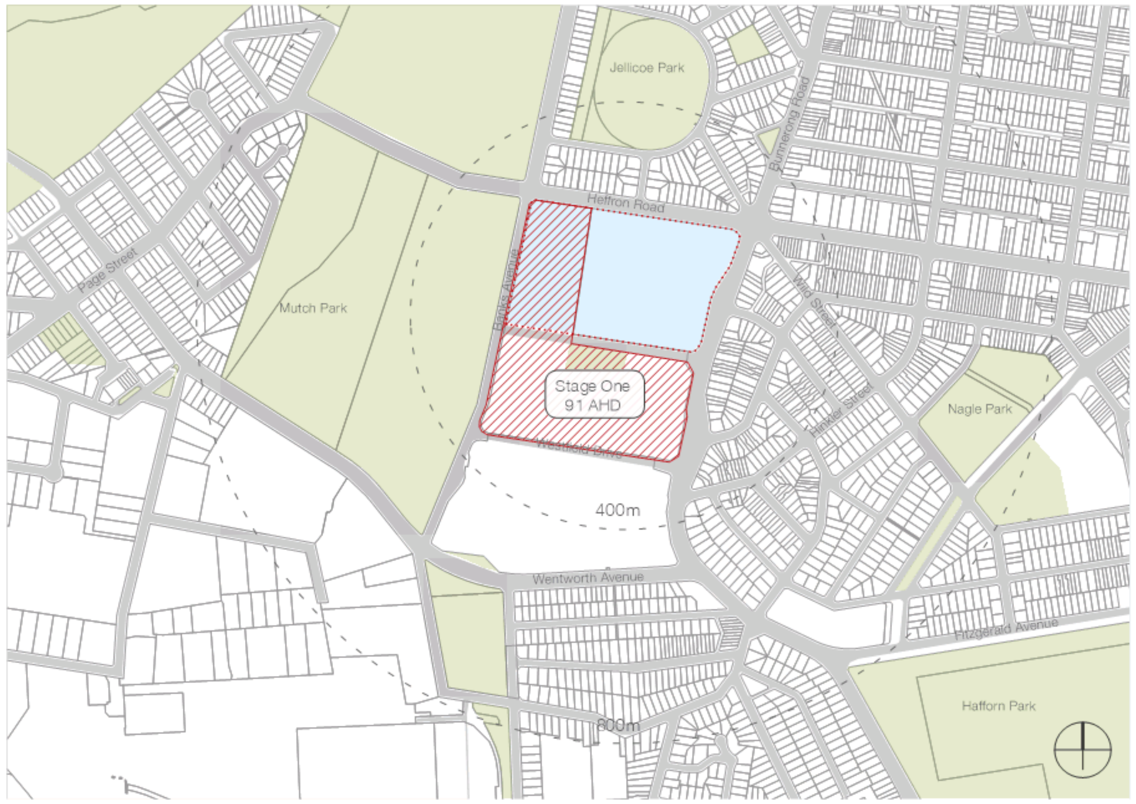
D	0.5	S	1.5
E	0.55	T	2
F	0.6	U	2.5
G	0.65	V1	3
H	0.7	V2	3.2
K	0.85	V3	3.3
L	0.9	W	3.55
N	1		
P	1.2		

Key

H	7.5	T	25
I	8.5	T1	26
J	9	T2	28
K	10	U	32
L	11	U1	33
M	12	V	39
N	14	W	44
P	17		
Q	19		
R	22		

Introduction

1.6 Height Restriction OLS

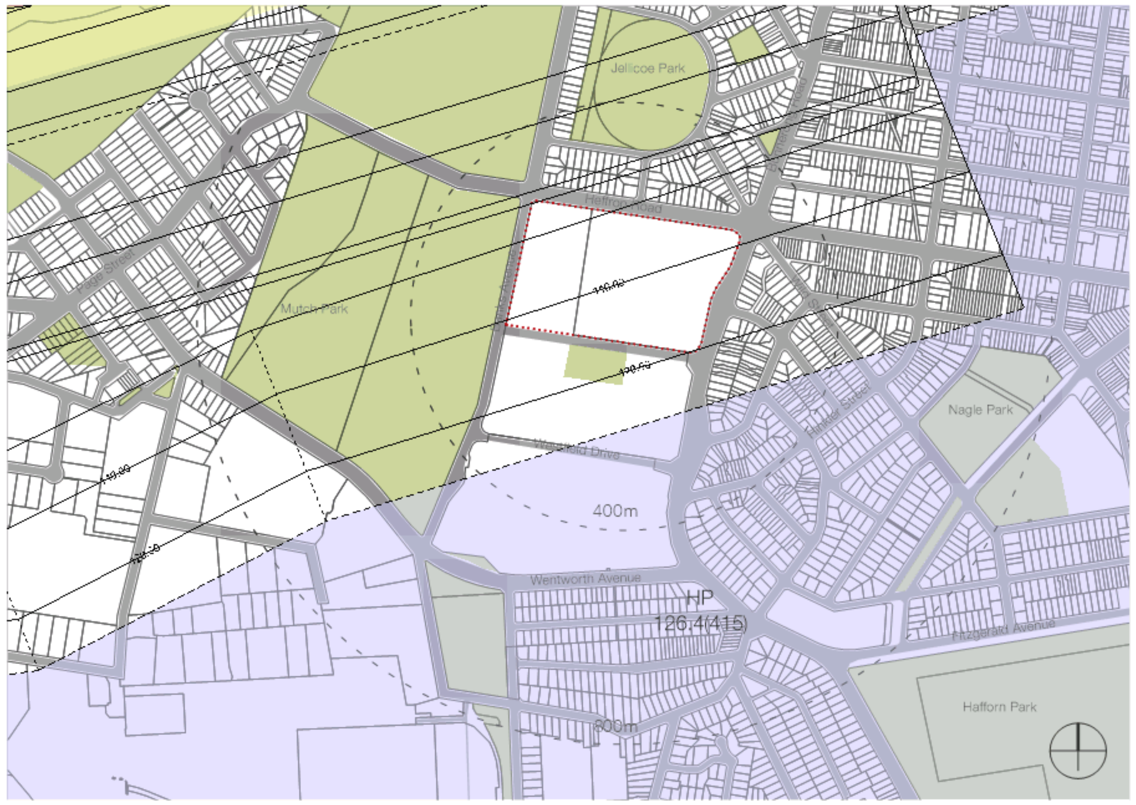


The Stage 1 precinct has a Controlled Activity Approval of 91m AHD for buildings, which penetrates the obstacle limitation surface (OLS) at 51m AHD.

Key

- Site Boundary
- Stage One Approved

1.7 Height Restrictions - PAN OPS



The Stage 1 precinct has a 'procedures for air navigation services - aircraft operations (PAN- OPS)' limit of 110m in the north west and 120m AHD for the buildings in the south east of the site. The built form will remain within these heights.

Key

- Site Boundary

Introduction

1.8 Overview of Existing Masterplans

Overview

The masterplan for Pagewood Green Stage Two has been through an iterative process to refine the configuration and built form into its current state. The evaluation of each masterplan has come together into a well tested and well developed proposal for the site. The urban design framework draws on many of the principles and key moves established in earlier reports while improving other aspects, such as the street network.

Council Masterplan by Hill Thalis, 2016

The masterplan prepared for and endorsed by Bayside Council in 2016 was prepared by Hills Thalis.

The plan provided a structure which:
- supported adaptive reuse of older buildings along Bunnerong Road;
- created a wedge park to draw amenity into the site and connect the wider open space network;
- created well proportioned and walkable blocks and local streets; and
- communal courtyards at ground level with no basement below to ensure deep soil zones. The result is deep 'donut' style basements.

Hassell Masterplan, 2017

The masterplan prepared by HASSELL for Meriton in 2017 built upon the initial design response by Hills Thallis and was included in the planning proposal considered as part of the gateway determination in December 2017.

The major differences to the initial plan included:
- proposed FSR of 2.35:1;
- Existing clock tower retained for dedication to the council (this was not accepted by council);
- realignment of the open space to the west of the site in order to maximise afternoon sun; and
- the addition of sleeved podium car parking with communal open space above.

Hassell Masterplan Review for Council by Hills Thalis, 2017

The masterplan prepared by Hills Thallis for Bayside Council in 2017 evaluated the design response by HASSELL and consolidated their findings into a new plan.

Hills Thallis responded with a masterplan that included:
- An FSR of 2.35:1, as per HASSELLS plan;
- retention of the second existing building;
- return to the original orientation of the linear park/open space; and
- return to the basement car parking scenario.

Site Analysis

2

The analysis provided in this section explores the existing conditions of the local area and considers the potential impact on the future development of the site. This assessment will inform the type of built form, the quantity of public open space and amenities that are suitable for the site. This section culminates in a synthesis of the 'opportunities' and 'constraints' for the development that are applicable to the site based on a thorough understanding of the local neighbourhood.

Site Analysis

2.1 Existing Land Uses and Built Form

The built form in the local area reflects the existing land uses.

The predominate land use includes low density residential, while there are light industrial uses in and around the airport.

The emerging leader for higher density development in the local area, is the stage one portion of the site, which is under construction. This contains residential and support uses up to 20 storeys. This increase in height and form responds to the significance of Eastgarden and Maroubra as a strategic centre.

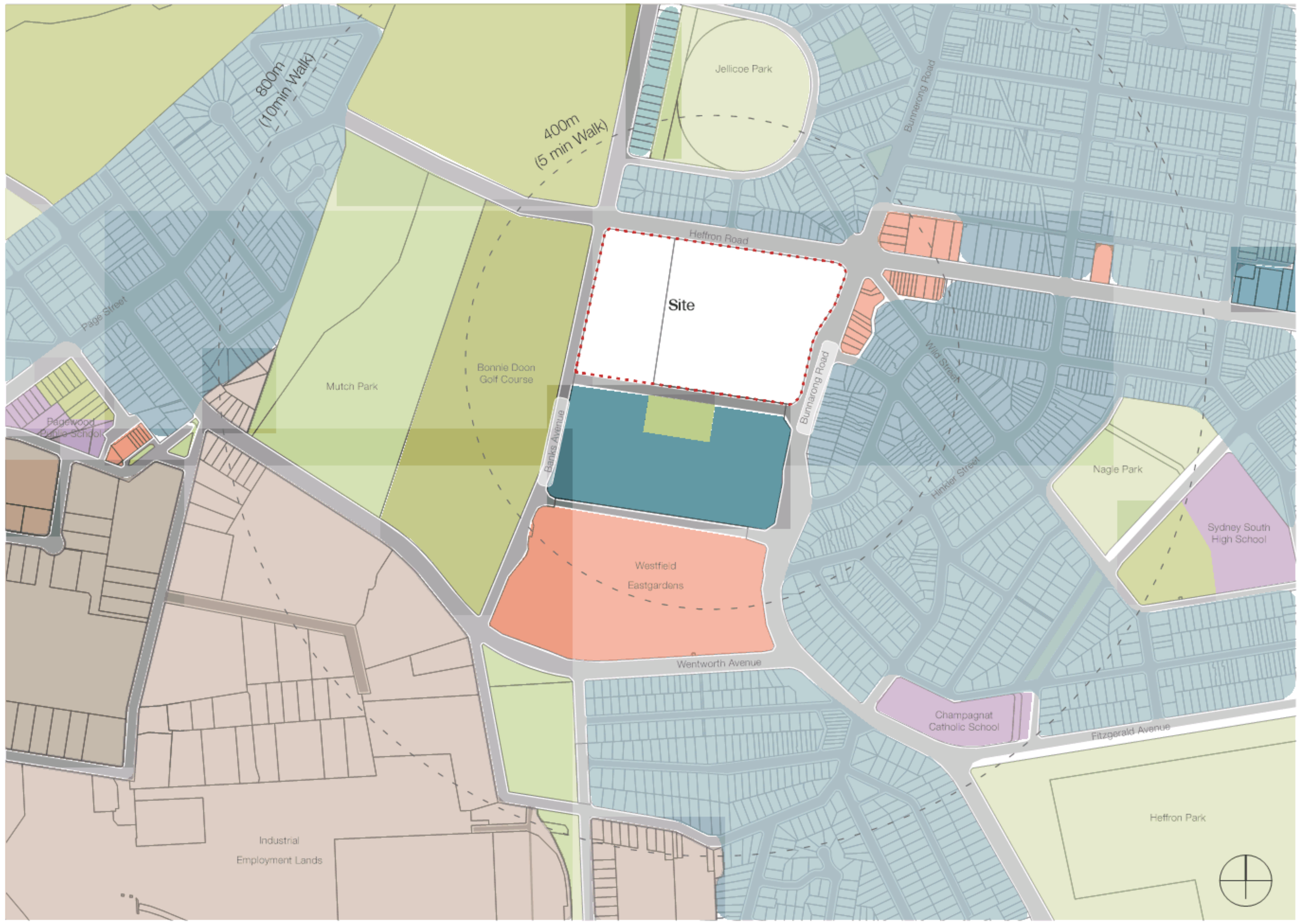
There are three schools in the local area that service the local area: Sydney South Public High School, Champagnat Catholic College and Pagewood Public School.

Local retail is consolidated in the six storey Westfield Eastgardens shopping mall with a Coles, Woolworths, Big W, Kmart, Target and Myer, Hoyts Cinema as well as Eastgardens Library.

Some additional retail is located around Bunnarong and Heffron Road intersection to the north west of the subject site.

Key

- Public Open Space
- Private Open Space
- Low Density Dwellings
- Medium Density Apartments
- High Density Apartments
- Retail
- Shopping Malls
- Education Facilities
- Employment Sector
- Site Boundary



Site Analysis

2.2 Topography

The gradient of the region slopes away from the town centre of Maroubra down to Botany Dams to the north west and south to Botany Bay.

The subject site has minimal gradient, as shown in the adjacent plan. The 2m intervals are not sufficient to show the slope, which drains toward the south of the site.

Key

- Water body
- 12m
- 14m
- 16m
- 18m
- 20m
- 22m
- 24m
- 26m
- 28m
- 30m
- 32m
- 34m
- 36m
- 38m
- 40m
- 42m
- 44m
- 46m
- 48m
- 50m
- 52m
- 54m
- 56m
- Site Boundary

Site Analysis

2.3 Recreation and Amenity

The subject site is fortunate to be located in close proximity to many green open spaces and active recreation spaces. It is a short walk to Bonnie Doon Golf Course, Mutch Park, Jellicoe Park, Hensley Athletics Field, Nagle Park and the new recreation spcae within Pagewood Green Stage 1. Within a 800m radius, residents will have access to ~25ha of public open space (this does not include schools or Bonnie Doon Golf course).

There are several schools within the local area that will serve future residents of Pagewood Green. This includes Sydney South Public High School, Champagnat Catholic College, Pagewood Public School, Daceyville Public School, Banksmeadow Public School, Maroubra Junction Public School and Lycée Condorcet: the International French School of Sydney.

Key

Water Body	Rugby/Soccer Field
Retail	Running Track
Childcare Facilities	Outdoor Fitness
Education Facilities	Public Toilet
Public Open Space	Dog Walking
Private Open Space	Childrens Playground
Bicycle Friendly Route	Picnic/BBQ Facilities
Dedicated Lanes	Aquatic Centre
Trails	Gymnastics Centre
Site Boundary	Cycling Track
	Cricket Pitch/Nets
	Netball/Basketball Courts
	Tennis Courts
	Golf Course
	Food Retail

Site Analysis

2.4 Movement

The network of roads in the area services the wider area connect Pagewood to Sydney CBD via Southern Cross Drive (M1) and Anzac Drive and directly out to the south eastern suburbs of Sydney.

The site is well serviced by a network of buses that connect it to key employment areas, as well as railway stations (Mascot) and future light rail. The proponent has been in discussion with Transport for New South Wales (TfNSW) for new bus services to directly service the site, as the first building of Pagewood Green Stage One is now complete, these services will expand over time.

Lightrail connecting Kingswood Junction to the CBD is in the advanced stages of construction and will be available to the future residents of Pagewood Green. The lightrail is expected to extend down Anzac Parade, through Maroubra Junction, in future stages of development.

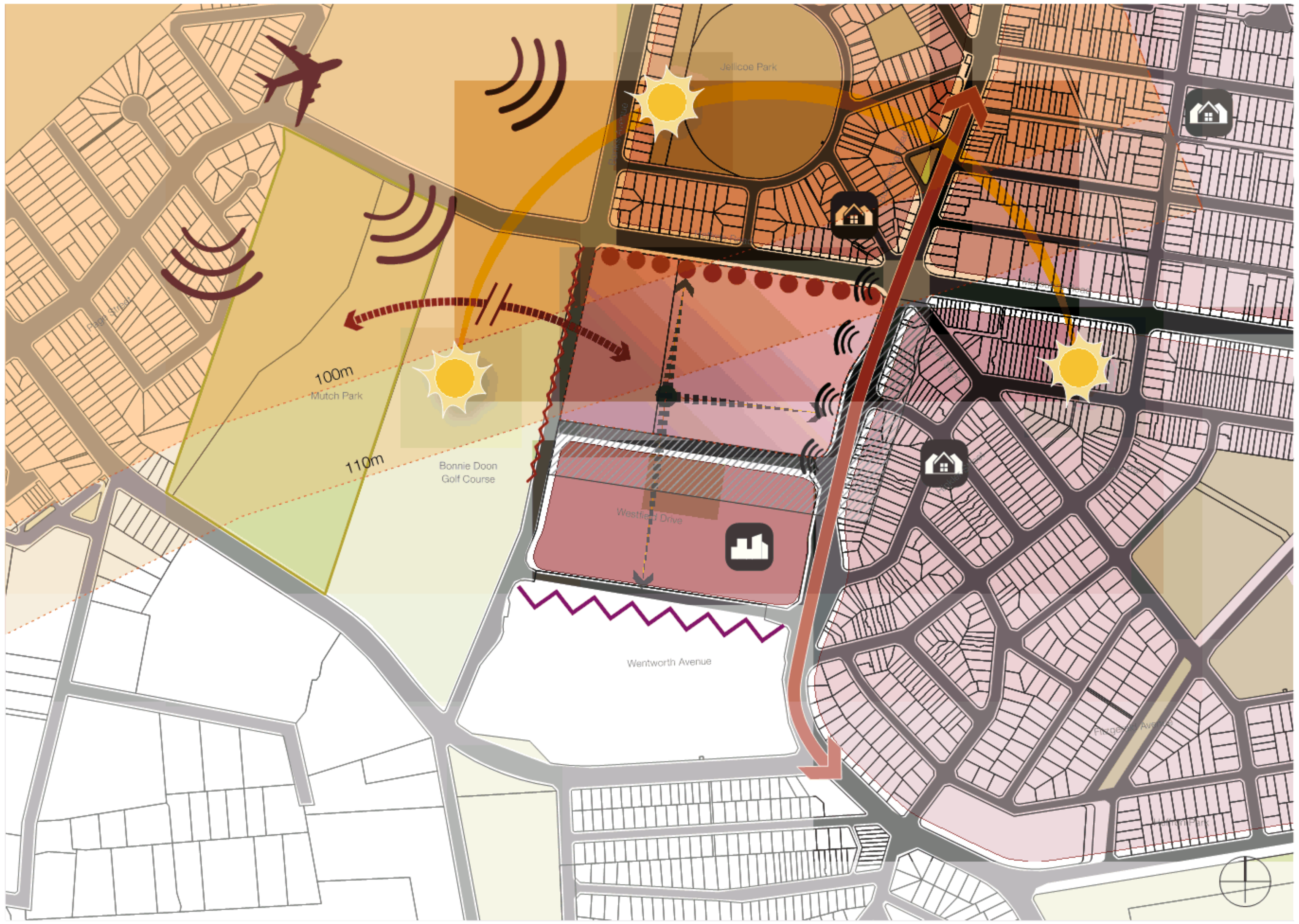
Key

- Military Barracks
- Employment Sector
- Street Retail
- Shopping Malls
- Water Body
- Vegetation
- Secondary Roads
- Primary Roads
- Express way
- Train Lines
- Bus Routes
- Light Rail Route
- Future Light Rail Station
- Bus Stops
- Site Boundary

Site Analysis

2.5 Constraints

- Bunnerong Road is located adjacent to the site - it consists of a four lane highway.
- The interface with Eastgarden Westfield is currently a blank facade and not ideal for pedestrian walkability.
- Local retail is consolidated in the internalised six storey Westfield Eastgardens shopping mall.
- Amenity and sunlight to the adjacent low density residential dwellings must be preserved.
- An appropriate transition in scale is required for the interface with the existing low density residential. The separation provided by the wide roads helps this condition.
- The proximity of the airport creates height restrictions on the subject site.
- Golf course separates the site from active recreation spaces in Mutch Park.



Key

- Pan Ops Height Restrictions
- Low Density Dwellings
- High Density Dwellings
- Height Gradient
- Public Park
- Plane Noise
- Road Noise
- Hard Wall
- Bus Stops
- Site Boundary

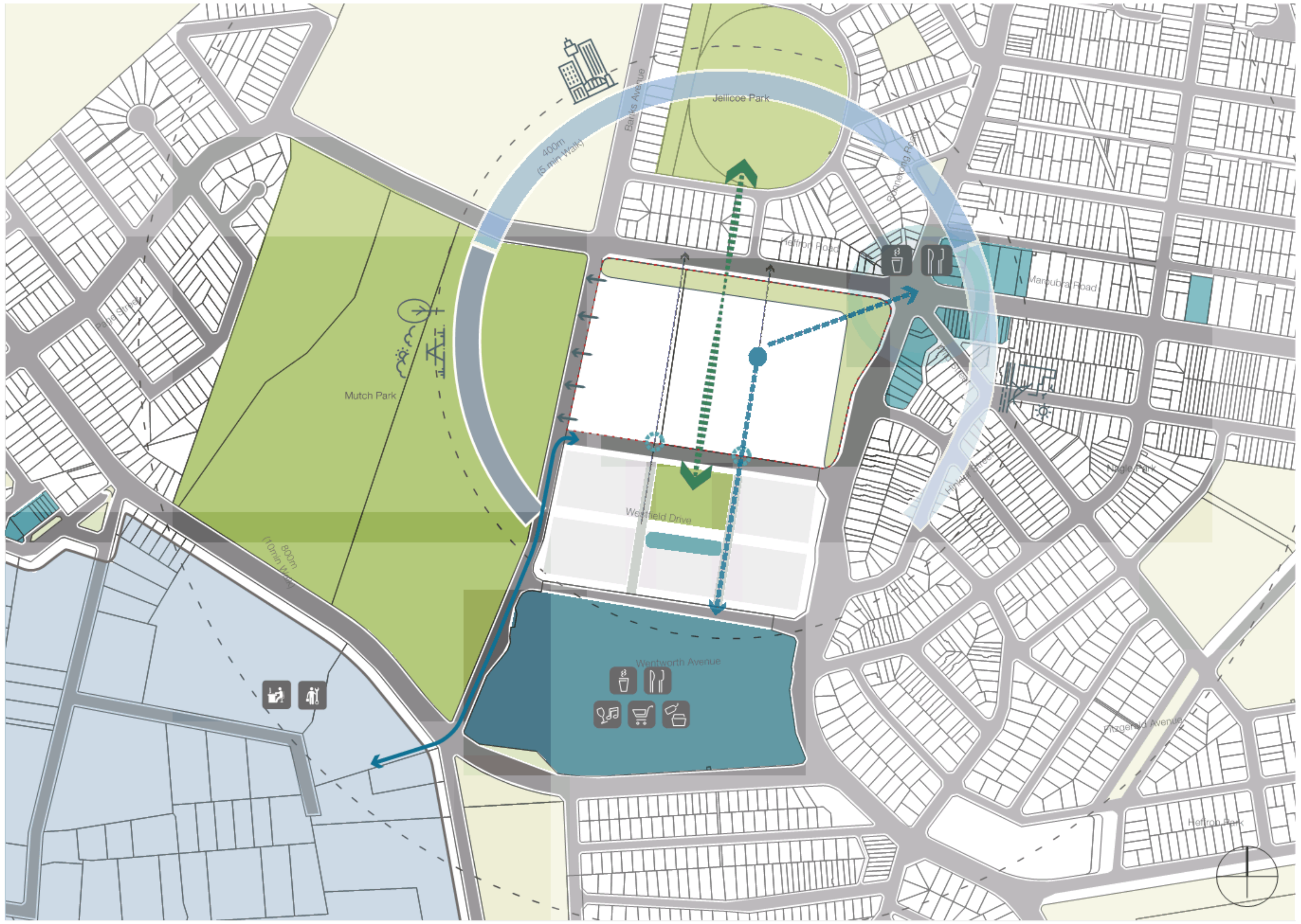
Site Analysis

2.6 Opportunities

- There is a network of public green open spaces that offer a range of programmed and passive recreation activities.
- Open space can be connected from Jelicoe Park through to the new public open space provided in Pagewood Green Stage One.
- There is unobstructed solar access to the site throughout the day.
- Employment lands and Eastgarden shopping mall provide local job opportunities within a walkable distance.
- There is a small retail activated node around the intersection in the north-east corner of the site. There is potentail to better link this with Westfield Eastgarden.
- Amenity and views to the west over the green open space can be captured.
- Close proximity to heavy/light rail connections, which is currently connected by frequent and direct bus routes.
- There is frequent and direct bus routes to major centres and employment opportunities.
- Services and amenities provided in the mall will be an asset to local residents.
- Buildings on site offer character opportunities to the site.
- There are schools available within a 10 minute walk.
- Retail offer within 400m/5min walk of the subject site

Key

Employment Lands	Un-obstructed Views
Shopping Mall	Green Connector
Street Retail	Retail Connection
Vegetation	Bus Stops
Secondary Roads	Site Boundary
Access Points	



Vision and Principles

3

The vision and principles will define the future character of the site and establish the values that underpin future development. The vision presents an image of the quality place and type of community that the development aims to create. The principles break down the specific qualities and measures that will be used by the developer to achieve this.

Vision and Principles

3.1 Vision

The Pagewood Green masterplan (stage two) will provide a framework for creating a strong sense of character and active vibrant streets that leads to a 'village feel'. By referencing historic land uses and the architectural qualities of the existing warehouses and centering activation around a village green to create a strong sense of place and belonging.

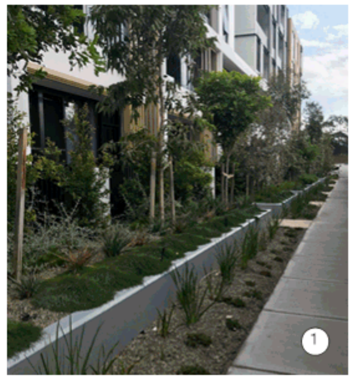
The proposed density will accommodate Sydney's population growth in accordance with Metropolitan strategy with an offer that is varied to accommodate a diversity of people. Provision of a varied dwelling sizes and building typologies that range from two storey town houses to one bedroom apartments will create a vibrant and diverse resident population. While, the offer of convenient amenities, such as childcare, possible aged care, possible medical suites and retail, will afford residents the opportunity to live locally and age in place.

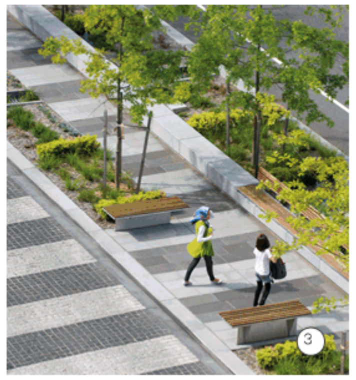
The intensity of dwellings, retail, amenities and services will support vibrant streets and open space, contributing to a community life in a transient city. High proportions of open space with deep soil zones for canopy trees and other vegetation will make a liveable environment that offers thermal comfort throughout the year. The precinct will prioritise pedestrians and other active transport modes while also offering a legible traffic environment.

The proposal will provide approximately two hectares of open space that will form a green spine through the site, linking Jellicoe Park and the open space in Pagewood Green Stage One. A civic plaza at the centre of the new development will be the heart of the future community, bringing people together through a shared enjoyment of the amenities and open space.

Vision and Principles

3.2 Principle 01: An accessible and legible site





Principles

- Extend the grid of Pagewood Green stage 1 through the precinct to provide clear east - west, north - south links.
- Connect key nodes, such as Jellicoe Park and Westfield.
- Clear hierarchy with distinctive uses and function.
- Streets as habitable open spaces and integrated public realm.
- Pedestrian priority throughout the study area that are accessible and walkable with short blocks.
- Create safe and active streets with adequate lighting and passive surveillance.
- A connected and comprehensive bicycle network.
- A logical and connected network of roads.

Figure 1: Residential street with semi-transparent interface with pedestrian path. Figure 2: Wide pavements and pedestrian friendly streets. Figure 3: Shared streets with clearly defined separation. Figure 4: Safe, active and well lit streets that provide places for people to linger and socialise. Figure 5: Highly vegetated streets that are passively irrigated.v

3.3 Principle 02: Diverse and connected open spaces

Principles

- Streets occupied as part of network of public open space.
- Different types of open space provision;
  - public, private, semi-private
  - hardscape and green spaces
  - public green spaces for recreation.
- Reinforce the regional green grid.
- Consideration for ecological sensitivities and geography.
- Ensure safety through passive surveillance and adequate lighting.
- Provide green roofs on podiums with loading and soil zones for large trees.
- Retain existing trees where possible.
- Private green roofs on each building to reduce thermal loading.
- Water Sensitive Urban Design (WSUD) integrated where possible.

Figure 1: Vegetated and habitable shared terraces on upper levels will include viewlines. Figure 2: Semi-enclosed shared terraces are sheltered and receive passive surveillance from above. Figure 3: green open space that is protected and activated by surrounding residential dwellings. Figure 4: Hardscapes are functional and provide a civic character, while reflecting the vegetated precinct character.

Vision and Principles

3.4 Principle 03: Streetscape Activation

Principles

- Fine grain variation, transition and rhythm at street level.
- Provide benches, street furniture and informal seating areas.
- Streets will serve as public spaces as well as conduits for traffic.
- Activation at corners and edges, as well as creating nodes within the precinct – centring/consolidating activity around select locations.
- Create a distinctive village feel to local neighbourhood through provision of fine grain treatment to the street scale.
- Create a main street on through connecting street.
- External facing – Activating surrounding streets, including Bunerong road.
- Minimise vehicular crossovers through laneway/rear access to basement and podium parking.
- Support retail uses with easily accessible on-street parking.

Figure 1: Informal gathering spaces and street furniture. Figure 2: Building transparency and direct interface with the street. Figure 3: Articulation and visual interest provided through materials and planting. Figure 4: On street dining and spill over from active retail.

3.5 Principles 04: Community program

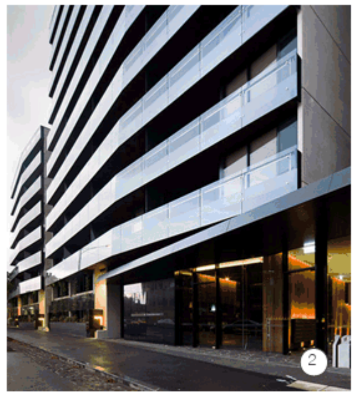
Principles

- Diverse housing types and sizes to promote population diversity.
- Accommodate a mix retail tenants, activities and informal opportunities for social interactions.
- Co-location of services such as retail, possible aged care and childcare.
- Provision of civic plaza and landscaped public open space.
- High quality street furnishings and informal gathering spaces in the public realm and private terraces.
- Introduce a civic plaza and network of open spaces, to complement the stage one master plan.
- Integration of public art.
- Create a linear park that will serve as a central community space linking the site north and south.

Figure 1: Communal rooftop terraces. Figure 2: Public art and interpretive signage. Figure 3: Public art and follies within the public realm. Figure 4: Play spaces for children - formal and informal offering.

Vision and Principles

3.6 Principle 05: A mix of building typologies



Principles

- A diversity of dwelling typologies with variation in heights, scale and form
- Provide a higher density around public space offering to maximise amenity and outlook for apartments.
- Building envelopes to ensure maximum solar access and compliance with Apartment Design Guidelines (ADG).
- Diversity within the building envelope with a range of dwelling sizes.
- Lower levels should interface with the street including balconies overlooking the streets and public realm.

Figure 1: Medium density residential developments. Figure 2: Mixed use development with direct interface with street. Figure 3: Town house with fine grain articulation at street level Figure 4: Podium tower typology with height that tapers away from street intersection. Figure 5: Podium tower with terrace style frontages that interface directly with the street.

3.7 Principle 06: Design excellence

Principles

- Review and analysis based on state policies around good design that includes the new strategies and frameworks created by the Government Architect New South Wales (GANSW).
- Considers economic, environmental and social benefits of proposed development, suggest pathways to achieving quality outcomes and a framework for assessment.

Figure 1: Better Placed 2017 by GANSW establishes statewide design principles. Figure 2: Urban Design Guide (GANSW 2018) outlines recommended methods. Figure 3: Evaluating Good Design (GANSW 2018) provides a measuring tool. Figure 4: Greener Places (GANSW 2017) establishes targets and values around public open space.

Vision and Principles

3.8 Principle 07: Architectural quality









Principles

- Reference history of the site through a range of mechanisms, such as reflecting the art-deco era warehouse/buildings in future designs, referencing historic land uses, using materials, detailing and form to revive character elements and /or interpretive signage.
- Contribute to local character through a consistent form, transition, setbacks and streetscape.
- Integrate podium car parking to allow for natural ventilation, while maintaining activation and retail/residential overlooking of the street.
- Minimise vehicular crossovers and presence of garage doors.
- Provide visual interest from the street through facade treatments, public art, green walls.
- Integrate public realm amenity into residential dwellings through views and outlooks.
- Create a façade and interface of the development that activates the street frontage to create an engaging environment for pedestrians, visually and materially, minimising blank façades at street level and positively contribute to the public realm.
- Build a distinct local character through vegetation, materials and detailing that provides residents and visitors with a sense of place.
- Create internal amenity through visual connection to greenery outdoors.
- Create a balance of transparency and privacy to street level dwellings.
- Integrate sustainable initiatives and passive systems where possible.

Figure 1: Facade articulation and visual interest in the detailing. Figure 2: Town houses that introduce variety and interest through material choices. Figure 3: Development is integrated with the surrounding landscape. Figure 4: Green roofs and balconies. Figure 5: Podium car parking with naturally ventilated mesh screening. Figure 6: Complimentary forms across multiple scales. Figure 7: Activated ground plane interface. Figure 8: Complimentary forms and geometries across different scales within the precinct. Figure 9: Informal places to linger, passive surveillance provided by transparency in upper levels.

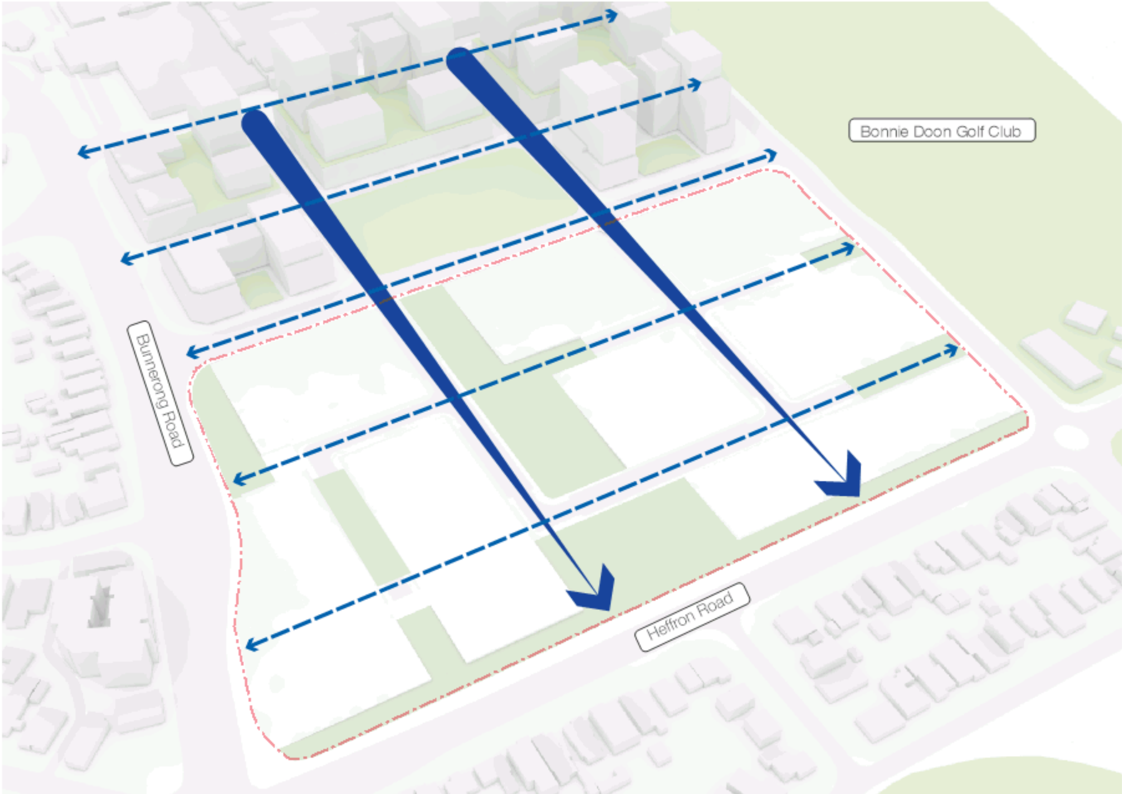
Design Response

4

The design response sets out a layered methodology for the configuration, scale and bulk of the site. From the structure of the roads to the qualities of the public open space and built form, this section overlays the elements of the future site in a systematic way to achieve an assurance of quality in the urban form and a logical narrative to the structure of the site.

Design Response

4.1 Urban Grain

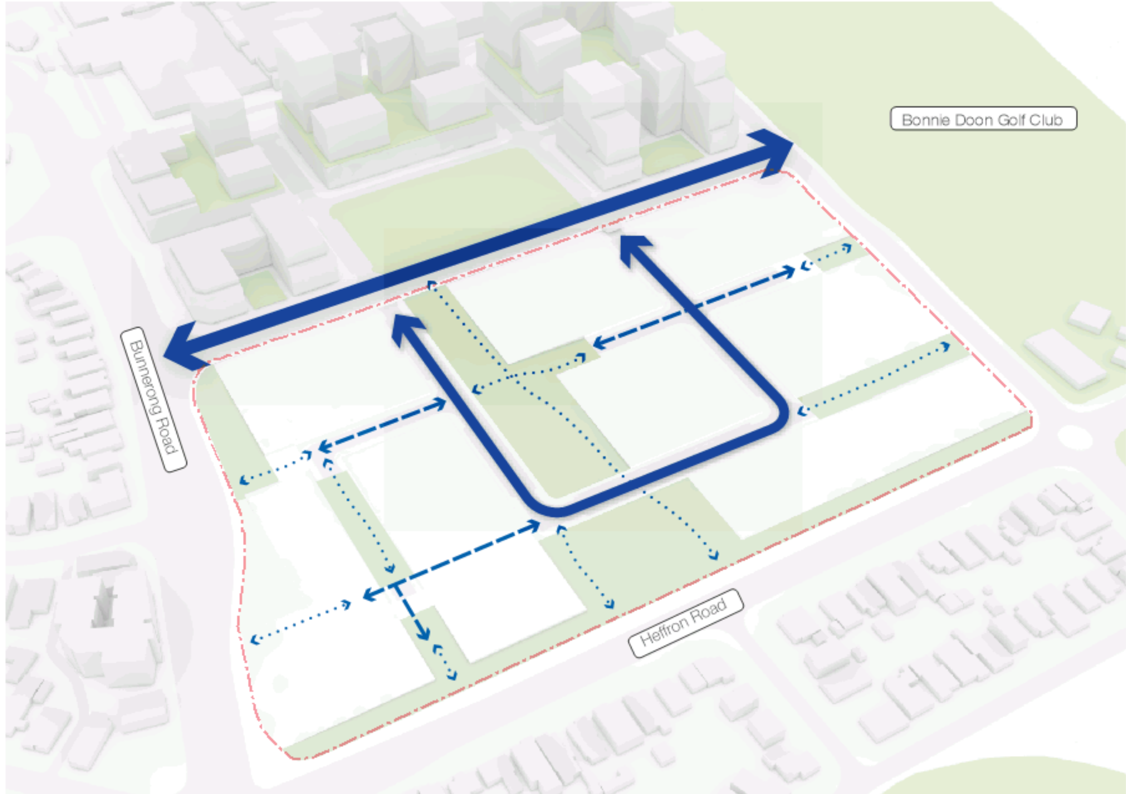


Continuation of the Grid

Extending the grid of stage one through the northern precinct to provide clear east-west and north-south links.

Key

- Building Plots
- Open Space & Landscaping
- Primary Movement
- Secondary Movement
- Site Boundary



Hierarchy of Streets

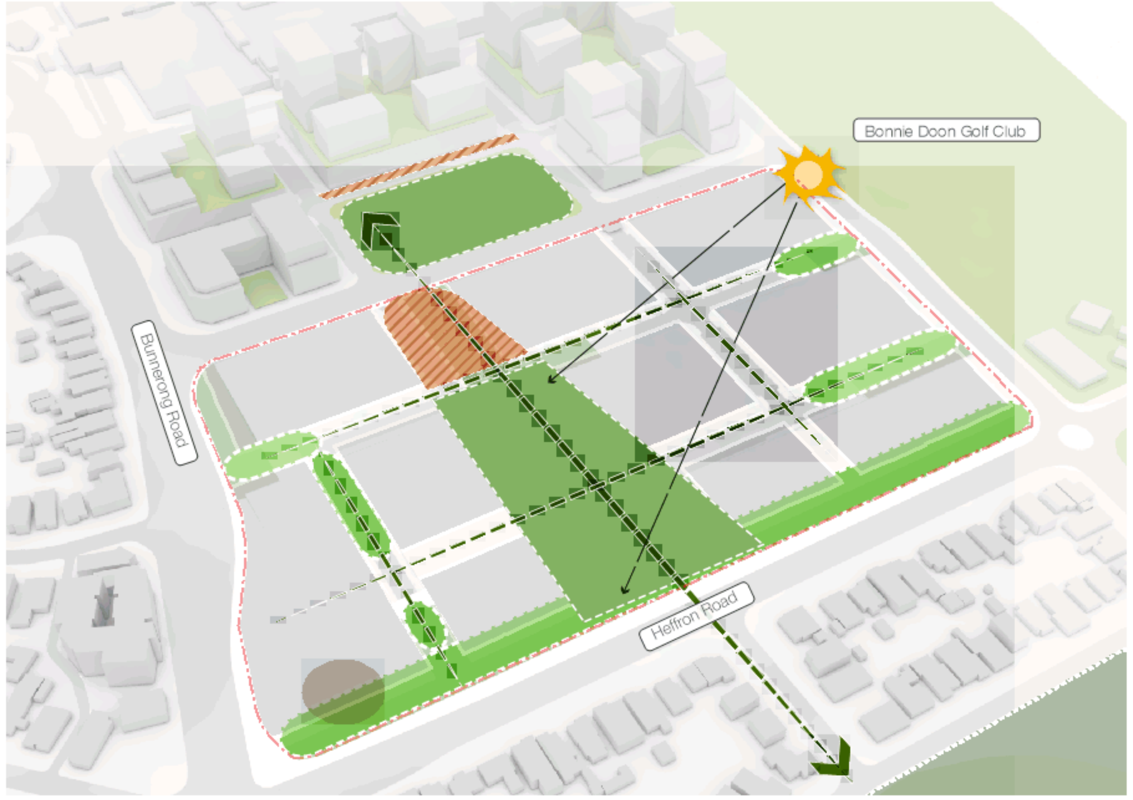
Creating a hierarchy of streets that create a legible and accessible environment, while discouraging through traffic.

Key

- Building Plots
- Open Space & Landscaping
- Main Access
- Primary Streets
- Local Access
- Pedestrian Links
- Site Boundary

Design Response

4.2 Public Domain Structure



Green Network

A network of integrated green spaces that includes surrounding infrastructure and integrates the streetscape.

Key

- Building Plots
- Existing Clocktower
- Primary Green Spaces (Public Open Space)
- Secondary Green Spaces (Public Open Space)
- Civic Plaza
- Main Access
- Primary Streets
- Green Links
- Site Boundary

Land Use and Frontages

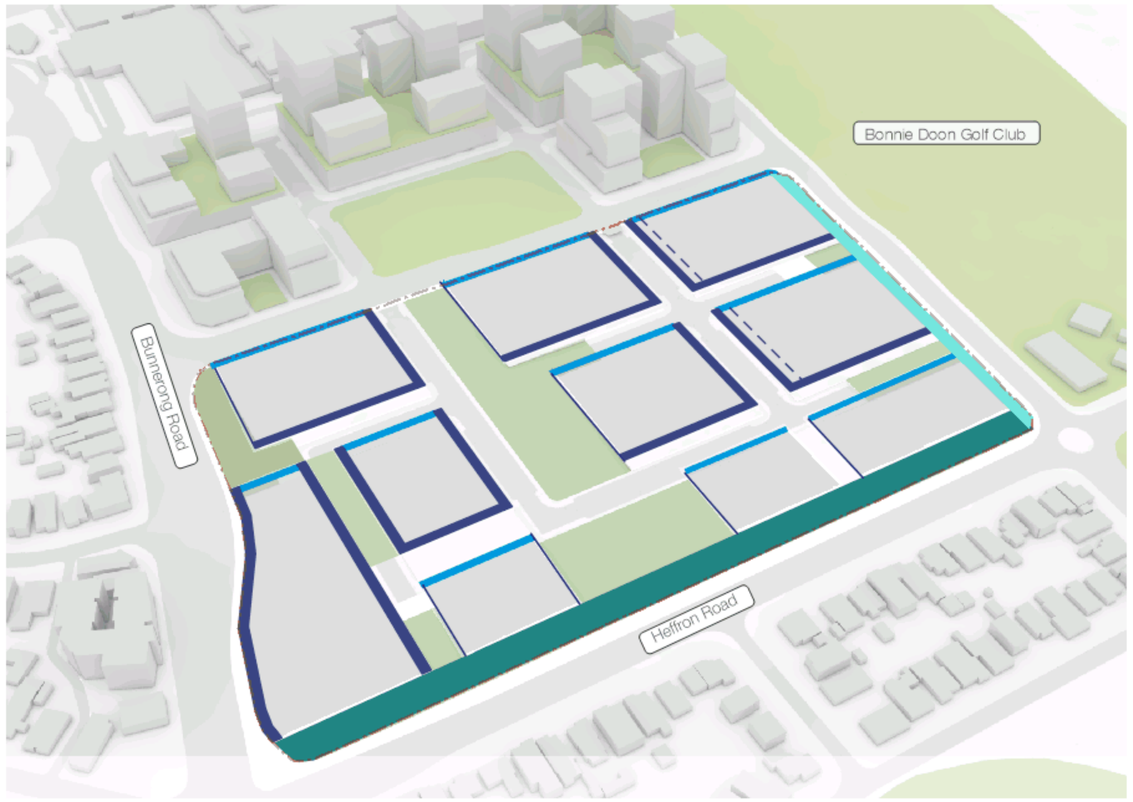
Reflecting the hierarchy of streets, the street typology integrates dedicated spaces for activation, retail and interface with open space.

Key

- Mixed Use Residential / Hotel / Serviced Apartments
- Mixed Use Residential Development
- High Density Residential
- Medium-Low Density Residential
- Medium-High Density Residential or Possible Aged Care
- Public Open Space
- Active Edges
- Semi - Active Edges
- Corner Active Nodes
- Site Boundary

Design Response

4.3 Building Envelopes

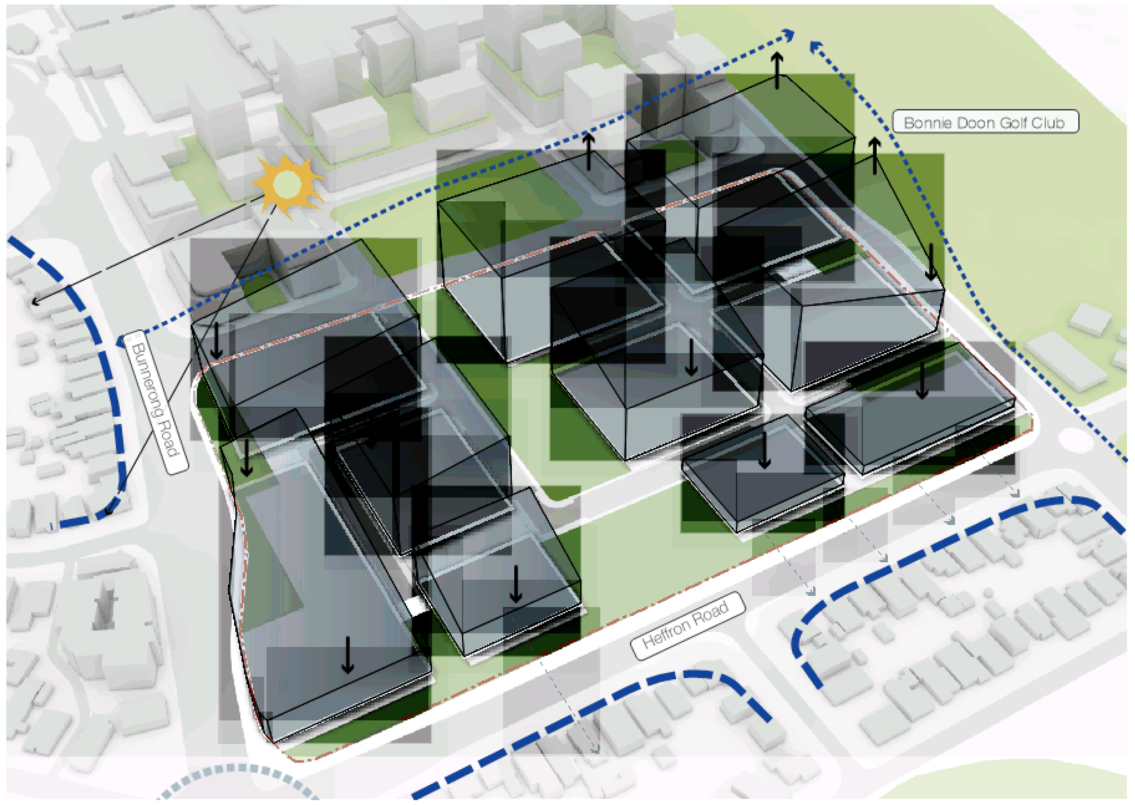


Setbacks

Street setbacks reflect the type of street and built form interface with the street.

Key

- Building Plots
- Public Open Space
- 2m Setback
- 4m Setback
- 6m Setback
- 10m Setback
- Additional 3m Podium Setback



Building Heights

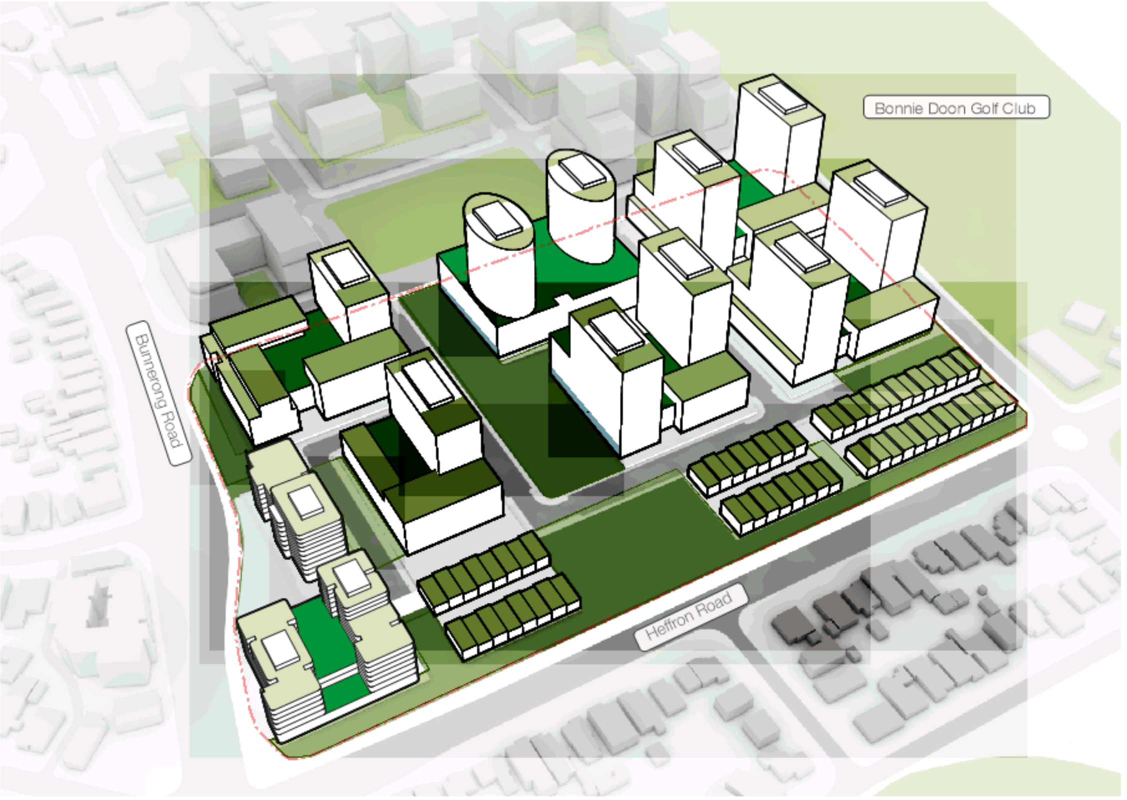
The building heights ensure that there is no overshadowing to the surrounding residential areas between 9am and 3pm. While also ensuring that the scale and visual bulk compliment surrounding development. The buildings step down in heigh toward the east and north of the site to manage transition in scale, while locating the higher density components in the least sensitive area of the site.

Key

- Residential Interface
- Public Open Space
- Site Boundary

Design Response

4.4 Built form and Open Space Typologies



Building Typologies

Building typologies are varied throughout the precinct with townhouses and terraces integrated into the podium to interface with residential streets, medium and high density development is integrated to the south and west of the precinct in the least sensitive parts of the site.

Key

- Tower
- Above Podium/Podium Sleeve Dwellings
- Podium Sleeve On-Street Terrace
- Street Level Retail
- Townhouses
- Medium Density/Possible Aged Care
- Communal Open Space
- Public Open Space

Layers Of Landscape

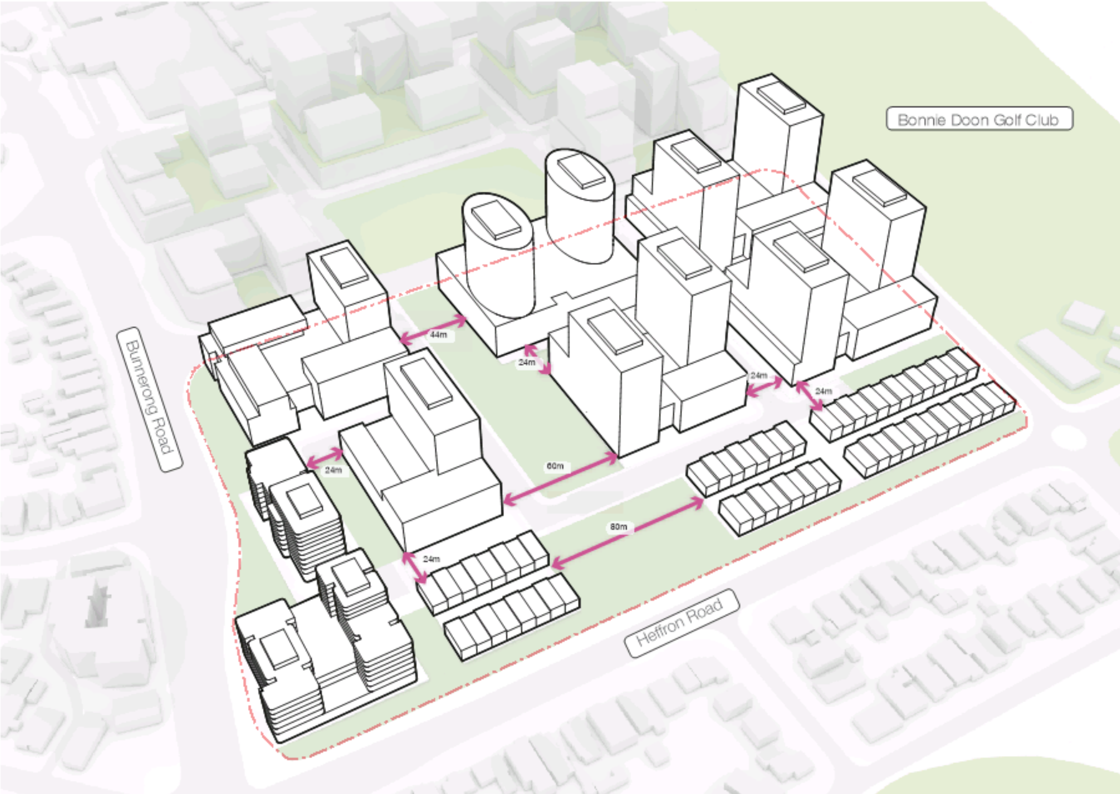
The site configuration consists of layers of landscaped space that serve the community in different ways. These landscape typologies build upon the public domain plan established for the precinct, which includes more than 2ha of public open space, this is approximately 23% of the site. Courtyards, communal terraces and rooftop spaces will be utilised for communal gardens and private open space. This will mean that most of the site has a landscaped surface.

Key

- Public Open Space
- Podium Communal Gardens
- Private Rooftop Terraces
- Active Retail Edges
- Semi - Active Edges
- Site Boundary

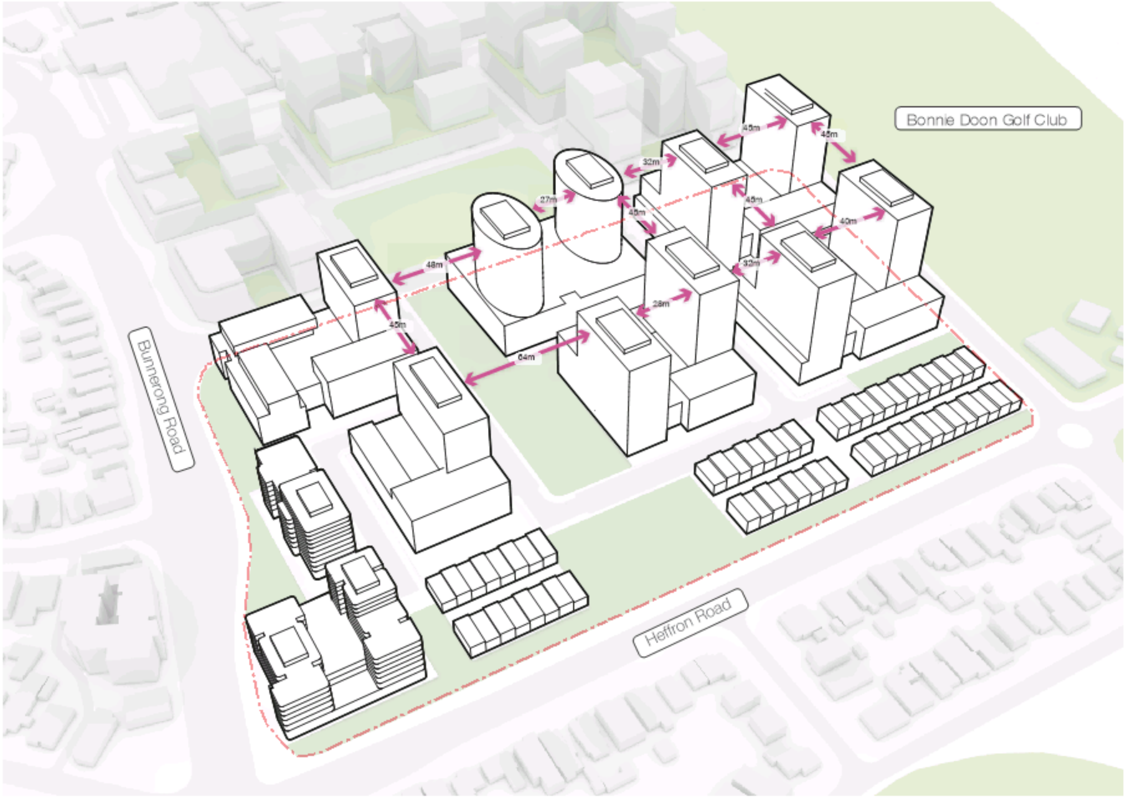
Design Response

4.5 Building Separation



Building Separation

The separation between buildings are compliant with the Apartment Design Guidelines (ADG). Dimensions from tower to tower either meet or exceed ADG standards.



Tower Separation

The separation between towers are compliant with, or exceed, the ADG standards.

Key

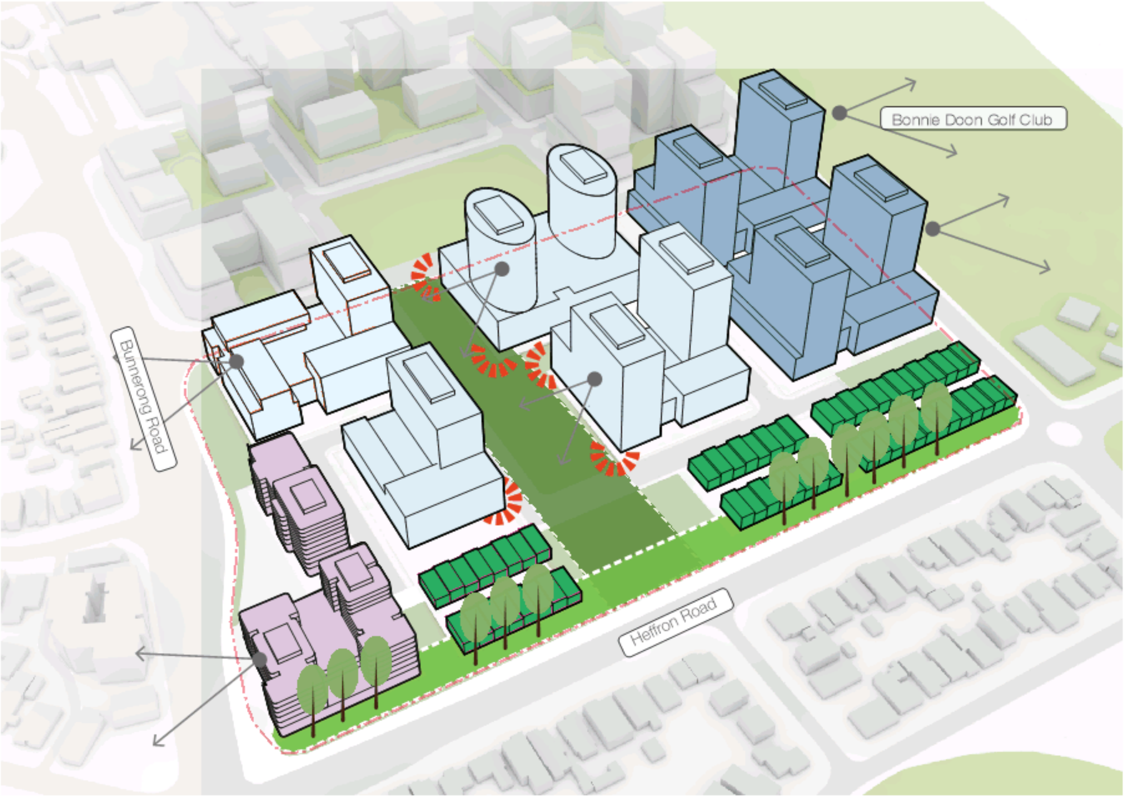
- Building Separation
- Public Open Space
- Site Boundary

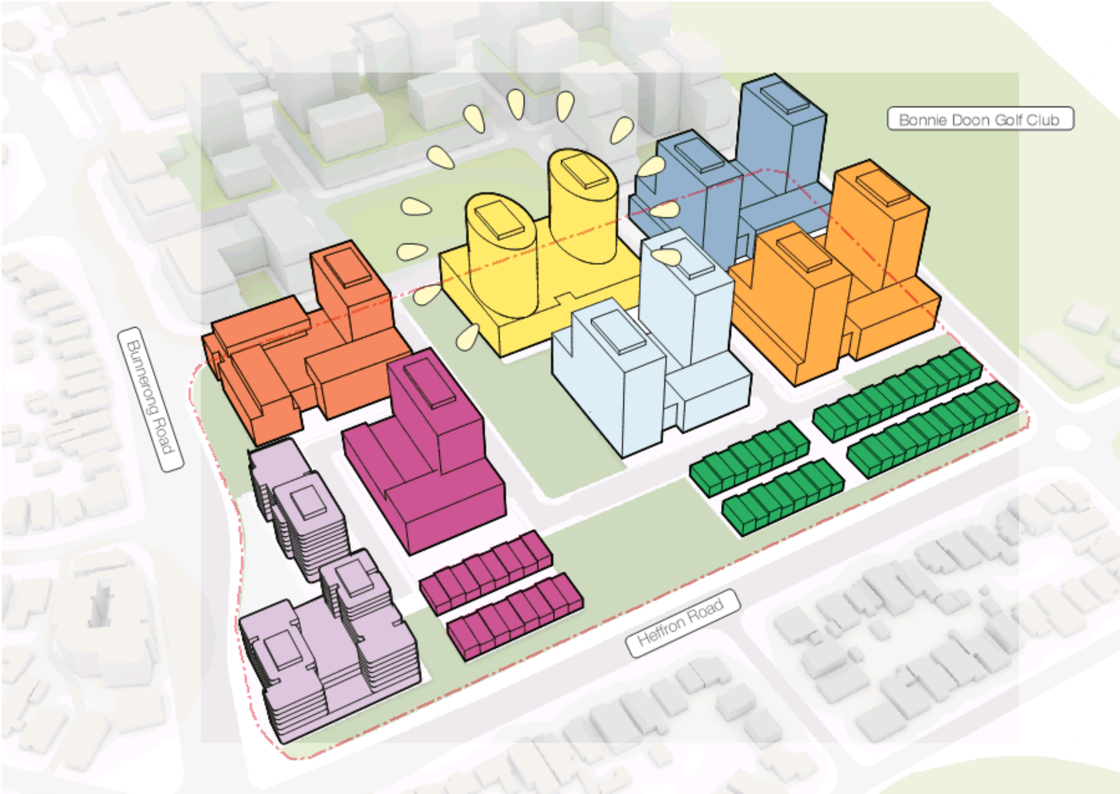
Key

- Tower Separation
- Public Open Space
- Site Boundary

Design Response

4.6 Design Excellence





Local Character

The precinct's urban grid creates a number of different blocks that will each have a slightly different character. Variation will be provided across the site and the characteristics of the developments will be localised to the specific urban setting within which they are situated. For instance, the outlook to green open space or Sydney CBD will be optimised, while street level residences with have a different look and feel.

Architectural Excellence

Tier one architects will be employed under the guidance of a single master architect to deliver variation across the site while ensuring quality design, compatibility and compliance with architectural standards. There is opportunity for the blocks that interface with the public domain to have distinct architectural qualities, such as central retail block adjacent to the civic plaza. Strong design principles will be established in future development application to guide development of the site.

Key

- Views
- Vegetated Areas
- Active Street Edges
- Possble Aged Care
- Town Houses
- Site Boundary

Key

- Site Boundary

Proposed Masterplan

5

This section introduces the proposed masterplan through plan, site section and 3D modelling. It demonstrates how the public realm will interface with the built form, including the nature of the road profile and landscaped building setback. It addresses the gross floor areas of each site, apartment yield and parking provision within the subject site.

Proposed Masterplan

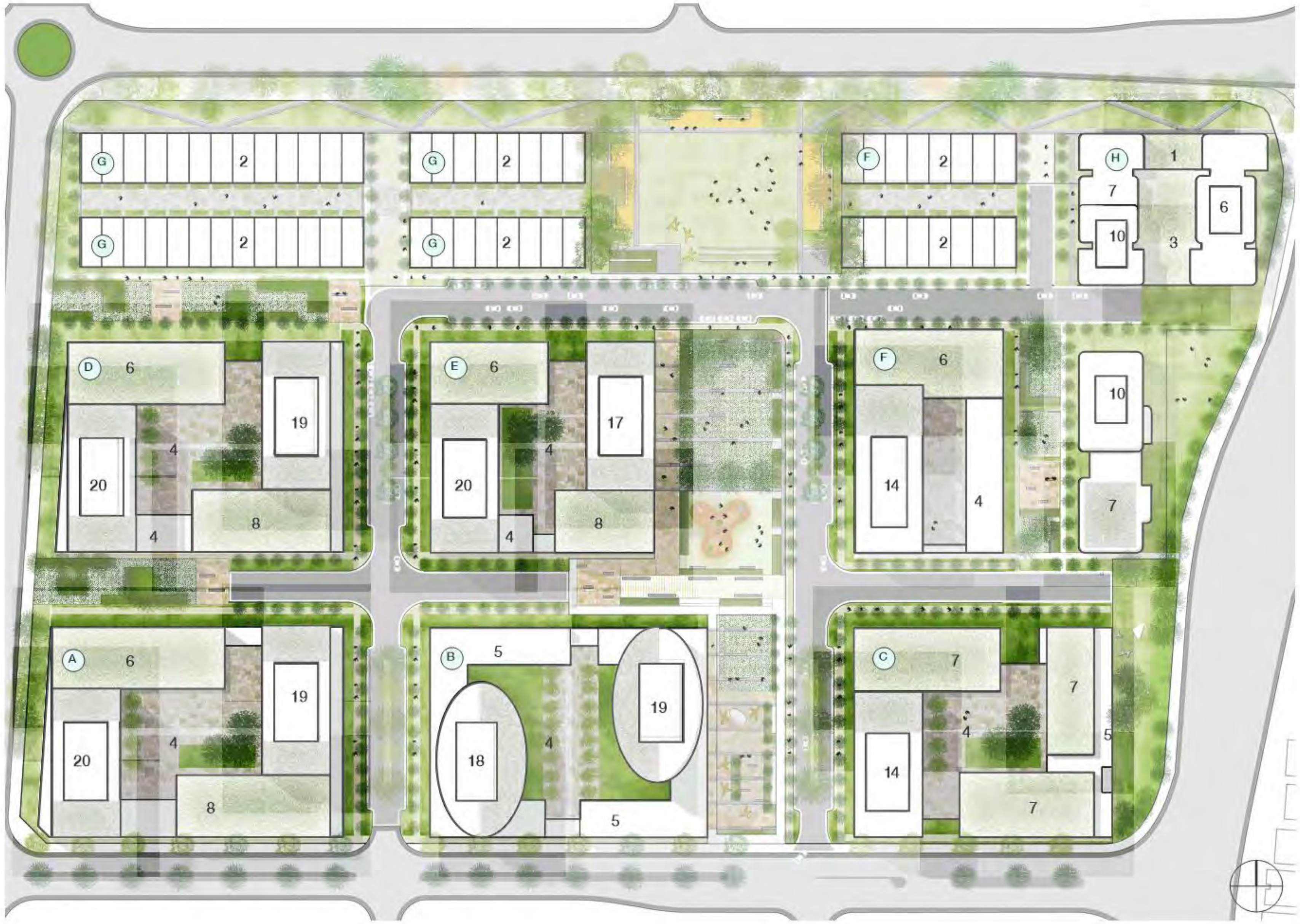
5.1 Site Layout Plan

The site varies from 20 storeys to two storeys across the site to create a sense of transition into the low density development surrounding the subject site.

The tallest parts of the plan are in the south west corner, which minimises overshadowing to sensitive areas and the surrounding development.

The open space forms a spine through the precinct, bringing sunlight deep into the development and allowing residents and retail in the local area to spill out into the public realm. This will form the basis of a high amenity, enjoyable new precinct that has a strong sense of local connection to place and one another.

The podium will allow for communal open spaces to form below the tower, providing shared facilities for residents of the building. The configuration around the podium will maximise solar access with towers to the east and west of the envelope, while also providing shelter from wind tunnel effects,with the two storeys above podium to the north and south of the communal open space.



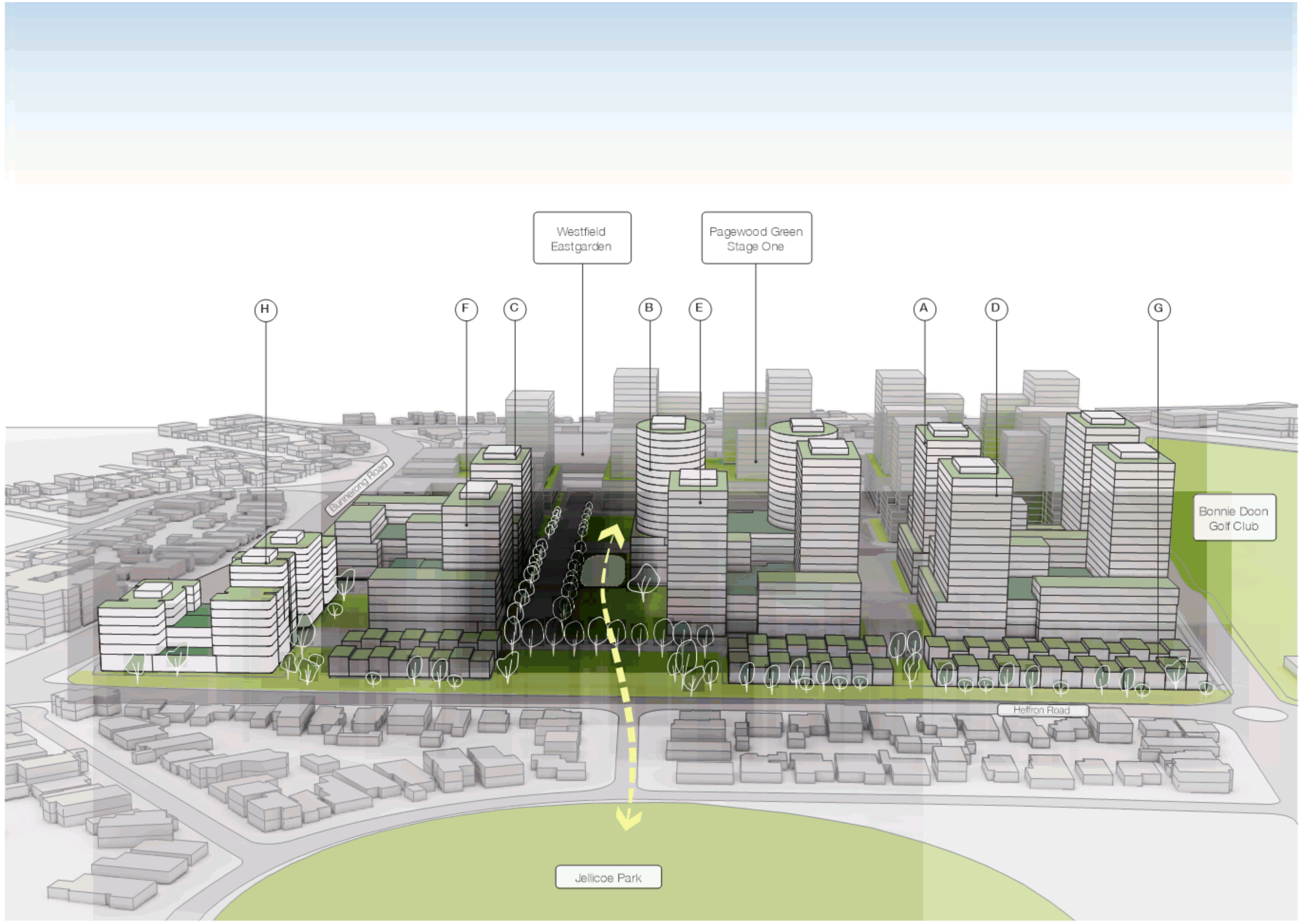
Proposed Masterplan

5.2 3D perspective

The perspective view of the proposed development demonstrates how the buildings step down in height toward the east of the site to manage transition in scale and creates an appropriate interface with the surrounding residential development. The building heights ensure that there is no overshadowing to the surrounding residential areas between 9am and 3pm. While also ensuring that the scale and visual bulk compliment surrounding development. The separation between buildings are shown, with dimensions from tower to tower that either meet or exceed ADG standards

Building typologies are varied throughout the precinct with townhouses and terraces integrated into the podium to interface with residential streets, medium and high-density development is integrated to the south and west of the precinct in the least sensitive parts of the site.

The built form frames a network of green spaces that includes public open space, communal podiums, private terraces and balconies. The linear park through the centre of the site is not only an inviting entry, it also creates a legible site that connects Jellicoe Park through to the public open space of Pagewood Green Stage I and onto Westfield Eastgardens. The civic square will create a vibrant heart to the future community, where the retail spills onto the street and people linger to enjoy one another's company.



Proposed Masterplan

5.3 Massing Envelopes

The massing envelope is a representation of the proposed planning control's maximum height at the boundary of the proposed building allotments.

Further design development within these envelopes will need to take into consideration ADG requirements, including solar access and building separation, and ensure no overshadowing east of Bunnarong Road between 9am and 3pm. These are considerations that will be applied as the built form is further resolved.

Building	Max Building Height	Height of Building	Storeys
A	RL91	69m	20
B	RL91	68.3m	20
C	RL91	68.2m	19
D	RL60	37m	9
E	RL91	69.5m	20
F	RL91	69.6m	20
G	RL91	68.6m	20
H	RL60	37.5m	10
I	RL37	16.6m	3
J	RL37	16m	3
K	RL37	15.3m	2
L	RL60	38m	10
M	RL60	38m	10

Assumptions
- Storey heights
  - 5.5 - 7m height for ground floor (floor to floor)
  - 3.1m height for other floors (floor to floor)
  - 2.5m height for plant & lift overrun level (floor to floor)

Proposed Masterplan

5.4 Subdivision Plan

LOT	Developable Area	Private Road	TOTAL	Percentage
A	7733 m^2	378.4 m^2	8111 m^2	
B	6824.4 m^2	436.4 m^2	7261 m^2	
C	6385.3m^2	783 m^2	7168 m^2	
D	7354.5 m^2	378.4 m^2	7733 m^2	
E	5578.4 m^2	436.4 m^2	6015 m^2	
F	6618.6m^2	2397.4 m^2	9016 m^2	
G	7611 m^2		7611 m^2	
H	7511 m^2		7511 m^2	
SUBTOTAL	55616.2 m^2	4810 m^2	60426 m^2	67.4%
PUBLIC OPEN SPACE			20208 m^2	22.6%
PUBLIC ROAD			8762 m^2	9.8%
ROAD RESERVES			193 m^2	0.2%
TOTAL SITE AREA			89589 m^2	100%

Key

- Residential
- Residential (Low Rise)
- Mixed Use
- Aged Care
- Public Road
- Private Road*
- Open Space
- Retail/Childcare
- Site Boundary

*All private roads are associated with respective lot boundaries, all of them include public access easements for pedestrians to increase the permeability of the site.

Proposed Masterplan

5.5 Development Yeild and Distribution

Lot Areas:

The total site Area of Pagewood Green Stage Two is 89,570m², while the permitted FSR is 2.35:1. This allows for a total GFA of 210,490m².

In summary:

- The site will offer retail GFA of 5,000m² at minimum.
- Lot B is a possible hotel or serviced apartments.
- Lots F and G both have a double row of terraces. There are 58 proposed terraces, 42 in Lot G and 16 terraces in Lot F.
- Lot H is possible aged care dwellings. This permits an additional FSR of 0.5:1 (3755.5 sqm) to be developed within the envelope.
- Affordable housing is yet to be located in masterplan and is subject to consultation with council.
- The residential GFA also includes 1,200m² for 2 x 75 space Childcare Centres.

TABLE OF AREAS

	Lot Area (sqm)	GFA (sqm)	Units (approx)
Lot A	8,111	38,074	375
Lot B	7,261	36,993	327
Lot C	7,168	21,614	192
Lot D	7,733	37,194	365
Lot E	6,015	33,201	319
Lot F	9,016	18,713	181
Lot G	7,611	7,050	42
Lot H	7,511	21,406*	214
Total	60,426	214,245	2,015

*The bonus 0.5:1 FSR associated with the potential aged care is added to the GFA of Lot H. This makes the total 210,490 sqm (allowable GFA) plus 3755 sqm (area of bonus FSR). If aged care is not proposed the bonus does not apply.

Proposed Masterplan

5.6 Parking

Parking Allowances:

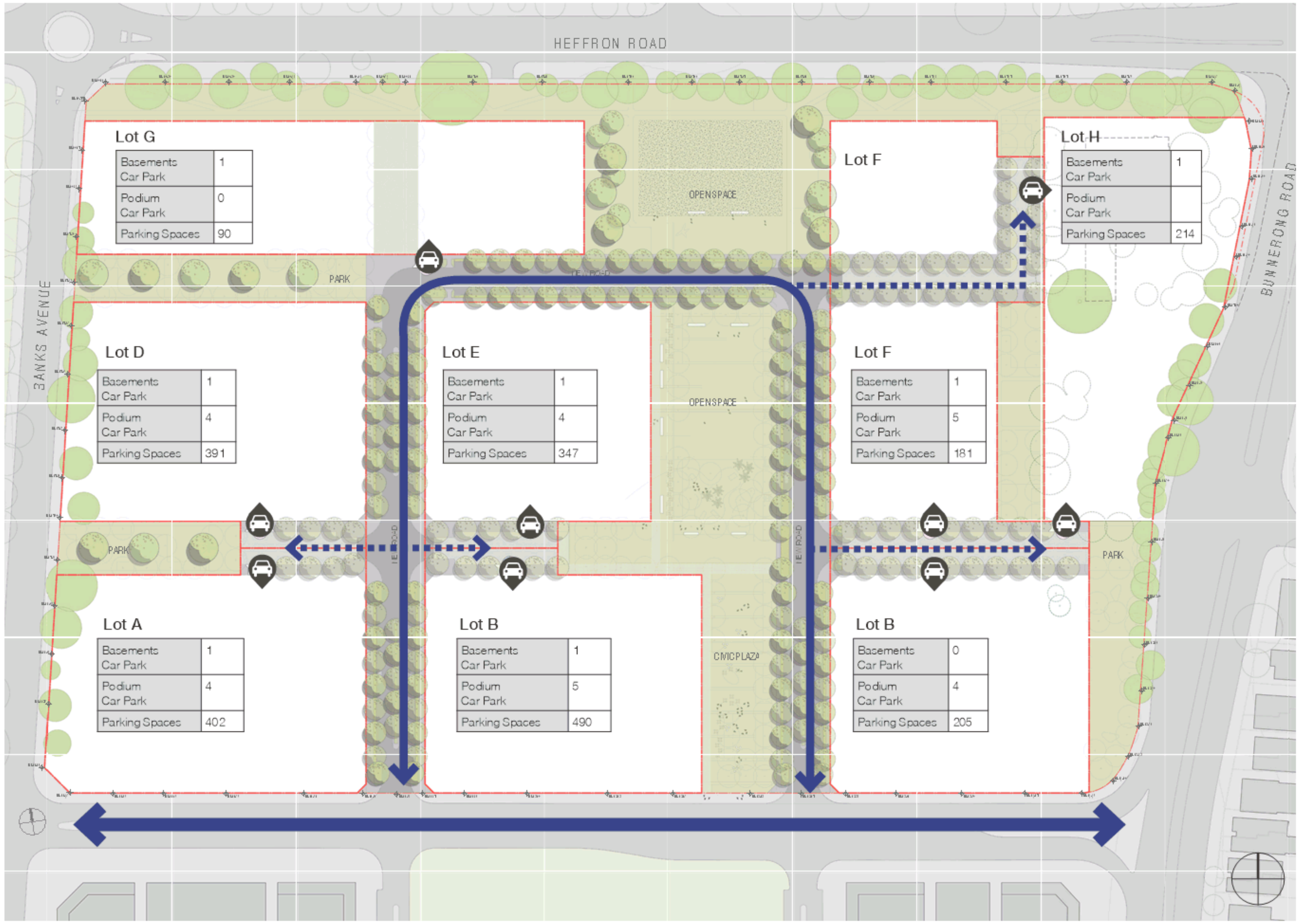
There are approximately 94 on street car parks provided, as well as an additional 2,344 parking spaces provided within the development envelopes. This is a total of 2,438 car parks across the site.

This accommodates a ratio of two cars per town house; 1.5 cars per 3 bedroom apartment; one car per two bedroom apartment; 0.5 car to every single bedroom apartment; as well as extra to support retail within the site.

TABLE OF AREAS

	Units	Parking Spaces
Lot A	375	402
Lot B	327	490
Lot C	192	205
Lot D	365	391
Lot E	319	347
Lot F	181	195
Lot G	42	90
Lot H	214	224
On Street		94
Total	2,015	2,438

The masterplan will accommodate a car sharing service with a fleet of approximately 20 share-car stations provided across the site. There will be 198 bike parks also located on the site to better facilitate active and sustainable modes of transport.



Key

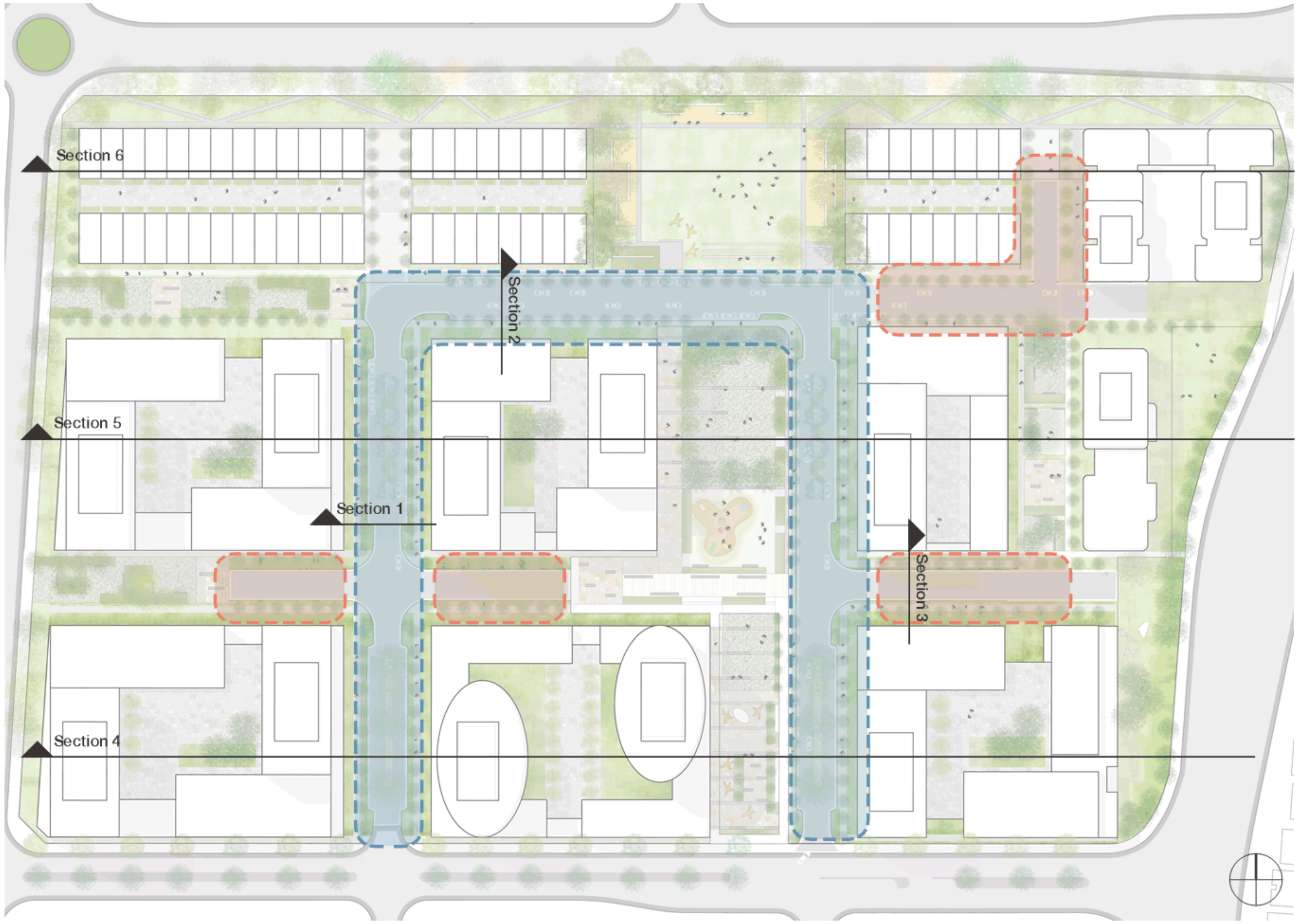
- Development Lots
- Vehicle entry to basement
- Key Road Linking to Major Roads
- Two-Way Loop Road Through Site
- Minor/Private Streets
- Site Boundary

Proposed Masterplan

5.7 Typical Street Sections

Six site sections have been identified to show the quality of experience on the street and the relationship to the built form.

Each of the sections demonstrates the different type of street profile, sections 1-3 highlighting the road profile, street setback and interface with the buillt form, while sections 4-6 are east to west cross-site sections of the entire subject site and incorporate the different types of public realm offer in the precinct.

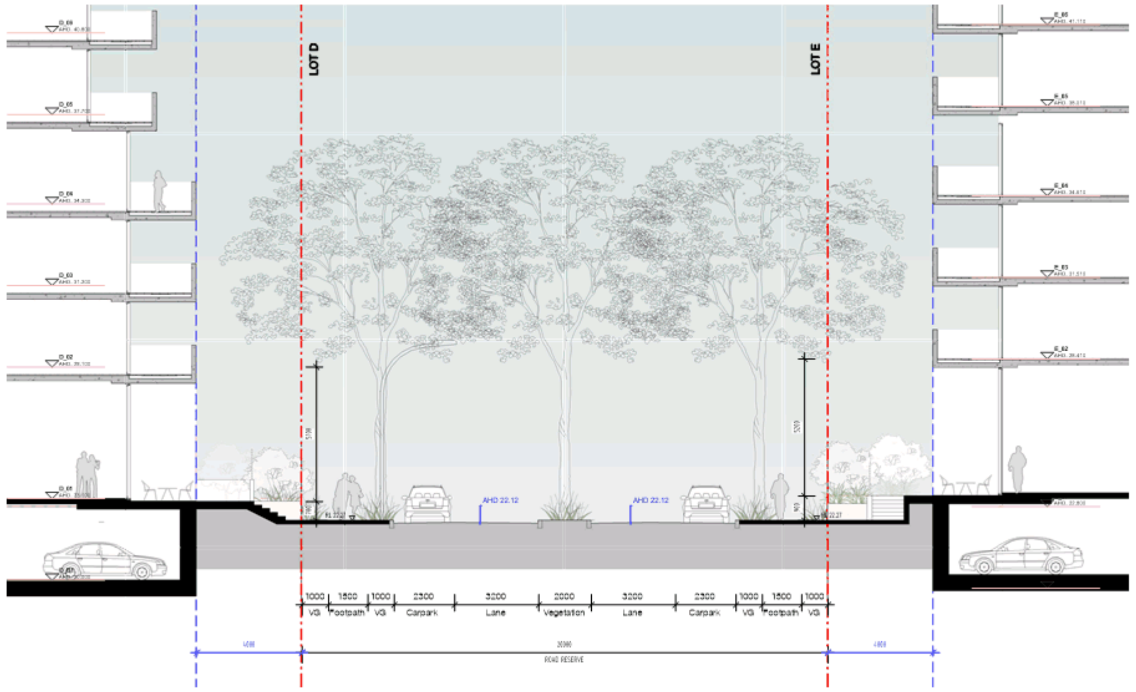


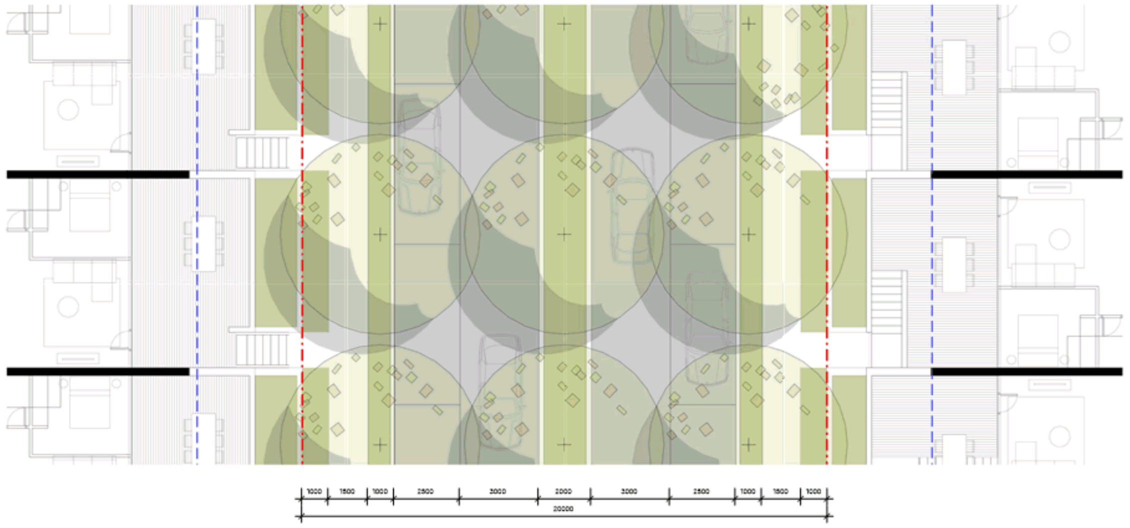
Key

- Local Road
- Primary Collector
- Site Boundary

Proposed Masterplan

5.8 Typical Street Sections



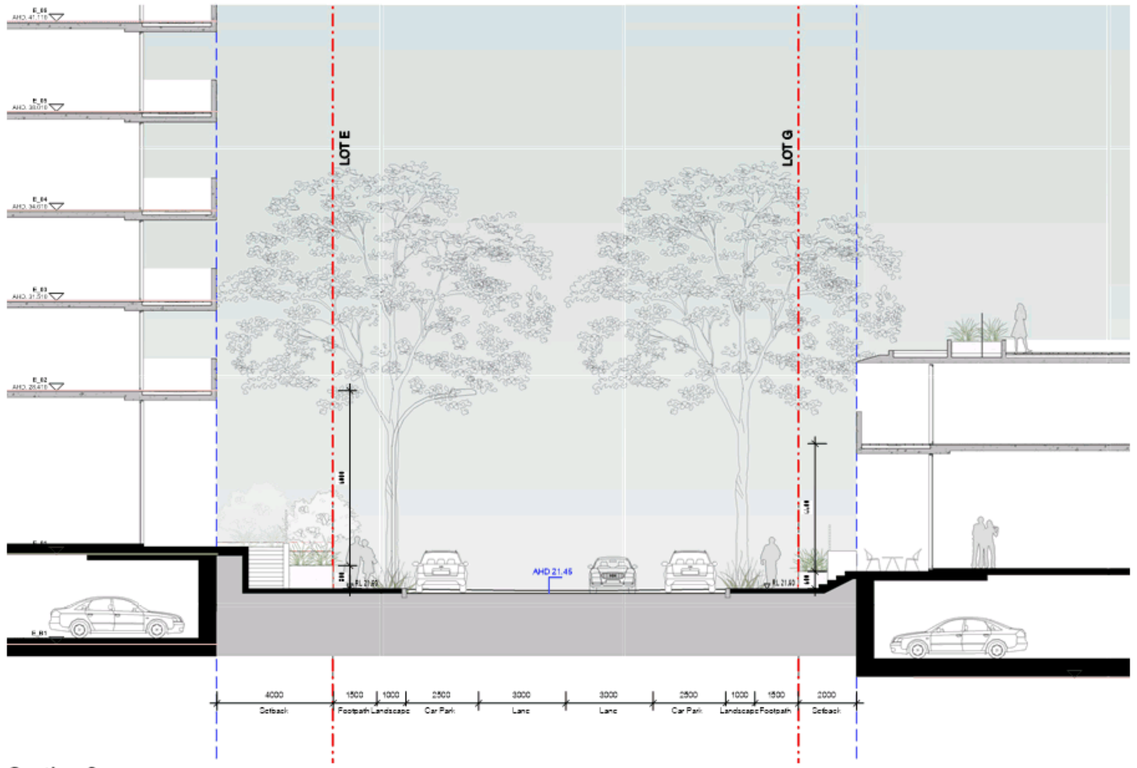


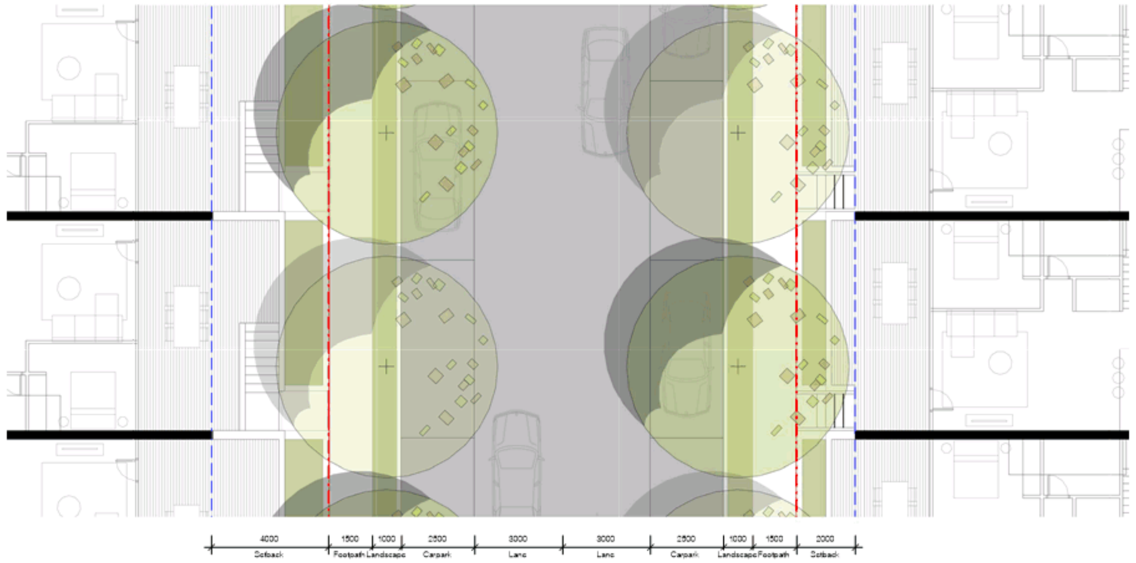
Section 1

This section shows how the north-south primary collector street and how it interfaces with the built form on either side of the road.

Proposed Masterplan

5.9 Typical Street Sections



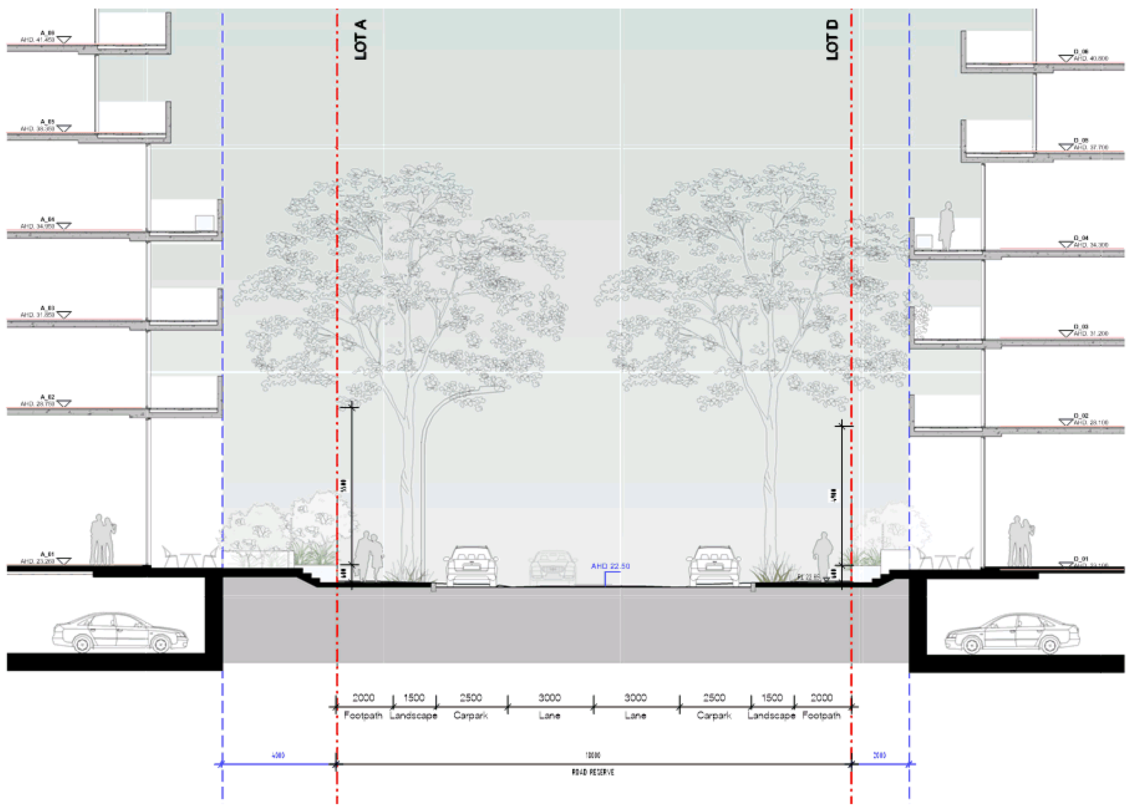


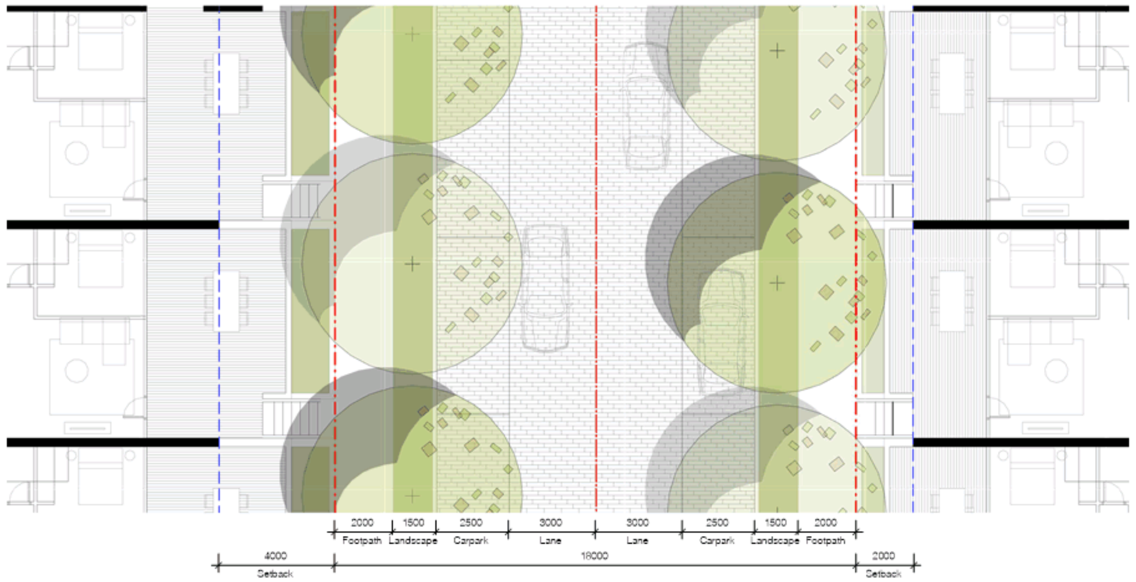
Section 2

This section shows how the east-west primary collector street and how it interfaces with the built form on either side of the road, this includes the town houses to the north of the site.

Proposed Masterplan

5.10 Typical Street Sections





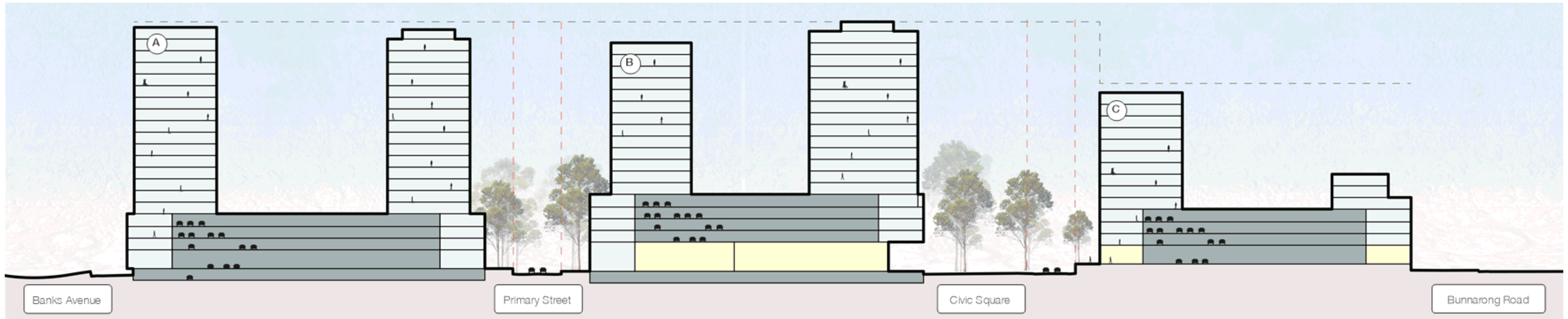
Section 3

Section 3 is a typical cross section of the private streets that are local access streets for future residents.

Proposed Masterplan

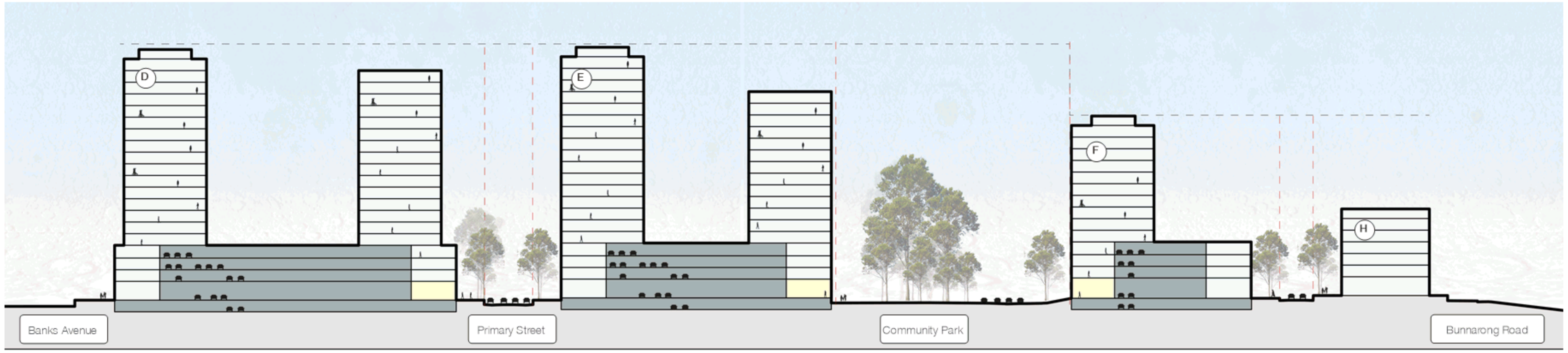
5.11 Through Site Sections

The through site section demonstrates the transition in height toward the east and north of the site. They also show how the break up of the development allows for wide streets and tower separation. The internalised parking is shown to be sleeved by residential apartments and the address of the commercial at ground level activates the civic spaces.

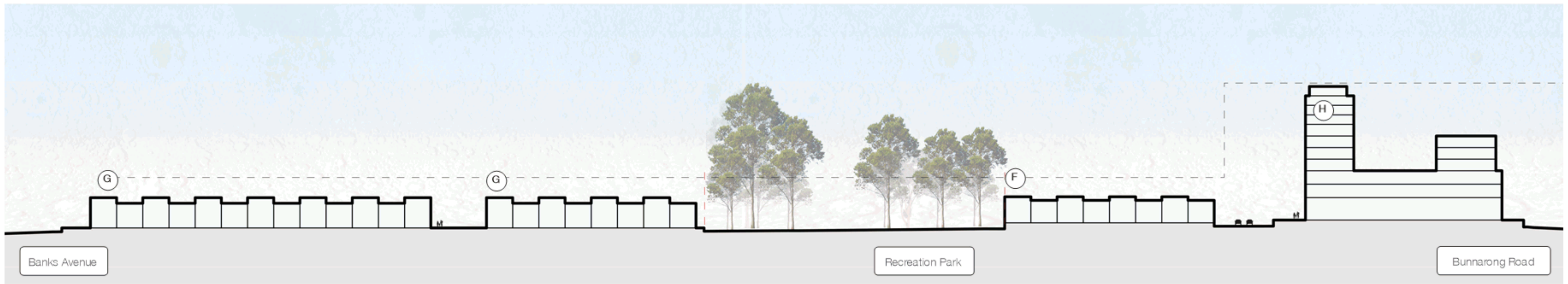


Section 4

Proposed Masterplan



Section 5



Section 6

Proposed Masterplan

5.13 Landscape Masterplan


Recreation Park

- Unprogrammed grassy lawn
- Spaces to kick a ball
- Space for group fitness
- Seating options at periphery


Civic Square

- Creates a forecourt to the retail offer
- Place of congregation and for people to linger and socialise
- Sense of entry into the precinct

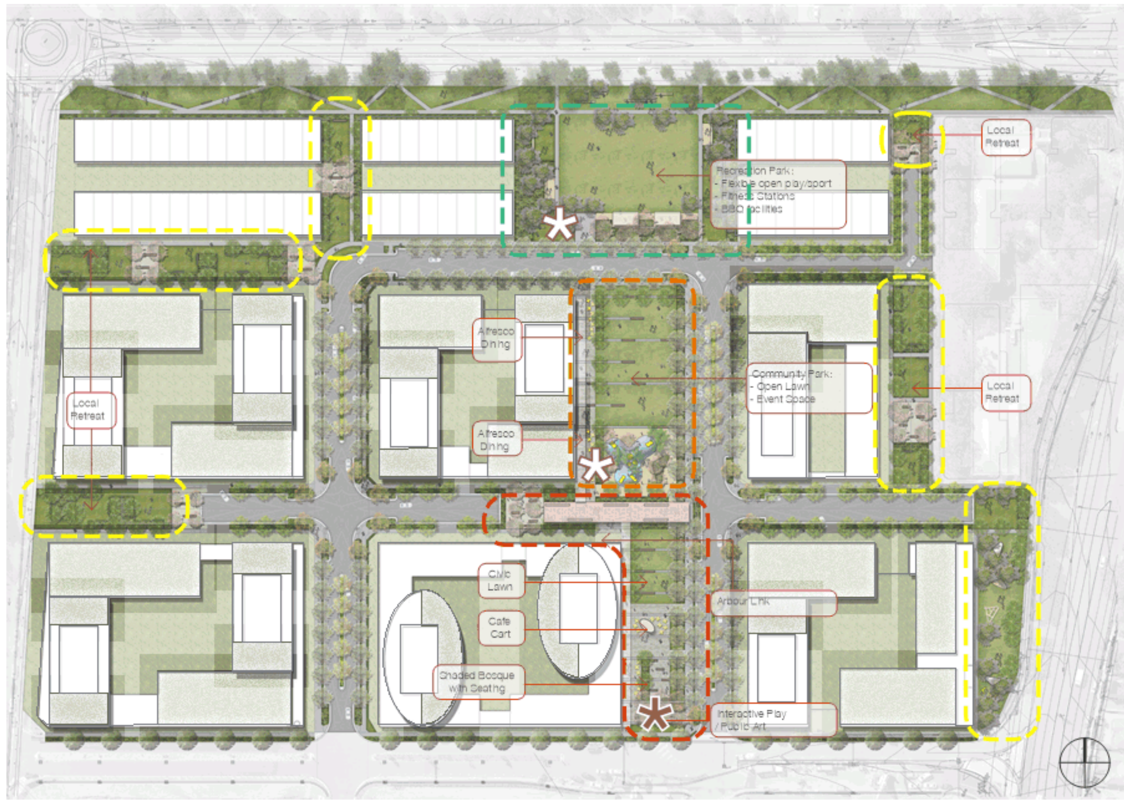

Link Parks

- Shaded and vegetated open spaces that contribute amenity to the wider precinct
- Transitory spaces at the edges of the subject area



Community Park

- Play spaces
- Informal seating spaces
- Informal open space for recreation
- Dining and alfresco area next to retail along building edges



Landscape concept by Urbis Landscape Architects

Materplan Principles

The future residents of Pagewood will be provided a range of open spaces for different lifestyles and activities within a short walk from their front door.

The landscape masterplan spatially implements the many themes that were established in the broader structure and vision. The key themes that have brought this plan together include:

- Integration - creating synergy with the built form and surrounding context and build an unique local character
- Connectivity - considers through site links, improves walkability and integrates multiple modes of transport
- Multifunctionality - to ensure spaces are appropriate to a range of user groups and useful to changing needs and populations.
- Participation - creating a public domain that bring to life the diversity of residents and users in Pagewood, encouraging informal encounters and building community.

Key

- Link Parks
- Road Interface
- Recreation Space
- Community Park
- Civic Square
- Primary Public Art Opportunity
- Secondary Public Art Opportunity
- Site Boundary

SJB Pagewood Green (Stage 2) 45

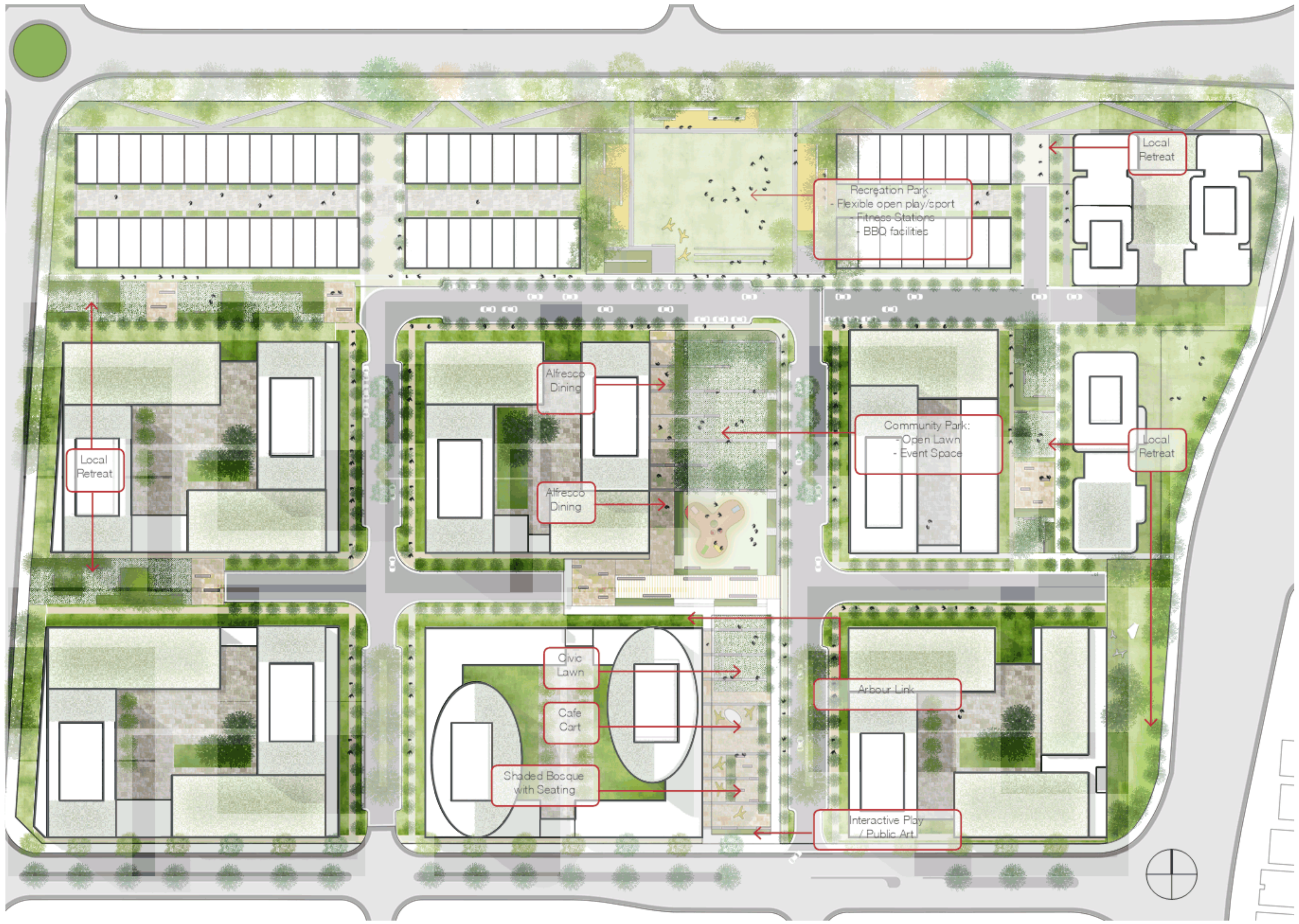
Proposed Masterplan

5.14 Open Space Metrics

There is 20,208sqm of public open space provided, this is 23% of the overall site which is substantial for urban infill developments and is in addition to the 8,000m2 already approved under Stage 1 of the Pagewood Green Development. There is also a substantial amount of communal open space provided on podiums and rooftops, which has the potential to double the open space offering and will comply with the relevant provisions of the ADG.

The proponent will also be providing additional indoor recreational facilities on a site by site basis, including swimming pools, gyms and exercise studios, which is over and above the requirements of the ADG.

This substantial provision of public and communal open space, both indoor and outdoor, is in addition to the network of 25ha of publicly accessible open spaces within an 800m catchment of the site.



Proposed Masterplan

5.15 Benchmarking Open Space

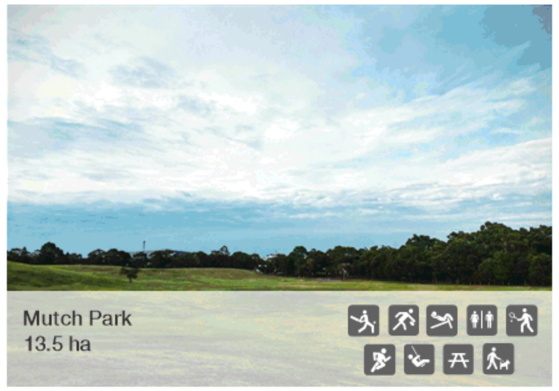
There are many measurements of public open space provision in new and existing suburban areas. These benchmarks vary in the manner that the provision is calculated and are dependent on dwelling density, type of open space, the amount of communal or private open space to compliment the offer, and most significantly the quality of the offer available. It is better to have one high quality, multi-purpose open space than multiple old, degraded, single purpose parks with no tree canopy cover.

Examples of these benchmarks include:

- Metropolitan Sydney's Planned Precincts have an average of 3.5sqm of public open space per person.
- The World Health Organisation (WHO) recommends 9sqm per person, this includes communal and private open space.
- The Government Architect NSW (GANSW) recommends approximately 14.3sqm per person of open space at a regional and local level. This is broken down into open space typologies, where the minimum to achieve is:
  - All dwellings within 400m of a local level park (0.5ha to 2ha)
  - All high-density dwellings (60 dwellings or more per hectare) within 200m of a local level park (0.1 to 0.5ha)
  - All dwellings within 2ha of a district park (2 to 5 ha)
  - All dwellings within 5km of a regional park (minimum 5ha)

The Pagewood Green achieves the open space target of the three benchmarks provided. The public open space offer within the site will approximately double the average open space allowance provided in Planned Precincts. While, generous balconies, communal terraces, indoor recreation spaces and the 2.2 ha of public open space, every resident will be able to readily access 9sqm per person of open space within the development site (as per the WHO benchmark). Lastly, the GANSW's recently established benchmarks will be more than met through the local provision of Pagewood Green and will face no deficiencies in open space offer and will be well supported by the quality of local offer due to the network of 25ha of publicly accessible open spaces within an 800m catchment of the site and greater than 60 ha within 2km of the site.


Pagewood Green (Entire)
3 ha


Mutch Park
13.5 ha


Jellicoe Park
5 ha

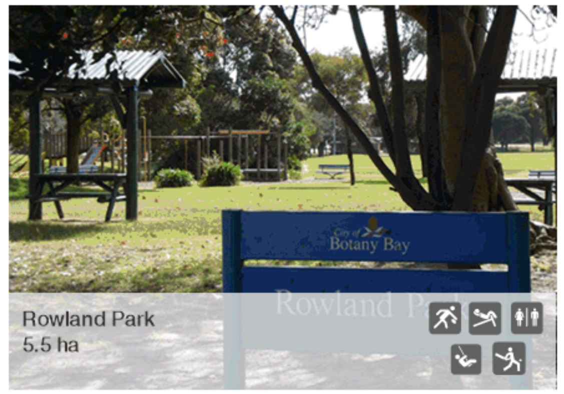

Nagle Park
4 ha


Hensley Park
2 ha


Snape Park
6 ha


Heffron Park
45 ha


David Phillips Sports Field
6ha


Rowland Park
5.5 ha

Scheme Analysis

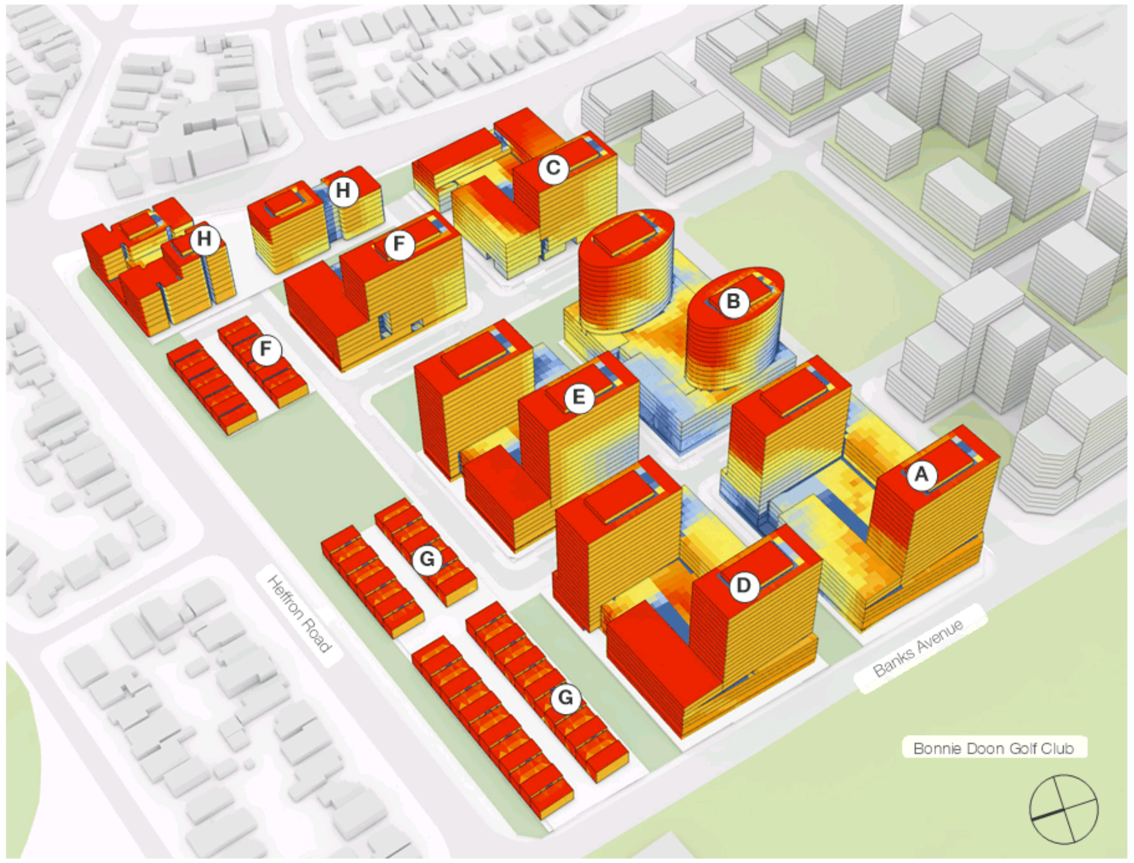
6

This section of the report demonstrates the sites ability to achieve solar requirements based on potential building envelopes that can be realised within the proposed planning controls. Solar access to façades and open space has been analysed demonstrating that the requirements of the ADG can be achieved.

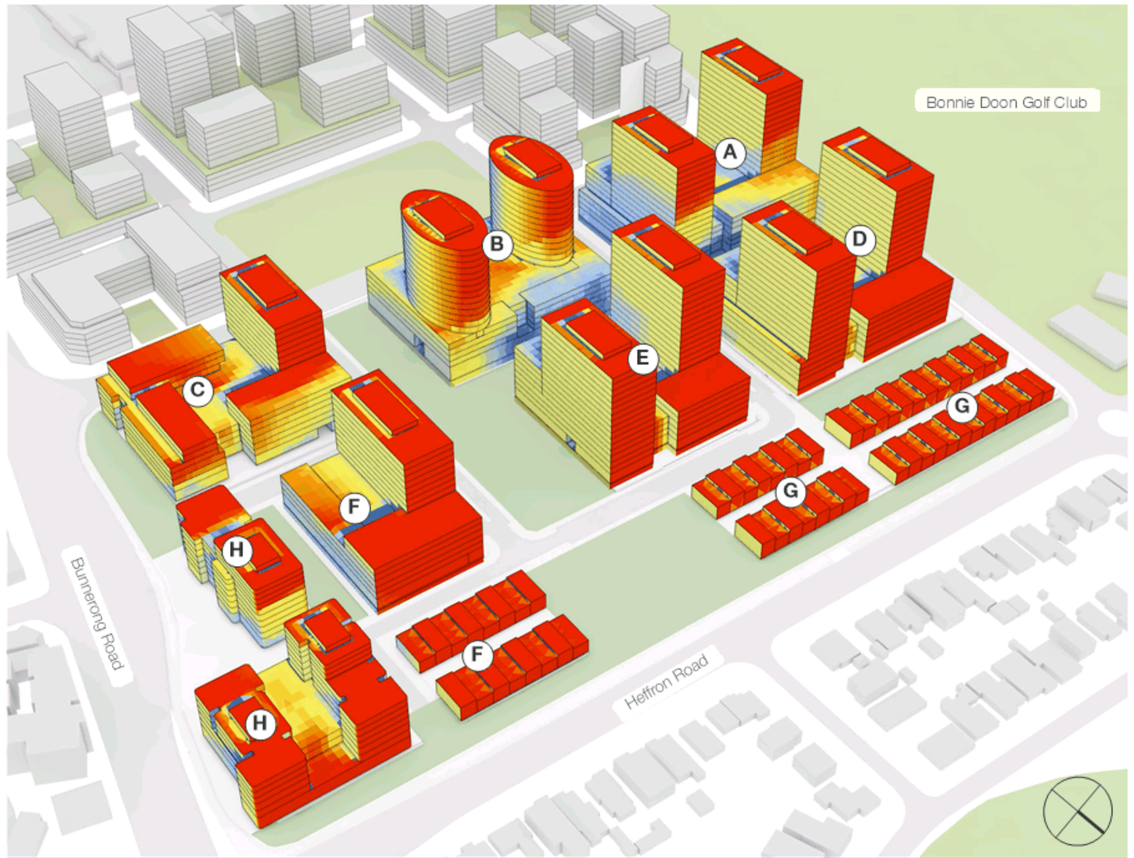
Overshadowing of neighbouring properties has also been assessed, including UB3, UB4, the central open space, and residential dwellings on the eastern side of Bunnerong Road, to ensure adequate solar access is achieved between 9am and 3pm throughout the year. The overshadowing analysis was taken on the shortest day of the year (the winter solstice) as a baseline. Based on the testing of the potential building envelopes, we believe that solar compliance can be achieved by residential dwellings on surrounding sites.

Scheme Analysis

6.1 Solar Insolation: Built Form



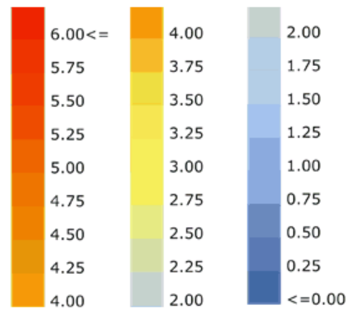
View from north west



View from north east

82.7% receives more than 2 hours of sunshine on the winter solstice
68.8% receives more than 3 hours of sunshine on the winter solstice

Note: this will be uplifted to 70% with more than 3 hours of sunshine through detailed design of the building, given that the assessment is based on envelopes and the %75 building efficiency under the ADG (i.e. resultant buildings will be smaller with better solar access).

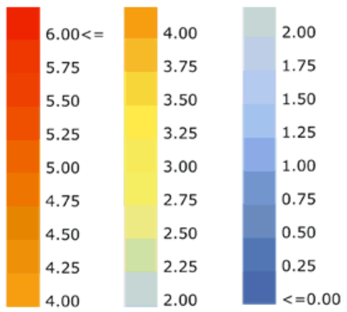


Scheme Analysis

6.2 Solar Insolation: Open Space

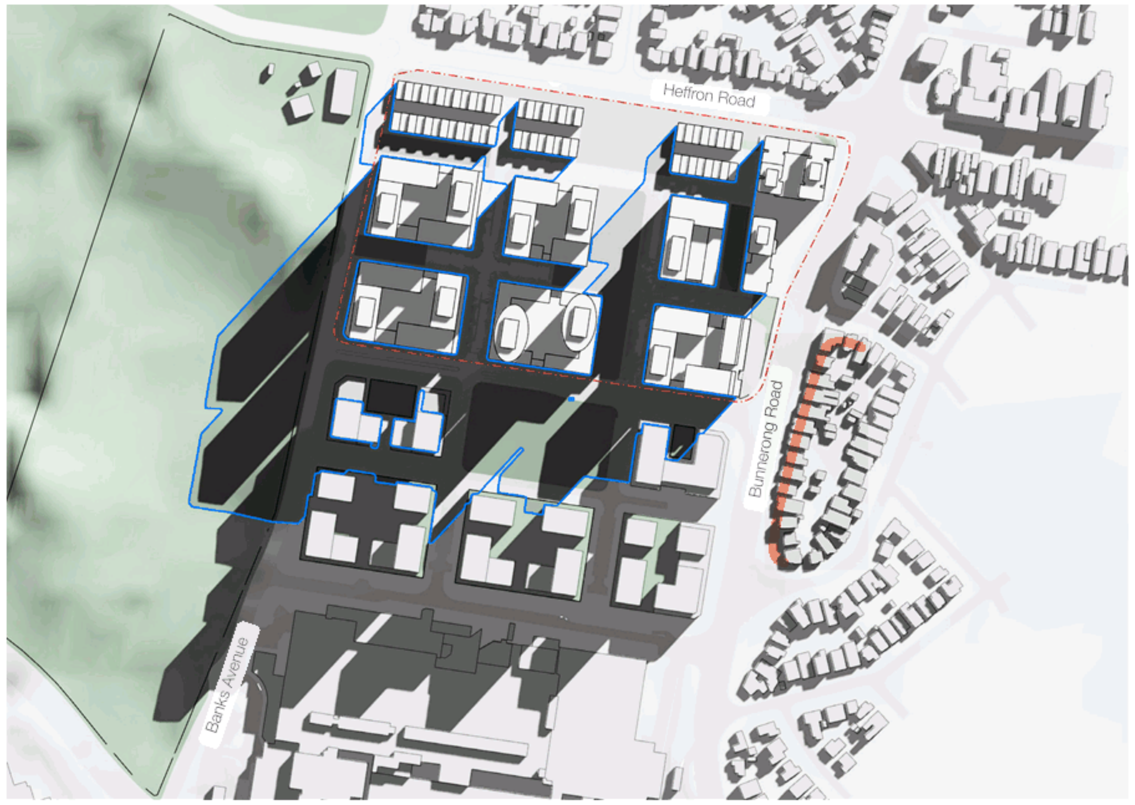
Solar Insolation - Public Realm

Approximately 76% of the public realm receives more than 2 hours of sunshine on the winter solstice, while 57% receives more than 3 hours of sunshine.



Scheme Analysis

6.3 Shadow Diagrams - Winter Solstice



9am - Winter Solstice

76% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls

10am - Winter Solstice

84% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls

Scheme Analysis

6.4 Shadow Diagrams - Winter Solstice

11am - Winter Solstice

91% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls

12pm - Winter Solstice

86% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls

Scheme Analysis

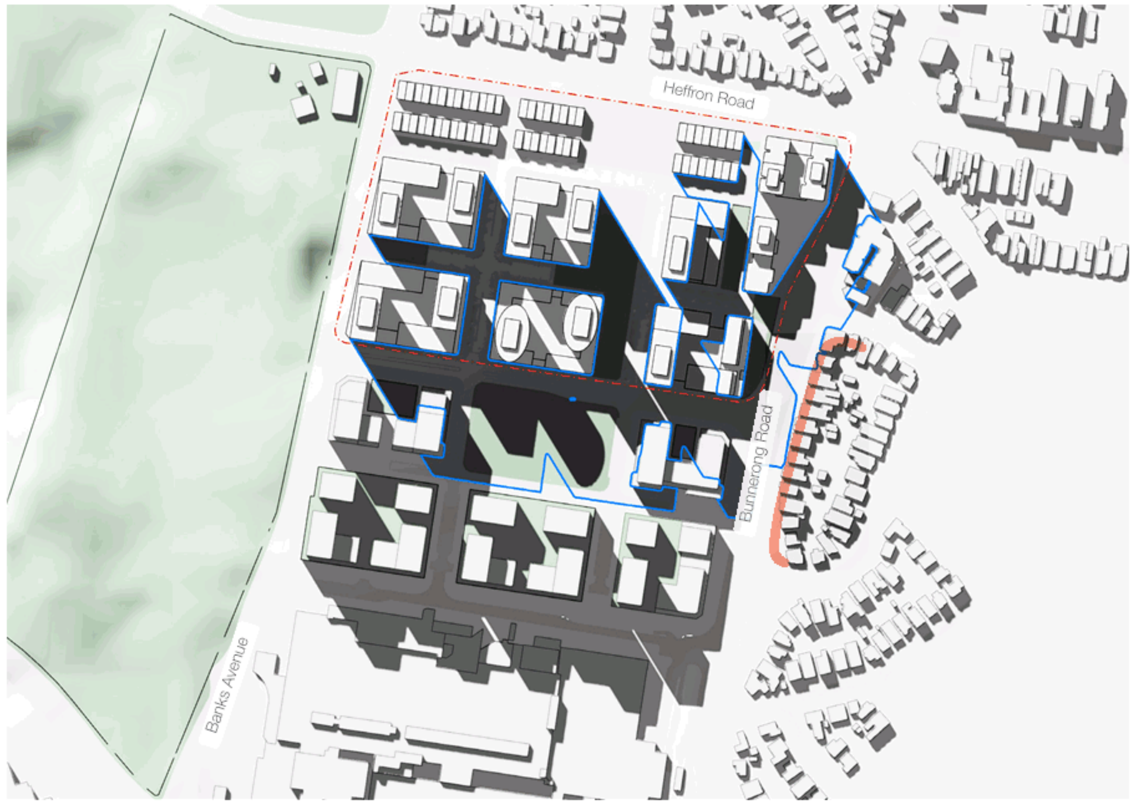
6.5 Shadow Diagrams - Winter Solstice

1pm - Winter Solstice

76% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls



2pm - Winter Solstice

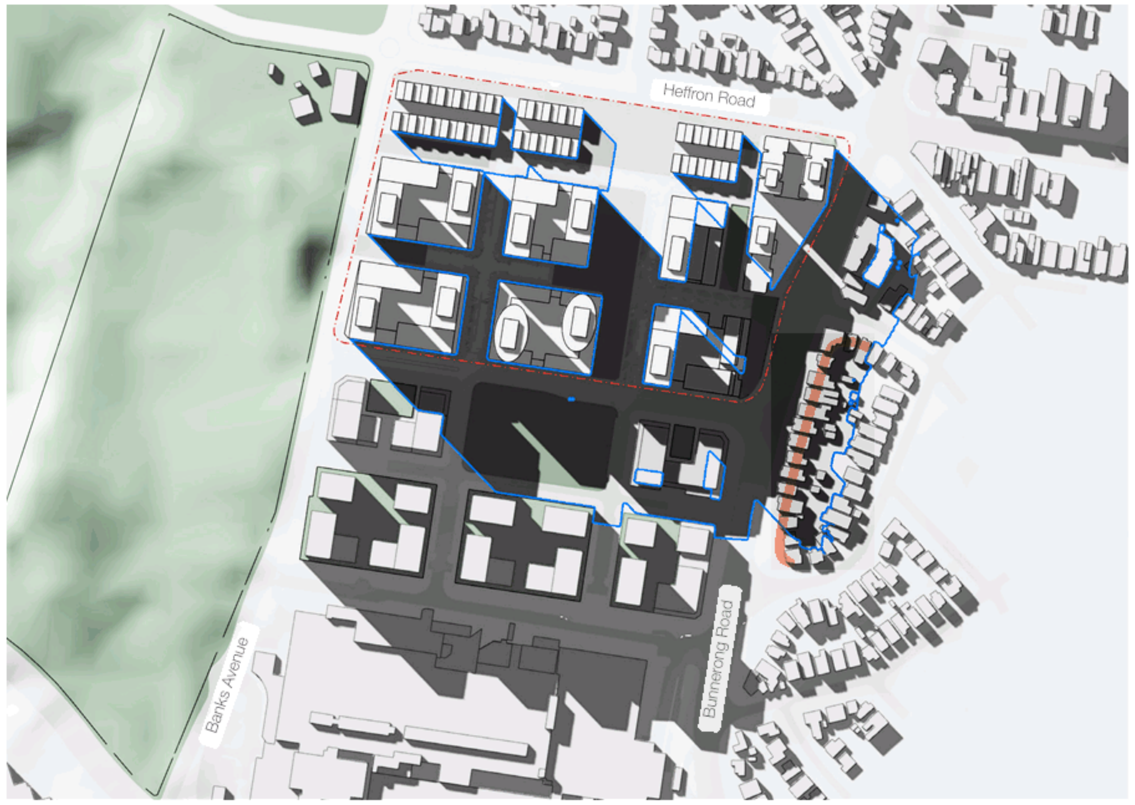
70% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls

Scheme Analysis

6.6 Shadow Diagrams - Winter Solstice



3pm - Winter Solstice

67% of public open space has direct sunlight.

Key

- Interface with Residential Area
- Site Boundary
- Shadow of permissible envelope under planning controls

SJB Architects

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SJB is passionate about the possibilities of architecture, interiors, urban design and planning.
Let's collaborate.

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Bayside Council
Serving Our Community

14 August 2017

Our Ref: 17/88576
Contact: Josh Ford 9562 1634

Karen Armstrong
Director, Sydney Region East
Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Dear Ms Armstrong

RE: Pre-Gateway Review of Planning Proposal at 128 and 130-150 Bunnerong Road, Pagewood (Ref. No. PGR_2017_BSIDE_001_00)

I refer to your letter dated 25 July 2017, advising that the Minister has received a request for a Pre-Gateway Review (PGR) for the Planning Proposal (PP) to amend *Rockdale Local Environmental Plan 2011* for land known as 128 and 130-150 Bunnerong Road, Pagewood.

Lodgement
A PP was lodged with Council on 13 April 2017, proposing the following amendments to the Botany Bay Local Environmental Plan 2013 (BBLEP 2013):

- Rezoning the subject site from R3 Medium Density Residential and IN1 General Industrial to R4 High Density Residential;
- Amending the Floor Space Ratio control from 1:1 to 2.35:1;
- Amending the Height of Building controls from 11m, 17m, 21m, 28m and 32m to 28m and 65m.

The subject land is identified as "BATA" on both *Key Sites Map 004* and *Key Sites Map 005* of the BBLEP 2013, which triggers a need for any new buildings to be constructed at the site to comply with *Clause 6.16 Design Excellence*.

The assessment of the PP has been delayed due to a range of extenuating circumstances. These include Council's limited staff resources during the time since lodgement of the PP, and the need to engage external consultants to complete a peer review of the various studies supporting the PP.

Preliminary Assessment
While internal technical staff referrals were undertaken within Council from 4 July 2017, consultant inputs in the areas of urban design, heritage, transport and land economics were deemed necessary to further progress the PP. Commission dates for these consultants ranged between 14 July 2017 and 28 July 2017 and the anticipated timeframe for finalisation of these peer reviews was 4 weeks. However, requests for additional information were made to the proponent, in order to assist with the process of peer review by the consultants that Council engaged. These requests related to traffic modelling data (27 July 2017) and CAD files for survey plan and architectural drawings (14 July 2017 and 27 July 2017). This information was provided to Council by Meriton on 11 August 2017, and was immediately forwarded to the consultants engaged by Council.

Mascot Customer Service Centre
141 Coward Street
Mascot NSW 2020, Australia
ABN 80 690 785 443 Branch 004
DX 4108 Maroubra Junction

Rockdale Customer Service Centre
444-446 Princes Highway
Rockdale NSW 2216, Australia
ABN 80 690 785 443 Branch 003
DX 25308 Rockdale

T 1300 581 299 F 02 9562 1777
E council@bayside.nsw.gov.au
W www.bayside.nsw.gov.au
Postal address: PO Box 21 Rockdale NSW 2216

Council's Outstanding Concerns
Despite the applicant's PGR application, in good faith, Council has been, and will continue to assess the PP. Due to the timing of Local Government elections, there are no Council meetings or Councillor Information Sessions scheduled for September 2017. Therefore, the target timeframe for reporting the matter to Council is November 2017, following a Councillor Information Session to be held in October 2017.

The following matters require clarification, and/or amendments to the Planning Proposal:

Planning History – Subject Site (Lot 1 & Part Lot 2)

- The submitted Planning Proposal outlines a history of rezoning, including a statement that refers to an *"earlier rezoning"* for the site (p. 4). This *"earlier rezoning"* applied to part of the subject land, and was notified on the commencement date of the Botany Bay Local Environmental Plan 2013, being 21 June 2013. It would appear that the LEP amendment was nearing completion under the planning instrument (Botany Local Environmental Plan 1995 – BLEP 1995) that applied prior to the commencement of the BBLEP 2013. Furthermore, it seems that rather than completing the amendment under the BLEP 1995, the NSW Department of Planning and Environment (DPE) instead chose to incorporate the zoning and development standards for the subject site into the BBLEP 2013, from its commencement date.

- It is also noted that Amendment 4 to the BBLEP 2013 (9 October 2015) included minor variations to the alignment of the zoning and development standards that currently apply to the land. However, the amendment did not change the zoning or development standards that have applied to the land since the commencement of the BBLEP 2013.

- It is just 4 years since this earlier rezoning was (effectively) notified at the commencement of the comprehensive BBLEP 2013. Therefore, the strategic justification to significantly vary the zoning and development standards that currently apply to the subject site is questionable. This is particularly the case when considering the fact that no Master Plan has been adopted by Council for Lot 1, which is entirely zoned IN1 General Industrial under the BBLEP 2013.

- Part 9-D *130-150 Bunnerong Road, Eastgardens* and Part 10 *Other Documents: Technical Guidelines for 130-150 Bunnerong Road, Eastgardens* of the Botany Bay Development Control Plan 2013 (BBDCP 2013) apply to part of the subject land. Part 9-D formed part of Amendment 1 to the BBDCP, which came into effect 16 December 2014.
  - While the DCP does include part of the subject site, it does not include *any* of the IN1 Industrial zoned land.
  - Part 9-D includes an artist's impression of the redevelopment of the site on page 12, which clearly illustrates the intent to develop part of the subject site for residential purposes (that part currently zoned R3 Medium Density Residential), and retain employment land uses on the area of the BATA site currently zoned IN1 General Industrial. The artist's impression was sourced from *"The New Eastgardens Masterplan – JBA Planning and Krikis Taylor Architects"*.
  - No other Masterplan has been adopted by Council, nor has the Part 9-D been amended or adopted by Council since Amendment 1 to the BBDCP 2013 in December 2014. Furthermore, Council has not given any signal to the community of an intent to further plan for the future of the land zoned IN1 General Industrial. The absence of a subsequent Council adopted Master Plan for the subject site makes it difficult to support the zoning and development standards being sought under the submitted Planning Proposal.

- Further to the above point, in the absence of any Council-endorsed Master Plan for the subject site, the submitted Planning Proposal relies heavily on the status of the locality as a "District Centre" in the *Draft* Central District Plan in justifying the conversion of employment land to residential and commercial land uses. In this regard, the planning for the subject site has seemingly driven the status of the broader precinct as a "District Centre", rather than any Master Planning to help inform the future use of what is a significant holding of employment land. The continued use of Lot 1 for employment-related activities, including port-related support activities, was clearly evident at a site inspection undertaken by Council staff on 9 August 2017.

<u>Adjoining Land to South (Southern Portion of Lot 2)</u>

- The Meriton site immediately south of the subject site was the subject of a NSW Land and Environment Court (LAC) determined development consent on 7 August 2015. That development consent issued by LAC identified tower building heights according to podium, building and plant room heights. The maximum building height (to plant room) identified in the LAC development consent is 67.9 metres. Amendment 4 to the BBLEP 2013 was notified on 9 October 2015 (which included both Lots 1 and Part 2 within the BATA site). The amendment included minor variations to the alignment of the zoning and development standards that currently apply to Lots 1 and 2, but did not change the zoning or development standards that have applied to the land since the commencement of the BBLEP 2013. These controls include a maximum Height of Building development standard of 44 metres on the very Southern extent of Lot 2, which represents a significant height difference of 23.9 metres *below* that which was approved under the LAC development consent (67.9 metres). The BBLEP 2013 does not include any height incentives for the BATA site, which is identified as "Area 1" on map sheets HOB_004 and HOB_005. Clauses 4.3(2B) and 4.6(8)(b1) of the BBLEP 2013 include provisions to prevent any height increases beyond the development standards identified on map sheets HOB_004 and HOB_005 relating to "Area 1".

- It seems to be the case that the LAC development consent for Lot 2 is driving the zoning and developments standards (particularly the 65m building height) being sought by the proponent under the submitted Planning Proposal, via a precedent planning argument. Strategic planning needs to be undertaken for what is part of a broader precinct involving a stand-alone shopping centre (Westfield Eastgardens) and land that is currently zoned for medium density and industrial purposes. This is particularly the case since the site has been included in the Draft Central District Plan. Council has not been privy to any strategic planning that has been undertaken to inform the viability of the site as a District Centre. Varying the current zoning and development standards that apply to the site without consideration of the broader precinct is deemed to be a poor planning outcome for what could, potentially, be a District Centre.

- Clauses 4.4(2B) and 4.4(3)(b) of the BBLEP 2013 limit any further increase to the Floor Space Ratio development standards for the BATA site beyond those identified on map sheets FSR_004 and FSR_005. The Southern portion of Lot 2 has retained an FSR of 3:1 (zoned B4 Mixed Use) and 1:1 (zoned R3 Medium Density Residential) since the commencement date of the BBELP 2013, while Lot 1 (zoned IN1 General Residential) and the Northern portion of Lot 2 (zoned R3 Medium Density Residential) have retained an FSR of 1:1 since this time. The application of an FSR of 2.35:1, as sought under the submitted Planning Proposal, is considered excessive when considering the maximum FSR of 1.65:1 identified under Clause 4.4B(3) for land zoned R3 Medium Density Residential and R4 High Density Residential. While the subject land doesn't meet all of the requirements for a Development Application to trigger this clause, it nevertheless provides an indicator about what is considered an appropriate FSR for a "larger site" zoned R3 Medium Density

Residential or R4 High Density Residential. Furthermore, even if the FSR incentive Clause 4.4(2A) did apply to the land zoned R3 Medium Density Residential at the site, that clause identifies a maximum FSR of 1.5:1 for land zoned R3 Medium Density Residential zone or R4 High Density Residential zone. This point further demonstrates that the FSR of 2.35:1 being sought under the Planning Proposal is excessive for the site.

Urban Design

- Compatibility with the scale of low density residential areas to the North and East of the subject site, including future buildings in the Southern portion of the BATA site.
- Minimising overshadowing of Central Park and the future buildings to the South, as the massing strategy and height do not appear to have minimised overshadowing impacts.
- Ability of building envelopes to comply with the design principles of SEPP 65 and the objectives of the Apartment Design Guide, particularly solar access.
- Appropriateness of providing podium-tower building typology with above ground parking and the impacts on safe pedestrian movement and permeability throughout the site.
- Building envelope height capability in accommodating rooftop services and parapets etc.

Heritage

- The Statement of Significance in the submitted Heritage Impact Statement does not address previous employment-related land uses at the site, including the construction of planes during the Second World War and the involvement of staff in designing the former Holden manufacturing plant.
- While the site has no heritage listing, a number of built form elements within the site may have a degree of heritage value and further investigation is warranted.
- A Heritage Interpretation Strategy should be prepared for the site.

Transport & Parking

- The Masterplan submitted with the PP proposes a set of carparking rates *below* the current carparking requirements of the Botany Bay DCP and the Stage 1 DA consent that applies to the site, and is heavily based on assumptions about the *potential* extension of a light rail service to the site – which there is no evidence to suggest would ever occur.
- Given the abovementioned point, traffic generation analysis may be inaccurate, as it has been based on inadequate modal splits and assumptions about potential future public transport, not *current* public transport options available to the site.
- Given that Council is in receipt of a Planning Proposal for the adjoining site (Westfield Eastgardens), cumulative traffic impact in the locality needs to be modelled and assessed.

Economic Impact

- The subject PP involves a loss of industrial land at 128 Bunnerong Road. The Draft Central District Plan requires a precautionary approach be taken to any conversion of employment lands.
- Given the abovementioned point, a critique is required of the assumptions, evidence and analysis in the submitted Economic Impact Assessment, to determine the appropriateness

and supply/demand impacts of rezoning employment land to residential and commercial purposes.

- The proposed quantum of non-residential floor space (retail and childcare centre) outlined in the PP needs to be reviewed, including an assessment of whether this floor space area is adequate and viable, or whether it could potentially be increased to provide adequate space to facilitate local services to support the surrounding community.

- An assessment needs to include the economic and operational contribution of the site to the productivity, functioning and support it provides as a port-related industrial land use.

Voluntary Planning Agreement

- A meeting was held between the proponent and Council staff on 13 July 2017, where the possibility of a VPA was raised. Council has commissioned a suitably qualified consultant to peer review the land economics information submitted with the PP. This review will include the assessment of the value in uplift arising from the PP.

- Council's expectation is that VPAs are negotiated in conjunction with Planning Proposals, so that significant public benefits can be delivered to the community. The Planning Proposal would rezone land to accommodate a significant residential population, therefore requiring significant contribution to public infrastructure, services and facilities in order to accommodate this population and the existing broader community in the locality. This is particularly the case for the BATA site (Lot 1), where future land use has not been planned for beyond its current IN1 General Industrial zoning.

Next Steps

Council understands that DPE will now prepare a PGR report and forward that report (including the subject correspondence) to the relevant Planning Panel for a strategic merit assessment to determine whether or not the PP should proceed to Gateway. It is also Council's understanding that DPE will notify Council of the determination shortly after it is made by the Planning Panel.

Should you have any queries in relation to this matter, please contact myself on 9652 1851 or Josh Ford (Urban Strategist) on 9562 1634.

Yours faithfully

per.

Clare Harley
Manager Strategic Planning

5

PAGEWOOD GREEN STAGE 2 MASTER PLAN

PLANNING PROPOSAL

PEER REVIEW

8th November 2017

Prepared for Bayside Council by

hill thalis
ARCHITECTURE + URBAN PROJECTS PTY LTD
P: 92116276 E: philip.t@hillthalis.com.au www.hillthalis.com.au

CONTENTS

1

This report has been completed to assist Bayside Council with their Urban Design Assessment of Meriton's proposed redevelopment of the former British American Tabacco Australia (BATA) site at Pagewood.

The site is bound by Bunnerong Road, Heffron Road and Banks Avenue and Meriton Boulevard- immediately adjacent to a similarly proportioned and redeveloped site north of Westfield Eastgardens.

In July 2017 Hill Thalis was engaged by Bayside Council to assess Meriton's revised master plan for Pagewood Green Stage 2 (referred to in this document as **"Revised Proposal"**). This follows earlier work undertaken by Hill Thalis to produce a comprehensive Urban Design Study for the site in 2016.

This report will critique the merits of Meriton's Revised Proposal through graphic analysis and comparison with the previously completed 2016 Urban Design Study - referred to in this document as **"Draft Council Master Plan"** (prepared by Hill Thalis).

The following assessment details both the Revised Proposal (Meriton) and the Draft Council Master Plan and critically analyses the ability to provide a best practice urban structure and distribution of built form for the BATA site.

INTRODUCTION

1.1 SITE ATTRIBUTES

The site is located in the north-east corner of Pagewood, and is bounded by Bunnerong Road to the east, Heffron Road to the north, Banks Avenue and golf course to the west, and Westfield Drive and shopping centre to the south. A new street, Meriton Boulevard, has been constructed east west across the centre of the site. The part of the site to the south of Meriton Boulevard has already been rezoned, and the current Peer Review relates to the portion of the site to the north of Meriton Boulevard.

This large site is well located, and has the following attributes that would support a Planning Proposal to change its use, create a new public domain and allow more intensive developmet:

- Pagewood / Maroubra Junction are within a growing region with ready access to nearby centres;
- The site has reasonable access to public transport, principally buses. Despite contentions to the contrary by the applicant over several years, there remains at this time no publicly available confirmation of any superior public transport, such as Light Rail or Metro;
- The site is located in an established centre, which is adding high density residential to a major retail centre;
- Rezoning / Planning Proposals for such sites are generally compatible with the Draft District Plan by the GSC and Metropolitan Plan objectives for Sydney;
- The wider area has a reasonable proportion of open space, with potential additional connections to existing parks and for additional parklands;
- The site benefits from wide roads on both the northern and eastern sides, and a street edge to a golf course to the west;
- The site is of sufficient area to accommodate infill residential development complemented by community uses, of which there are some good examples across metropolitan Sydney;

Council have the vision to create a new vibrant mixed-use community, with a high quality public domain and good residential amenity.

1.2 MERITON PLANNING PROPOSAL

The key elements of Meriton's Planning Proposal are:

A change in the zoning from IN1 General Industrial and R3 Medium Density Residential to R4 High Density Residential;
A maximum floor space ratio (FSR) of 2.35:1; and
Maximum building heights across the subject site of part 28m and part 65m.

1.3 A BRIEF HISTORY OF SITE PLANNING

This site was formerly used for industrial purposes in the pre and post-war period, including car manufacturing and tobacco processing. With the shift of such industrial and manufacturing processes, the site has had a recent history of rezoning and now redevelopment.

The rezoning of the south part of the site was approved during protracted Section 34 Conference process in the Land and Environment Court of NSW prior to 2015.

Architectural Competitions for Blocks to the South of Meriton Boulevard

Since that time there have 4 architectural competitions for blocks within this approval.

The competitions have been held since 2015. Philip Thalis, a director of Hill Thalis, has been involved in judging 2 of these competitions (those experiences have informed subsequent urban design and architectural advice for the northern part of the site). At the conclusion of the judging of the first competition, Philip Thalis wrote to Council regarding the competition process and the controls for the southern blocks;

Drawing on our experiences of the competition, review of the planning controls and our previous experience advising the City of Sydney / CSPC on the Meriton's ACI site, we make the following initial suggestions aimed at improving the planning and design outcomes;

A Public Domain

In our extensive experience of such major projects, the full extent of the public domain should be dedicated to Council.

In our review of the ACI and other sites, we observed that 'public walkways' over private sites invariably had been gated, or otherwise impeded. Quasi forms of public access have a poor track record, and raise all sorts of dilemmas for body corporates, community title schemes as well as equity problems for people who are already paying Council rates, insurance, maintenance and liability issues.

It would be better if more streets allowed some through traffic, rather than being configured as cul de sacs or de facto driveways. Of course such streets should be low speed, with perhaps limited movements allowed at the site's perimeter (eg left in/ left out). This would reduce the effect of the site being an enclave, alien to the wider neighbourhood.

The landscaping of the public domain's parks and streets also needs to be given much more consideration. We suggest there should be a design competition of leading landscape architects, and that the brief should include WSUD best practice.

B Development Controls

We encourage Council and Meriton to explore a slight relaxation of the adopted development controls.

In particular the 0.5m scope for 'articulation' is far too tight, and clearly stymies genuine modulation of the massing. The controls tended to be a straight-jacket, that overly restricted the architects.

There could also be more scope to locally vary heights and setbacks.

We note that the building separations in the DCP do not meet either the old RFDC or the new ADG controls. Again more scope for variation would be helpful.

C Yield

Meriton have been granted a very high yield, with heights and FSR's greater than any in the Eastern Suburbs with the exception of certain parts of Bondi Junction. Therefore surely Meriton can easily give something back, such as dedicated public space, parks and playgrounds, off site public domain and infrastructure improvements and affordable housing provision.

This would be consistent with international contemporary best practice.

D Design Excellence

As a juror, I felt that the schemes lacked joy and imagination. This is going to be home for 480+ households and the largest building in Botany LGA. Its design matters, and in my estimation none of the schemes approached would could objectively be called design excellence, despite the architects' hard work and competence.

Meriton's target yield also seemed to give the architects limited scope to explore design improvements.

Council's Draft Master Plan (for part of the block to the North of Meriton Boulevard)

in 2016, Botany Council, subsequently amalgamated to form Bayside Council, commissioned Hill Thalis Architecture + Urban projects to prepare a draft Master Plan for the northern part of the site, that included some remnant industrial buildings and areas of mature trees. This Plan related to the part of the site to the north of Meriton Boulevard, and built on the experiences of the architectural competitions that had already been held (see above observations).

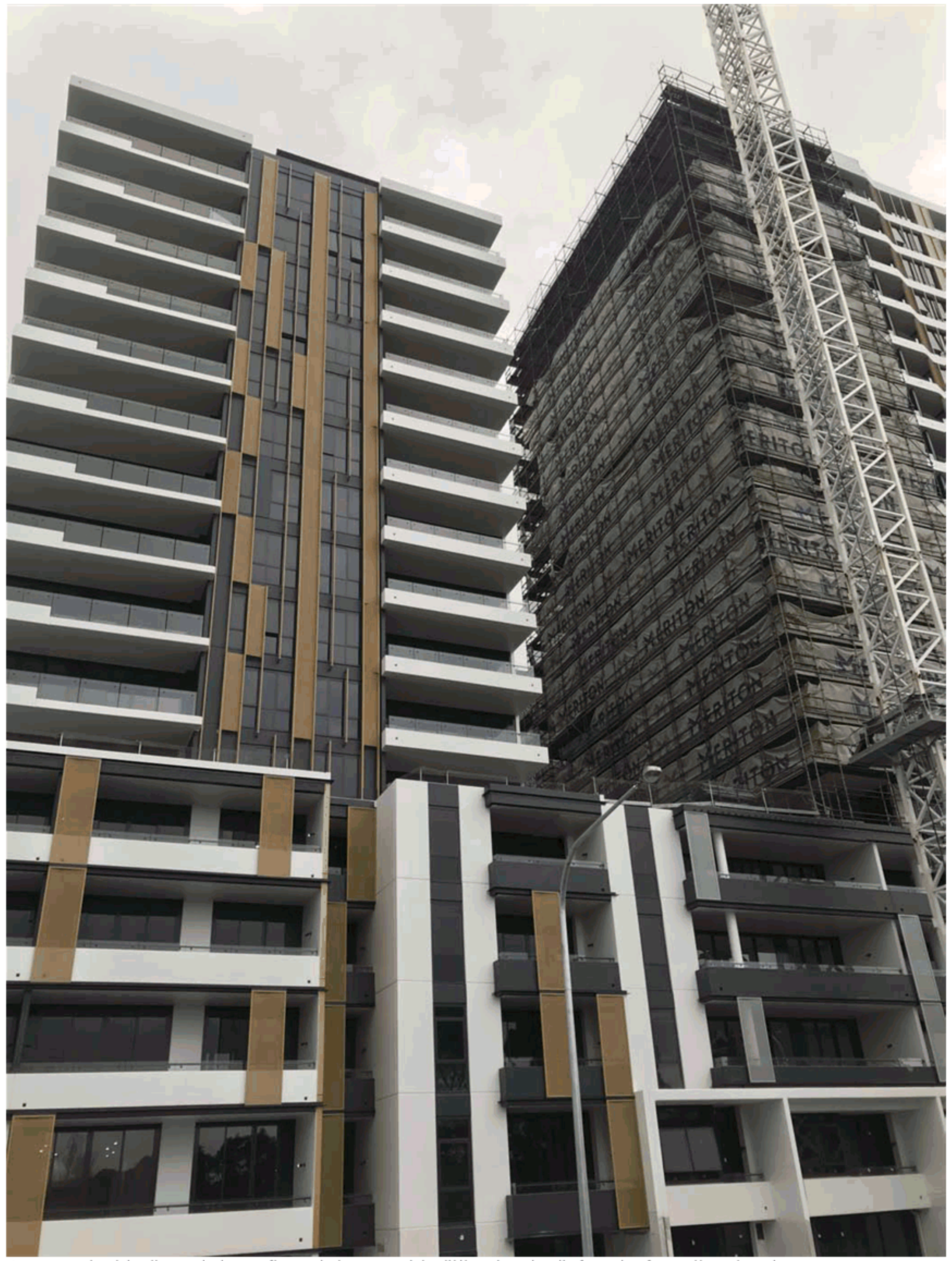
The draft Master Plan envisaged the following;

Public Domain
- a public street structure that related to the site's dominant geometry, historic alignments and the streets to the south and north;
- a dedicated, connective local street system, integrated with new public parks, to make the area more walkable, amenable and available to the wider community;
- additional public park areas to supplement the 8 000m2 Central Park on the south side of Meriton Boulevard;
- generous park verges to both Bunnerong Road and Heffron Road that retained the existing mature trees;

Community Uses
- various community uses distributed across the site to cater for the site and wider area's community, if possible reusing historic buildings on the site, or as new distinct public buildings located in relation to new parks;

Development
- distributed building heights of 4, 6 and 6.5, 9, 14 and 18 storeys to create diversity across the site, and while accommodating significant density, relieve aggregated bulk to the maximum extent possible;
- building articulation in all blocks to have a range of heights, open courtyards and areas of deep soil planting;
- reasonable retention of major elements of the historic fabric, in particular where they have architectural merit and are visible in the wider public domain;
- ***the master Plan proposed two different overall yields; the preferred scheme had a gross FSR of 1.62:1, whereas a higher density of 1.8:1 could be supported if metro or light rail were planned to improve access to the site (it is noted that to date no plan has subsequently been adopted for either of these public transport initiatives, making the site reliant of existing limited bus services).***

1.4 EVALUATION OF THE FIRST BUILDINGS ON SITE


Aggregated bulk and deep floorplates provide little visual relief or sky from the street
source: Hill Thalis

The first block (subject to the initial competition) is now nearing completion on site, which is illustrated in the accompanying images.

From observations on our recent site visit, the following comments are noted:

- The buildings are higher than any building in the wider neighbourhood (the nearest 20+ storey buildings are along South Dowling Street at Green Square, and in Bondi Junction Centre);
- Due to the fairly flat topography and height and size of the block, it is very prominent in the wider area, being visible from large parts of the City of Sydney, Randwick LGA, Bayside Council LGA and beyond;
- The aggregation of L-shaped tower forms creates a mass of very dominant bulky forms, with no visible breaks as seen from many angles;
- The tower elements' 24 metre building depth are well in excess of the 18m maximum Building Depth required in the ADG, and exacerbate the aggregated bulk of the buildings;
- The large block has a minimum 5 storey scale, with no inset gardens, courtyards or relief;
- The front garden setbacks constitute the only deep soil area on the block, and have very limited scope for the planting of trees of any size;
- The deep soil landscape area appears to be well below ADG requirements;

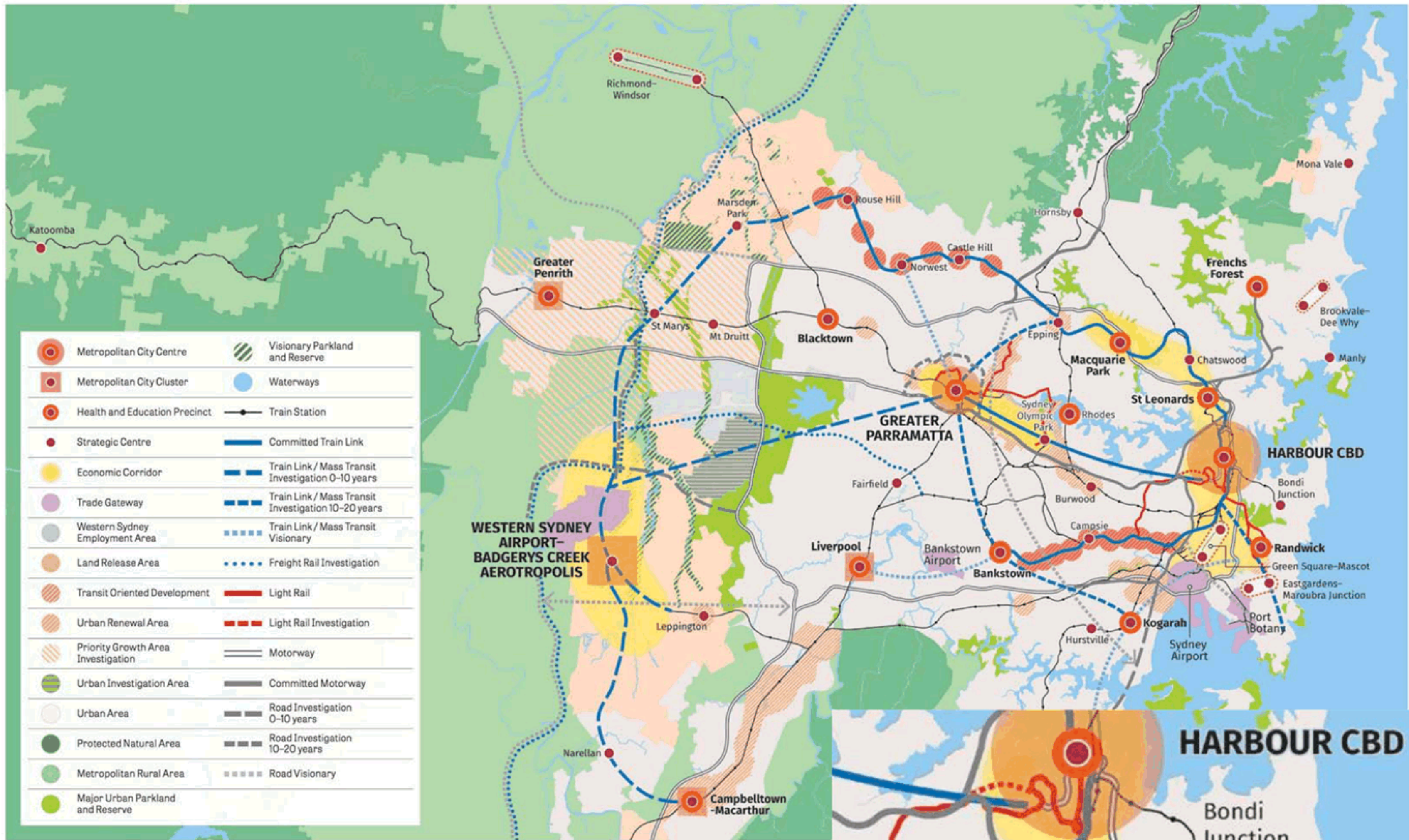
The second block is now under construction. The cumulative impact of the bulk of multiple blocks will have a major impact on the wider area, which is substantially lower in scale and intensity.


Aggregated bulk and deep floorplates provide no visual relief or sky from afar
source: Hill Thalis

2

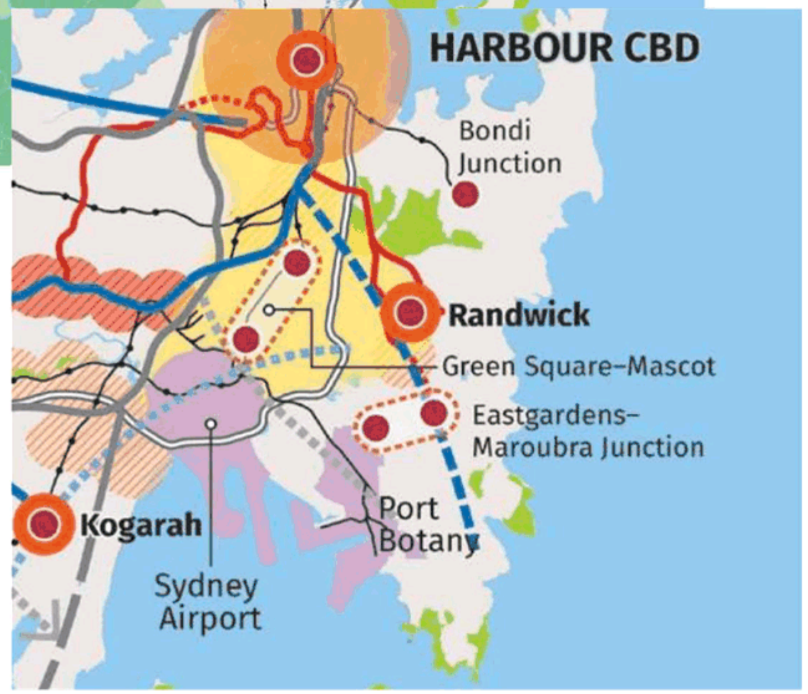
BROADER CONTEXT

Figure 58: Greater Sydney Structure Plan 2056 – the three cities



NOTE: Committed projects of: Western Harbour Tunnel & Beaches Link, F6 – WestConnex to President Avenue Kogarah, Parramatta Light Rail Stage 2 and Sydney Metro West are subject to final business case, no investment decision yet. Routes and stops for some transport corridors/projects are indicative only.

Greater Sydney Commission | Draft Greater Sydney Region Plan 2017



2.1 METROPOLITAN CONTEXT

The Bata site in the eastern suburbs of Sydney is well located to the City, hospitals, universities, ocean coastline and Botany Bay. This part of Sydney also enjoys a lovely coastal climate.

Public transport is limited to local and regional bus services. The Greater Sydney Structure Plan 2056 identifies Eastgardens-Maroubra Junction as a pair of strategic centres - but physical dislocation and lack of high frequency, high capacity public transport prevents them becomming so.

The plan identifies the desirability of investigating north south mass transit through Maroubra Junction over the next 10-20 years, making the site suited to only modest urban consolidation at present.

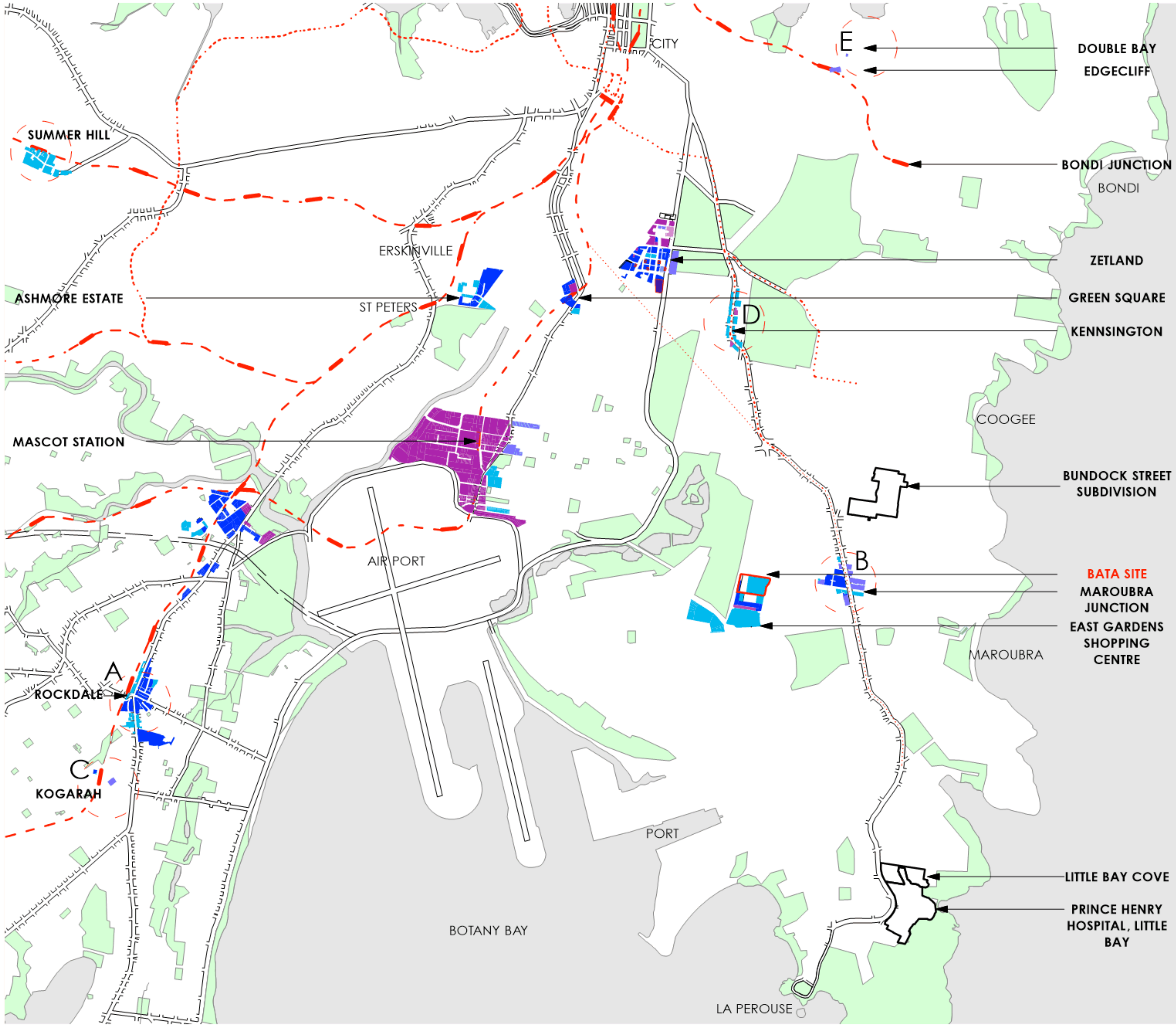
Due to limited transit choices and lack of structural metropolitan public transport at present, residents and workers who own a car, would most likely favour car use for local and regional journeys. Walking might be a choice for journeys up to 2.5kms (1/2 hour) and cycling up to 10km (1/2 hour)

hill thalis

Note:All boundaries and setouts should be confirmed with survey

Urban Design Assessment - BATA rezoning
8/11/17 Rev -
for Bayside Council

2.1
Metropolitan Context
1:2500 @ A3



2.2 URBAN CENTRES

Sydney's east has a variety of centres with widely differing LEP building heights, and public transport service. City and town centres are logical places to focus increased housing density.

The city has most concentrated services, entertainment and employment, and pre-eminent public transport, 7 heavy rail stations and radiating bus and ferry services. Other established centres with co-located services are represented here by Bondi Junction and Rockdale on heavy rail lines and Maroubra on a well serviced regional bus route.

New centres include Wolli Creek located on a heavy rail intersection. Buildings of significant height are permitted to 46m. The Ashmore Estate proximate to St Peters and Erskinville and their rail stations permits buildings heights to 30m. At Green Square buildings heights to 46m are permitted. At Zetland, much closer to the City building heights in excess of 60m are permitted. Tower building footprints here are limited to 750m2.

More alarming is the relentless 92Ha extent of 46m building height permitted in loose proximity to Mascot station. With only about 15% of the affected area built, this has resulted in many bulky 12 story slab wall buildings overbearing the public spaces of the streets.

Closer to the Bata site, the East Gardens shopping centre lacks the varied and complex mix of uses and public facilities of a town centre. The shopping Centre cordons off its self from its urban situation and is organised to prioritise car access. While pedestrian access is not prevented, the limited entry points lack the easy open access of a street based town centre like Maroubra Junction, twice the distance away from the Bata site.

legend

structural public transport

- heavy rail
- light rail
- future mass transit GSSP

LEP building heights

- 60+m
- 46m
- 30m
- 24m
- 21m

A, B, C, D, E
Centres shown on the density metrics graph

hill thalis

Note:All boundaries and setouts should be confirmed with survey

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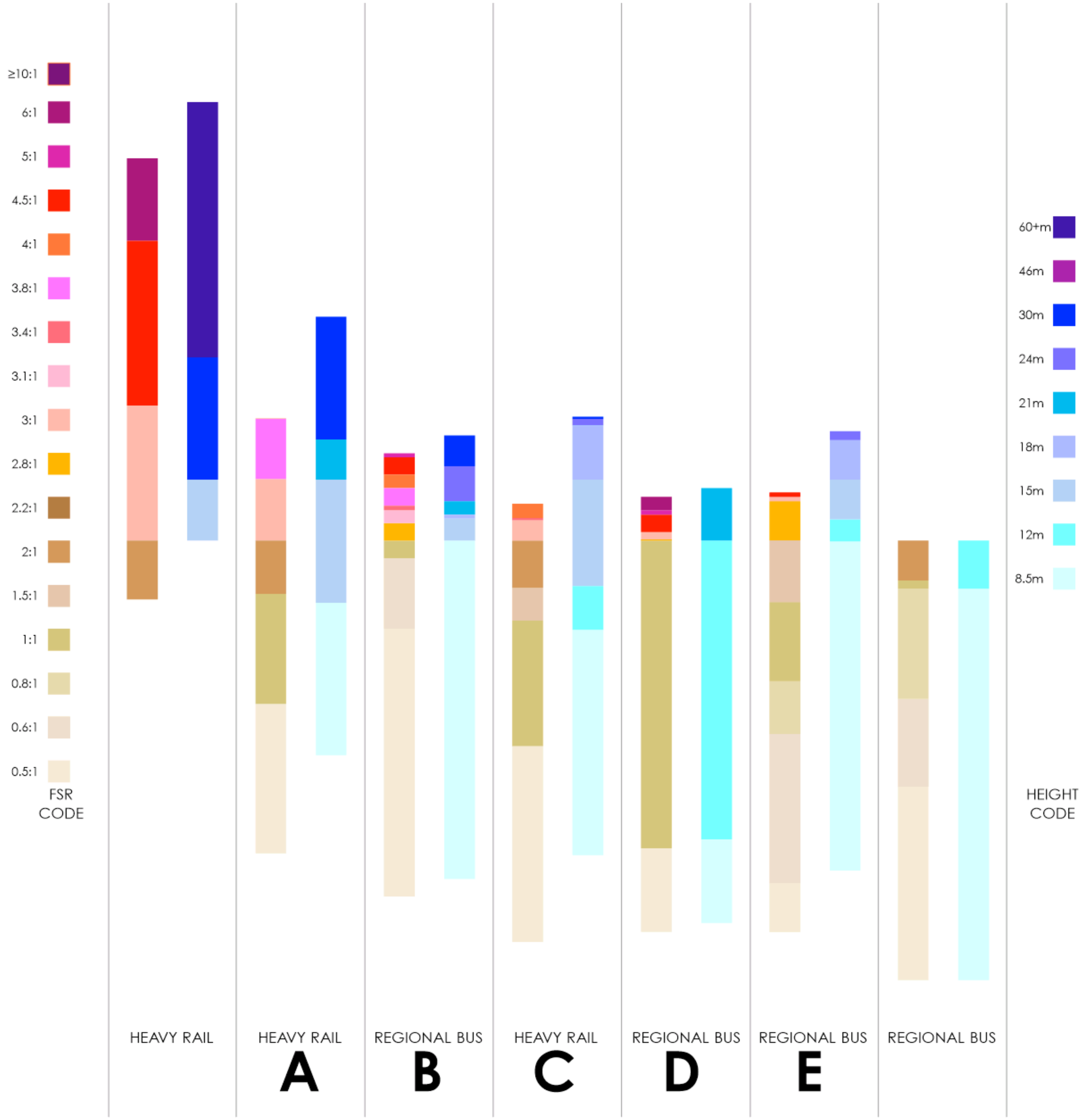
2.2
Urban Centres
1:2500 @ A3



2.3 THE METRICS OF DENSITY

The vibrancy of city and town centres brings together the concentration and co-location of varied services and activities for entertainment and employment with a resident population. Increasing housing density at centres increases the liveliness of the place.

Sydney's east has a variety of centres with varied densities. Higher density is occurs in areas of concentrated services and connective public transport.

The graph shows key LEP controls for seven centres, 5 coded to 2.2 Urban Centres drawing. Greater height and FSR is generally located at more complex centres with higher levels of public transport.

hill thalis

Note:All boundaries and setouts should be confirmed with survey

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2.3
The Metrics of Density
1:2500 @ A3

2.4 COMPARABLE RENEWAL SITES

There a number of large sites in the vicinity that have been rezoned and redeveloped over the last decade, including:

Prince Henry Hospital, Little Bay

Layout; Adapted layout of publicly-dedicated streets, retaining heritage alignments and buildings, connecting to Anzac Parade to the west
Parks; Series of new parks and community uses.
Density; gross FSR applied to whole site, higher net site densities. Retail at entry
Scale: Retained heritage building, 2 storey houses, and 3 to 6 storey apartment buildings

Little Bay Cove, Little Bay

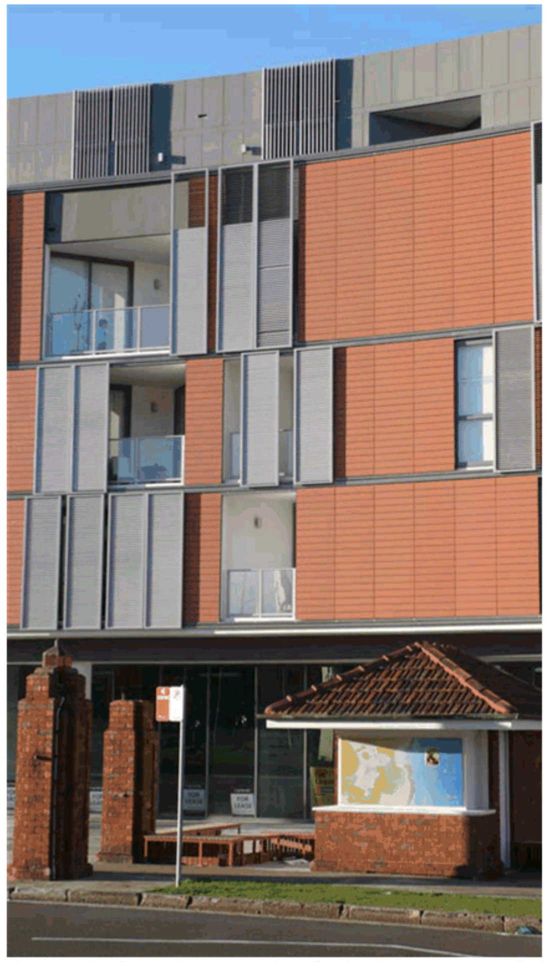
Layout; New grid of publicly-dedicated streets connecting to Anzac Parade to the west, and open ended streets to the other frontages
Parks; Large central environmental park with lake and wetland, pocket park with playground.
Density; gross FSR applied to individual blocks, higher net site densities
Scale: 2 storey houses, and 4 and 5 storey apartment buildings

Bundock Street Defence site, Kingsford

(northern part constructed as first stage of approved 48 hectare Master Plan)

Layout; New grid of publicly-dedicated streets connecting to Bundock Street to north, and Holmes Street to south
Parks; Large 12 hectare environmental park with wetland, bike track, playing fields and community centre open. A series of urban smaller urban parks in future stages
Density; 0.5:1 gross FSR applied to whole site, higher net site densities
Scale: 2 storey houses, and 3 and 4 storey apartment buildings

From the analysis above it can be seen that Meriton have been granted and are now seeking further development that is hugely larger than that granted on other major renewal sites in the vicinity in recent times.



The modest 4-6 storey scale of Prince Henry Hospital maintains an openness and identity with robust increases in density - source: Hill Thalis

Streets at Little Bay Cove form connective precincts and draw orientation from the topogrphy and coastline - source: Hill Thalis

The open and generous structure at Little Bay Cove is flexible to a range of building types and uses over time source: Hill Thalis

3

SITE AND OBJECTIVES

3.1 DESIGN PRINCIPLES

Public Domain

To provide a high quality public domain framework with a variety of usable public open spaces, parks and squares accessible and available to the wider community;
To provide a permeable and legible network of connective public streets, lanes and walkways, which provides pedestrian / cycle links to public transport, accessibility through the site and connections with the surroundings;
To dedicate all new streets and parks to the public authority so that the site forms part of the area's public space network;
To create streets and parks of sufficient generosity in relation to the higher densities proposed on this site;
To create parks of varying size, orientation and usability to serve the future community, and directly link northward to Jellicoe Park to extend the area's emergent Green Grid;
To provide high quality community facilities to serve the new and surrounding community;
To retain elements of the site's former industrial fabric to act as markers and physical reference points for the future community;

Built Form

To provide an identifiable benchmark and deliver a high standard of architectural excellence.
To ensure a mix of housing types and choices;
To have a high degree of compliance with the design principles and controls in SEPP 65 and the ADG;
To retain and adapt buildings that have historic and potential heritage significance and adaptive reuse potential, with consideration to how they are accessed and relate to the surrounding precincts and the wider community;
To address the existing and potential streets and public spaces;
To have adequate building separations that align with SEPP 65 and the ADG to ensure adequate sunlight, breezes and privacy while allowing outlook and street address;
To relieve the agglomerated bulk of long and tall street frontages, articulating the mass by introducing a range of scales, and landscaped breaks along each street frontages within most blocks.

Landscape

To provide a generous landscape environment that mitigates urban heat island effects.
To ensure water management is based on the principles of water sensitive urban design and ecological sustainability;
To provide varied tree planting in public and private space;
To provide adequate Deep Soli area within each block in compliance with the ADG to allow the planting of substantial trees and garden areas for the benefit of future residents;
To retain to the maximum extent possible the mature trees on the site.

Capacity Testing

To review the proposed yield and envelope having regard to SEPP 65 and ADG provisions and broader urban design implications;
To accommodate a reasonable site density, with regard to its strategic location, public transport provision and urban design capacity.

3.2 RESPONSE TO PLANNING REPORT

The following is an extract of section 6.7. *COMPARISON WITH HILL THALIS SCHEME* from the April 2017 Planning Proposa supporting Meriton's Revised Proposal with particular comparison to the previously completed Hill Thalis Preferred Master Plan:

1 *The streetscape layout proposed by Hill Thalis has been adopted, however larger setbacks have been provided to the northern, eastern and western building frontages to maximise solar access. The proposed design and width of the road reserves outlined in the Hill Thalis concept plan has also been adopted.*

2 *The centrally located public open space (Wedge Park) has been incorporated but rotated to maximise solar access to the open space and provide a more useable public domain.*

3 *Elements of the existing buildings along Heffron Road have the capacity to be kept, with substantially setback medium density residential buildings provided along this interface in response to the site's heritage and character.*

4 *Provision of a centrally located civic open space.*

5 *Lower scale buildings along the northern portion of the site, with buildings up to 20 storeys within the less sensitive pockets of the site towards the south and west.*

Key differences adopted in the Hassell concept plan, which are considered to provide a superior urban design outcome:

A *The proposal has introduced podiums to the majority of the buildings consistent with the design approach within the southern portion of the BATA site. The podiums will accommodate above-ground car parking sleeved with apartments and elevated communal open space to maximise solar access. The inclusion of the podiums accounts for the significant variation between the proposed FSR of the Hill Thalis scheme (1.8:1) and the Hassell scheme (2.35:1).*

B *Building orientations and heights have been rationalised to improve efficiency, maximise solar access, natural ventilation, outlook and to ensure building depths will support a range of apartment layouts.*

C *Car parking will largely be accommodated within the podium levels to avoid the need for excessive excavation and fill.*

D *The increased building separations removed the need for non-habitable building facades across the entire site.*

E *The height of buildings along the Bunnerong Road frontage have been reduced to minimise overshadowing to the residential properties to the east.*

F *The northern access point to Banks Avenue and the western access point to Heffron Road have been deleted as they are located too close to the intersection of these roads and are not supported on traffic grounds (see Appendix F).*

G *The extent of public open space has been increased from 20% of the site area contemplated by Hill Thalis to 30% of the site area in the Hassell scheme.*

As a basis for this assessment Hill Thalis notes the following responses:

1 This is incorrect. Whilst a similar layout has been adopted, the Revised Proposal is rotated at a less desirable orientation with critical connective pieces of street reserve deleted. Please see section 4.3.

2 This is incorrect. The rotation noted in the Revised Proposal offers less solar penetration to major public spaces, particularly between the times of 11am and 1pm in mid-winter. Please see section 4.4.

3 The Revised Proposal appears to maintain a minimum number of historic and character elements along the Heffron Road frontage only. As Bunnerong Road is a primary frontage and source noise other historic elements are well suited to being adapted to provide a buffer as well as non-residential uses better suited to that frontage, and should be maintained.

4 Noted. With amended orientation and disconnective street edge.

5 The location of 8 storey buildings to the northern edge of the site is not considered "low" as these are significantly taller than the width of the adjacent street. A low scale would be consideredto be no more than 6 visible storeys from the street . The orientation, depth and arrangement of taller elements must be carefully considered to provide maximum amenity to the public domain and between buildings.

A There appears no valid reason why car parking should not be provided in basements. Above ground podium parking should be avoided. The addition of building bulk by podium car parking has significant impacts on achieving amenity of solar access and ventillation, deep soil, mature landscape, through block links, stormwater management and mitigation of urban heat island effect.

It should be noted that the Draft Council Master Plan envisaged a gross FSR of 1.62:1, and the mentioned 1.8:1 would only be supported should major new public transport such as metro or light rail be provided. This is not the case currently. Therefore no credible case for an increased FSR of 2:35:1 has been justified by Meriton's Consultants.

B This peer review finds that this claim cannot is not justified, and cannot be supported. Please see sections 4.7 - 4.11.

C This strategy is sub-standard for a dense urban project when significant contamination or similar constraints prevent the integration of basements, and is not supported. Please see section 4.7 and Recommendations.

D Whilst building separations may satisfy some requirements of the ADG we note the excessive depth of floorplates and the arrangement of tall "L" shaped forms may make achievement of amenity requirements difficult. Further testing of breaks between buildings, particularly in the south eastern and south western corners of blocks should be interrogated to enable solar access and ventilation to lower levels.

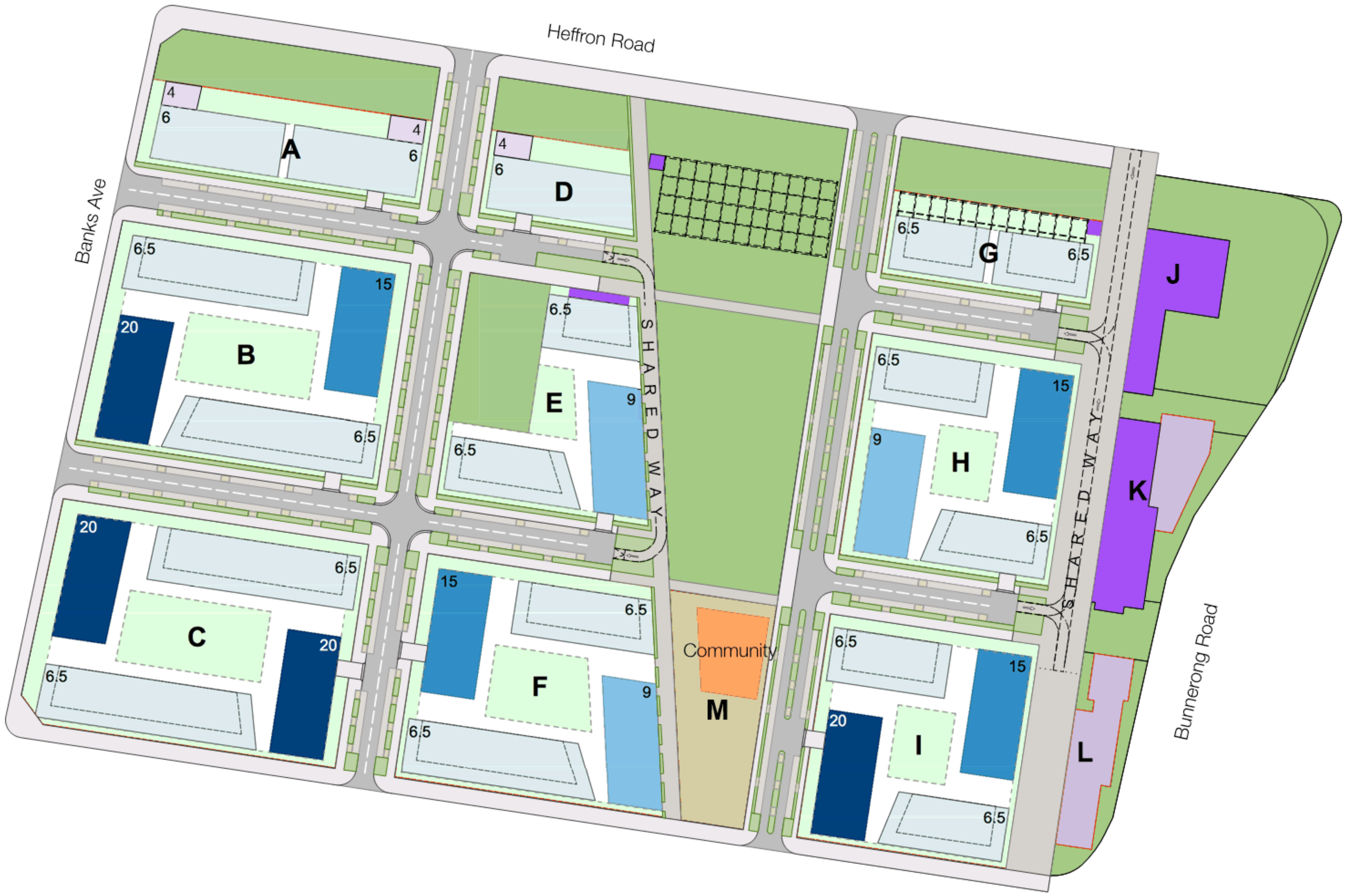
E The distance to properties across Bunnerong Road is greater than the relationships between towers within the revised proposal. It is noted that these detached dwellings take their private amenity from backyards located even further east. Elements that have been reduced along the eastern edge of the site should not compound bulk and compression further into the site.

F Whether or not these streets are open to traffic is subordinate to the creation of a connective and integrated street network. The street network should be holistic and without dead-stubs. Traffic management can be arranged in a number of ways through the making of the public domain. These elements should be returned to the public dedication network of streets.

G It is noted that the deletion of street elements and historic items has shifted the percentage of open space, but has not necessarily increased the actual quantum or quality. The area of public streets and parks as a percentage of the site together is the critical number. The loss of existing historic built form along Bunnerong road has removed a buffer to residential development and may increase the penetration of noise and related effects. The potential for communal and non-residential uses to activate the precinct as well as existing character would be lost.
This claim cannot be supported.

4

EVALUATION OF THE PROPOSAL



4.1 DRAFT COUNCIL MASTER PLAN

As part of the 2016 Urban Design Study a Draft Council Master Plan for Bayside Council was prepared by Hill Thalis, pictured left.

The plan provided a structure which reinforced and respected the heritage items which should be retained and re-worked to provide character and sense of place.

A wedge park was utilised to draw amenity and relief deep into the site as well as connect to the greater open space network being provided to the south.

Built form was distributed to respond to the structure, location of internal open space as well as open spaces beyond the site including Mutch Park and the golf course to the west.

The location of the wedge park biased to the east of the site locates the majority of built form away from the major traffic and noise pollution source along Bunnerong Road and allows for the creation of well proportioned and walkable blocks and local streets.

- New streets as detailed
- New park/open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished
- Built form heights and dimensions as noted

hill thalis

Note:All boundaries and setouts should be confirmed with survey

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4.1
Draft Council Master Plan
1:1500 @ A3

4.2 MERITON REVISED PROPOSAL

The Meriton Revised Proposal (Pagewood Green Stage 2 Master Plan) was developed subsequent to the Draft Council Master Plan, and is pictured left. For the purposes of this review the colours and graphic qualities have been modified to allow comparison between the plans.

Notable differences to the 2016 Preferred Master Plan include:

- The disconnection of the street network - resulting in a number of cul-de-sacs and building frontages without a street or lane;

- The relocation of the wedge park to the western half of the site, resulting in the majority or urban blocks being located closer to Bunnerong Road;

- The re-orientation of the wedge park from primarily north to north east with resultant overshadowing (detailed analysis in furthe rpages);

- The inclusion of above-ground podium parking, resulting in the loss of courtyards with deepsoil and an increase in bulk and diminished ability to provide through-block links;

- Clustering of similarly proportioned built form which may result in significant overshadowing and an inability to meet SEPP65 and Apartment Design Guide benchmarks.

Whilst the Revised Proposal provides a number of positive changes, several key strategies should be further revised to optimise and provide a best-practice urban exemplar. Please see section B for recommendations subsequent to the comparative analysis contained in the following pages.

- New streets as detailed
- New park/open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished

Built form heights and dimensions as noted

hill thalis

Note:All boundaries and setouts should be confirmed with survey

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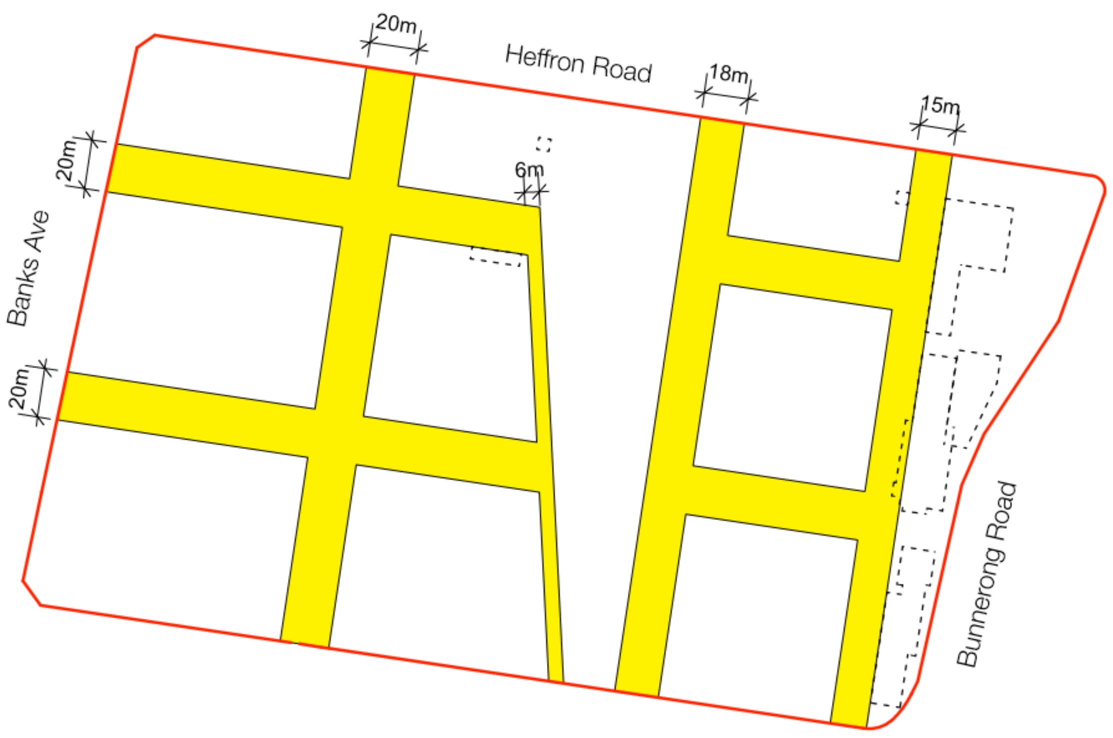
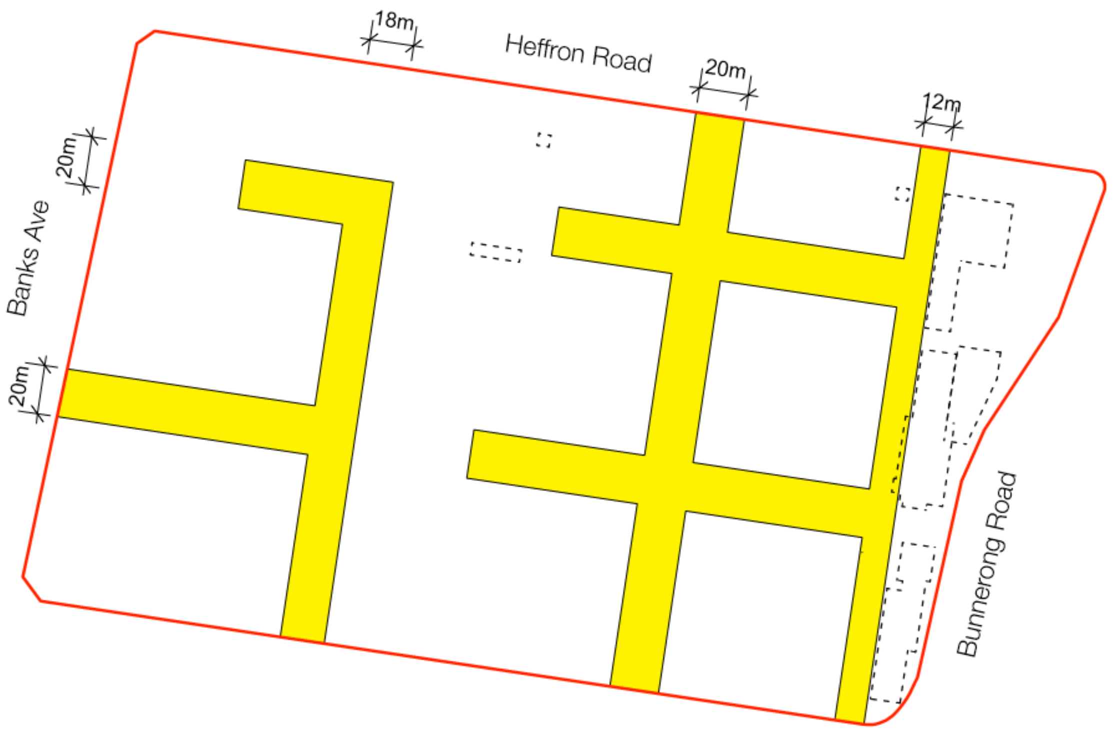
4.2
Meriton Revised Proposal
1:1500 @ A3



Draft Council Master Plan



Revised Proposal (Meriton)

4.3 PUBLIC STREET NETWORK

A Connected and distributed street network of local streets is essential to new urban places, offering a choice of wayfinding.

Street networks should not be predicated on a concentrated traffic model, rather a distributed and equitable hierarchy of street and lane types.

Should traffic control and mitigation be required, a number of strategies can be employed i.e left in, left out access - but this should not prevent the dedication of a holistic and integrated street network.

The Revised proposal provides an incomplete street network which leaves several blocks without adequate street address, particularly along the eastern edge of the central park.

Street and lane reservations should be provided along each block boundary, but may take the form of a share-way or traffic limited environment to suit the desired access in, out and around the site.

A concentration of limited entry and exit points should be avoided to prevent amenity impacts to any one area of the site.

The unfinished nature of the street network is unsupportable.

New street reservation

Heritage items shown dotted

hill thalis

Note:All boundaries and setouts should be confirmed with survey

Urban Design Assessment - BATA rezoning
8/11/17 Rev -
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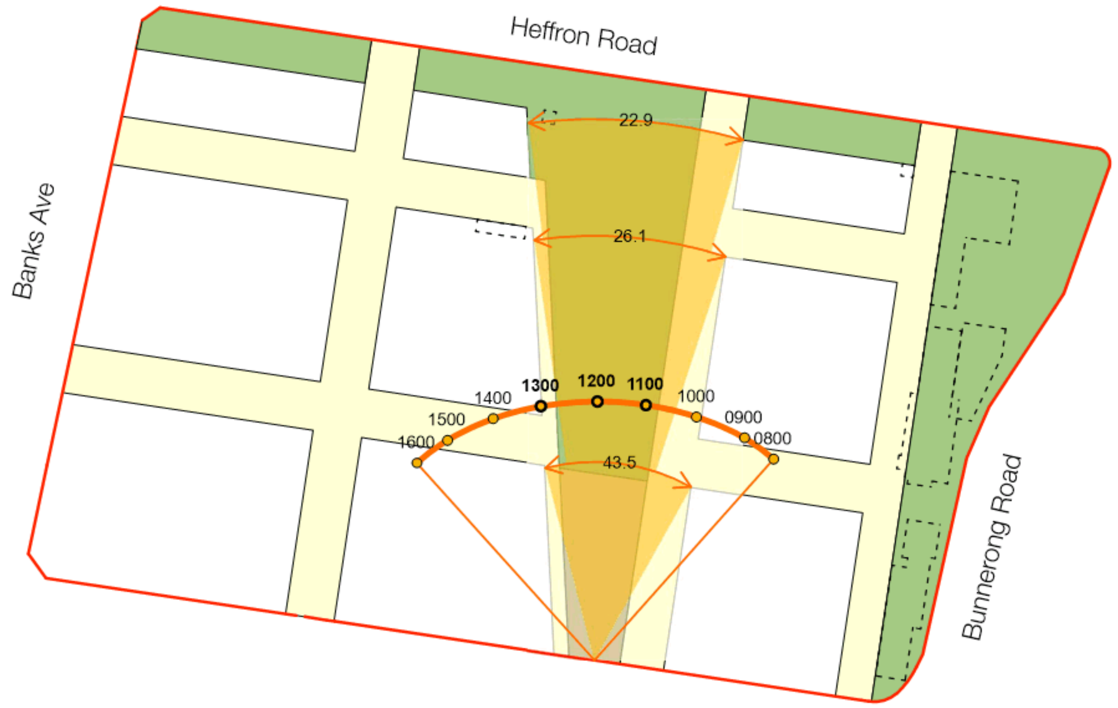
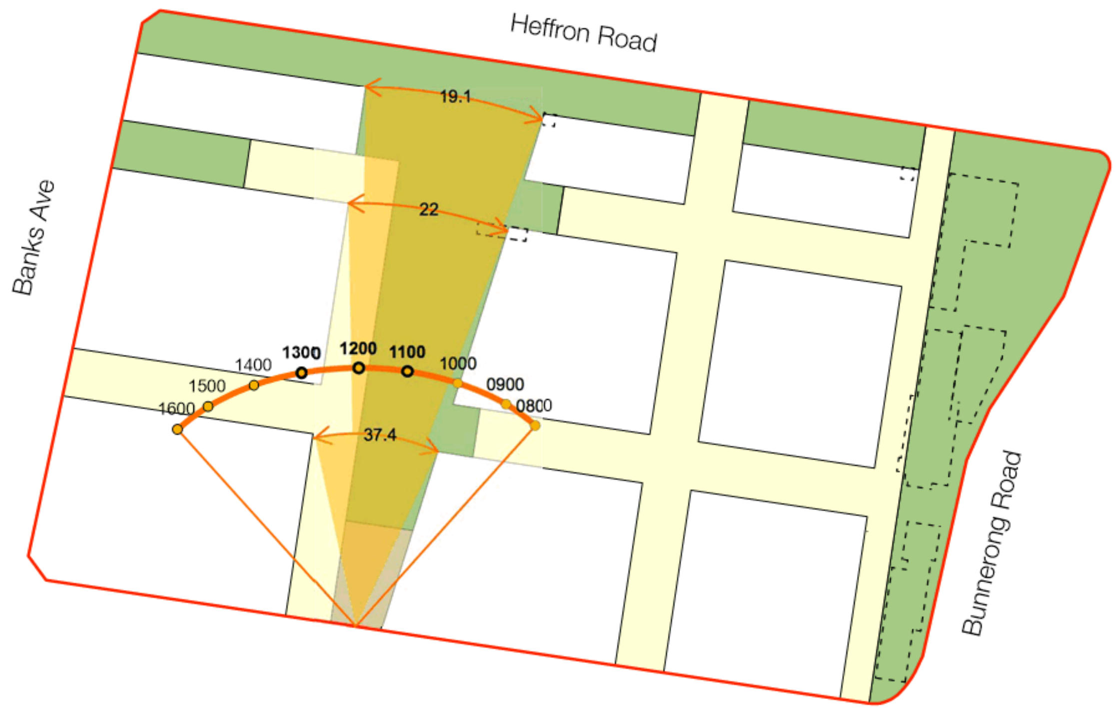
4.3
Public Street Network
1:2500 @ A3



Draft Council Master Plan



Revised Proposal (Meriton)

4.4 PARKS AND OPEN SPACE

Whilst the total area of streets and open space is comparable between the Draft Council Master Plan and the Revised Proposal, it is critical in dense urban environments that the clarity, orientation and proportion of these spaces maximise amenity and solar access.

The Revised Proposal provides for a wedge park that pulls open space deep into the site. The change in orientation from the Draft Council Master Plan provides less solar access in total due to its rotation further east of north (up to 14% less).

Importantly the more easterly orientation reduces the potential solar access to open spaces at the critical time between 11am and 1pm.

In order for public spaces to provide maximum amenity and relief in dense environments their orientation and proportion should be optimised to both time of day and season as well as adjacent built frontage heights and length of street-wall.

The definition and dedication of streets and open space in the Revised Proposal is confused. The deletion of street portions converted to pocket park detracts and confuses from the primary open space and increases the proportion of parks at the expense of streets.

New Street
New Park/Open Space
New square/plaza
All potential heritage items shown dotted

hill thalis

Note:All boundaries and setouts should be confirmed with survey

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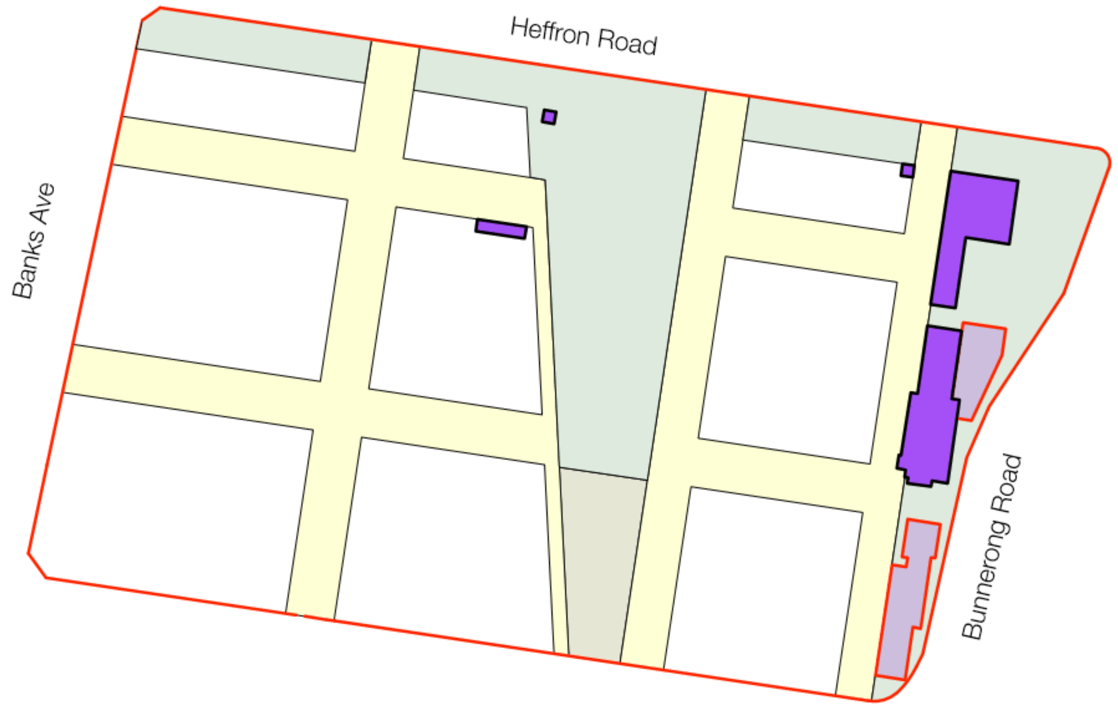
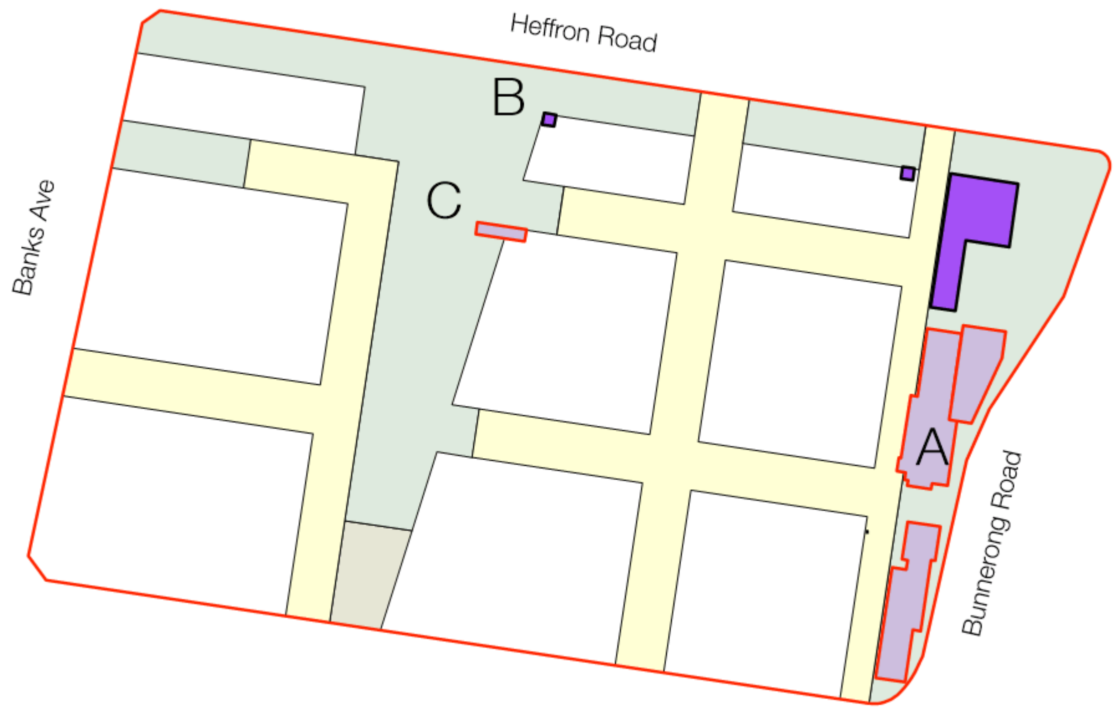
4.4
Parks and Open Space
1:2500 @ A3



Draft Council Master Plan



Revised Proposal (Meriton)

4.5 HISTORIC AND CHARACTER ELEMENTS

Retention of valuble existing built fabric and the way in which it is integrated is critical to establishing a character of place from day one.

The Revised Proposal treats historic elements differently to the preferred Master Plan in a number of ways:

- The number and presence of heritage items along the Bunnerong Road frontage is greatly reduced (A). This limits the presence and understanding of the buildings as an ensemble and representation of use of the site over time.

The resultant new park is thin in proportion and not redily useable. It is also adjacent to significant traffic on Bunnerong Road. This historic fabric should be maintained to provide a buffer to traffic and also allow activation to the lane as well as a variety of potential mixed, retail or community uses to enliven the precinct, which are better suited to the Bunnerong Road frontage;

- Remnant built form in the centre of the site has differing/diminished relationships to the open space. Where smaller footprint elements are better suited as objects in the round and facades integrated into new development, the Revised Proposal reverses this.

The approach adopted by the Revised Proposal to integrate the small footprint elements (B) into new built form risks them being less recognisable. These elements should be considered 'free' and linked to any new built form only lightly.

Broader facade elements (C) should be maintained, but are best integrated into new built form. Retaining these elements in open space reduces the sight lines along and through the open space and prevent a coherant public edge to the park.

The strategy of retention and interface with heritage items is not optimal.

- New Street
- New Park/Open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished

hill thalis

Note: All boundaries and setouts should be confirmed with survey

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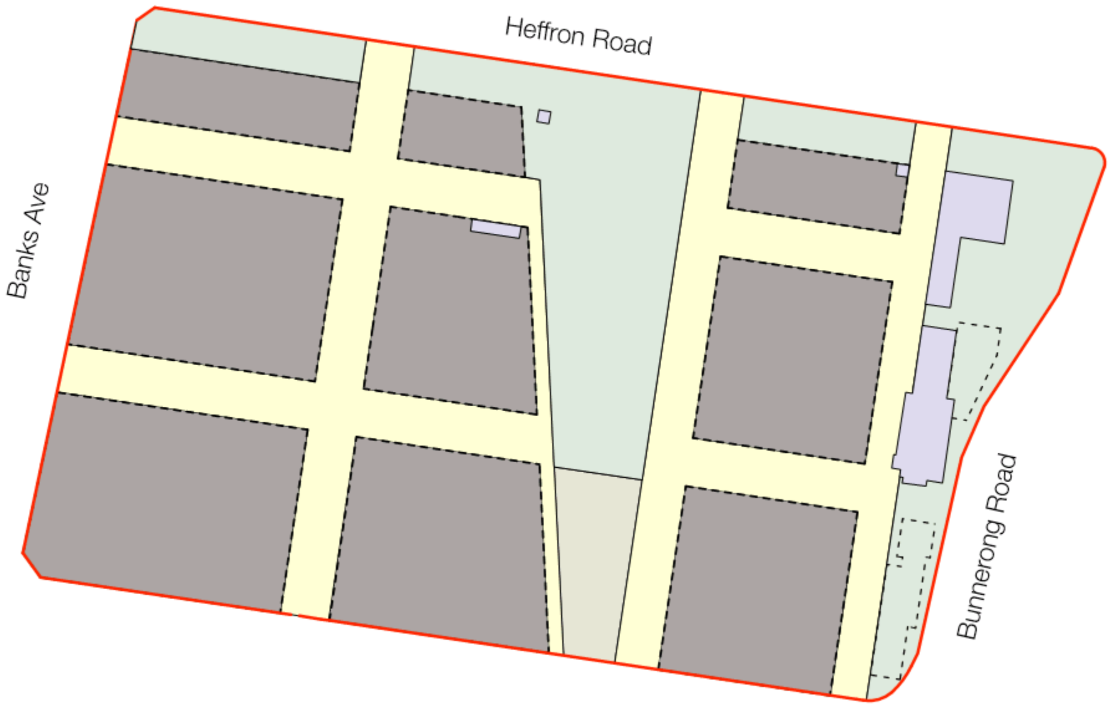
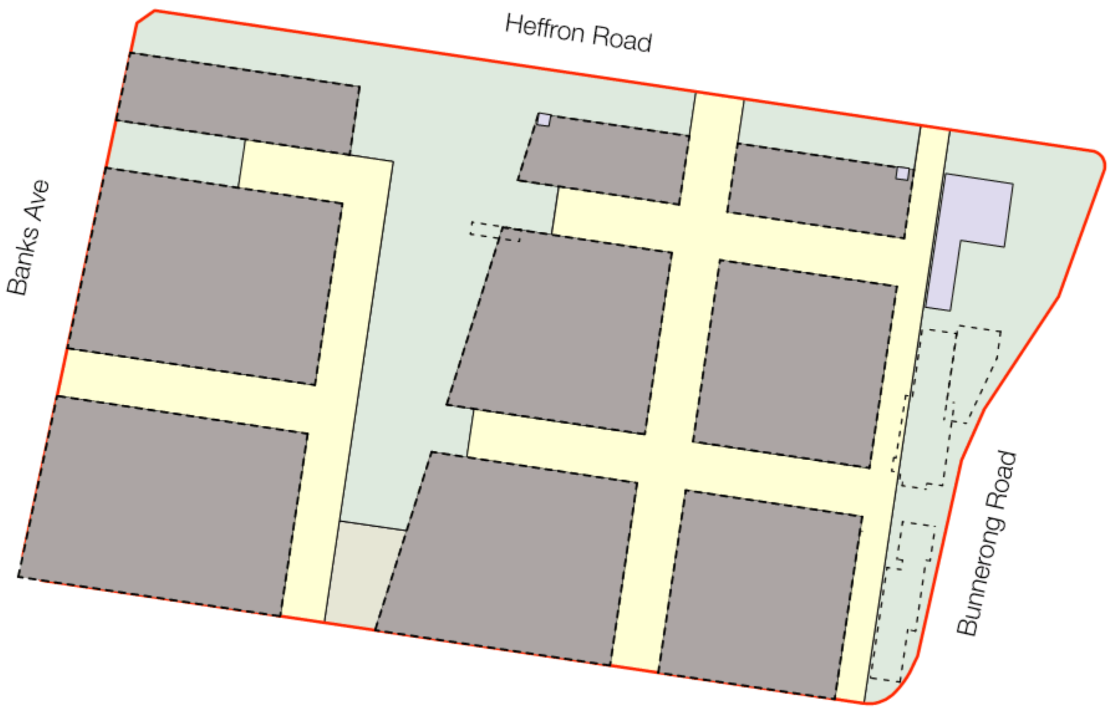
4.5
Historic and Culture Elements
1:2500 @ A3



Draft Council Master Plan



Revised Proposal (Meriton)

4.6 URBAN BLOCKS

Whilst the area of urban blocks is similar, their distribution, orientation and frontage is critical to providing urban amenity and address.

The primary sources of amenity are the new wedge-park and existing Mutch Park and golf course to the west. A significant source of noice and air pollution from Bunnerong Road should be mediated by biasing development away from this source.

The Revised Proposal locates the majority or urban blocks in the eastern half of the site - further away from the major sources of amenity to the west, but closer to Bunnerong Road.

The location of blocks is not optimal.

- New Street
- New Park/Open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished shown dotted
- Proposed urban blocks

hill thalis

Note: All boundaries and setouts should be confirmed with survey

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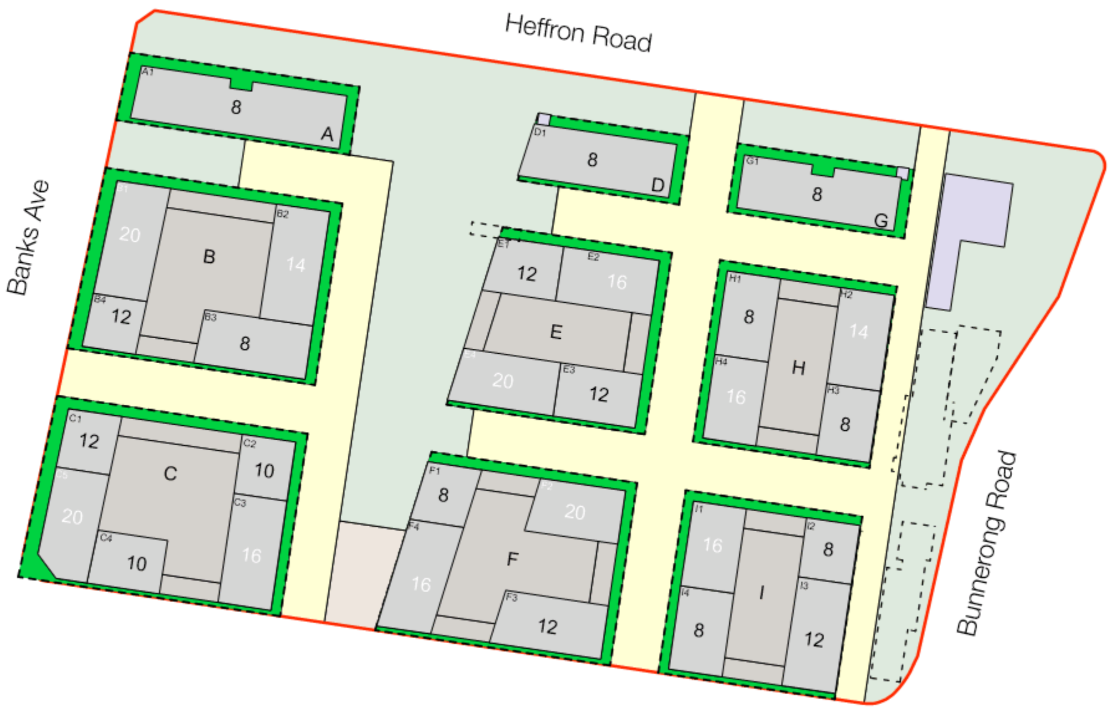
4.6
Urban Blocks
1:2500 @ A3

Draft Council Master Plan

Note: Built form in this plan is updated and takes account of the higher yields sought by Meriton's review of the Draft Council Master Plan. Please see section 5.3 for recommendations



Revised Proposal (Meriton)

4.7 DISTRIBUTION OF BUILT FOR LOWER LEVELS

Urban blocks should supplement the landscape of streets and open spaces with courtyards and unimpeded deep soil zones.

Increased density and the loss of private open space must be supplemented with significant vegetation for environmental benefit, amelioration of urban heat island effect, privacy as well as mental and physical health.

Courtyards and landscape at ground provide for infiltration of stormwater, options for through-block links as well as significant mature vegetation.

The revised proposal proposes above ground parking causing the loss of all central courtyards.

Recent developments of a similar scale in the immediate vicinity, as well as eastern Sydney generally, have provided basement parking with deep soil as an integrated approach.

There appears no valid reason to deviate from the preferred approach, and any proposals should provide deepsoil zones, unimpeded, in line with SEPP65, the ADG and Council policies - as a minimum.

- New Street
- New Park/Open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished shown dotted
- Proposed built form footprints
- Potential deep soil landscape

hill thalis

Note:All boundaries and setouts should be confirmed with survey

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4.7

Distribution of Built Form - lower

1:2500 @ A3

Draft Council Master Plan

Note: Built form in this plan is updated and takes account of the higher yields sought by Meriton's review of the Draft Council Master Plan. Please see section 5.3 for recommendations

Revised Proposal (Meriton)

4.8 DISTRIBUTION OF BUILT FOR UPPER LEVELS

The orientation, depth and distribution of taller built forms must be carefully balanced to provide amenity within dwellings, between buildings and to streets and open spaces adjoining.

The revised proposal locates significant built form in an east-west arrangement which creates overshadowing and compression. Block E and F are of particular concern.

The orientation of built form north to south along its longest edge provides for faster moving shadows and deeper penetration of sunlight into blocks and courtyards, particularly in winter.

In this case, the orientation of taller elements north to south provides better orientation to the central open space.

To further limit the over-shadowing impacts of taller elements a limit to the 750sqm maximum gross footprint of towers should be enforced.

Limiting the footprint of towers provides additional breaks between buildings in a more slender proportion, reduces bulk at the street level and from beyond the site, and may allow an increase in the overall number of towers achievable.

The Revised Proposal has not coordinated the number, orientation or separation of taller elements in a cohesive manner which maximises amenity and reduces impacts of bulk and appearance.

The built form proposed is not supported.

- New Street
- New Park/Open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished shown dotted

Built form heights and dimensions as noted

hill thalis

Note: All boundaries and setouts should be confirmed with survey

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4.8

Distribution of Built Form - Upper

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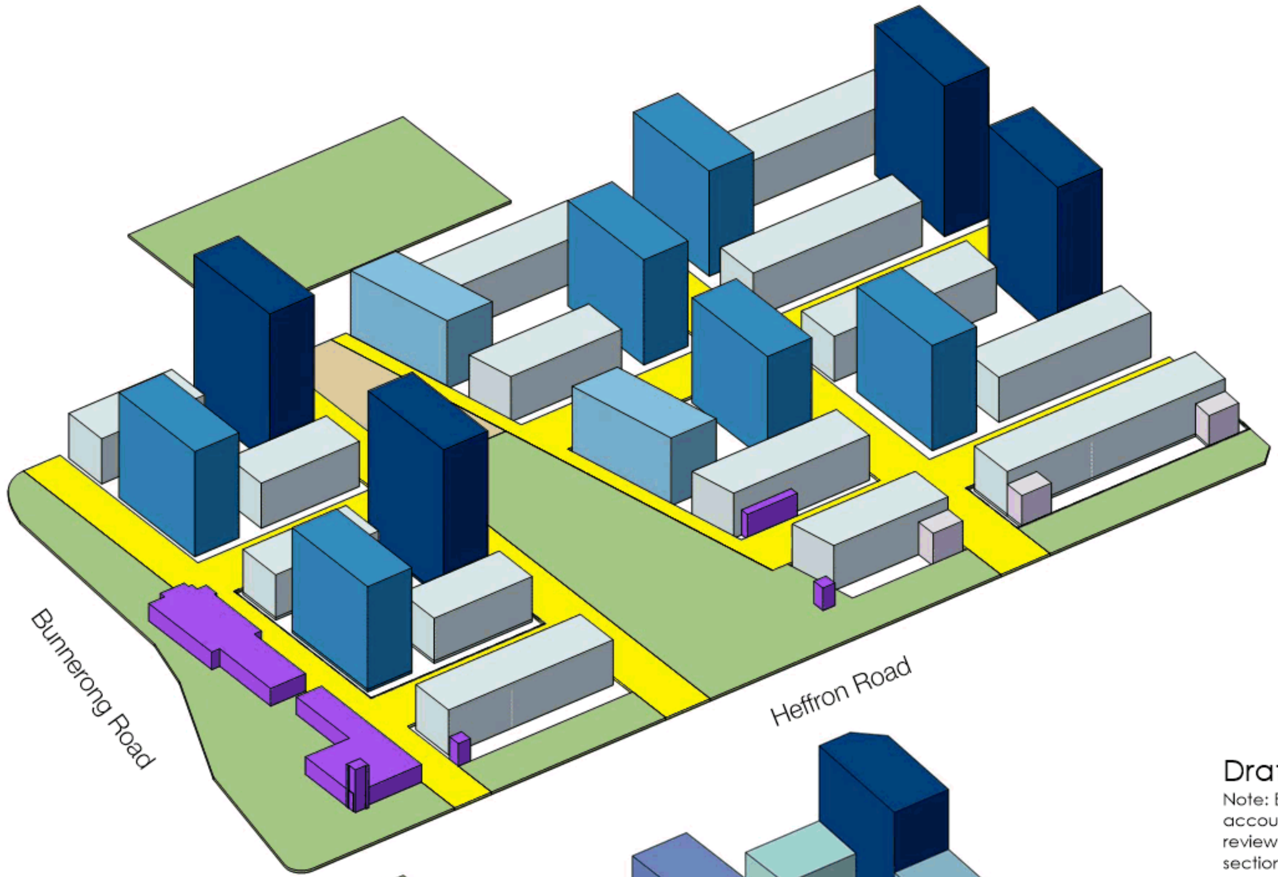
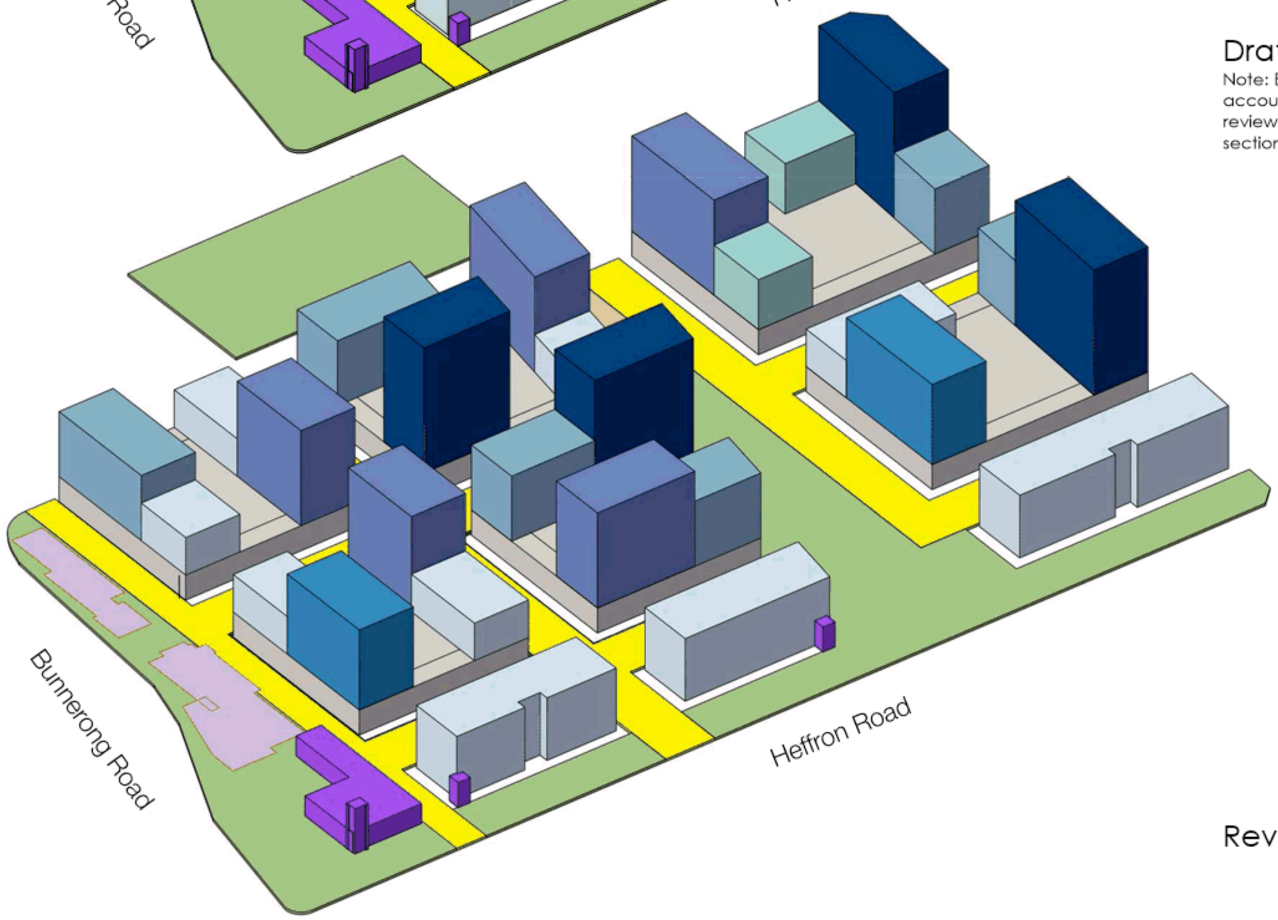


Draft Council Master Plan

Note: Built form in this plan is updated and takes account of the higher yields sought by Meriton's review of the Draft Council Master Plan. Please see section 5.3 for recommendations



Revised Proposal (Meriton)

4.9 MASSING AND BULK

The distribution and orientation of built form should be calibrated to maximise residential amenity and to provide a high degree of openness to streets and open space - avoiding aggregated bulk.

The clustering of built form within the Revised Proposal is claustrophobic and impacts highly on the availability of solar access to the public domain and dwellings at lower levels - particularly in the centre of the site.

The north south orientation and less concentrated distribution of the taller elements in the Draft Council Master Plan affords greater separation between towers for outlook, solar access and privacy as well as solar access around buildings to streets and open spaces as well as central courtyards.

- New Street
- New Park/Open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished

Built form heights and dimensions as noted

hill thalis

Note: All boundaries and setouts should be confirmed with survey

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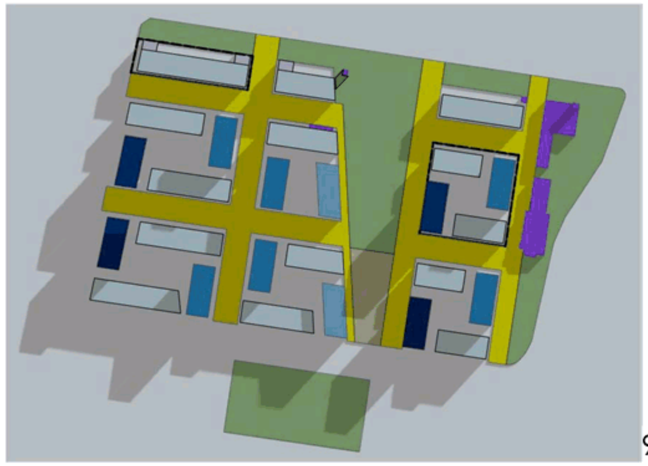
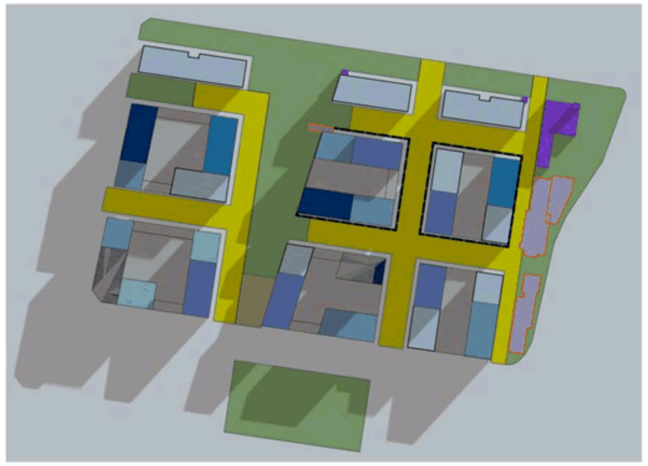
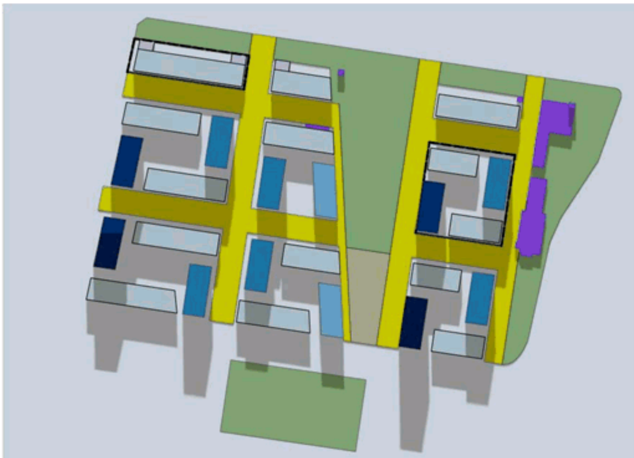
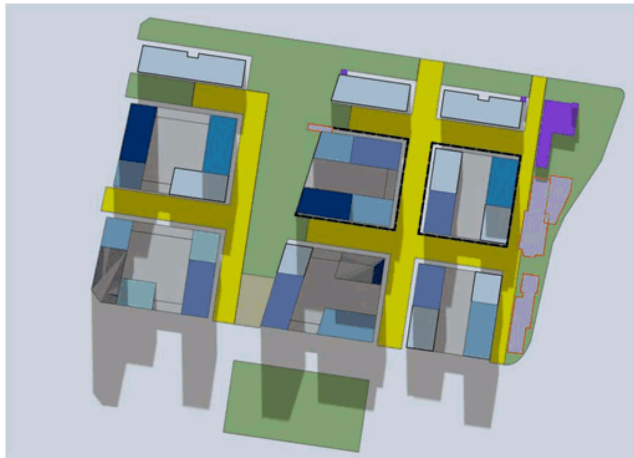
4.9
Massing and Bulk
1:2000 @ A3

9am, June 21

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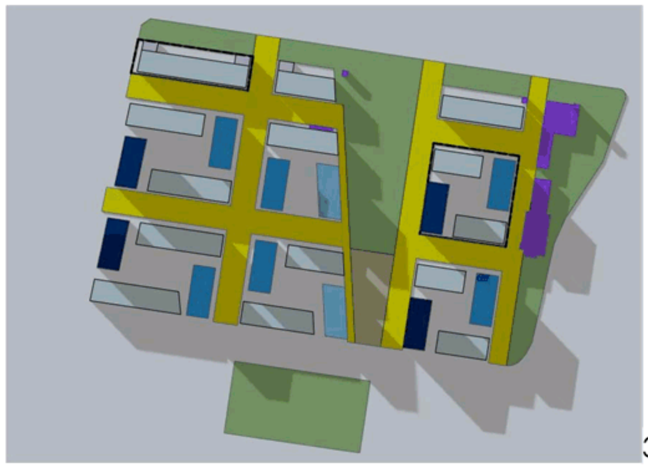



3pm, June 21

Draft Council Master Plan

Revised Proposal (Meriton)

4.10 SOLAR ACCESS AND OVERSHADOWING

Solar access across the public domain, within blocks and around built form is critical to providing amenity within dense urban environments.

The built form proposed in the Revised Proposal shows significantly increased over-shaddowing impacts on the central park, streets and adjacent park in stage 1 to the south.

This increase in overshadowing should be mitigated by providing an orientation such as that in the Draft Council Master Plan.

- New Street
- New Park/Open Space
- New square/plaza
- Heritage item retained
- Heritage item demolished

Built form heights and dimensions as noted

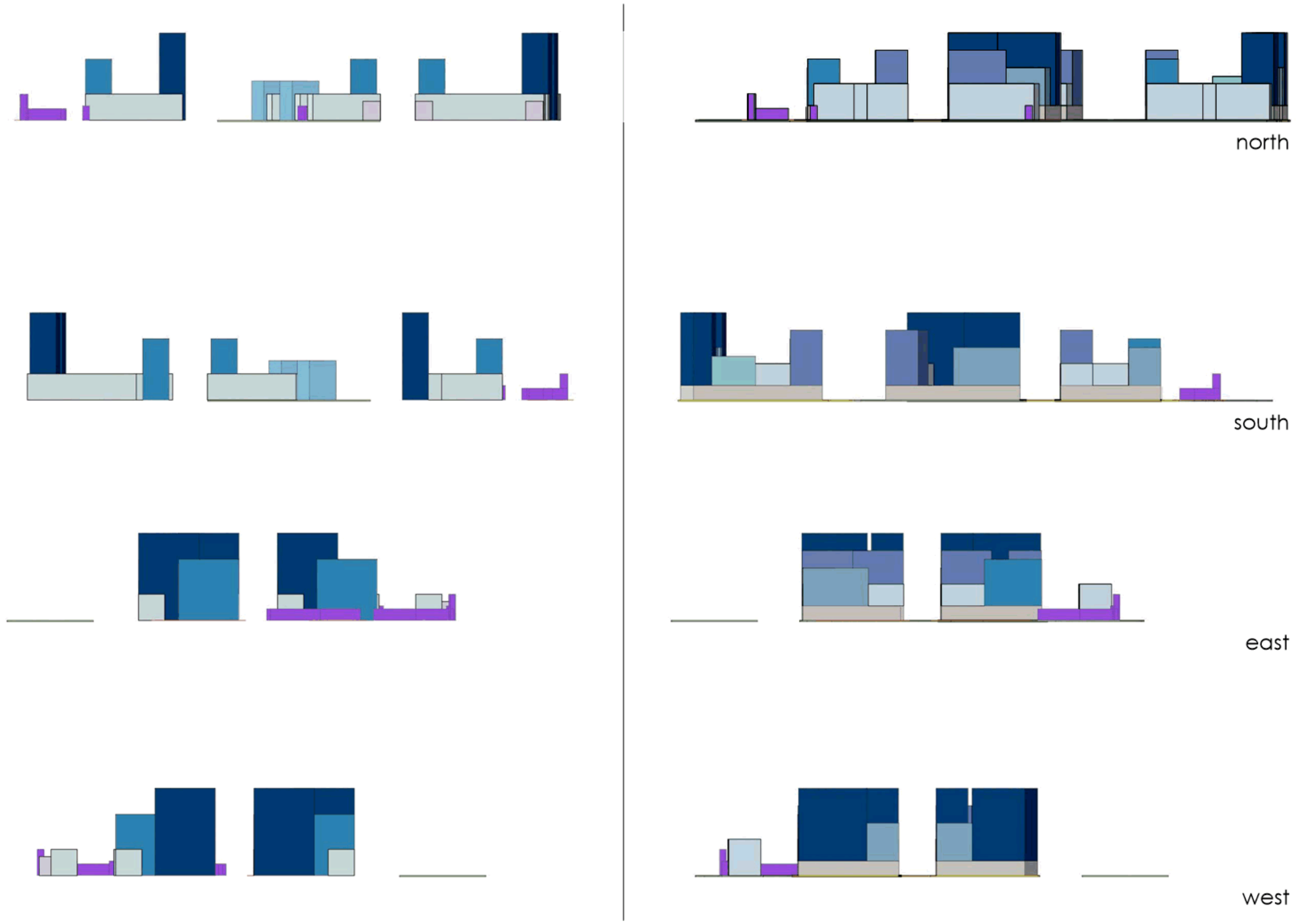
hill thalis

Note: All boundaries and setouts should be confirmed with survey

Urban Design Assessment - BATA rezoning
8/11/17 Rev -
for Bayside Council

4.10
Solar Access and Overshadowing
1:5000 @ A3

4.11 BUILT FORM DISTRIBUTION



Draft Council Master Plan

Revised Proposal (Meriton)

The appearance of significant built form within the city when approaching and passing the site is a critical consideration.

The built form distribution of the Revised Proposal demonstrates a consistently denser and illegible elevation of built form.

The arrangement of built form should provide regular and meaningful breaks between taller elements to provide relief at the immediate, local and city-scale.

The aggregation of building bulk directly affects the amenity of residential environments.

Equitibly distributing taller elements provides for greater prospect and longer views, increased visibility of sky and sunlight and ventillation through blocks, particularly at lower at lower levels.

The aggregation of bulk will make satisfaction of SEPP65 and Apartment Design Guide objectives more difficult, resulting in less urban and residential amenity.

hill thalis

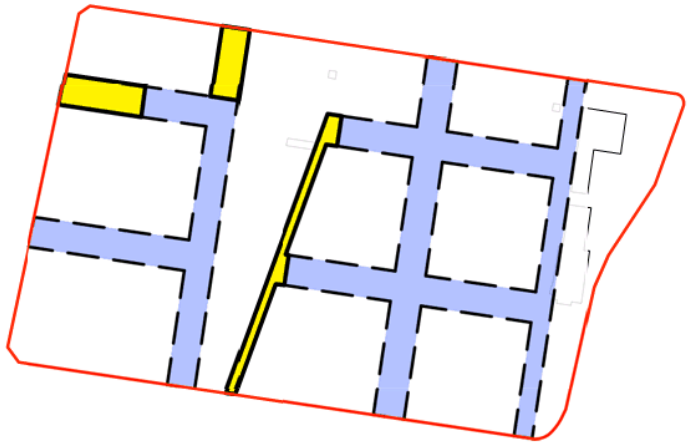
Note:All boundaries and setouts should be confirmed with survey

Urban Design Assessment - BATA rezoning
8/11/17 Rev -
for Bayside Council

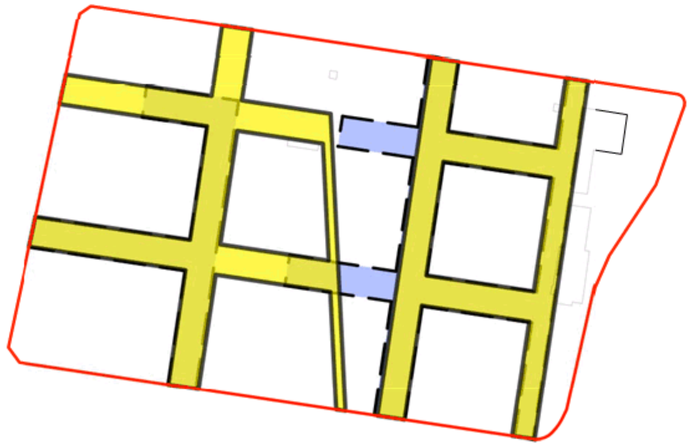
4.11
Macro Elevations
1:3000 @ A3

5

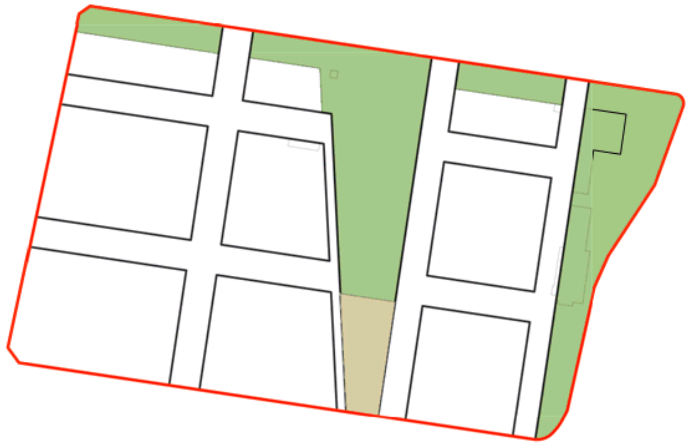
RECOMMENDATIONS



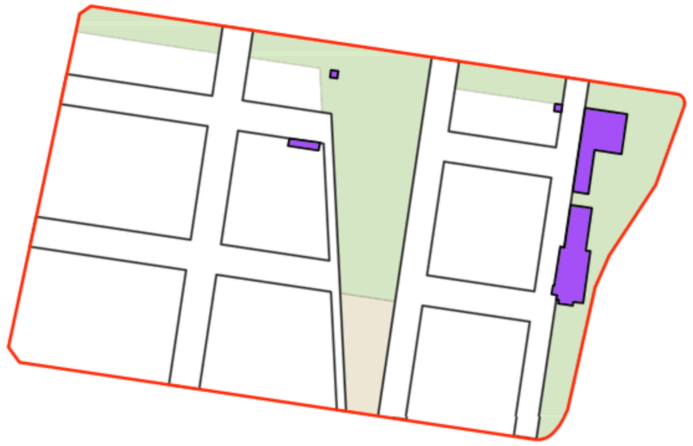
1. Complete the public street network
Revised Meriton street nework shown blue



2. Orient the public street network to optimise solar access to public spaces



3. Make defined public parks and places



4. Retain and adapt additional historic element

5.1 PUBLIC DOMAIN STRUCTURE RECOMMENDATIONS

1 Complete the public street network

Complete the network of street reserves to form a complete and coherent network with no dead-ends, dedicated to Council. The definition of this network is primary to any traffic requirements which can be accommodated through design of the public domain within the holistic and connected network of reserves.

Whilst some streets may not allow traffic in some portions now, it is important the network is connective and flexible over time.

2 Orient the public street network to optimise solar access to public spaces

Orient the public domain structure to maximize the amenity of open spaces and primary street frontages at key times in the day and throughout different seasons. This should include solar penetration to public spaces between 11am and 2pm in mid winter, and courtyard spaces open to north-east to capture the prevailing breeze for cooling in summer.

3 Make defined public parks and spaces

Define public open spaces with a connective street network.

Balance the arrangement of streets, blocks and open space so that the majority of new buildings are located to the west of the site - away from the noise and pollution of Bunnerong Road, and between the new wedge park and the amenity of Bonnie Doon Golf Course and Mutch Park.

4 Retain and adapt additional historic and character elements

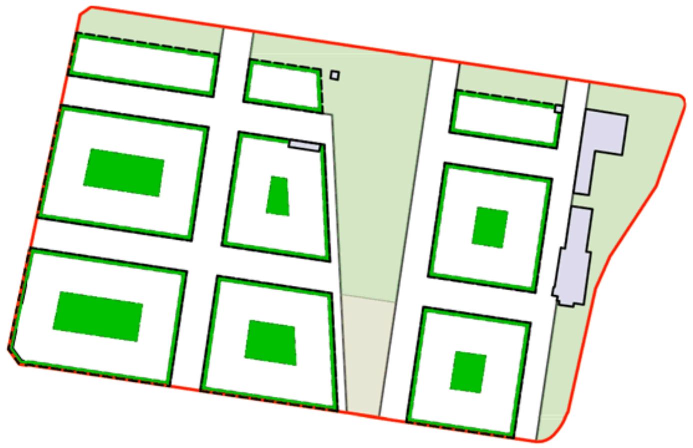
Retain, integrate and adapt as many existing buildings to maintain character, allow for non-residential and community uses and provide a buffer between Bunnerong Road and new residential development.

hill thalis

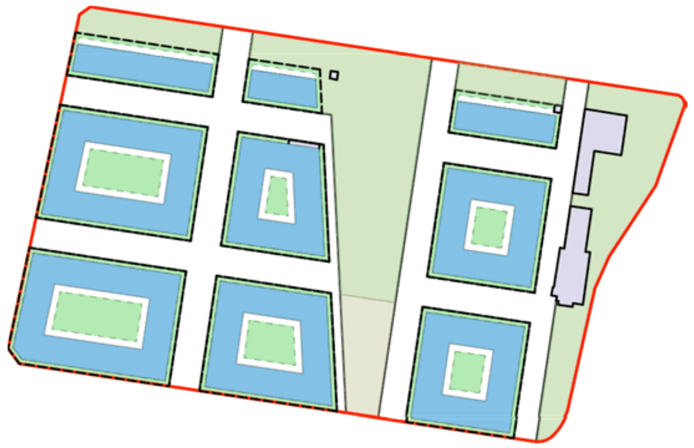
Note:All boundaries and setouts should be confirmed with survey

Urban Design Assessment - BATA rezoning
8/11/17 Rev -
for Bayside Council

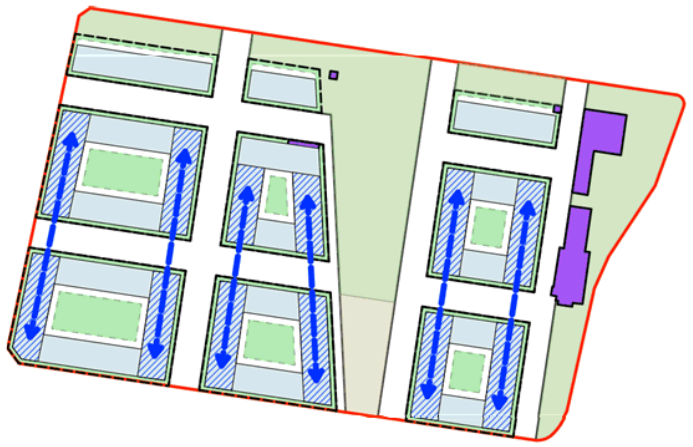
5.1
Recomendations - Public Domain
1:1500 @ A3



1. Integrate basement footprints to provide for unimpeded deep soil zones



2. Provide a street-based perimetre block type response at lower levels



3. Align and offset tower elements north-south to minimise overshadowing to the public domain and within blocks

4. Offset tower forms and create breaks to provide amenity, variety, outlook and relief

5.2 BUILT FORM RECOMMENDATIONS

1 Integrate basement footprints to provide for unimpeded deep soil zones

Provide an arrangement within blocks which integrate car parking in basements primarily under built footprints that maximize unimpeded deep soil.

Provide significant landscape (large trees) at ground level to provide amenity, privacy and through block link opportunities.

Design central courtyard landscapes to provide environmental benefits such as relief of urban heat island and stormwater cleansing and catchment management.

2 Provide a street based perimetre block type response at lower levels

Limit the depth of perimeter block building envelopes (gross) to a maximum18m to provide adequate separations and maximize opportunities to meet and exceed SEPP65 and ADG requirements.

Provide well located breaks in built form to limit the visual bulk along streets and provide glimpses into landscaped courtyards.

3 Align tower elements north-south to minimise overshadowing to the public domain and within blocks

Locate taller elements in a generally north-south orientation to limit the overshadowing impacts to other buildings and the public domain.

Distribute taller elements throughout the site with reference to amenity and park frontage to maximize the number of apartments receiving park and district views.

4 Offset tower forms and create breaks to provide amenity, variety, outlook and relief

Limit the footprint of all elements taller than 6 storeys to 750m2 (gross) to provide visual relief, cross ventilation and solar penetration around and between towers.

Avoid clustering tall elements to prevent compression and overshadowing. Allow for relief and contrast so towers read as free elements.

5.3 PEER REVIEW MASTER PLAN RECOMMENDATIONS

This peer review takes account of the higher yields sought by Meriton's review of the Draft Council Master Plan and recommends:

- That the planning proposal as submitted should be revised to accord with the plan illustrated, left;

- That all streets (yellow) and parks (dark green) be dedicated to Council;

- That consistent street alignments and setbacks be provided througout;

- That street frontages within each block provide a range of built form heights with clear unobstructed breaks between buildings;

- An increased maximum gross FSR of 2:1;

- That the maximum heights be distributed in accordance with the plan, left.

- Maximum building envelope depths of 18m;

- That all blocks should have deep soil planting to accord with the ADG (unimpeded);

- No above ground car parking be permitted, with visitor parking predominantly on street.

The adoption of the forementioned recommendations has the ability to create a best-practice model for urban renewal sites in Sydney.

Any revised proposal should be supported only through the demonstration of best practice urban design and architectural quality in line with Better Placed, SEPP65, Apartment Design Guide and other critical policies.

New Street
New Park/Open Space
New square/plaza
Heritage item retained
Deep Soil Zones within blocks (no basements below)

Built form heights and dimensions as noted

MERITON

23 May 2019

Ms Clare Harley
Manager Strategic Planning
Bayside Council
446-446 Princes Highway
ROCKDALE NSW 2216

Dear Ms Harley

PLANNING PROPOSAL – 128 AND 130-150 BUNNERONG ROAD, PAGEWOOD

Further to our meeting on 17th May 2019, and follow up email from Ms Lowe on the same date, we provide the following response to the recommendations made by the Bayside Local Planning Panel following its consideration of the Planning Proposal on 30th April 2019.

Concept Design / Comparison

As requested, please find attached a package of drawings that provide a Revised Scheme at 2.35:1 that has adopted additional levels of basement car parking (note – 2-3 basement levels is the maximum before there are issues with acid sulphate soils etc), reduction of podium heights, and increased articulation of building height the across the site.

Importantly, the reduction of podium level parking has reduced the mass at street level and allowed the design to introduce more building height articulation on the tower forms. As per page 2 of the package it is also important to note that while the plans (at this stage) are presented as envelopes, consistent with the ADG, the actual future built form will be about 25% smaller.

The comparison on page 3 demonstrates that the suggestion by the BLPP that a reduction in FSR to 2:1 to mitigate impacts such as overshadowing, bulk and scale is not necessary. The attached package demonstrates that these matters have been addressed via the Revised Scheme and only marginal improvement is achieved by the reduction in the density. For instance:

- The Revised Scheme achieves better height articulation in the podium and tower forms
- The Revised Scheme achieves a reduced street wall height similar to the 2:1 scheme
- The Revised Scheme maintains height variations from 2 to 20 storeys with a range of dwelling types (note - the Hills Thallis Scheme was from 6/7 to 20 storeys and had the same number of taller towers than the Revised Scheme)
- The Revised Scheme has substantially increased the solar access to public open space across the site in the winter solstice by 15% (to an 69% of open space with 3hours or more direct sunlight) while the 2:1 scheme only achieves 70% (or a further 1.5%). This increases to 83% of all public open space that receives more than 2hours of direct sunlight.

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- The Revised Scheme has substantially increased the solar access to Central Park in the winter solstice by 23.6% (to 68% with 3hours or more direct sunlight) while the 2:1 scheme only achieves a further 2.9%. This increases to 88% of the Central Park that receives more than 2hours of direct sunlight.
- The revised Scheme will allow for a range of architectural outcomes as demonstrated on Page 8 and 9. The design excellence strategy will allow for high calibre architects to be given the flexibility

Accordingly, we would maintain that the endorsed FSR can be retained while addressing the key matters raised by the BLPP.

Open Space

As per page 6 and 7 of the Annexure A, the proposal will add 3ha of public open space to the 25ha of open space within an 800m catchment of the site and exceeds all relevant standards for the provision of and access to open space. This is complimented by the substantial access to direct sunlight demonstrated above. This means that the site will be providing more open space then required and the local community will receive a 12% increase in available public open space which has been integrated into the design as per the Council's design advice to provide a visual and recreational link from Jellicoe Park through the site to the Eastgardens shopping centre.

Please advise should you require anything further.

Yours faithfully
MERITON GROUP

Matthew Lennartz
Executive Manager – Planning and Government

Encls.

SJB Architects

Pagewood
BATA 2
Council response 2

23-05-2019

Prepared for
Meriton

Issued
23 May 2019

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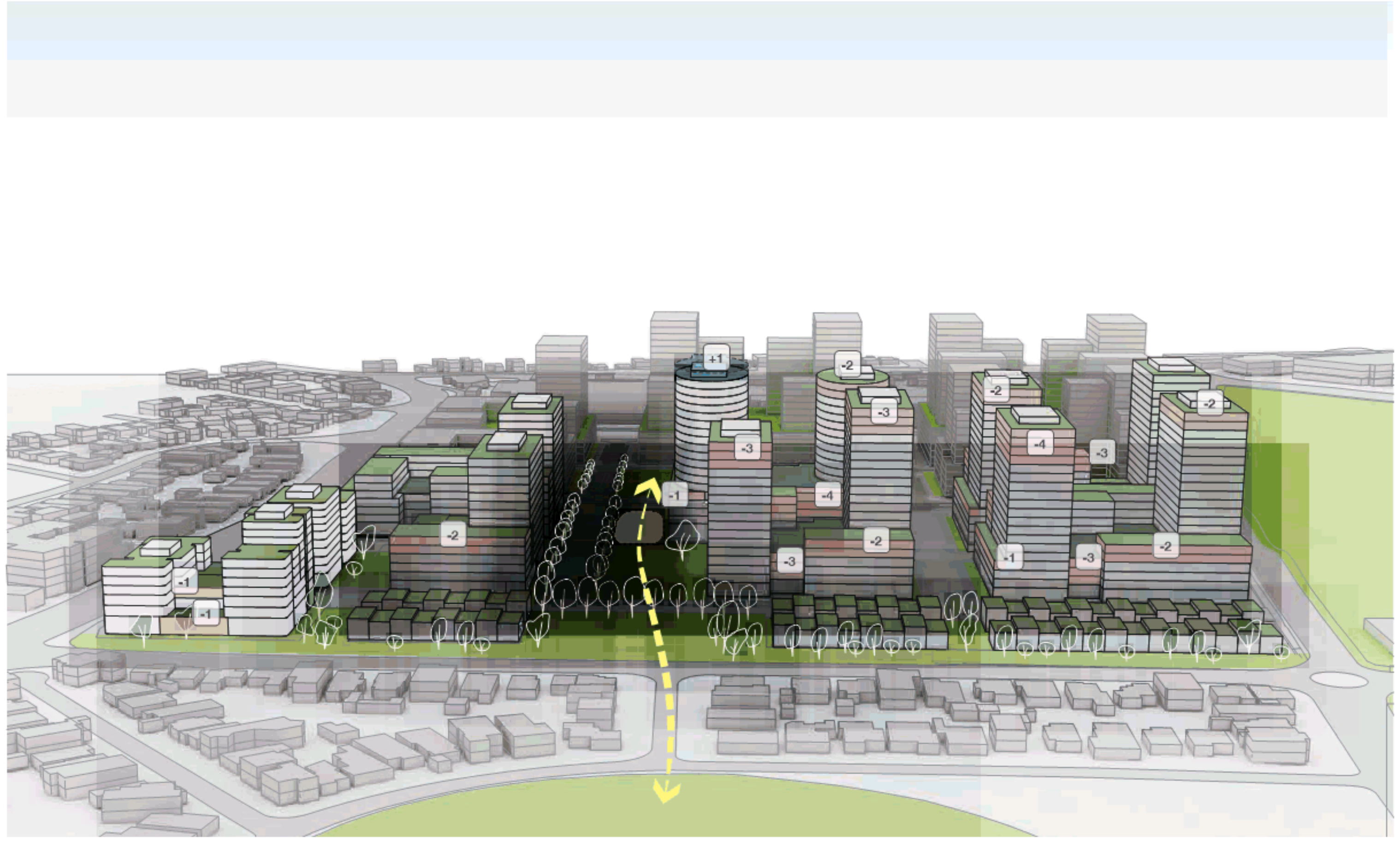
Revised concept retaining proposed FSR (2.35:1)



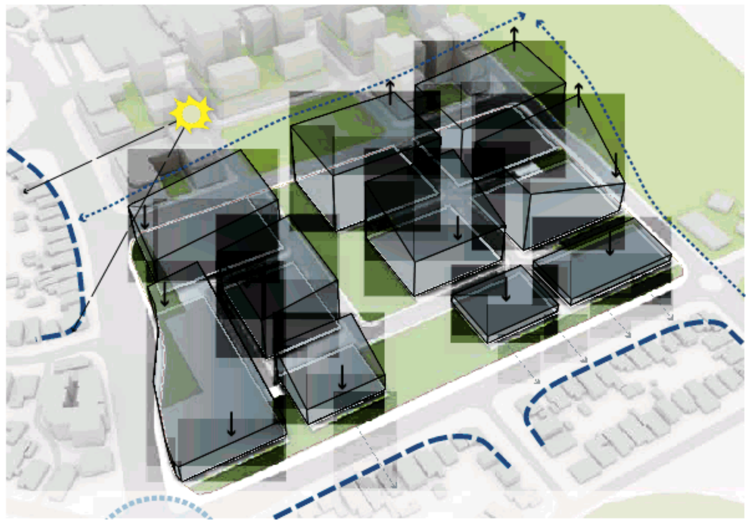
Proposed changes to massing

The diagram above shows proposed changes to the massing of a 2.35:1 scheme that improves height variation, reduces the overall bulk and scale, and allows goods solar access to the surrounding buildings and open space. This increase in variation and the reduction to visual bulk of the building envelope is acheived through changes to the car parking, adding underground basements instead of podium carparking.

Importantly, the proposed scheme is a representation of the built form envelope. The final built outcome will be 75% of the mass that is shown here. This will further reduce the visual bulk and scale, with a more articulated and varied form.

Key

- Levels reduced by introducing below ground car parking
- Added level to achieve greater variation in height accross the site
- Public Open Space



Principle of height transition (UDF)

The Urban Design Framework (UDF) reinforces the principle of transition in building heights diagonally from the south-western corner to the north-eastern corner to ensure minimal overshadowing to the surrounding context and to maximum solar access to open space.

Key

- Residential Interface
- Public Open Space
- Site Boundary

Masterplan Review for Council by Hills Thalis, 2017. With building heights ranging from 6 to 20 storeys

Revised concept options

Original concept with 2.35:1 FSR

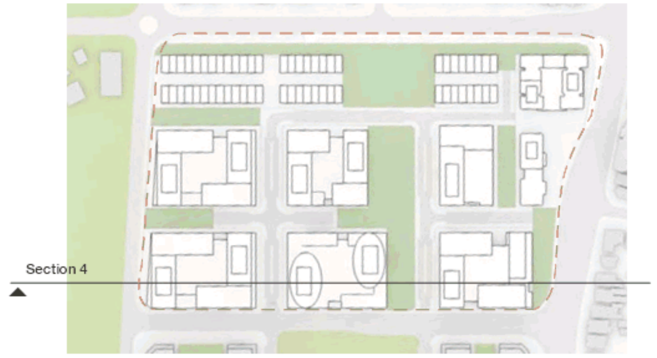
Key Data:
- GFA = 210,490sqm
- 20,208sqm public open space
- 60% Solar access to open space for more than 3 hours or more
- Building heights vary from 2 storeys to 20 storeys
- Podium car parking integrated into development

Revised concept with 2.35:1 FSR

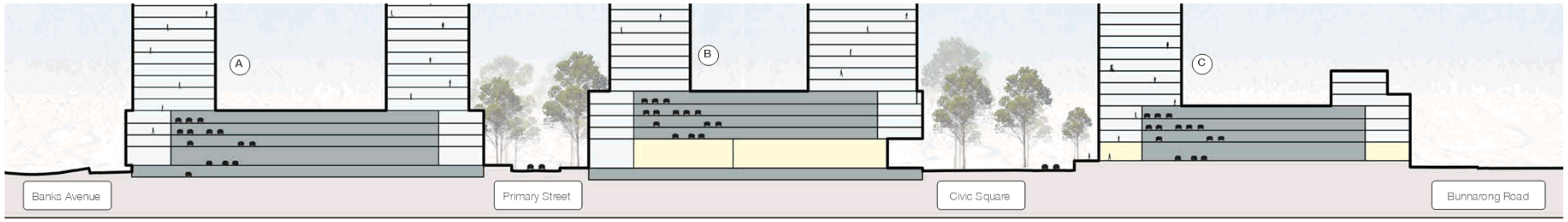
Key Data:
- GFA = 210,490sqm
- 20,208sqm public open space
- 69% Solar access to open space for more than 3 hours
- Building heights vary from 2 storeys to 20 storeys
- Basement and podium car parking integrated into development
- VPA/Affordable housing offer maintained

Revised concept with 2:1 FSR

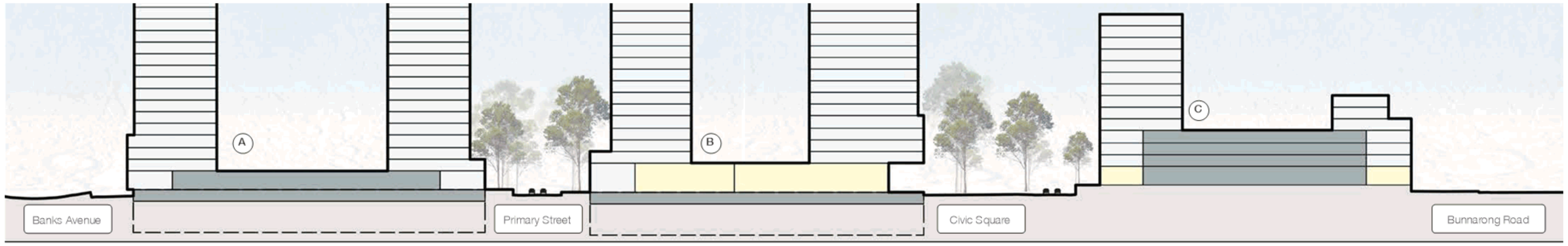
Key Data:
- GFA = 179,140sqm
- 20,208sqm public open space
- 70% Solar access to open space for more than 3 hours
- Building heights vary from 2 storeys to 20 storeys
- Basement and above ground car parking integrated into development
- VPA/Affordable housing offer reduced



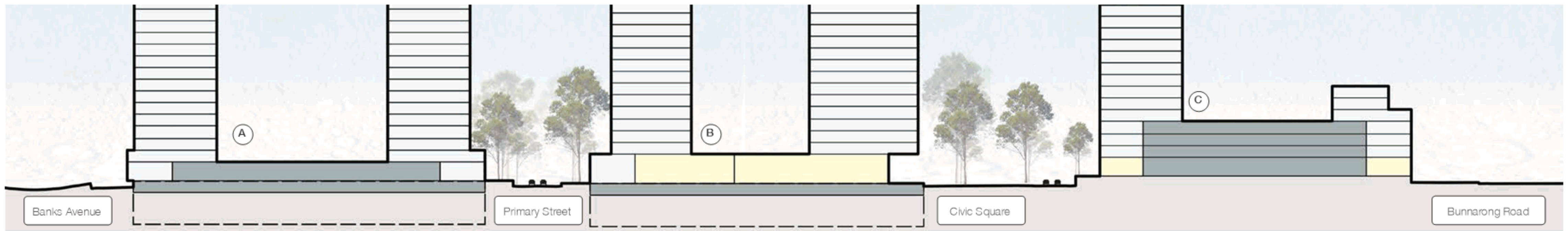
Site sections



Section 2.35:1 (Original Scheme)



Section 2.35:1 (Revised Scheme)



Section 2:1

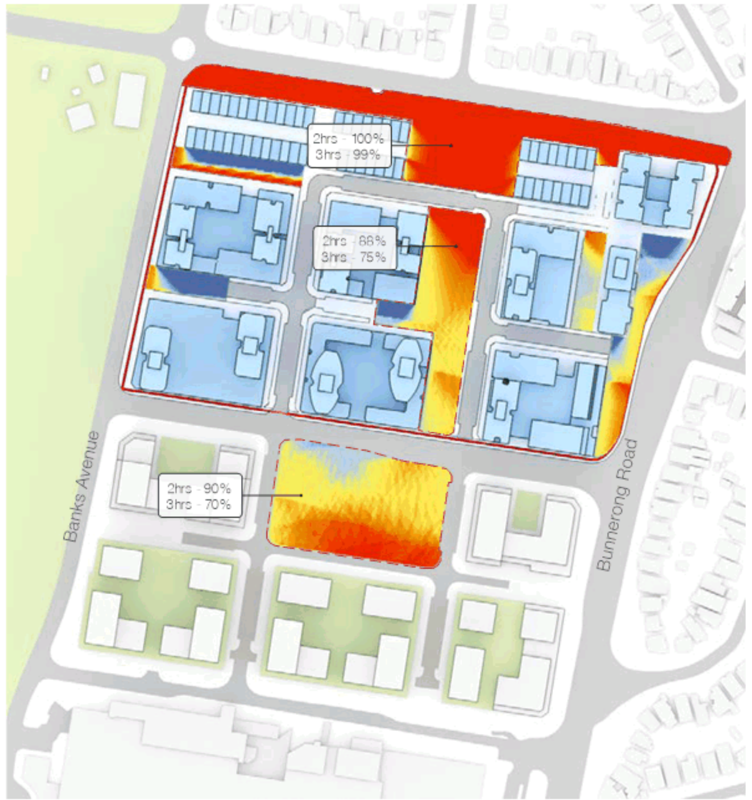
Access to public open space

Solar Insolation - 2.35:1 Original Scheme

Overall 78% of the public realm receives more than 2 hours of sunshine on the winter solstice, while 60% receives more than 3 hours of sunshine.

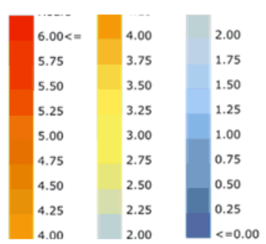
Solar Insolation - 2.35:1 Revised Scheme

Overall 83% of the public realm receives more than 2 hours of sunshine on the winter solstice, while 69% receives more than 3 hours of sunshine.



Solar Insolation - 2:1 Scheme

Approximately 85% of the public realm receives more than 2 hours of sunshine on the winter solstice, while 70% receives more than 3 hours of sunshine.



Open space offer

The subject site is fortunate to be located in close proximity to many green open spaces and active recreation spaces. It is a short walk to Bonnie Doon Golf Course, Mutch Park, Jellicoe Park, Hensley Athletics Field, Nagle Park and the new recreation spcae within Pagewood Green Stage 1. Within a 800m radius, residents will have access to ~25ha of public open space (this does not include schools or Bonnie Doon Golf course).

Pagewood Green stage one achieved 3.5sqm of open space per person with an 8000sqm local park, which is the same as the average of Metropolitain Sydney's Planned Precincts. This scheme, Pagewood Green stage two acheives 6.5sqm per person.

Key data:

- 23% of site is public open space
- 20,208sqm of public open space
- There is more than 15,000sqm in communal open space.
- 6.5sqm of public open space per person
- 11sqm of combined communal and public open space (not including balconies or communal facilities)

Key

- Water Body
- Retail
- Childcare Facilities
- Education Facilities
- Public Open Space
- Private Open Space
- Communal Open Space
- Bicycle Friendly Route
- Dedicated Lanes
- Trails
- Site Boundary
- 400m/800m boundary offset
- Golf Course
- Food Retail
- Rugby/Soccer Field
- Running Track
- Outdoor Fitness
- Public Toilet
- Dog Walking
- Childrens Playground
- Picnic/BBQ Facilities
- Aquatic Centre
- Gymnastics Centre
- Cycling Track
- Cricket Pitch/Nets
- Netball/Basketball Courts
- Tennis Courts

Open space offer

There are many measurements of public open space to which this proposal has benchmarked and exceeded the average open space offer.

The Metropolitan Sydney's Planned Precincts have an average of 3.5sqm of public open space per person. The proposed offer exceeds this quantum per person with approximately 6.5sqm of public open space per person.

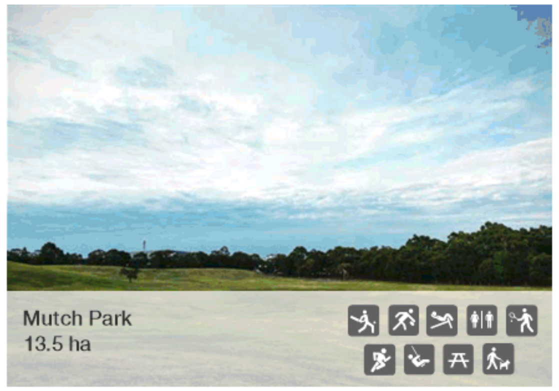
The World Health Organisation (WHO) recommends 9sqm per person, this includes communal and private open space. Generous balconies, communal terraces, indoor recreation spaces and the 2 ha of public open space, every resident will be able to readily access to more than 11sqm per person of open space within the development site.

The Government Architect NSW (GANSW) recommends approximately 14.3sqm per person of open space at a regional and local level. This is broken down into open space typologies, where the minimum to achieve is:

- All dwellings within 400m of a local level park (0.5ha to 2ha)
- All high-density dwellings (60 dwellings or more per hectare) within 200m of a local level park (0.1 to 0.5ha)
- All dwellings within 2ha of a district park (2 to 5 ha)
- All dwellings within 5km of a regional park (minimum 5ha)

The GANSW's recently established benchmarks will be more than met through the local provision within Pagewood Green will be well supported by the quality of local offer due to the network of 25ha of publicly accessible open spaces within an 800m catchment of the site and greater than 60 ha within 2km of the site.


Pagewood Green (Entire)
3 ha


Mutch Park
13.5 ha


Jellicoe Park
5 ha

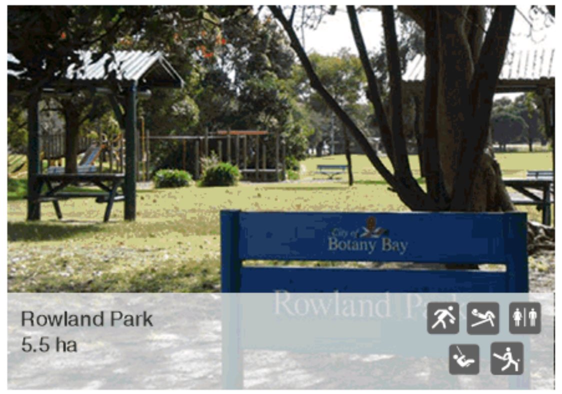

Nagle Park
4 ha


Hensley Park
2 ha


Snape Park
6 ha


Heffron Park
45 ha


David Phillips Sports Field
6ha


Rowland Park
5.5 ha

Precedent Images

Mid-rise apartment buildings

Podium units with parking behind

Town houses

Town houses with articulation

Slender towers with low rise podium units

Precedent images continued

Dining integrated with communal open space

Townhouses with landscape setback

Pedestrian thoroughfare with retail and supermarket

SJB Architects

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We create spaces people love.
SJB is passionate about the
possibilities of architecture,
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Let's collaborate.

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ECONOMIC IMPACT ASSESSMENT

128 & 130-150 BUNNERONG ROAD, PAGEWOOD

24 OCTOBER 2018
FINAL
PREPARED FOR MERITON

URBIS

URBIS STAFF RESPONSIBLE FOR THIS REPORT WERE:

Director	Princess Ventura
Associate Director	Ryan McKenzie
Consultant	Chinmay Chitale
Project Code	PER0052
Report Number	Final

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report has been prepared on behalf of Meriton in support of a Planning Proposal request to rezone the land at 128 and 130-150 Bunnerong Road, Pagewood (the subject site).

Our analysis indicates that the subject site does not have the attributes of other stronger industrial precincts located within the Bayside Council. Within the Bayside Council, precincts such as Banksmeadow and Port Botany achieved higher ratings providing users with:

- Fewer land use conflicts than smaller isolated precincts
- Large contiguous industrial / business zoned precincts
- Direct access to major roads and highways.

The subject site does not have the visibility to support industrial users that appeal to a local customer base, or the transport accessibility to appeal to growing industrial sectors such as freight and logistics.

In addition, the Stage 1 Masterplan Consent for Lot 2 will deliver 2,223 apartments to the south of the subject site and create a land use conflict with the subject site's existing industrial use. The existing approvals also restrict apartments to limit the impact on existing residential uses on the opposite side of Bunnerong and Heffron Roads.

The Planning Proposal for the subject site received Gateway Determination on 12 December 2017 supporting the proposal and allowing it to 'proceed subject to conditions'.

The Planning Proposal and this report have been revised to address the following alterations of Gateway Determination dated 8th of October 2018:

- A requirement of a minimum of 5,000 square metres of gross floor area for commercial floor space and/or other permitted non-residential land uses
- Update the number of jobs to reflect the provision of an additional 5,000 square metres of non-residential land uses.

As part of the masterplan prepared by SJB, the concept identifies the potential to establish a serviced apartment in Lot B of the subject site. The Planning Proposal for the subject site has been amended to include serviced apartments as additional permitted uses for the subject site under Schedule 1 of Botany Bay LEP 2013. The development of a serviced apartment on the subject site will deliver further employment benefits for the Eastgardens / Maroubra District Centre in the order of 0.61 jobs per room.

According to Meriton the existing freight and warehousing tenants at the subject site currently employ only 15 workers, substantially lower than the estimated 342 direct ongoing jobs in childcare and retail that can be generated by the proposed development. This excludes ongoing jobs for the management and maintenance of the proposed 2,015 units.

In addition, the subject site attributes are well aligned and well suited to residential as the site has strong access to amenities and employment precincts such as Port Botany. The limited land available for residential development in a housing market with high underlying demand has resulted in a housing shortage and an affordability constraint within the Bayside Council area. New residential supply that will be delivered on the subject site will meet this demand that will improve affordability outcomes for the Bayside Council area and also deliver dwellings close to employment centres that have further capacity to grow such as the Sydney Port and East Gardens Shopping Centre.

In terms of demand for industrial land there are a number of economic changes within the NSW economy that impact land use relevant to the subject site's change in zone. For instance, in 1996 the economy relied heavily on the manufacturing sector which comprised 13.5% of GSP. By 2015 however this had contracted to 7.4% of GSP.

This change reflects structural shifts in the NSW economy, specifically:

- A contraction in trade exposed sectors, driven by an increasing Australian dollar over this period
- Increasing imports and consumption is driving demand for freight and logistics services

- Growth in 'knowledge based' sectors such as financial and professional services
- Growth in health care services, driven by an ageing population requiring health and aged care services.

The resident employment trends over 2006 to 2011 for the Bayside Council reflect similar trends to NSW, with growing employment in the service sectors and declining employment in the manufacturing sector.

- In 2011 there were a surplus of jobs compared to resident workers within the transport, postal and warehousing and manufacturing industries. This reflects the concentration of industrial land uses within the Bayside Council, in particular the role of Port Botany in providing port related services to the NSW economy. Additional housing should be delivered with accessibility to these jobs to support the workers employed within Port Botany.
- In terms of future employment growth there is an estimated additional 1,268 industrial based jobs in the Bayside Council by 2031 requiring an estimated additional 12.7 hectares of industrial land, which can adequately be met by the LGAs 18 hectares of undeveloped land.
- Further to this, there are better located industrial precincts outside the LGA with significant capacity to accommodate additional industrial jobs growth:
  - Eastern Creek (562 hectares)
  - Moorebank (336 hectares)
  - Marsden Park (238 hectares)
  - WSEA (10,000 hectares).

These precincts contain a large component of undeveloped land, and have a number of significant competitive advantages over the subject site.

Further to this, there are a number of economic benefits associated with developing the subject site:

- The proposed development on the subject site is estimated to result in an increase in direct and indirect employment and economic activity (Gross Value Added – GVA):
  - 171 direct and 531 indirect annual equivalent jobs from the construction of the proposed development concept resulting in gross value add of $102.6 million
  - 342 direct and 196 indirect jobs from the operation of the childcare and retail facilities resulting in gross value add of $57.5 million
  - 0.61 jobs per room developed as part of the potential serviced apartment.
- The 342 direct ongoing jobs to be delivered by the Planning Proposal will constitute a substantial 16%-31% of the projected 1,100–2,100 jobs (2016-36) at the Eastgardens / Maroubra District Centre. The direct ongoing jobs also represent an extensive 2,180% increase on the 15 jobs currently provided on the site under its existing use.
- It is worth noting that there will be peaks and troughs on actual jobs during construction. For instance, it has been estimated that approximately 1,000 construction workers were present on site during peak construction periods.
- In addition, the subject site's redevelopment will accommodate an additional 2,770 local-residents (as advised by SJB):
  - Based on the current spending profile of residents within the Bayside Council, an average spend per capita of $13,514 in $2018 is calculated
  - Therefore, additional population could generate $37.4 million in retail expenditure (in $2018)
  - Increasing the local resident population will activate the area, providing passive security for the residents, workers and visitors of the site.

The Plan identifies priorities for each District across Sydney, with the subject site being located in the Eastern City District. According to The Plan, the Eastern City will be a significant focus for investment and intensive growth over the next 20 years including:

- Increased access to work for residents through improved transport infrastructure networks
- The development of the subject site will house workers close to Port Botany
- Development of the subject site will improve housing affordability by adding supply to the local housing market.

INTRODUCTION

Urbis has been appointed by Meriton Group to undertake an Economic Impact Assessment of the proposed rezoning of the former British American Tobacco site (128 Bunnerong Road, Pagewood). The intended outcome of the Planning Proposal is to amend the *Botany Bay Local Environmental Plan 2013* (BBLEP 2013) as follows:

- Rezone the subject site from part IN1 General Industrial and part R3 Medium Density Residential to R4 High Density Residential.
- Increase the maximum floor space ratio (FSR) development standard from 1:1 to 2.35:1.
- Increase the maximum height of buildings development standard to part RL 37.0 (15m), part RL 60.0 (39m) and part RL 91.0 (70m).

A masterplan illustrating the type of development facilitated by the Planning Proposal has been prepared by SJB. The masterplan contemplates a high-density residential development with buildings of 2-20 storeys oriented around a network of internal roads and public open space. The development will accommodate approximately 2,015 dwellings and allowance has been made for 5,200 sq.m retail floor space and two childcare centres totalling 1,200 sq.m.

As part of the masterplan prepared by SJB, the concept identifies the potential to establish a serviced apartment in Lot B of the subject site. The potential inclusion of serviced apartments in Lot B will further contribute to the mix of lands uses provided within the site and is a response to the site's strategic centre location and new conditions associated with the amended Gateway Determination.

The serviced apartment yield will be determined as part of a future DA, however, its inclusion in considered as part of this report as it will add to the potential of the site to create employment, and meet the minimum requirement of 5,000 sq.m of non-residential floor space as part of the Gateway Determination as amended.

The rezoning of the subject site to R4 High Density Residential is intended to facilitate the redevelopment of the entire area, which could potentially involve additional apartments, community spaces and childcare.

The purpose of this report is to:

- Explore industry and employment trends at the state and LGA level, and their land use implications for the subject site.
- Assess the competitive positioning of the subject site relative to other industrial precincts, within the new Bayside Council.
- Evaluate the suitability of the subject site for industrial, mixed use and residential uses.
- Consider whether the rezoning of the Precinct is consistent with the NSW Department of Planning Greater Sydney Regional Plan (2018) and other relevant government documents.
- Identify broader economic benefits associated with the proposed rezoning.

The report is structured as follows:

- **Section one** provides an overview of the subject site, its regional and locational context, and considers the alignment of the proposal rezoning with relevant government policy documents.
- **Section two** identifies the key competitive industrial precincts and supply within the new Bayside Council. This section provides a description of each precinct and rating based on location, scale and access, and determines the overall surplus / deficit of employment land moving forward.
- **Section three** sets out an overview of the new Bayside Council employment profile, having regard to historic, current and projected labour market segmentation. This includes analysis of the resident workforce and job base. The demand for industrial land is then quantified for the new Bayside Council.
- **Section four** identifies the economic benefits associated with the construction and ongoing operations of the redeveloped precinct.

1. STUDY BACKGROUND

This Chapter provides an overview of the subject site. Relevant government growth strategies and policies are analysed in the context of the proposed development concept for the subject site.

1.1. SUBJECT SITE

The subject site is located within a broader site known as 128 and 130-150 Bunnerong Road, Pagewood. The site is within the Bayside Local Government Area (LGA) and is legally described as Lot 1 DP1187426 and Lot 24 DP 1242288.

The Planning Proposal request relates to Lot 1 DP1187426 and Lot 24 DP 1242288 and covers an area of approximately 8.95ha. The site has frontages to an internal road (Meriton Boulevard) to the south, Bunnerong Road to the east, Banks Avenue to the west and Heffron Road to the north.

A masterplan illustrating the type of development facilitated by the Planning Proposal has been prepared by SJB. The masterplan contemplates a high-density residential development with buildings of 2-20 storeys oriented around a network of internal roads and public open space. The development will accommodate approximately 2,015 dwellings and allowance has been made for 5,200 sq.m retail floor space and 1,200 sq.m for two childcare centres (600 sq.m each).

The subject site was previously occupied by industrial uses associated with the manufacturing operations of British American Tobacco Australasia (BATA).

A map of the subject site and surrounding areas is provided in Map 1.1 overleaf. The subject site is part of a second stage of a broader development that will deliver over 3,700 dwellings. The proposed rezoning of the subject site will facilitate the delivery of 2,015 new apartments.

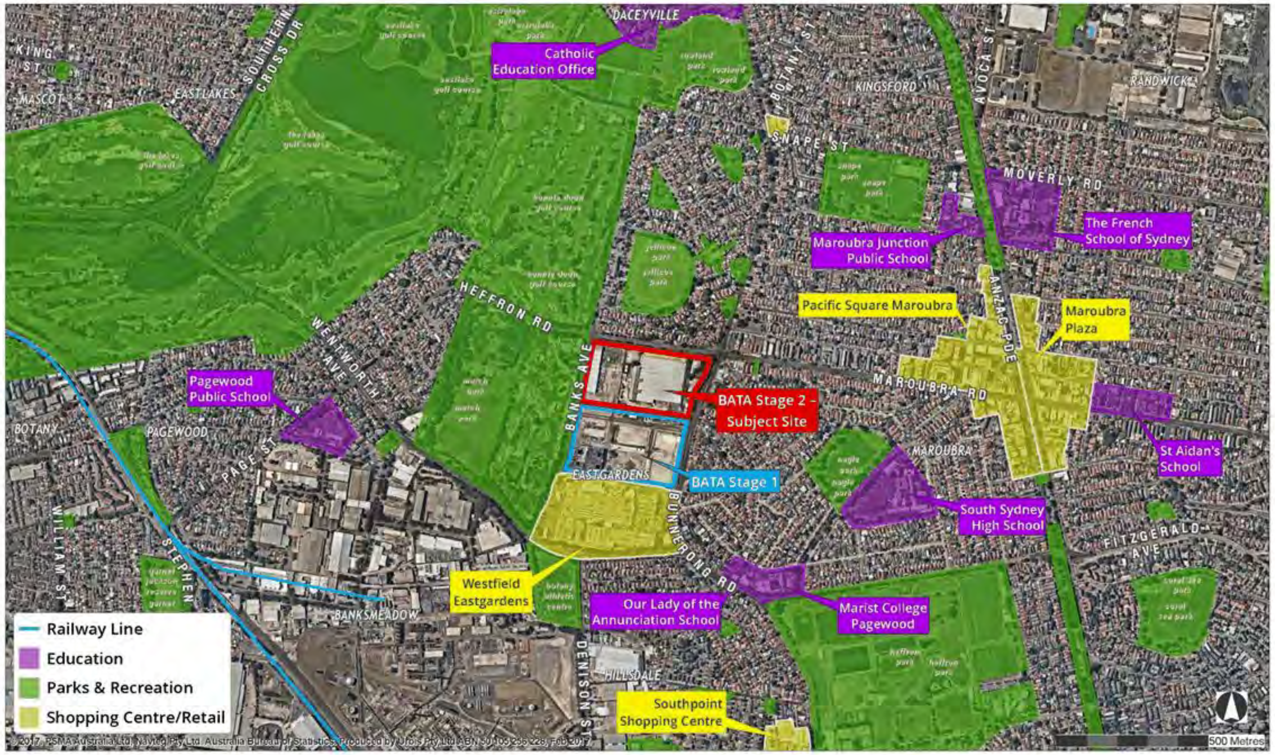
The site is currently used for industrial warehouse by a WSI Logistics who provide freight forwarding services.

As shown in Map 1.2, the subject site is in close proximity to the following key locations:

- Westfield Eastgardens Shopping Centre
- Substantial provision of open space including Mutch Park, Jellicoe Park, Nagle Park and Heffron Park
- South Sydney High School, Maroubra Junction Public School, St Aidan's Primary School and Matraville Public School.

Subject Site – Stage 1 and 2

Map 1.1



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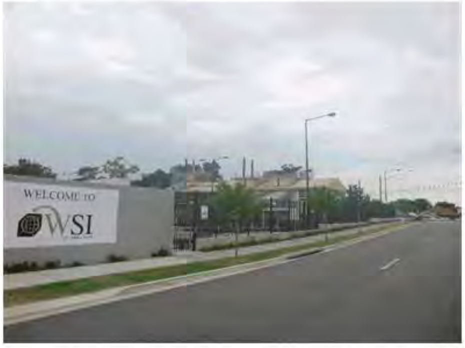
SUBJECT SITE AND SURROUNDING AMENITY

AMENITY

The site is surrounded to the north and east by detached residential, to the west by the Bonnie Doon Golf Course and the south by redevelopment in accordance with the Stage 1 masterplan. Westfield Eastgardens is located to the south of the site, providing extensive grocery and discretionary retail offer to surrounding residents.

The following images provide a snap shot of the subject site collected through a physical inspection of the site.

Figure 1 – Subject site and surrounds



Picture 1 – Southern-boundary of subject site

Source: Urbis

Picture 2 – Existing buildings to be demolished

Source: Urbis

Picture 3 – Bunnerong Road, south facing

Source: Urbis

Picture 4 – Boundary between Stage 1 and Westfield East Gardens

Source: Urbis

1.2. PROPOSED CONCEPT

Meriton is seeking to rezone the subject site from part IN1 General Industrial and part R3 Medium Density Residential to R4 High Density Residential to allow for the development of approximately 2,015 apartments.

In addition to this, allowance has been made for ancillary non-residential uses identified for the site, specifically:

- Two childcare centres totalling 1,200 sq.m
- 5,200 sq.m retail floor space.
- 5,000 sq.m of non-residential land use, potentially as serviced apartment.

Table 1 below outlines the scale of the proposed development.

Table 1 – Proposed Residential Development Concept

Land use	Floor area	Dwelling yield	FSR	Height
Residential Apartments	205,489.5 sq.m	2,015 units	2.35:1	2 – 20 levels

Source: Urbis

Map 1.2 overleaf provides an outline of the distribution and scale of the proposed development across the subject site.

It illustrates that the built form will be high density residential buildings ranging between 8 and 20 levels in height.

A network of strategically located and connected open spaces with a combined area of 20,208 sq.m will be integrated into the development.

Built form and distribution of preferred development option

Map 1.2

Source: SJB

6 STUDY BACKGROUND

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28 AND 130-150 BUNNERONG ROAD, PAGEWOOD ECONOMIC IMPACT ASSESSMENT

1.3. RELEVANT GOVERNMENT DOCUMENTS

There are broader regional government frameworks that are relevant to the subject site. These identify key priorities and objectives for Sydney and the Bayside Council. These include:

- Greater Sydney Region Plan (2018)
- Eastern City District Plan (2018)
- The Broader Western Sydney Employment Area Draft Structure Plan (2013)
- Local employment strategies such as:
  - Botany Bay Planning Strategy 2031 (2009)
  - Rockdale City Council Employment Lands Strategy (2007).

1.3.1. Greater Sydney Regional Plan and Eastern City District Plan (2018)

The final versions of the Region Plan and Eastern City District Plan were released in March 2018 and aim to ensure land use and transport opportunities develop more equitably across Greater Sydney.

The Region Plan conceptualises Greater Sydney as a metropolis of three '30-minute' cities, and is presented with the District Plans to reflect the most contemporary thinking about Greater Sydney's future.

The Region Plan is underpinned by four key pillars which outline specific objectives to be achieved. The four pillars include:

- Infrastructure and Collaboration
- Liveability
- Productivity
- Sustainability.

The Plan is supported by the NSW Long Term Transport Master Plan and a set of District Plans.

Identified in the Plan are priorities for each District, including key regional and strategic centres that are recognised for their renewal opportunities around existing/proposed infrastructure and which therefore offer opportunities for increased residential density close to jobs.

The priorities for this Eastern City District include:

- Providing housing supply, choice and affordability, with access to jobs and services
- Creating and renewing great places and local centres, and respecting the District's heritage
- Growing a stronger and more competitive Harbour City
- Delivering integrated land use and transport planning and a 30-minute city
- Protecting and enhancing scenic and cultural landscapes.

The District Plan sets a strategic housing target of 157,500 for the Eastern City District by 2036, equating to an average annual supply of 7,875 dwellings. At a local level, Bayside Council's housing target requires an additional 10,150 dwellings by 2021 based on the target suggested in the Plan.

The District Plan recognises that there are opportunities within the Eastern City District to deliver beyond the minimum dwellings needed in the short term. It acknowledges the importance of addressing the pent-up demand that has resulted from past undersupply. It also draws attention to the importance of addressing housing choice and affordability to provide supply for the talented workforce needed to contribute to the Eastern City District's global city aspirations and needs.

In the context of the objectives for the Eastern City District, the subject site offers significant opportunity for housing growth coordinated with existing infrastructure by providing housing near established employment, services and educational facilities.

Figure 10 – Eastern City District Structure Plan 2036

Note: The site's approximate location is shown with a red star.

Source: Greater Sydney Commission

1.3.2. The Broader Western Sydney Employment Area Draft Structure Plan (2013)

The completion of the Sydney motorway network, in particular the M4 / M7 interchange, combined with the availability of large low-cost parcels of land, has seen Western Sydney emerge as a dominant location for 'traditional' manufacturing, warehouse and logistics uses. The Western Sydney Employment Area (WSEA) is a major contributor to the supply of industrial land, together with a number of precincts along the M4 and M5 motorways including Moorebank, Ingleburn and Campbelltown.

In June 2013, the draft WSEA Structure Plan was released and it proposed to expand the WSEA from its current location at the intersection of the M4 and M7 down to and incorporating part of the South West Growth Centre and to take in the lands around Badgerys Creek identified for a second Sydney airport.

The proposed extension of the existing WSEA boundary will include an additional 4,537 hectares of new industrial lands to include Badgerys Creek, therefore equating to almost 10,000 hectares of industrial land.

Moving forward, WSEA in particular has competitive advantages for manufacturing operations in terms of access to workforce, available land area, and separation from sensitive land uses such as residential. It is well placed to accommodate 'upsizers' with reasonable supply of large sites which are limited elsewhere in the Sydney region; with these groups diversifying from local manufacturing into import and distribution models requiring additional floorspace.

There are also opportunities to build on the region's strength in manufacturing to position the Broader WSEA to become Sydney's advanced manufacturing hub. The potential catalytic effect of the Second Sydney Airport is also likely to enhance the competitive advantage of WSEA.

The NSW Department of Planning has identified key push and pull factors that will affect the take up and viability of land within the broader WSEA. These push and pull factors are considered in Table 2.1, together with the long term effect that this may have on smaller industrial precincts, such as the subject site.

1.3.3. Local Employment Strategy

In May 2016, NSW Premier Mike Baird and the Minister for Local Government Paul Toole announced the formation of 19 new councils in NSW as part of the NSW Stronger Councils initiative. This is expected to deliver better services and infrastructure such as roads, parks, playgrounds and sporting facilities.

New councils will receive a wide range of benefits including up to:

- $15 million to invest in community projects like junior sporting facilities, playgrounds and library or pool upgrades
- $10 million to streamline administrative operations, with the option of redirecting unspent funds into community projects.

The subject site now sits within the Bayside Council, which is the amalgamation of Botany Bay Council and Rockdale Council. This would require an assessment of existing planning strategies under the previous councils.

Botany Bay Planning Strategy 2031 (2009)

Botany Bay City Council undertook a planning strategy to provide the framework for growth for the next 25 years to guide the preparation of the Botany Bay LGA Local Environmental Plan (2013).

The key strategy directions identified within the document are listed below:

- Enhancing housing choice and liveability
- Revitalising Botany Road and traditional centres
- Managing growth in the Eastern centres
- Maintaining Sydney Airport as a global gateway
- Maintaining Port Botany as a global gateway
- Protecting the natural environment.

The strategy document also addresses key employment and dwelling targets identified within the NSW Metropolitan Strategy (2005) and the East Subregional Strategy (2007). There is targeted to be 6,500 additional dwellings and 11,700 additional jobs within Botany Bay LGA by 2031. However, housing capacity analysis within the document identifies:

"Only around 108 hectares of the LGA is unconstrained land… a notional capacity of around 3,000 additional dwellings is identified. This falls well short of the target of 6,500. After excluding constrained land, the settings under the existing development controls do not provide sufficient capacity to meet the target."

This suggests that residential intensification within the LGA is required to meet this dwelling target.

The document also outlines future directions regarding the long term potential for the subject site to become a mixed use precinct.

Rockdale City Council Employment Lands Strategy (2007)

Rockdale City Council produced the Employment Lands Strategy (2007) to inform the Rockdale Local Environmental Plan (2011). The document is meant to guide a broader number of important qualitative outcomes that will make the City of Rockdale a more attractive place to live and visit.

The document also identifies, employment targets set out by the NSW Draft Subregional Strategy for the South Sydney region, which projects an additional 13,000 jobs in the Rockdale LGA by 2031.

The document outlines precinct specific strategies for the Council's employment lands, with the aim to protect the viability of industrial uses and provide greater employment opportunities on these precincts. Generally, these include:

- Protect existing employment sites that are suited to continued industrial use
- Retain existing industrial uses while facilitating greater employment generation through increased FSRs
- Rezone fragmented portions of industrial land to B4 mixed use given their compatibility to surrounding residential density as well as promoting greater job diversity in the region.

The document also outlines the economic significance of Sydney Airport to Rockdale's local economy, with significant growth in both employment and investment in activities closely associated with logistics and transport. However, more traditional forms of industrial activity such as manufacturing and warehousing have relocated outside of Rockdale Council to locations with lower rents and less expensive land costs.

The spatial redistribution of the manufacturing/warehousing industry in Sydney also has implications on the subject site and competing industrial precincts in the newly formed Bayside Council, with tracts of industrial land in the Western Sydney Orbital becoming attractive alternatives to traditional industrial areas for transport and logistics related activity.

2. COMPETITIVE POSITIONING

Section 2 will identify the industrial precincts within the Bayside Council, and their competitive positioning relative to the key attributes required by industrial tenants.

This section also consider other key regional industrial precincts that have significant undeveloped supply of industrial lands that can accommodate future demand for industrial lands.

2.1. COMPETING INDUSTRIAL PRECINCTS

Around 520 hectares within Bayside Council are identified as industrial land in the NSW Department of Planning and Environment's Employment Lands Development Program (ELDP). These industrial lands are illustrated in Map 2.1 (2 pages overleaf).

The 2015 ELDP Update Report notes that Bayside Council has around 24.2 hectares of undeveloped industrial lands, of which around 21.4 hectares is located in the Banksmeadow precinct.

Across the Sydney Metropolitan Region, Bayside Council contributes 3.8% of total employment lands, 4.7% of total developed and 0.8% of total undeveloped land (Source: NSW DPE ELDP 2015 Update Report).

In addition to industrial lands within the Bayside Council boundaries, there are substantial tracts of industrial lands abutting the Bayside Council boundary. These include:

- Additional Port Botany Lands around Yarra Bay (within the Randwick LGA)
- Industrial lands in Marrickville and Sydenham
- Land in South Sydney around the Alexandra Canal.

South Sydney includes the suburbs of Alexandria, Zetland and Beaconsfield which collectively comprise of the City of Sydney's "Southern Employment Lands". City of Sydney is proposing amendments to its LEP to broaden the mix of permissible uses in the South Sydney Area Employment Lands.

City of Sydney Council estimates that new zonings will allow a wider variety of businesses and organisations to locate in the area with up to 9,000 more expected over the next 15 years in jobs created in new forms of industrial activity, creative industries, retail and knowledge-based companies.

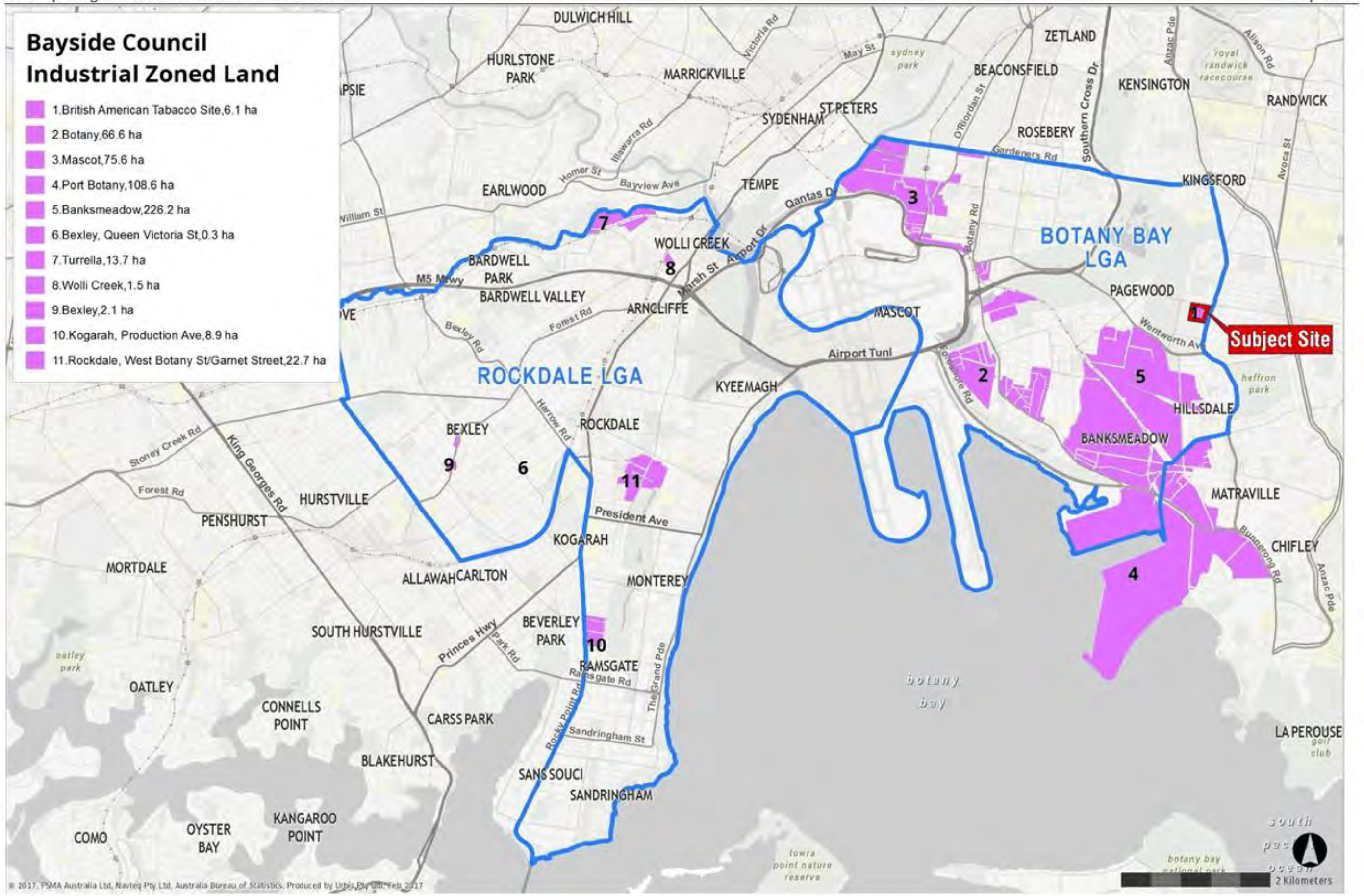
Industrial Lands
Bayside Council Table 2.1

Precinct Number	Precinct Name	Current Employment Zones	Hectares
1	**British American Tobacco Site (Subject Site)**	**IN1 General Industrial**	**6.1**
2	Botany	SEPP (Port Botany)	66.6
3	Mascot	IN2 Light Industrial	75.6
4	Port Botany	IN2 Light Industrial	108.6
5	Banksmeadow	IN2 Light Industrial	226.2
6	Bexley, Queen Victoria Street	IN2 Light Industrial	0.3
7	Turrella	IN2 Light Industrial, SP2 Infrastructure	1.3
8	Wolli Creek	IN2 Light Industrial	1.5
9	Bexley	IN2 Light Industrial	2.1
10	Kogarah, Production Ave	IN2 Light Industrial	8.9
11	Rockdale, West Botany Street / Garnet Street	IN2 Light Industrial	22.7
	Total Industrial Lands – Bayside Council		**519.9**

Source: Employment Lands Development Program 2015, Urbis

Competing Industrial Precincts – ELDP 2015

Map 2.1



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COMPETITIVE POSITIONING 13

2.2. INDUSTRIAL LAND ASSESSMENT

Industrial Demand Drivers – Bayside Council

Urbis have undertaken a high level review of the industrial precincts within the new Bayside Council area. There are currently around 520 hectares of industrial zoned land within the Bayside Council.

The precincts have varying characteristics that would appeal to tenants and investors. Urbis has identified key factors that drive tenant interest and underpin the functioning of industrial precincts:

- **Access** to motorway networks, B-Double routes and / or multi modal facilities.
- **Scale** of the precinct, with larger precincts offering opportunities for expansion, intensification of activity and clustering of similar industries and supply chain synergies. For the purposes of this assessment we have identified precincts with <10 hectares as small scale, 10-30 hectares as medium scale and >30 hectares as large scale.
- **Land use compatibility** with surrounding uses, and whether sensitive noise receptors (e.g. residential areas where impacts on neighbourhood amenity can lead to land use conflict) have the potential to conflict with freight vehicles/traffic.

Table 2.2 presents an evaluation of each precinct with a 'high', 'medium' or 'low' rating (high being positive and low being negative). These ratings are based on key success factors described above. Table 2.3 provides a detailed audit of each industrial precinct within the Bayside Council.

Industrial Viability

Competing Industrial Precincts, Bayside Council — Table 2.2

	Precinct	Access	Scale	Land use compatibility	Overall Viability Ranking
1	**British American Tobacco Site (Subject Site)**	Medium	Low	Low	**Low**
2	Botany	High	Medium	Medium	**Medium**
3	Mascot	Medium	High	Medium	**Medium**
4	Port Botany	High	High	Low	**High**
5	Banksmeadow	Medium	High	Medium	**Medium**
6	Bexley, Queen Victoria Street	Low	Low	Medium	**Low**
7	Turrella	Low	Medium	Low	**Low**
8	Wolli Creek	Medium	Medium	Low	**Medium**
9	Bexley	Medium	Low	Medium	**Medium**
10	Kogarah, Production Ave	Medium	Low	Medium	**Medium**
11	Rockdale, West Botany Street / Garnet Street	Medium	High	Medium	**Medium**

Source: Urbis

Bayside Council Industrial Areas

Summary

Table 2.3

Precinct Number	Precinct and Zoning	Access	Scale	Land use compatibility	Future Viability	Recommendations
1	British American Tobacco Site (Subject Site)	Vehicular access via Bunnerong Road and Heffron Road, however no direct access to a major arterial road or motorway. Bus routes also provided on Bunnerong Road and Heffron Road.	**6.1 hectares** Formerly the BATA site, the precinct served as the distribution and warehousing arm for BATA's Australasia's business operations, however is small scale relative to larger competing industrial precincts.	Residential uses to the immediate north and east. However, vacant industrial zoned land to the south currently provides buffering to Westfield Eastgardens to the south.	Limited ability to support further industrial related employment. Limited road connection for heavy vehicles limits transport accessibility to subject site.	Planning proposal for potential upzoning of subject site to R4 High Density Residential.
2	Botany	Strong access to Airport and Western Sydney through M1 Motorway and Foreshore Road, Botany Road.	**66.6 hectares** Serves a range of engineering services, warehousing and manufacturing uses.	Residential uses scattered across the precinct, with retail uses located along Botany Road.	Strong viability given the continued role of precinct to provide urban support services to local residents. Limited scope for additional employment beyond current construction activity.	Retain as industrial zoned land to protect general industrial uses to continue supporting the local economy.
3	Mascot	High accessibility to Airport and Sydney CBD by Mascot train	**75.6 hectares** Clustering uses include logistics, manufacturing, and	The precinct is well separated from surrounding residential uses, with South Sydney Employment	Strong viability to increase support for airport freight and logistics industry related uses. Limited	Retain and increase IN1 zoning to facilitate intensified clustering of airport related freight and logistics, given its

Precinct Number	Precinct and Zoning	Access	Scale	Land use compatibility	Future Viability	Recommendations
		station. However, access to Port Botany is constrained by traffic congestion along General Holmes Drive.	airport related activity.	Lands located to the north and west of the precinct. Residential uses are located to the east of O'Riordan Street.	potential to expand current IN1 zoning.	important role in a growing Sydney Airport.
4	Port Botany	Access to Airport and Sydney CBD subject to congestion along Foreshore Road/Botany Road and General Holmes Drive.	**108.6 Hectares** Serves primarily heavy industrial and oil/gas clustering uses.	No immediate residential uses surrounding the precinct, with low density housing located further out to the north in the suburb of Matraville.	Strong viability to support future port related activity and export related industries, and maintain role as state significant infrastructure serving the NSW economy.	Retain SEPP zoning to protect state significant infrastructure which will continue to support provide port related services for the NSW trade economy.
5	Banksmeadow	Access to Airport and Sydney CBD subject to congestion along Foreshore Road/Botany Road and General Holmes Drive.	**226.2 Hectares** Serves heavy industrial uses, including oil terminals, the Sydenham-Botany Goods Railway and the Orica Chemical Factory.	Immediate surrounding uses include light industrial and business to the north, and residential uses immediately surrounding the east and west of the precinct.	Strong viability to retain land as a future precinct for port and manufacturing uses.	Retain as IN3 Heavy Industrial to continue supporting port and manufacturing related uses. Potential to relocate heavy industry on undeveloped land and intensify current uses.

Precinct Number	Precinct and Zoning	Access	Scale	Land use compatibility	Future Viability	Recommendations
6	Bexley, Queen Victoria Street	Access through Queen Victoria Street, though however precinct is separated from major roads or motorways.	**0.3 Hectares** Consists of dated warehousing and storage facility, and a mechanical smash repair service.	The precinct is surrounded by immediate low density residential uses, and there is no buffering to protect from industrial noise.	Low long term viability given its small scale of uses and dated condition of buildings, separated from main industrial precincts within the region.	Limited opportunity to expand current IN1 zoning due to immediate surrounding residential areas. Potential to rezone to residential zoning given its compatibility with existing residential neighbourhood.
7	Turrella	No direct access to a major road or motorway impedes access to the precinct. Railway line separates the precinct, therefore access between the two industrial areas is via Reede Street.	**13.7 Hectares** The precinct contains a mix of warehousing, manufacturing and automotive services, with the majority of buildings incorporating offices.	Residential properties abutting Reede, Turrella and Loftus Streets, which represent the precinct's only points of entry/exit. This causes heavy vehicles movements along residential areas and schools.	Low long term viability given no known synergies with other established precincts in the Council, limited road access and parking, and land use conflicts with abutting residential properties.	Proposed rezoning of the precinct to B4 Mixed Use, B2 Local Centre, and R4 High Density Residential should proceed given its compatibility with existing residential neighbourhood adjacent to the precinct and increased residential density around stations.
8	Wolli Creek	Main road access through Princes Highway. Arncliffe train station is located 400 metres from the precinct.	**1.5 Hectares** Contains a mix of automotive uses, including service centres for Mazda, Kia and Ford.	The precinct is surrounded by high density residential uses to the west and south; however the nature of uses on the precinct does not	Strong long term viability to maintain automotive uses, and will continue to support existing adjacent car dealership businesses.	Retain industrial zoning to continue providing urban services to local residents.

Precinct Number	Precinct and Zoning	Access	Scale	Land use compatibility	Future Viability	Recommendations
				cause any significant noise to residents.		
9	Bexley	No direct access to arterial road or motorway, with main linkages provided through Forest Road.	**2.1 Hectares** The precinct is separated into two smaller clusters along Forest Road. Contains a mix of local businesses within the storage and automotive repairs, as well as low grade ancillary office facilities.	The precinct is surrounded by immediate low and medium density residential housing; however noise reception is likely to be subdued from passing traffic on Forest Road.	Medium long term viability given existing business continued role as urban support for local residents. However, there is potential to relocate to larger scale precincts in the region in pursuit of clustering and synergies.	Retain existing industrial zoning, although opportunities to relocate to larger precincts within the Council and create synergies with like uses.
10	Kogarah, Production Avenue	Direct connection provided through Rocky Point Road, affording good access for local residents.	**8.9 Hectares** A clustering of automotive smash repairs, electrical and warehousing.	The precinct is buffered from residential uses by recreational zoned land to the east, but is surrounded by low density housing to the north, south and west. This could potentially cause land use conflict if noise is not adequately contained.	Strong long term viability, clustering/agglomeration of automotive and warehousing will continue to support local businesses within the region.	Retain as IN2 Light Industrial to continue to provide urban support for local residents.

Precinct Number	Precinct and Zoning	Access	Scale	Land use compatibility	Future Viability	Recommendations
11	Rockdale, West Botany Street / Garnet Street	Precinct is split by West Botany Street, which connects to Bay Street and Princes Highway. Rockdale train station is located 1.1km to the west.	**22.7 Hectares** Precinct contains a mix of automotive, hardware and bulky goods uses. Potential to increase FSRs to increase employment yield in precinct.	The precinct is well buffered by recreational land to the east, but abutting residential properties to the north of precinct may cause some land conflict issues.	Strong long-term viability as precinct will continue to service of the needs local and regional population. Potential to rezone Garnet Street portion of industrial land to mixed use, in accordance with the Rockdale City Council Employment Lands Strategy (2007).	Retain as IN2 Light Industrial to provide bulky goods retail and urban support services for local and regional residents.

Major Western Sydney Industrial Precincts

In addition to assessing Bayside Council industrial precincts, it is important to assess the competitive positioning of the subject site against major industrial precincts elsewhere in Sydney that have the capacity to accommodate additional growth, and have strong locational characteristics to attract tenants.

Urbis have identified a number of major industrial precincts with these characteristics:

- Eastern Creek (562 hectares)
- Moorebank (336 hectares)
- Marsden Park (238 hectares)
- WSEA (10,000 hectares).

These precincts contain a large component of undeveloped industrial land, which is able to absorb demand from new business creation and industrial users that require larger premises to operate.

There are a number of significant competitive advantages that these precincts have over the subject site:

- B-double truck access
- Significant amounts of undeveloped land
- Direct access to major roads and intermodal terminals (IMTs)
- Larger lot sizes
- Minimal land use conflicts with non-industrial land uses.

Competitive Positioning

Major Central West Industrial Precincts Table 2.4

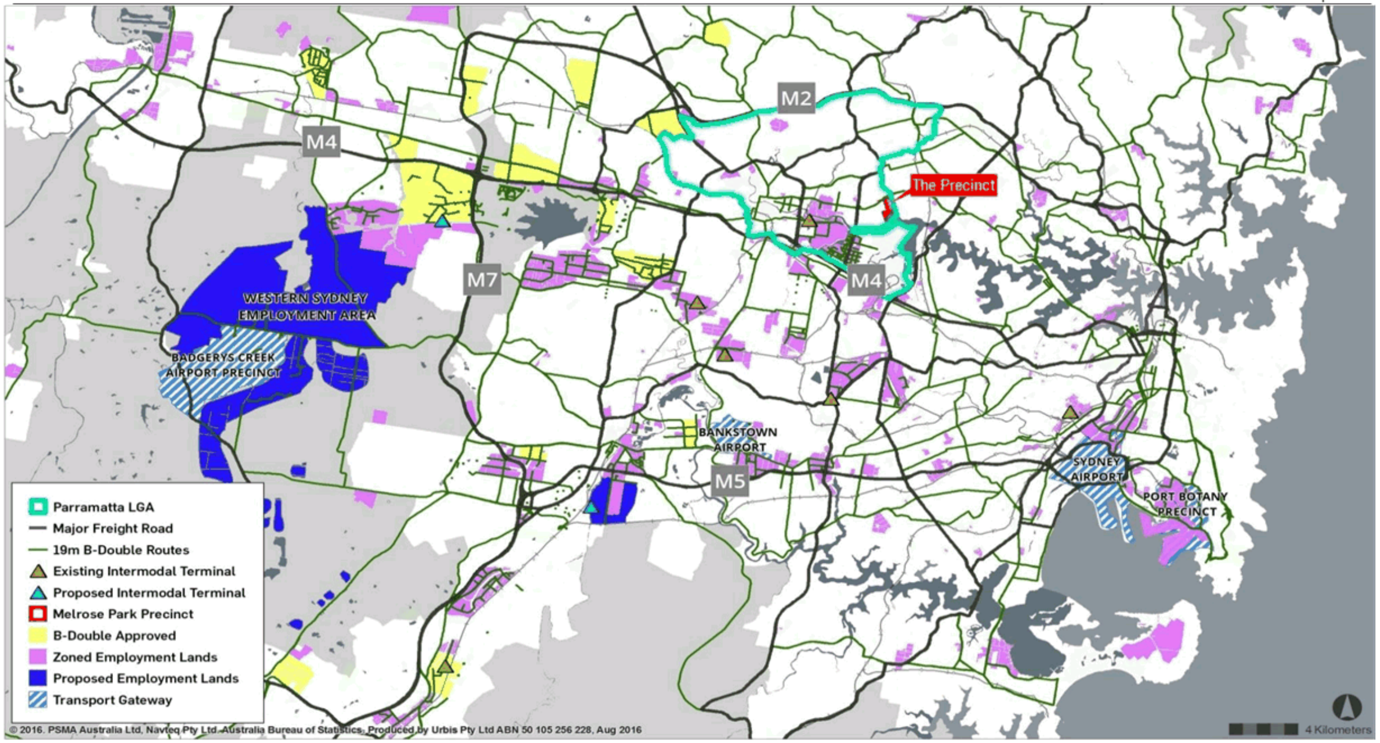
PRECINCT	SIZE	ENABLERS OF GROWTH
Eastern Creek	**Area:** 562 hectares The largest industrial precinct within the Blacktown LGA)	• Large amount of undeveloped industrial land (as at 2015, there was 14 hectares of undeveloped industrial land) • B-double trailers permitted in this area (Map 2.2) • Close proximity to the proposed Western Sydney Intermodal Terminal at Eastern Creek (within approximately 4km) • The take-up of 23 hectares of land in this precinct was equivalent to 12% of the total for the Sydney Metropolitan Region. Demand for residual land parcels is therefore expected to be strong, reflecting the positive attributes of the Eastern Creek Precinct.
Moorebank	**Area:** 336 hectares The second largest industrial precinct within the Liverpool LGA.	• Large amount of undeveloped industrial land (as at 2015, there was 11.7 hectares of undeveloped industrial land) • Proposed Moorebank Intermodal Terminal project (currently under construction), with an estimated value of $570 million, involves the development of freight terminal facilities linked to Port Botany and the interstate freight rail network by rail on defence land. The addition of the Moorebank Intermodal Terminal is expected to have a capacity for up to 1.1 million containers per year by 2030 for import-export freight, and up to 500,000 containers a year for interstate freight. The import-export terminal (stage 1) is expected to commence operations in late 2017and interstate terminal in 2019, with expected economic benefits of around $120 million a year for the economy of Southwestern Sydney.

PRECINCT	SIZE	ENABLERS OF GROWTH
Marsden Park	**Area:** 238 hectares (123 hectares of business park land)	• The industrial precinct rezoning has been fast tracked under the Government's Precinct Acceleration Protocol • Key infrastructure in this area is access to the M7 Motorway (via Richmond Road) • Significant expenditure in new infrastructure ($56 million upgrade of Richmond Road) • Alignment of land use, transitioning from the Local Centre (B2) located on Richmond Road and South Street, to Business Park (B7) land use, and then to Industrial land use (IN1/IN2) facilitating a range of complementary uses • Ability to leverage the strength of an established business park location • Significant population growth associated with the North West Growth Centre • A planned Marsden Park town centre • Take up of business park land was around 4 hectares in 2014 – largest take-up of business park land within Metropolitan Sydney, followed closely by Norwest at around 3 hectares. Marsden Park has the largest stock of undeveloped business park land, currently at around 94 hectares (as at January 2015) • Land supply / capacity for future development.

PRECINCT	SIZE	ENABLERS OF GROWTH
WSEA	**Area:** Around 10,000 hectares	• Close proximity to key regional infrastructure corridors including the M4 and M7 Motorways which, supports access to distribution networks and nodes, such as the Port and Airport • B-double trailers permitted in some areas (Map 2.2) • Proximity to planned infrastructure such as intermodal terminals (Moorebank and Eastern Creek) • Connections to the proposed Moorebank Intermodal Terminal would potentially drive some demand from the south of the WSEA • Proposed intermodal and freight line located within the WSEA in the Eastern Creek precinct that may assist in driving co-location of business park users with the freight based operations • Take-up activity was concentrated in the precincts of Eastern Creek, Smeaton Grange, Erskine Park, Glendenning, Campbelltown Blaxland Road and Huntingwood West. Collectively take-up in these precincts totalled 96 hectares (in 2014), demonstrating that development is largely focused within WSEA where undeveloped and services land is available.

B Double Access Locations

Map 2.2



2.3. SUMMARY AND IMPLICATIONS

Our analysis indicates that the subject site does not have the attributes of other stronger industrial precincts located within the Bayside Council. This is due to larger regional precincts (such as Banksmeadow and Port Botany) or small industrial precincts that play a more specialised role.

Within the Bayside Council, precincts such as Banksmeadow and Port Botany achieved higher ratings providing users with:

- Access to a diversity of lot sizes that support a larger range of uses
- Fewer land use conflicts than smaller isolated precincts
- Large contiguous industrial / business zoned precincts
- Direct access to major roads and highways.

In addition, there are a number of smaller precincts that are well located and play a more specialised role that include a mix of business zoned land that provide services to a local community (e.g. Kogarah, Rockdale – West Botany Street) or enterprise corridors along major roads (e.g. Wolli Creek) that rely on passing traffic. These uses do not involve large scale warehousing and distribution and are therefore less reliant on fast access to the motorway network. Typically, these local services require exposure from passing traffic and therefore are ideally situated along a major road, which are therefore unlikely to be supported on the subject site.

The subject site does not have the visibility to support industrial users that appeal to a local customer base, or the transport accessibility to appeal to growing industrial sectors such as freight and logistics. In addition, the Stage 1 Masterplan Consent for Lot 2 will deliver 2,223 apartments to the south of the subject site and create a land use conflict with the subject site's existing industrial use.

A common factor amongst all the highly ranked Bayside Council precincts and the regional precincts is a lack of land use conflict. Land use conflicts are an issue in that they co-locate sensitive noise receptors with industrial uses that generate noise not only during the day, but at times after hours. Co-locating these uses can result in pressure from the community to constrain industrial operations, impacting their viability.

3. EMPLOYMENT ANALYSIS

Section 3 will identify economic trends that impact industrial land use and whether there is sufficient undeveloped industrial land to accommodate forecast employment growth.

Western Sydney industrial lands are subject to structural economic change. The broader economic trends within Metropolitan Sydney being witnessed is the gradual relocation of large industrial users to Western Sydney and the urban renewal of vacant industrial sites in inner and middle ring suburbs.

Growing industrial sectors such as transport, freight and logistics are seeking properties that provide strong transport links that reduce the time taken to transport freight between distribution centres and end users. Traditional trade exposed industrial users on the hand, such as manufacturing have experienced consistent contraction in size since the early 1990s.

These trends indicate that market demand will be focused on industrial land towards large lots in Western Sydney, directly adjacent transport infrastructure and away from conflicting land use.

3.1. ECONOMIC STRUCTURAL CHANGE

Chart 3.2 shows NSW GSP growth between 1995 and 2015 by industry sector. Over this period the structure of the NSW economy changed significantly. In 1996 the economy relied heavily on the manufacturing sector which comprised 13.5% of GSP. Since 1990, the following industries have increased their share of the NSW GSP:

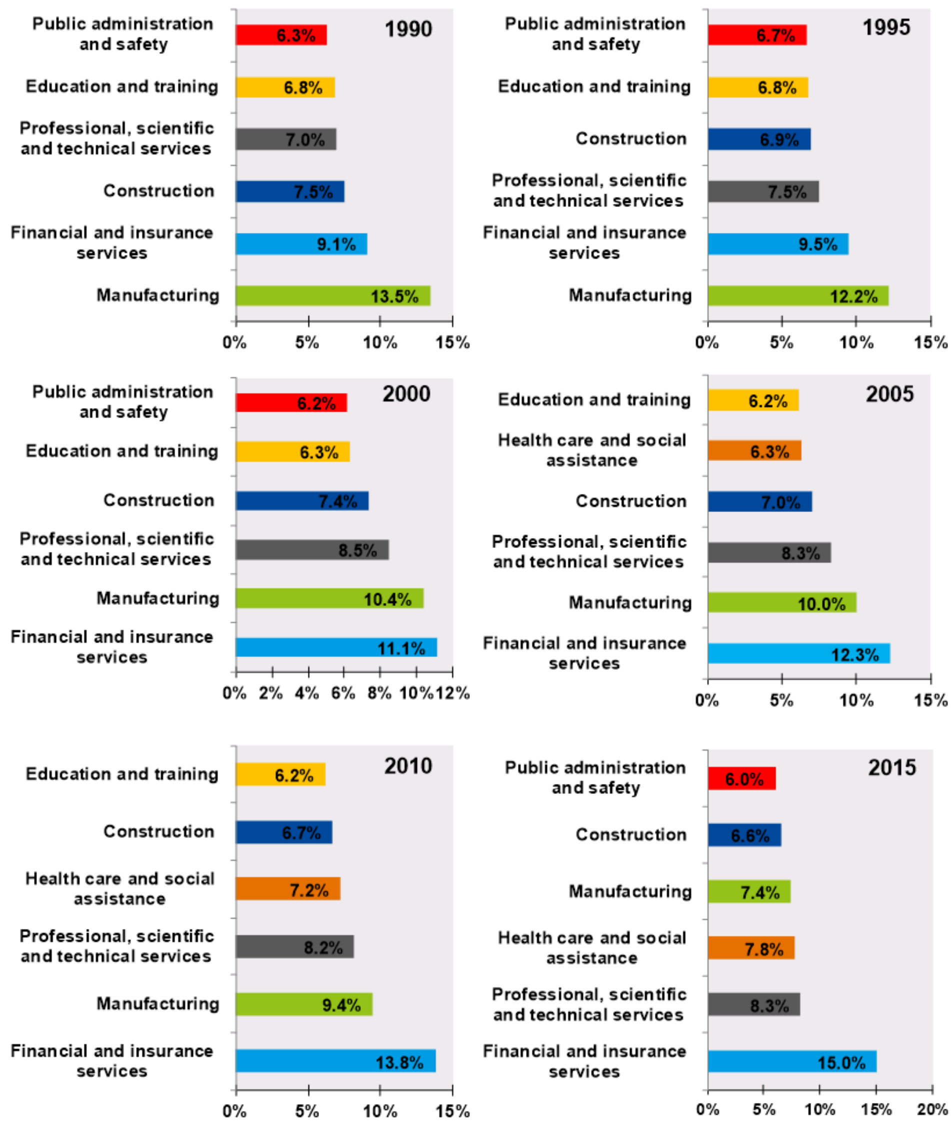
- The financial services and construction sectors have increased their share from 9.1% in 1990 to 15% in 2015
- Professional, scientific and technical services increased from 7% to 8.3% in 2015
- The health care and social assistance sector grew slightly from 5.6% in 1993 to 7.8% in 2015
- Transport. Postal and warehousing which are key users of industrial land have expanded from 4.5% to 5.1% in 2015.

The growth rates reflect structural shifts in the NSW economy. Namely:

- A contraction in trade exposed sectors, driven by an increasing Australian dollar over this period
- Increasing imports and consumption is driving demand for freight and logistics services
- Growth in 'knowledge based' sectors such as financial and professional services
- Growth in health care services, driven by an ageing population requiring health and aged care services.

Gross State Product, Industry Sector

NSW Chart 3.1



Source: ABS Australian National Accounts: State Accounts June 2015; Urbis

3.2. EMPLOYMENT ANALYSIS

A review of resident employment trends by industry in Bayside Council between 2006 and 2011 (as shown in Chart 3.3) confirms that:

- The largest resident employment growth sectors were in hospitals and health facilities, offices, schools and town centres. From a land use perspective, the increased employment growth in these sectors does not create any additional demand for industrial zoned land
- Employment has been affected by the same structural shifts affecting the broader NSW economy, with strong growth amongst service sectors and falling employment in the manufacturing sector
- While resident employment grew by 1.9% from 2006 to 2011, manufacturing jobs declined by 12% over this period.

The majority of the Bayside Council resident workforce growth was in non-industrial sectors including the following:

- Health Care and Social Assistance (+1,510 jobs)
- Professional, Scientific and Technical Services (+1,075 jobs)
- Education and Training (+819 jobs).

There was employment contraction experienced by Bayside Council residents in the following sectors:

- Manufacturing (-603 jobs)
- Retail Trade (-110 jobs)
- Wholesale Trade (-47 jobs).

Resident Workers Growth

Bayside Council 2006 and 2011 Chart 3.2

	Bayside Council		
Industry Sector	**2006**	**2011**	**2006-11 Total Change**
Health Care and Social Assistance	5,540	7,050	1,510
Professional, Scientific and Technical Services	3,866	4,941	1,075
Education and Training	3,210	4,029	819
Accommodation and Food Services	4,701	5,360	659
Administrative and Support Services	2,283	2,817	534
Financial and Insurance Services	3,569	3,956	387
Transport, Postal and Warehousing	5,879	6,189	310
Rental, Hiring and Real Estate Services	1,032	1,304	273
Public Administration and Safety	3,460	3,733	272
Construction	3,647	3,904	258
Other Services	2,370	2,538	168
Arts and Recreation Services	901	1,032	131
Information Media and Telecommunications	1,555	1,629	74
Mining	49	72	24
Electricity, Gas, Water and Waste Services	430	445	15
Agriculture, Forestry and Fishing	82	35	-47
Wholesale Trade	3,333	3,235	-98
Retail Trade	6,605	6,494	-110
Manufacturing	5,229	4,626	-603
Total	**57,739**	**63,389**	**5,650**

Source: ABS Census 2006 and 2011; Urbis

Chart 3.4 compares the number of jobs provided within Bayside Council with the number of Bayside Council resident workers in 2011. As at 2011, the number of Bayside Council resident workers (57,200) exceeded the number of local jobs (55,926) by 1,274. The data shows that there are a number of imbalances between the skills of residents and available jobs within the LGA in a number of categories.

In the following categories, there is a mismatch between the number of jobs provided within the LGA and the skills of local residents, therefore labour must be imported for the following sectors:

- Transport, Postal and Warehousing (+19,733 jobs)
- Manufacturing (+3,182 jobs)
- Wholesale Trade (+1,932 jobs)
- Retail Trade (+1,003 jobs).

There are fewer jobs provided in the Council than there are resident workers, in the following sectors meaning that these workers need to travel beyond the Council to work (exported labour):

- Finance and Insurance Services (-2,971 jobs)
- Health Care and Social Assistance (-2,914 jobs)
- Professional, Scientific and Technical Services (-1,701 jobs)
- Education and Training (-1,317 jobs).

The particular shortage in jobs within these 'white collar' and service industry sectors highlights a broader need for the Council to increase its business zoning capacity.

Jobs Gap Analysis (+ Surplus / -Deficit)

Bayside Council, 2011 Chart 3.3

Source: BTS 2011 Journey to Work; Urbis

Table 3.1 illustrates the projected employment for Bayside Council between 2016 and 2031 and its distribution across different industry sectors using BTS data. The table shows that employment within the Council is projected to increase by around 17,300 jobs between 2016 and 2031 (around 1,200 jobs per annum).

The following industries are expected to experience large employment growth, and are consistent with the Council's historic trends:

- Retail Trade (+2,625 jobs)
- Health Care and Social Assistance (+2,133 jobs)
- Transport, Postal and Warehousing (+1,968 jobs)
- Public Administration and Safety (1,799 jobs).

The industry sectors listed above have implication for future land use, particularly for non-industrial land uses. With the exception of transport, postal and warehousing, these sectors are typically not accommodated in industrial sites; rather these jobs occur in local/business/commercial centres or adjacent to residential areas.

Table 3.2 examines how the projected employment growth for Bayside Council is likely to be split by property type and is illustrated in Chart 3.5. The analysis is based on Urbis derived benchmarks looking at land use proportions by different categories of employment. The table indicates that the employment split by sector is likely to be as follows:

- **Office sector:** to account for around 41% of employment growth, equal to around 7,000 additional jobs between 2016 and 2031. Includes office components of sectors where majority of employment is accommodated in 'non-office' floorspace, for example education and training, health, arts and recreational services, and industrial sectors such as construction and urban services.
- **Retail sector:** to account for around 15% of employment growth, equating to around 2,800 jobs between 2016 and 2031. This includes retail components of accommodation, food services and wholesale trade.
- **Health sector:** to account for around 11% of employment growth, equating to around 1,900 jobs between 2016 and 2031.
- **Off-site employment** (employment that is not property based e.g. drivers of commercial vehicles, construction site workers)**:** to account for 9% of employment growth, equating to around 1,600 jobs between 2016 to 2031.
- **Industrial sector:** to account for around 7% of employment growth, equating to around 1,300 jobs between 2016 to 2031. The vast majority of this growth would be driven by the transport, postal and warehousing sector. Components of 'non-industrial' sectors such as retail, wholesale trade and information technology are also included.
- **Education sector:** to account for around 4% of employment growth, equating to around 700 jobs between 2016 and 2031.
- **Home based employment:** to account for around 1% of employment growth, equating to around 200 jobs between 2016 and 2031.

Table 3.2 and Chart 3.5 demonstrate that around 68% of all employment growth is projected to be in the office, health and retail properties, as opposed to 7% projected in industrial zoned lands. This analysis suggests that moving forward, existing non-industrial employment precincts and centres will deliver the majority of future employment growth.

Employment Forecast

Bayside Council, 2016 to 2031 Table 3.1

	Forecast								2016-31	
	2016		2021		2026		2031			
Industry Sector	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Total Change**	**Annual Growth %**
Retail Trade	8,044	9%	9,132	10%	9,824	10%	10,669	10%	2,625	1.9%
Health Care and Social Assistance	4,925	6%	5,712	6%	6,416	6%	7,058	7%	2,133	2.4%
Transport, Postal and Warehousing	28,074	32%	28,324	30%	29,252	29%	30,042	28%	1,968	0.5%
Public Administration and Safety	4,866	5%	5,473	6%	6,067	6%	6,665	6%	1,799	2.1%
Professional, Scientific and Technical Services	3,681	4%	4,205	4%	4,732	5%	5,432	5%	1,751	2.6%
Accommodation and Food Services	5,656	6%	6,246	7%	6,696	7%	7,200	7%	1,544	1.6%
Administrative and Support Services	3,193	4%	3,501	4%	3,779	4%	4,136	4%	943	1.7%
Information Media and Telecommunications	902	1%	1,183	1%	1,441	1%	1,824	2%	922	4.8%
Construction	4,453	5%	4,701	5%	4,974	5%	5,263	5%	810	1.1%
Education and Training	3,077	3%	3,316	4%	3,572	4%	3,831	4%	754	1.5%
Rental, Hiring and Real Estate Services	1,948	2%	2,183	2%	2,404	2%	2,651	3%	703	2.1%
Arts and Recreation Services	662	1%	832	1%	968	1%	1,234	1%	572	0.0%
Other Services	2,674	3%	2,819	3%	2,968	3%	3,125	3%	451	1.0%
Wholesale Trade	5,357	6%	5,359	6%	5,574	6%	5,796	5%	439	0.5%
Financial and Insurance Services	1,239	1%	1,359	1%	1,487	1%	1,639	2%	400	1.9%
Unclassified	2,071	2%	2,113	2%	2,159	2%	2,193	2%	122	0.4%
Electricity, Gas, Water and Waste Services	329	0%	358	0%	392	0%	423	0%	94	1.7%
Mining	35	0%	40	0%	44	0%	47	0%	12	0.0%
Agriculture, Forestry and Fishing	44	0%	42	0%	41	0%	39	0%	-5	0.0%
Manufacturing	7,274	8%	6,803	7%	6,671	7%	6,582	6%	-692	-0.7%
Total Employment	**88,504**	**100%**	**93,701**	**100%**	**99,461**	**100%**	**105,849**	**100%**	**17,345**	**1.2%**

Source: BTS ; Urbis

Employment Split by Property Type

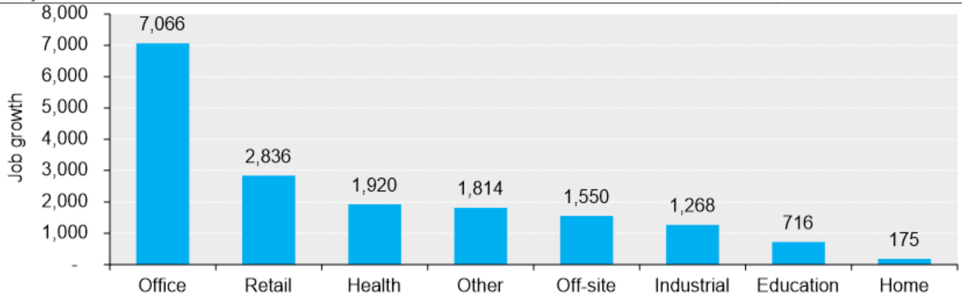
Bayside Council, 2016 to 2031 Table 3.2

Industry Sector	Job Change 2016-31	Job Split by Property Type																	
		Industrial		Office		Retail		Education		Health		Other		Off-site		Home		Total	
Health Care & Social Assistance	2,133			10%	213					90%	1,920							100%	2,133
Retail Trade	2,625	10%	263			90%	2,363											100%	2,625
Education & Training	754			5%	38			95%	716									100%	754
Accommodation & Food Services	1,544					25%	386					75%	1,158					100%	1,544
Wholesale Trade	439	80%	351			20%	88											100%	439
Professional, Scientific & Technical Services	1,751			98%	1,716											2%	35	100%	1,751
Construction	810	10%	81	5%	41									70%	567	15%	122	100%	810
Other Services	451			95%	428							5%	23					100%	451
Public Administration & Safety	1,799			90%	1,619							10%	180					100%	1,799
Manufacturing	-692	100%	-692															100%	-692
Financial & Insurance Services	400			98%	392											2%	8	100%	400
Rental, Hiring & Real Estate Services	703			98%	689											2%	14	100%	703
Administrative & Support Services	943			95%	896							5%	47					100%	943
Transport, Postal & Warehousing	1,968	50%	984											50%	984			100%	1,968
Information Media & Telecommunications	922	20%	184	80%	738													100%	922
Arts & Recreation Services	572			30%	172							70%	400					100%	572
Electricity, Gas, Water & Waste Services	94	90%	85	10%	9													100%	94
Unclassified	122			95%	116							5%	6					100%	122
Mining	12	100%	12															100%	12
Agriculture, Forestry & Fishing	-5													30%	-2	70%	-4	100%	-5
Total Employment	**17,345**	**7%**	**1,268**	**41%**	**7,066**	**16%**	**2,836**	**4%**	**716**	**11%**	**1,920**	**10%**	**1,814**	**9%**	**1,550**	**1%**	**175**	**100%**	**17,345**

Source: BTS ; Urbis

Jobs by Land Use

Bayside Council 2016 to 2031 Chart 3.4



Source: BTS 2011 Journey To Work; Urbis

3.3. INDUSTRIAL DEMAND FORECAST AND GAP ANALYSIS

Table 3.1 presents the calculations for deducing the projected industrial land capacity in Bayside Council by 2031.

There is currently 24.2 hectares of undeveloped industrial employment lands according to NSW Employment Land Development Program (ELDP) 2015 within the Bayside Council, comprising of the Botany Bay and Rockdale LGAs. Taking into account the potential withdrawal of the subject site from industrial land supply (row C), combined with the total demand for industrial floorspace based on 100 jobs per sq.m (row E), results in a surplus of industrial land of around +54,000 sq.m in Bayside Council. This suggests that there is more than enough capacity to support industrial employment growth within Bayside Council over the next 15 years.

Table 3.1 – Industrial Land Gap Analysis, 2031

	Bayside Council	**2016-31**
A	Undeveloped Industrial Land (as per ELDP 2015) (sq.m)	+242,000
B	Rezoning of Subject Site	-61,000
C	*Total Potential Supply (A-B)*	*181,000*
D	Industrial Jobs Growth (2016-31)	1,268
E	Land Area (sq.m) per Job	100
F	*Total Industrial Land Demand (sq.m) (D x E)*	*126,770*
G	**+Surplus / -Deficit Industrial Land Capacity (C-F) (sq.m)**	**+54,230**

Source: Employment Land Development Program 2015; Urbis

3.4. SUMMARY AND IMPLICATIONS

This section covered off a number of the key economic trends impacting employment land demand, specifically:

- In 1996 the economy relied heavily on the manufacturing sector which comprised 13.5% of GSP. By 2015 however this had contracted to 7.4% of GSP, reflecting structural shifts in the NSW economy:
  - A contraction in trade exposed sectors, driven by an increasing Australian dollar over this period
  - Increasing imports and consumption is driving demand for freight and logistics services
  - Growth in 'knowledge based' sectors such as financial and professional services
  - Growth in health care services, driven by an ageing population requiring health and aged care services.
- The resident employment trends over 2006 to 2011 for the Bayside Council reflect similar trends to the NSW GSP, with growing employment in the service sectors and declining employment in the manufacturing sector.
- Bayside Council has more local workers located within its boundary than local jobs. The exceptions to this are jobs within the transport, postal and warehousing and manufacturing, which currently have a surplus in jobs compared to resident workers. This reflects the concentration of industrial land uses within the Bayside Council, in particular the role of Port Botany in providing port related services for the NSW economy.
- In terms of future employment growth there is an estimated additional 1,268 industrial based jobs in the Bayside Council by 2031 requiring an estimated additional 12.7 hectares of industrial land, which is adequately met by the LGAs 18 hectares of undeveloped land.
- Further to this, there are better located industrial precincts identified in Section 2.2 providing significant capacity to accommodate additional industrial jobs growth:
  - Eastern Creek (562 hectares)
  - Moorebank (336 hectares)
  - Marsden Park (238 hectares)
  - WSEA (10,000 hectares).

These precincts contain a large component of undeveloped industrial land, and have a number of significant competitive advantages over the subject site.

4. ECONOMIC BENEFITS

This section identifies the potential employment and economic generation potential associated with the proposed development on the subject site. Specifically, this section addresses the following points:

- Potential employment and economic benefits generated during the construction of the proposed development
- Potential employment and economic benefits generated in the ongoing operation of the proposed development
- Qualitative assessment of additional economic benefits.

Modelling included in this report uses REMPLAN to assess current and potential economic impacts. REMPLAN is an Input-Output model that captures inter-industry relationships within an economy. It can assess the area-specific direct and flow-on implications across industry sectors in terms of employment, wages and salaries, output and value-added (Gross Regional Product). A region can be defined at a national, state or Local Government Area level.

REMPLAN base data is drawn from the Australian Bureau of Statistics and other government agencies. It provides highly reliable, up-to-date, and defensible economic modelling across any state or region in Australia. A summary of the REMPLAN Methodology is provided in Appendix A.

Previous modelling of economic impacts has used ABS Input-Output tables from 1996-97. The multipliers are close to 20 years old and are less accurate in estimating impacts on the economy, particularly due to:

- Productivity changes throughout the economy over the past 20 years
- The changing industry make-up of the Australian economy since 1997 – for example the decline in manufacturing and the rise in financial services.

4.1. CONSTRUCTION

As an indicative estimate for modelling purposes, construction costs associated with the proposed development could be in the order of $873.5 million over the 10-year construction period. After allowing for potential contingencies during the construction process, construction costs would equate to around $960.9 million. Capital expenditure assumptions have been informed by Meriton and Rawlinson's Australian Construction Handbook (2018).

Estimated Construction Costs for Proposed Development

Subject Site — Table 4.1

Land Use	Unit	Size (1)	Cost per unit (2)	Total cost ($M) (1)*(2)
Residential	apt.	2,015	$400,000	$806.0
Parking	sq.m	35,000	$1,725	$60.4
Open Space	sq.m	20,200	$48	$1.0
Childcare	sq.m	1,200	$1,840	$2.2
Retail	sq.m	5,200	$763	$4.0
Total				**$873.5**
Contingency allowance				10%
Total (incl. contingency allowance)				**$960.9**

Source: Rawlinsons Australian Construction Handbook (2018); Urbis

The construction of the development at the subject site is estimated to have the potential to generate $19.4 million in direct Gross Value Added (GVA) per annum and $83.1 million in indirect GVA per annum. Employment represents total numbers of employees without any conversions to full-time equivalence.

Further to the additional direct employment that can be generated from the ongoing operation of the new development and during construction, there are multiplier effects throughout the local, state and national economies. These multiplier effects will be a result of increased demand for materials, services and products from a whole range of suppliers. In economic terms, it represents the absorption of excess supply in other parts of the economy driven by an increase in aggregate demand.

The construction period is estimated to generate an average 171 direct jobs and 531 indirect jobs per annum over the life of the project. It is worth noting that there will be peaks and troughs of actual jobs on the subject site, for instances it has been estimated that approximately 1,000 construction workers were present on site during peak construction periods.

Urbis notes that there are other industry bodies that attempt to estimate employment that can be generated by investment. For instance, the Urban Development Institute of Australia (UDIA) in a submission to the National Commission of Audit identified a total employment (direct and indirect) impact of 11.8 full-time equivalent jobs for every $1 million investment.

Annual Economic Activity – Construction

Subject Site — Table 4.2

Construction Cost[1]	($M)	96.1
Employment		
Direct Jobs	(no.)	171
Indirect Jobs	(no.)	531
Total Jobs	**(no.)**	**702**
Economic generation GVA		
Direct GVA	($M)	19.4
Indirect GVA	($M)	83.1
Total GVA	**($M)**	**102.6**

1. 10% contingency allowance included
Source: Rawlinsons Construction Handbook (2018), REMPLAN, Urbis

4.2. ONGOING OPERATIONS

In addition to the construction phase of the proposed development, the ongoing operations of the non-residential components of the development will also create jobs and generate economic activity (in GVA).

The number of direct jobs for the proposed development was estimated using industry benchmarks on jobs per net lettable area. Direct jobs are entered into REMPLAN to produce an estimate of indirect jobs, and direct and indirect GVA.

The proposed development on the subject site will include space for childcare and retail, which is estimated to generate some 342 total jobs from ongoing operations as shown in Table 4.3.

Proposed Non-Residential Gross Floor Area and Employment

Subject Site — Table 4.3

Non-Residential	GFA (sq.m)	GFA (sq.m) per job	Ongoing Jobs
Childcare	1,200	71	17
Retail	5,200	16	325
Total Non-Residential	**6,400**		**342**

Source: Urbis

Furthermore, the potential serviced apartments in Lot B as identified by SJB in the concept masterplan will generate an additional 0.61 jobs per developed room. This benchmark includes both contracted and workers employed directly by the serviced apartment.

The direct and indirect impacts from economic activity forecast to occur from the proposed development are detailed in Table 4.4.

Once fully developed, it is anticipated that the proposed development on the subject site will result in 342 direct and 196 indirect ongoing jobs. These job numbers do not include the potential employment associated with the 5,000 sq.m serviced apartment.

The 342 direct ongoing jobs to be delivered by the Planning Proposal will constitute a substantial 16%-31% of the 1,100-2,100 jobs (2016-36) projected in the Eastgardens / Maroubra District Centre outlined in the Draft Eastern City District Plan. The direct ongoing jobs will also represent an extensive 2,180% increase on the 15 jobs currently provided on the site under its existing use.

The ongoing operations of the childcare and retail components of the development are estimated to have the potential to generate $24.7 million in direct Gross Value Added (GVA) per year, and $32.8 million in indirect GVA. GVA figures have been estimated using economic employment multipliers most relevant to the operation of childcare centres and retail uses.

Annual Economic Activity – Ongoing Operations

Subject Site — Table 4.4

	Direct effect	Indirect effect	Total
Jobs	342	196	538
Economic generation GVA p.a. ($M)	24.7	32.8	57.5

Source: REMPLAN, Urbis

4.3. RETAIL SPEND

Based on the masterplan provided, the indicative number of residents to be accommodated across the subject site is 2,770 people (as advised by SJB).

Based on the current spending profile of residents within the Bayside Council, an average spend per capita of $13,514 in $2018 is calculated. Therefore, additional population could generate $37.4 million in retail expenditure (in $2018) per annum, as illustrated in Table 4.5. These values do not account for future retail price inflation.

Concept Plan Resident Spending by Product Category per Annum

Based on 2,770 Additional Residents ($Million $2018) — Table 4.5

Number of Residents	Year	Food Retail	Food Catering	Apparel	Home-wares	Bulky Goods	Leisure/ General	Retail Services	Total Retail[1]
2,770 Residents	2018	14.8	6.4	3.9	3.0	3.8	4.1	1.5	**37.4**

1. Spend per annum
Source: ABS MarketInfo 2012; Urbis

The economic benefits associated with this additional spending growth is that it has the potential to improve turnover performance of existing retail precincts in the vicinity of the subject site, and in turn generate additional employment within these precincts.

4.4. AFFORDABILITY AND HOUSING TARGETS

The proposed development can contribute to improving housing affordability and the delivery of housing targets set within NSW's Eastern City District Plan (2018).

Table 4.6 outlines the additional dwelling targets set for the Eastern City District by 2021. A target of delivering 10,150 additional dwellings has been set for the Bayside Council by 2021, equivalent to 19.8% of the total additional new dwellings projected for the Eastern City District.

The proposed development on the subject site will make a significant contribution in achieving this target by providing up to 2,015 new residential apartments to the local region, equivalent to delivering almost a fifth of the additional dwelling targets set for the LGA.

Housing Targets

Eastern City District

Table 4.6

Region	% of Eastern City District Total	Additional Dwellings by 2021
Bayside Council	19.8%	+10,150
Eastern City Total	**100%**	**+46,550**

Source: Eastern City District Plan (2018), Urbis

The limited land available for residential development in a housing market with high underlying demand has resulted in a housing shortage and an affordability constraint within the Bayside Council area. New supply that will be delivered on the subject site will meet this demand, improving affordability outcomes for the Bayside Council area.

Table 4.7 outlines the key drivers of residential housing demand relevant to the subject site. The table shows that the subject site attributes are well aligned and well suited to residential as the site has strong access to amenities, employment options and future public transport infrastructure.

Residential Demand Drivers

Subject Site Table 4.7

Factors	Comments	Implications for the Subject Site
1. **Access to amenities**	• Westfield Eastgardens Shopping Centre is located approximately 500 metres to the south of the subject site, a shopping centre which provides discretionary retail for local and regional residents. • There are a number of schools located close to the subject site including South Sydney High School, Pagewood Public School and Maroubra Junction Public School. • There are a number of recreational parks located close to the subject site, including Mutch Park, Jellicoe Park and Heffron Park. • Prince of Wales Private Hospital is located 3.4km north of the subject site, with City East Specialist Day Hospital (1.8km) and Maroubra Medical Centre (1.8km) also located in proximity to the subject site.	• The subject site's close proximity to Westfield Gardens makes it a desirable location for housing, noting strong residential access to high quality retail amenity and services. • Good access to schooling and recreation will attract residential demand from couple families with children.
2. **Access to employment**	• The subject site has good access to major commercial employment nodes due to its proximity to the M1 Motorway entry access point. The subject site is located near the Anzac Parade Corridor, which provides linkages to major employment precincts including: – Randwick Health and Education Precinct (3.5km, 9 minute drive) – Port Botany Industrial Area (6.5km, 12-minute drive) – Sydney CBD (10.7km, 28 minute drive).	• Residents often prefer to live close to work, enabling them to minimise travel times and improve work life balance. • The subject site's close proximity to the emerging Randwick Health and Education Precinct is expected to drive future residential apartment demand on the subject site.

Factors	Comments	Implications for the Subject Site
3. Transport and infrastructure	• The proposed CBD and South East Light Rail will connect the Sydney CBD to the south eastern suburbs of Randwick and Kingsford, with a potential extension along the Anzac Parade Corridor. Three potential extensions to Maroubra Junction, Malabar and La Perouse will improve the subject site's connectivity to other areas of Sydney. • The subject site is located adjacent to a bus station on Bunnerong Road, which provides connection to Little Bay and the Sydney CBD	• Access to good public transport and road infrastructure are important to potential purchasers and renters. Particularly, linkages to the CBD, airport and major employment centres. • The proposed CBD and South East Light Rail is expected to revitalise Sydney's south eastern suburbs, as improved connectivity and linkages will create new jobs and reshape the existing community. In turn, these benefits are set to be realised by future residential development on the subject site.

4.5. SUMMARY AND IMPLICATIONS

The proposed development on the subject site is estimated to result in an increase in direct and indirect employment and economic activity (Gross Value Added – GVA). This will occur in the construction phase of the proposed development and also through the ongoing operations of the non-residential land uses. The results of the economic benefits analysis are summarised in the following table:

Annual Economic Activity

Subject Site Table 4.8

Construction Phase	Direct effect	Indirect effect	Total
Jobs	173	539	**712**
Economic generation GVA p.a. ($M)	19.7	84.2	**103.8**
Ongoing Operations			
Jobs	342	196	**538**
Economic generation GVA p.a. ($M)	24.7	32.8	**57.5**

Source: REMPLAN; Urbis

The proposed development is also expected to deliver an increase in housing by renewing an existing urban area, improving housing affordability by delivering increased housing supply with strong access to employment, amenity and transport infrastructure.

The potential inclusion of serviced apartments in Lot B will further contribute to the mix of lands uses provided within the site and is a response to the site's strategic centre location and the requirements of the Gateway Determination. The development of a serviced apartment on the subject site has the potential to add create employment (0.61 jobs per room).

APPENDIX A SUMMARY OF REMPLAN METHODOLOGY

- REMPLAN uses either the value of investment or employment generation as the primary input. For this analysis, the value of total upfront investment has been used as the key input to assess the benefits of the construction phase, whereas future employment on the site is the input to assessing the on-going economic benefits of the operation phase
- Outputs from the model include employment generated through the project and economic Gross Value Added at the state level
- Employment generated includes all full-time and part-time jobs created over the life of the construction phase; or in terms of the on-going operations, total on-going jobs generated
- Gross Value Added or GVA is a measure of the value of goods and services produced in an area, industry or sector of an economy during a certain period. In this case, GVA represents the total economic contribution of the project
- Both the direct and indirect benefits are modelled for employment and value added:
  – *Direct* refers to the effect felt within the industry where the investment is being made. For example, during the construction phase, new direct jobs are created within the construction industry
  – *Indirect* effects are those felt within industries that supply goods to the industries directly affected by the investment as well as consumption flow-on effects associated with additional income to households through higher wages and salaries.
- Economic benefits are modelled for the construction and the on-going operation phases. For both phases, the employment and value-added numbers are presented on an annualised basis
  – Construction phase benefits accrue each year when the project is under construction (or a pro-rata basis for any part year construction period).
  – On-going benefits accrue each year of operation.

DISCLAIMER

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This report has been prepared with due care and diligence by Urbis and the statements and opinions given by Urbis in this report are given in good faith and in the reasonable belief that they are correct and not misleading, subject to the limitations above.

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Josh Ford
Bayside Council
PO Box 21
Rockdale NSW 2216

Thursday, 5 October 2017

Dear Josh

Subject: 128 & 130-150 Bunnerong Road, Pagewood

HillPDA was commissioned by Bayside Council (Council) to undertake a peer review of the Economic Impact Assessment (EIA) for 128 & 130-150 Bunnerong Road, Pagewood (referred to the Assessment hereafter) prepared by Urbis.

The Assessment was prepared on behalf of Meriton in support of the Planning Proposal request to rezone the land for the aforementioned site from part IN1 General Industrial and part R3 Medium Density Residential to R4 High Density Residential.

The current scheme for the Planning Proposal as per the EIA prepared by Urbis seeks approval for the following uses:

- 2,068 apartments;
- 100-place childcare centre (totalling 1,200sqm);
- Retail uses (totalling 1,000sqm); and
- Community uses totalling 2,000sqm.

The planning proposal includes the rezoning of Lot 1 (currently IN1 Land) and additional dwellings on that part of Lot 2 immediately to the west of Lot 1.

As stated above Urbis describes the proposal as 2,068 new dwellings (representing a net additional 1,098 dwellings given the planning proposal spans part of Lot 2 which already has development consent in place for 2,223 dwellings). It's a little unclear from that description what the net increase in dwellings will be – it appears that have assumed a net increase of 2,068 new dwellings. From our calculation we estimate it would be around 1,477 given that the final scheme would provide around 3,700 dwellings of which 2,223 dwellings have Stage 1 consent on Lot 2.

The below section provides a peer review of the aforementioned Assessment.

Relevant Government Documents

HillPDA agrees with Urbis that the Planning Proposal is consistent with the following goals of *A Plan to Grow Sydney*:

- Providing a competitive economy;
- Improving housing choice;
- A sustainable city that protects the natural environment; and
- Providing housing near established employment, services and education facilities.

The Assessment argues the Planning Proposal contributes to meeting key employment and dwelling targets specified in Botany Bay Planning Strategy 2031 (2009) and employment targets set out in the Rockdale City Council Employment Lands Strategy. However the Assessment fails to demonstrate how the Planning Proposal is consistent and/or was factored in with recent targets and goals/directions set out in the Draft Central District Plan (2016).

In amending a LEP in the Sydney Metro area, a Council must be able to establish that the amendment is aligned with the relevant Metropolitan and **District Plans**.

Upon reviewing the District Plan, HillPDA finds the Planning Proposal is largely consistent with the following actions of the Policy:

- P5: Develop better understanding of the value and operation of employment and urban services land. This outcome encourages an increase in total jobs;
- P6: Identify opportunities to grow and better connect the south east area of the Central District;
- L1: Prepare local housing strategies - increase housing choice by supporting affordable and appropriate housing for all;
- L4: Encourage housing diversity;
- 3.4.1: Plan for the growth of centres. Job targets for Eastgardens-Maroubra Junction range from 8,000 to 9,000;
- 3.5: Growing economic activity in centres
  - help to stimulate economic activity and innovation through the co-location of industries
  - provide jobs closer to home in support of the 30-minute city

  - promote healthier lifestyles and community cohesion with improved walking, cycling and transport access to a wider range of services and opportunities
- 3.7: Improving 30-minute access to jobs and services;
- 4.1: The Central District's people. By 2036, the District's population is projected to grow by an estimated 325,000 people; to around 1.338 million. To accommodate these new residents, the District will require new housing and employment opportunities.

Based on the above, HillPDA concludes the Planning Proposal is aligned with the District Plan.

HillPDA also note that the Assessment does not consider Section 117 Direction 1.1 which relates to Business and Industrial zones.

This Direction applies when a planning proposal would affect land within an existing or proposed business or industrial zone. It is recommended the Assessment is updated to address the five key requirements of Direction 117, these being:

- Follow the objectives of the Direction;
- Retention of existing business and industrial zones;
- No net loss of potential floorspace for employment uses and related public services in business zones;
- Not reduce the potential floorspace area for industrial uses in industrial zones; and
- Be in accordance with a Strategy approved by the Director General of the DP&I.

HillPDA considers the Planning Proposal to be consistent with relevant strategic and statutory planning controls. Moreover the development will have a number of positive benefits for the surrounding area including improving housing choice and affordability and increased employment and economic activity during both the construction and operational phase as well as the potential to revitalise redundant land in and around the Subject Site.

Competitive Positioning

Competing Industrial Precincts

The Assessment refers to and applies data from the NSW DPE Employment Lands Development Program (ELDP) 2015 Update

Report. More recent data has since become available, namely the Employment Lands Development Monitor[1] (ELDM) 2016.

The changes between 2015 and 2016 datasets are described as follows:

- There is 531.0Ha of industrial land within Bayside Council compared to 520Ha in 2015 (as reported in the Assessment);
- Around 9.9Ha of this land is undeveloped in 2016 down from 24.2Ha in 2015 (as adopted in the Assessment);
- Across the Sydney Metropolitan Region, Bayside contributes to 3.9% in 2016 of total employment lands compared to 3.8% in 2015 (as reported in the Assessment);
- Bayside contributes to 4.9% in 2016 of total developed lands compared to 4.7% in 2015 (as reported in the Assessment);
- Bayside contributes to 0.3% of total undeveloped land in 2016 compared to 0.8% in 2015 (as reported in the Assessment).

The above comparisons reveal that the level of undeveloped land, and in turn land available for future industrial uses, is substantially lower than presented in the Assessment. The implications of this is discussed in greater detail below (refer to 'Industrial Demand Forecast and Gap Analysis' of this Report).

Industrial Demand Drivers

HillPDA consider the industrial demand drivers identified in the Assessment, namely; access, scale and land use compatibility to be reasonable. HillPDA also considers the use of these drivers to test the viability of the various industrial precincts within the new Bayside LGA and the ranking they have assigned for each of the precincts which includes a low overall viability ranking for the subject Site to be reasonable (refer to pages 14 to 19 of the Assessment).

HillPDA agrees with Urbis that industrial uses are better suited to some of the other stronger industrial precincts within Bayside due issues of scale and land use compatibility.

Major Western Industrial Precincts

With declines in manufacturing and a growth in imports, warehousing, transport, distribution and logistics businesses have thrived. These types of businesses together with larger manufacturing services have shifted their preferred locations from

[11] ELDP has been renamed to the ELDM

the inner city to the Outer-West and South-West of Greater Sydney. These locational decisions have been supported by improvements to the outer orbital ring roads and motorways (M5 and M7), Australia's largest integrated transport and urban development known as WestConnex and the proposed development of intermodal facilities such as the Moorebank Intermodal. These locations benefit from the availability of larger sites required for modern logistics businesses.

As such HillPDA agrees with Urbis' rational for undertaking a competitive positioning assessment of Major Western Sydney Industrial Precincts, including Eastern Creek, Moorebank, Marsden Park and WSEA (refer to pages 20 to 23 of the Assessment).

As established in the Assessment the Major Western Sydney Industrial Precincts, including Eastern Creek, Moorebank, Marsden Park and WSEA (refer to pages 20 to 23 of the Assessment) contain a large component of undeveloped industrial land and possess a number of competitive advantages over the Subject Site such as:

- B-double truck access;
- Direct access to major roads and intermodal terminals (IMTs);
- Larger lot sizes; and
- Minimal land use conflicts with non-industrial land uses.

Based on the above, HillPDA also acknowledges the difficulty in retaining industrial uses at the site, with such operations better suited to these Major Western Industrial Precincts.

Employment Analysis

Economic Structural Change

As established in the Assessment there has been significant structural change between 1995 and 2015 with growing GSP in industries such as financial and insurance services, health care and social assistance and professional services which has been offset by a fall in manufacturing. A review the latest data release demonstrates this trend has continued in 2016 with manufacturing remaining at 7.4%[2] of total GSP.

Employment Analysis

HillPDA agrees with the methodology used for the job gap analysis (refer to page 29 - 32 of the Assessment) and conclusions made by

[2] ABS

Urbis relating to the majority of employment growth being in the office, health and retail properties as opposed to industrial zoned properties.

Industrial Demand Forecast and Gap Analysis

HillPDA agrees with the methodology used in determining the industrial land gap analysis (refer to page 33 of the Assessment) however have identified issues with two of the assumptions used in this analysis, described as follows:

- Based on the latest ELDM data there was only 9.9Ha of undeveloped land in 2016 compared to 24.2Ha in 2015; and
- The Assessment assumes an employment density of one job per 100sqm. Research indicates that the average job density across Sydney's employment lands is substantially lower than this at one job per 200sqm.[3]

Revising the analysis to reflect the above indicates that there is actually a deficit of 21.56Ha in industrial land capacity. The calculations are provided in the below table.

	Bayside Council	2016-31
A	Undeveloped industrial land (as per ELDM 2016) Ha	9.9
B	Rezoning of Subject Site (Ha)	6.1
C	Total Potential Supply (A-B)	3.8
D	Industrial Job Growth (2016-31)*	1,268
E	Land Area (Ha) per Job	0.02
F	Total Industrial Land Demand (Ha) (D*E)	25.36
G	Surplus / Deficit Industrial Land Capacity (C-F) (Ha)	-21.56

Source: Employment Land Development Monitor 2016 * As provided in the Assessment

Although the above suggests the future employment growth for industrial based jobs within Bayside Council will not be adequately met by the LGA, there are better located industrial precincts (including Eastern Creek, Moorebank, Marsden Park, WSEA) providing significant capacity to accommodate additional industrial jobs growth. Much of the anticipated employment growth for industrial based jobs in Bayside LGA is likely to gravitate towards these Precincts which offer significant competitive advantages.

[3] Employment Lands Development Program 2015

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Economic Benefits

Construction

HillPDA consider the construction cost assumptions for the non-residential land uses and estimate of construction costs for the proposed development to be reasonable and in line with industry standards[4].

However as discussed above HillPDA believe that the total construction costs may be somewhat misrepresented since the Assessment assumes a net increase of 2,068 dwellings. HillPDA estimate it would be around 1,477 given that the final scheme would provide around 3,700 dwellings of which 2,223 dwellings have Stage 1 consent on Lot 2. As such the construction costs may be substantially lower than the estimated $983m proposed in the Assessment.

Annual Economic Activity

REMPLAN as sourced in the Assessment is a widely accepted model to measure economic activity in the industry.

Conversely, HillPDA source their multipliers from ABS Australian National Accounts: Input-Output Tables 2012-13 (ABS Pub: 5209.0). These tables identify first round effects, industrial support effects and consumption induced multiplier effects at rates of $0.620, $0.647 and $0.945 respectively to every dollar of construction.

The table below quantifies associated economic multipliers resulting from the construction process based on the economic multipliers from the Australian National Accounts assuming a construction cost for the proposed scheme of $983m as sourced from the Assessment. As discussed above the construction costs and associated benefits are likely to be substantially lower than this however.

Table 1: Construction Multipliers ($m)

	Direct Effects	Production Induced Effects		Consumption Induced Effects	Total
		First Round Effects	Industrial Support Effects		
Output multipliers	1	0.620	0.647	0.945	3.3088
Output ($million)	983	610	636	929	3,253

Source: Hill PDA Estimate using data from ABS Australian National Accounts: Input-Output Tables 2012-13 (ABS Pub: 5209.0)

[4] Rawlinsons Australian Construction Handbook (2017); Residential construction costs were provided by Meriton and are assumed to remain at $400,000 per apartment.

HillPDA estimates the total economic activity generated by construction to be $3.3b which is well above the $98.5m estimated in the Assessment.

Note that the multiplier effects will occur over a national reach and are not necessarily local. The ABS states that:

"Care is needed in interpreting multiplier effects; their theoretical basis produces estimates which somewhat overstate the actual impacts in terms of output and employment. Nevertheless, the estimates illustrate the high flow-on effects of construction activity to the rest of the economy. Clearly, through its multipliers, construction activity has a high impact on the economy."

In particular the multiplier impacts can leave the impression that resources would not have been used elsewhere in the economy had the development not proceeded. In reality many of these resources would have been employed elsewhere. It should also be noted, as stated in the NSW Treasury guidelines, that:

"Direct or flow on jobs will not necessarily occur in the immediate vicinity of the project – they may be located in head office of the supplier or in a factory in another region or State that supplies the project"[5].

Nevertheless, economic multiplier impacts represent considerable added value to the local and broader Australian economy.

Construction Related Employment

It is estimated that the equivalent of 2.35 construction positions over 12 months are created for every one million dollars of construction work undertaken[6]. Based on $983m of construction cost, HillPDA estimate some 2,310 job years[7] would be directly generated by the development as shown in the table below, which is well above the 176 estimated in the Assessment.

[5] Source: Office of Financial Management Policy & Guidelines Paper: Policy & Guidelines: Guidelines for estimating employment supported by the actions, programs and policies of the NSW Government (TPP 09-7) NSW Treasury
[6] Source: ABS Australian National Accounts: Input-Output Tables 2012-13 (ABS Pub: 5209.0)
[7] Note: One job year equals one full-time job for one full year

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Table 2: Construction Employment

	Direct Effects	Production Induced Effects		Consumption Induced Effects	Total
		First Round Effects	Industrial Support Effects		
Multipliers	1	0.728	0.794	1.423	3.945
Employment No. per $million	2.352	1.713	1.869	3.347	9.280
Total job years created	2,312	1,684	1,837	3,290	9,123

Source: Hill PDA Estimate using data from ABS Australian National Accounts: Input-Output Tables 2012-13 (ABS Pub: 5209.0) adjusted by CPI to 2015.

The ABS Australian National Accounts: Input-Output Tables 2012-13 identified employment multipliers for first round, industrial support and consumption induced effects of 0.73, 0.79 and 1.42 respectively for every job year in direct construction. Including the multiplier impacts, HillPDA estimates the development will generate over 9,100 job years (see table above) directly and indirectly, which again is well above the 663 estimated in the Assessment.

Proposed Non-Residential GFA and Employment

HillPDA generally agree with employment densities used to calculate the ongoing jobs (refer to page 37 of the Assessment). 16sqm per job for retail is on the high end of the range for retail (typical of food specialty retail), with 18 to 20sqm a more appropriate estimate, however the difference would not be significant.

The estimated direct GVA p.a. of $10.9m in the Assessment, which equates to $101,869 GVA per worker appears high considering the proposed employment used. Based on IBIS World Report which relate to the proposed employment uses we would estimate the GVA per worker to be approximately $38,313 giving a total GVA of $4.1m.

Retail Spend

HillPDA considers the indicative number of residents of 3,309 (which equates to 1.6 residents per apartment) to be somewhat understated in the Assessment. Adopting an occupancy rate of 2.2 residents per apartment[8] and allowing for a 5% vacancy rate, HillPDA estimates the Subject Site will accommodate 4,300 new residents. Assuming an average retail spend of $13,075pa in $2016 (which we consider to be reasonable) means the total retail expenditure generated from additional residents will increase from $43.3m as stated in the Assessment to $56.5m.

[8] The Botany Bay LGA Community Profile 2016 indicates the occupancy rate for apartments is in the order of 2.4. HillPDA has applied a more conservative rate of 2.2 for the purpose of this analysis to reflect future trends i.e. Smaller household sizes and an increasing proportion of lone person households.

Affordability and Housing Targets

As established in the Assessment, HillPDA agrees the proposed development has the potential to contribute to improving housing affordability and the delivery of housing targets set within the NSW's Central District Plan (2016).

Residential Demand Drivers

HillPDA considers the rationale provided in the Assessments for site's suitability for residential uses in terms of:

- proximity to amenities including Westfield Eastgardens, school establishments and recreational uses;
- proximity to employment precincts including Randwick Health and Education Precinct and Port botany Industrial Area; and
- being well serviced by public transport

to be reasonable and just.

Conclusion

Overall there is sufficient justification to rezone the Subject Site to allow for mixed used predominantly residential development given the existing or potential land conflicts with residential to the north, south, east and west and given the site's proximity to major amenities (i.e. Westfield Eastgardens), employment hubs and education establishments.

The only issue is our analysis shows that rezoning the Subject Site would result in the loss of 6 hectares of industrial land in Bayside LGA. Despite this the site is not proximate to the ports area and it is surrounded by residential on all sides.

Retail Demand

In this next section we have assessed the appropriate size for retail uses on the Subject Site and suggested an appropriate retail mix.

Catchment

With Westfield Eastgardens immediately to the south of the Subject Site, offering a strong retail offer that serves the broader area, we would anticipate the catchment for the retail uses on site would be confined to the immediate local area primarily servicing the residents on site and those residents within a walkable catchment. Retail uses on site would have a secondary role to Westfield Eastgarden, offering local residents with a convenience based shopping alternative.

Assuming 7,900[9] additional persons reside on the BATA site (which incorporates the Subject Site) over the next decade (this equates to ~790 person p.a. to 2026), HillPDA estimates the population with walking distance of the Subject Site will increase from some 3,300 persons in 2016 to over 11,500 persons in 2031.

Residential Expenditure

Residential expenditure for the catchment within walking distance of the Subject Site was sourced from AnySite Data (2016) which provides household expenditure by broad commodity type.

Based on the above, and assuming population growth forecasts as discussed above, HillPDA has forecast household retail expenditure in the catchment to increases from $49.0m in 2016 to $188.9m in 2031. Note the forecasts allow for 10% of expenditure from beyond the trade area and assume growth in real retail spend per capita of 0.8% per annum consistent with the long term trend in historic spend.

The type of retail demand from residents would be for high value retail facilities with an emphasis on convenience. Based on this and the strong retail offer provided immediately to the south at Westfield Eastgardens, HillPDA would anticipate the retail uses on site has the potential to capture up to 15% of the residential expenditure available within the catchment.

Based on the above assumed capture rate the retail uses on site could capture up to $7.3m of retail expenditure in 2016 from residents, increasing to $28.3m in 2031.

Retail Demand

Demand for retail floor space is forecast by applying target turnover rates (or industry benchmarks[10]) to captured spend. Assuming a target turnover rate of $7,000/sqm (based on industry benchmarks) and growth at 0.5% per annum to allow for real turnover increases in line with historic trend[11] HillPDA has forecast demand for around

[9] This assumes 3,700 apartments on the whole of BATA site and an occupancy rate of 2.2 persons per dwelling has been adopted based on ABS data for the Bayside LGA. HillPDA have also allowed for a 5% vacancy rate.
[10]Note: Derived from various sources including Urbis Retail Averages, ABS Retail Survey 1998-99 escalated at CPI to $2016, Shopping Centre News, HillPDA and various consultancy studies.
[11]Note: Expenditure per capita has increased at an average rate of 1.0% above CPI every year since 1986 although HillPDA is currently using an assumption of 0.8% growth per annum from 2016 onwards. Around half of this increase has translated into an increase in retail floorspace per capita (from 1.8sqm in the 1980s to around 2.2-2.3sqm today). The balance of the increase in expenditure has translated into a real increase in turnover per square metre rates.

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2,500sqm in 2021 increasing to over 4,100sqm of retail floor space by 2031.

Based on similar sized centres the amount of shop front space should be adjusted upwards by a further 10% to accommodate complementary non-retail uses such as real estate, financial, travel and medical services as well as 1 or 2 vacancies.

Given the above there would be sufficient demand for 4,500sqm of shop front space.

Recommended Retail Mix

Based on a review of similar sized retail offering (i.e. 3,000sqm-5,000sqm) there is potential for a convenience based retail offer comprising of:

- A small or medium format supermarket/grocer;
- Possibly an Asian grocery (mini-major);
- Several complementary specialty stores (e.g. bakery, patisserie, newsagency, butcher);
- Several personal services (e.g. hairdresser, laundromat, etc);
- Several cafes and restaurants; and
- Several commercial suites.

Yours sincerely

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HERITAGE IMPACT STATEMENT

128 & 130-150 BUNNERONG ROAD, PAGEWOOD

19 NOVEMBER 2018
PREPARED FOR KARIMBLA CONSTRUCTIONS

URBIS

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Report Number	03 Final to client – 19.11.18

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EXECUTIVE SUMMARY

Urbis has been engaged by Karimbla Constructions to prepare the following Heritage Impact Statement for the subject site, 128 Bunnerong Road, Pagewood. Condition 1 (g) of the *Alteration of Gateway Determination* (ref PP_2017_BSIDE_007_00), dated 9 October 2018, requires an updated Heritage Impact Statement assessing the revised proposal.

The site previously formed part of a larger site which was constructed for General Motors Holden then from the 1980s was occupied by British American Tobacco Australasia (BATA) facility. BATA have since vacated the site and most of the site has been zoned and is under construction for a residential/mixed use precinct, in line with prevailing planning strategies.

The subject site has no associated heritage listings. The site is located in the general vicinity of Jellicoe Park (Item 155) and Harris Reserve (Item 66), both items of local heritage significance listed within Schedule 5 of the *Botany Bay Local Environmental Plan 2013 (LEP)*.

A comprehensive Heritage Impact Statement was completed by Urbis (March 2017) for the original planning proposal and it concluded that there would be no negative heritage impacts on the items in the nearby vicinity. This remains unchanged with the modified proposal.

The previous HIS also identified a number of built elements remaining on the site that have a degree of local heritage significance. These elements include the former Administration Building and the remnant original and distinctive fabric associated with the plant building pillars.

Subsequent to the above the client has liaised with Bayside Council who have no objection to the demolition of all buildings on the site. The site has subsequently received approval under complying development for the demolition of all existing buildings located on the site. A number of other modifications to the original planning proposal have also been approved.

This Heritage Impact Statement has been prepared to assess the potential heritage impact of the *revised proposal* on the site which does not retain any of the existing buildings on the site.

Due to the identification of heritage significance in the previous HIS, the below recommendations and mitigation measures are proposed for the revised proposal.

Recommendations:

To mitigate the heritage impacts on the site it is recommended that the following be undertaken prior to demolition:

1. Photographic archival of the Administration Building, Canteen Building and general vistas incorporating the remaining buildings and elements collectively.

2. Salvage Report, completed by a suitably qualified heritage specialist, to identify building materials, decorative elements and other items which should be salvaged for re-use prior to demolition.

An Interpretation Plan should be developed as part of the future development application which interprets the former industrial use of the site and specifically its connection to the Australian car manufacturing industry. Elements, salvaged from the site may be utilised in this interpretation plan.

It is recommended that the above recommendations and mitigation measures are implemented to mitigate heritage impacts on the site.

1. INTRODUCTION

1.1. BACKGROUND

Urbis has been engaged by Karimbla Constructions to prepare the following Heritage Impact Statement for the updated planning proposal for the subject site at 128 Bunnerong Road, Pagewood.

The site previously formed part of a larger site which was constructed for General Motors Holden and from 1980 was occupied by British American Tobacco Australasia (BATA) facility. BATA have since vacated the site and most of the site has been zoned and is under construction for a residential/mixed use precinct, in line with prevailing planning strategies.

The area in blue in Figure 1 below is the subject of this assessment.

The subject site has no associated heritage listings. The site is located in the general vicinity of Jellicoe Park (Item 155) and Harris Reserve (Item 66), both items of local heritage significance listed within Schedule 5 of the *Botany Bay Local Environmental Plan 2013 (LEP)*.

Therefore, this heritage impact statement has been prepared to assess the potential heritage impact of the revised proposal.

1.2. SITE LOCATION

The site is located at 128 and 130-150 Bunnerong Road, Pagewood. It is legally described as the whole of Lot 1 in DP 1187426 and Lot 24 DP 1242288, respectively. It has frontages to Bunnerong Road to the east, Heffron Road to the north and Banks Avenue to the west. It is located within the Bayside LGA.

Figure 1 – Aerial imagery showing the approximate boundaries of the subject site (blue boundary).

Source – Nearmaps.com

1.3. METHODOLOGY

This Heritage Impact Statement has been prepared in accordance with the NSW Heritage Branch guideline 'Assessing Heritage Significance' (2001). The philosophy and process adopted is that guided by the *Australia ICOMOS Burra Charter* 1999 (revised 2013).

Site constraints and opportunities have been considered with reference to relevant controls and provisions contained within the *Botany Bay Local Environmental Plan 2013* and the *Botany Bay Development Control Plan 2013*.

Please note that the canteen building and the boilerhouse were not able to be accessed on the day of the site visit.

This report only addresses the *revisions to the planning proposal.* For the assessment on the original planning proposal (including rezoning) please refer to the Heritage Impact Statement completed in March 2017.

1.4. AUTHOR IDENTIFICATION

The following report has been prepared by Alexandria Barnier (Senior Consultant) and Gavin Patton (Heritage Consultant). Kate Paterson (Director, Heritage) has reviewed and endorsed its content.

Unless otherwise stated, all drawings, illustrations and photographs are the work of Urbis.

1.5. THE PROPOSAL

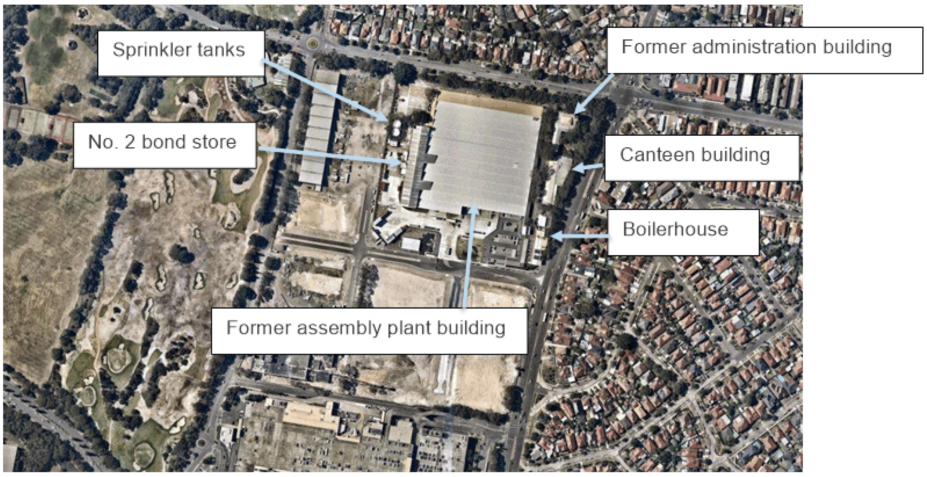
The revised approved proposal specifically includes:

- The demolition of the existing industrial buildings on the site (under complying development);
- A requirement for the inclusion of a minimum of 5,000 square metres of gross floor area for commercial premises and/or other permitted non-residential land uses;
- An update to the land use zoning of the site to include commercial premises, service apartments and recreation facilities (indoor); and
- A number of other administrative amendments to the Gateway Determination approval.

2. SITE DESCRIPTION

The site is bounded by Heffron Road along the northern boundary and Bunnerong Road to the east. The western side is bounded by a former service road. An access road extends west from Bunnerong Road and defines the southern boundary of the site. It is one of three vehicular access points to the site. Vehicle access was formerly also from the northern boundary and from the north-west corner, however these have since been closed. A description of the individual structures is set out below.

Figure 2 – Location of individual structures on the subject site.



Administration Building

There are two original buildings to the north-east corner of the site. The most distinctive is the two storey administration building which was built in the Inter War Functionalist Style (completed 1940). This building has some presence from the adjacent intersection (Bunnerong and Heffron Road) largely characterised by its clock tower with inset teal tiles. The horizontality of the building is emphasised by its rhythmic fenestration pattern and the pronounced string courses which run at the window sill height and the ceiling height of both floors. There is also a string course running along the top of the parapet.

There have been some changes to the primary façade of the administration building. A number of doors and small windows have been added which have had some impact on the legibility of the original design intent of the façade. There is also a large yellow bulkhead and ground floor ceiling height running part way along the façade. There is a WWI memorial tree and plaque in the setback from Bunnerong Road adjacent to the building.

Internally, the building appears to largely retain its original layout. It also retains its original timber office partitions. Otherwise, it appears that the building has largely been refit in line with its use by BATA and now comprises largely unremarkable fabric. Further investigation should be undertaken to determine whether original finishes are present under the existing.

Figure 3 – External images of the administration building.

Picture 1 – View west towards the principal eastern façade.

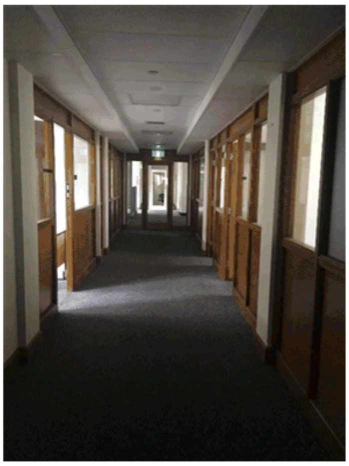
Picture 2 – Clocktower to the north-eastern corner.

Picture 3 – View towards the southern façade.

Picture 4 – View towards the southern western corner.

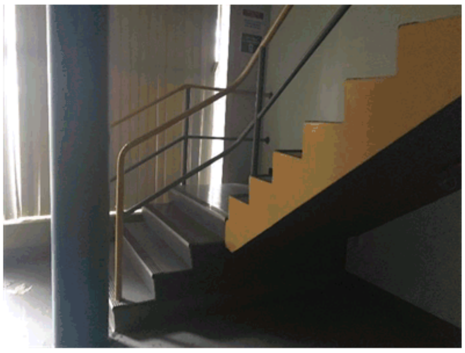
Picture 5 – View of the eastern facade

Figure 4 – Internal images of the former administration building.



Picture 6 – View north up ground floor hallway.

Picture 7 – View across ground floor office space.



Picture 8 – Original stairs from ground floor.

Picture 9 – View across northern space. Assumed to be former showroom.

The Canteen Building

The Canteen Building is located to the immediate south of the administration building. It was constructed in 1940 in the same style as the aforementioned however it is a single storey. The face brick building originally had a double storey entry feature element halfway down its eastern façade however this was removed in the 1950s when the building was expanded eastward towards Bunnerong Road. It was also extended to the north towards the administration building. There are unsympathetic awning structures to the northern and western facades. The building is therefore less remarkable than it originally was and makes a lesser contribution to the setting of the distinctive building described above.

Access to the internal spaces within this building was not possible on the day of the site inspection. It appears from looking through the windows that the building has been refit, similar to that above. Access should be gained and further investigation undertaken to determine extent of original finishes.

Figure 5 – External images of the canteen building.

Picture 10 – View towards northern façade of 1950s extension to the canteen building.

Picture 11 – View to the north-western corner.

Picture 12 – View along the western façade.

Picture 13 – View along part of the northern façade.

Picture 14 – View down eastern façade (1950s extension).

The Boiler House

The Boiler House building is located to the south of the Canteen Building. It postdates the earlier buildings, first appearing in historic aerials in 1950. The building is largely utilitarian in character with few qualities representative of an identifiable period. The building has a gable ended roof form. The fenestration is multipaned warehouse style and there are four vehicle entries along the western façade. There are a number of service risers from the roof. Access to this building was no permitted on the day of the site inspection.

Figure 6 – External images of the Boiler House.

Picture 15 – View east towards the boilerhouse.

Picture 16 – View to the north west corner.

Picture 17 – View towards the south west corner.

Picture 18 – View along the western façade.

Picture 19 – View of the ancillary structures to the north of the Boiler House.

Former Assembly Plant Building

This building was originally a sawtooth structure marked at the corners by a face brick pillar with inset teal tiles. The sawtooth structure was added to considerably throughout the history of the site however much has now been removed, with less than half remaining. Much of the early structure has been removed with less than half the sawtooth bays remaining. The two original pillars on the northern boundary are extant. The original fenestration along all facades has been replaced with contemporary fabric.

Internally it appears that the original sawtooth structure is relatively intact however the cladding over may have been replaced. Further investigation should be undertaken to determine if any machinery associated with General Motors has been retained, none was identified during the site visit.

Figure 7 – External images of the plant building.

Picture 20 – View along eastern façade.

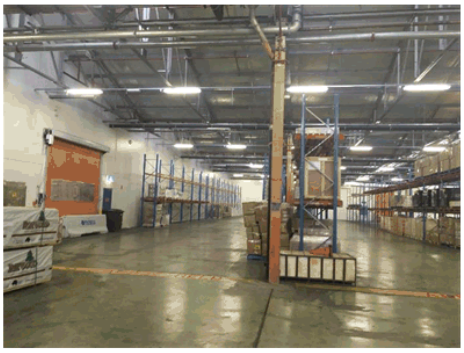
Picture 21 – Existing presentation of the assembly plant to the north-east

Picture 22 – View to the north-west corner.

Picture 23 – View along northern facade.

Figure 8 – Internal images of the assembly plant building.

Picture 24 – View east across plant building.



Picture 25 – View north across plant building.

No 2. Bond Store

To the west of the main factory building is the no. 2 Bond Store. The bond store dates from the 1940s and retains an original northern façade. However, the store has been substantially expanded south and the rear façade has been removed and replaced with contemporary wall sheeting. The northern façade is constructed of brick and is of the same character as the pillars on the building adjacent. It features face brick with inset tiles. The internal roof structure appears original and constitutes a series of steel trusses.

Figure 9 – External images of the No. 2 Bond Store.

Picture 26 – Remnant northern façade.

Picture 27 – View towards the north west corner.

Picture 28 – View along western façade.

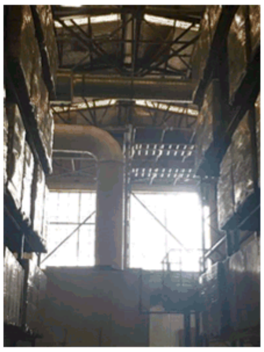
Picture 29 – View toward north west corner.

Figure 10 – Internal images of the no. 2 bond store.

Picture 30 – View across bond store.

Picture 31 – Original roof structure.

Picture 32 – View north towards inside of original façade.



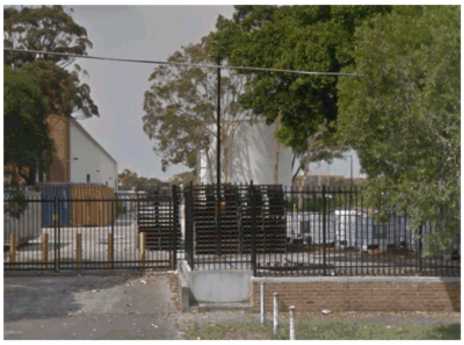
Picture 33 – View north towards inside of original façade.

Sprinkler Water Tanks

To the immediate west of the No.2 Bond Store is located two sprinkler water tanks. These appear to be of standard construction and were built between 1954 and 1963. The tanks are partly visible from Heffron Road as seen in the images below.

Figure 11 – Images towards the sprinkler water tanks.

Picture 34 – View south from Heffron Road.



Picture 35 – View south from Heffron Road.

Source: Google Earth

3. HISTORICAL OVERVIEW

3.1. AREA HISTORY

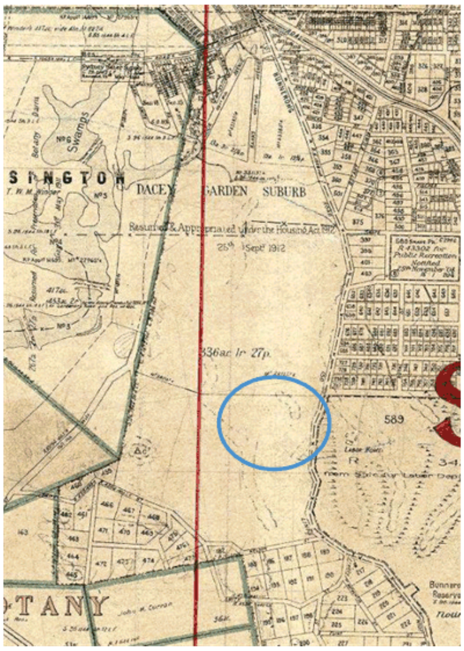
Pagewood was originally planned as a garden suburb, similar to neighbouring Daceyville. However, it was developed to provide housing after World War I when there was a shortage of land. The new suburb began developing in 1919 as an estate called Monash Gardens. The suburb was named Pagewood in 1929 to honour Alderman F.J. Page of Botany Council.[1]

3.2. EARLY DEVELOPMENT OF THE SUBJECT SITE

The plant occupies an original site which comprised an area of 25 acres at the corner of Bunnerong and Maroubra Bay Roads. The ground formation before the construction of the subject buildings was described as consisting of sand to an unknown depth with a stratum of 'Waterloo' rock typical of the area.

Development on the subject site appears to have been slow. The early map of the Parish of Botany in Figure 12 below indicates that there was no development on the subject site by this time and that it was not subdivided. It is possible that it had some agricultural uses, however ownership of the land was not formalised until the 1930s. Refer to Table 1 which sets out the original land grants which eventually comprised the General Motors Holden site.

Figure 12 – 1916. Botany Parish Map indicating the approximate extents of the subject site (circled blue).



Source: Land and Property Information

1

Table 1 – Early land grants which comprised the eventual General Motors Holden site.

Name of Portion	Area of Portion	Name of Grantee	Date of Grant	Reference
2463	18 and ¼ perches	Emily Martha Seabrook	22/8/1930	Vol.4429 fol. 147
2457	18 and ¼ perches	Ellen Eliza Rhodes	12/6/1931	Vol. 4486 fol. 143
2456	18 and ¼ perches	Robert Rhodes	12/6/1931	Vol. 4486 fol. 144
2435	7 and ¼ perches	Raymond Stubbs	1/9/1933	Vol. 4590 fol. 113
2445	9 perches	Horace Beeton	17/10/1933	Vol. 4594 fol. 174
2433	7 and ¼ perches	Frederick John Hillman	26/7/1934	Vol. 4636 fol. 116
2454	7 and ¾ perches	Henry Collen Wheelen	30/9/1935	Vol. 4716 fol. 135
2455	17 and ¼ perches	Angus Nugent	13/10/1936	Vol. 4795 fol. 218
2460	18 and ¼ perches	Alma Vera Abassden	27/7/1937	Vol. 4859 fol. 130
3497	25 acres	General Motors Holden	31/3/1939	Vol. 5028 fol. 158

3.3. GENERAL MOTORS HOLDEN

Land for GMHs Pagewood Plant, was purchased by the company in July 1939[2]. However, newspaper records indicate that construction had already began on the plant by June 3rd 1939.[3] The plant cost 270,000 pounds with only around 10,000 pounds being used outside the Commonwealth.[4] The plant was constructed in a record 7 and a half months. It used 1,000 tons of Australian steel and had heat absorbing windows covering an area equal to one and a half acres. The existing General Motors Holden (GMH) factory was officially opened on February 15th 1940 by then Prime Minister Robert Menzies.[5]

[2] Certificate of Title Vol. 5056 Fol. 10
[3] Cootamundra Herald, 8/1939
[4] Cootamundra Herald, 8/1939
[5] Truth, 2/1940

Figure 13 – March 1939. Empty site before construction of the plant.

Source: Construction, 3/1940

Figure 14 – March 1940. Construction of the roof of the plant.

Source: Building, 3/1940

Figure 15 – Undated. Construction of the warehouse building.

Source: Building, 3/1940

The consulting engineer for the Company was a Mr Gibson, while the builders were Concrete Constructions Pty. Ltd. At this time, it was one of a group of factories associated with the company, one in each State capital city except Hobart.

The foundations had industrial reinforced concrete foundations for each structural steel column. All exposed brick work in all buildings, fences, retaining walls and elsewhere was supplied by Wunderlich's "Colortex" texture bricks, of a specially selected buff colour. Over 50 types of specially moulded texture bricks were supplied for the works.

Around 320 contractors and sub-contractors were engaged in the construction of the plant. Some companies involved in the construction of the plant included:

- Roofing - James Hardie & Co. Pty. Ltd. Fibrolite and Wunderlich Limited's Durasbestos.
- Concrete flooring – Melocco Bros. Pty. Ltd.
- Slagwool insulation – Bradford Insulation Pty. Ltd.
- Ceiling plaster – Art. Plasto Pty. Ltd.
- Paints and varnishes – Sherwin-Williams Co. (Aust).
- Lighting brackets – British General Electric Co. Pty. Ltd.

<u>Administration Building</u>

The two storey Administration building at the corner of Heffron Road and Bunnerong Road was constructed with 18,267 square feet of floor space and housed Manufacturing, Sales, Finance, Audit, IDEC, Service and Traffic personnel. The roof comprised structural steel trusses and purlins, with cement asbestos corrugated roofing and box gutters. The tower to the north-east corner of the administration building was described in the March 1940 Building magazine as follows:

> *"Rising like a gigantic modern sentinel, the tower at the corner of the Administrative Building indicates the presence of the new General Motors-Holden's assembly plant from afar. Clear cut in design and silhouetting against the sky the tower symbolises the progressiveness of the organisation which it dominates. Wunderlick Limited's Colortex bricks of a buff tone were employed, while Agee glass bricks constitute the vertical panels."*

The arrangement of the windows and internal columns was designed to allow the subdivision of the internal offices in units of three feet in width between cross partitions. All windows to offices on the west side were in Coldlite non actinic glass, other office windows were in sheet glass and windows to the showroom was polished plate glass. The concrete ground floor was covered with Tasmanian Oak, marbled buff linoleum on a bituminous felt underlay was provided in all offices. Internally there was a dado to window sill height carried out in Queensland Maple veneer panels, nailed to Oregon timber grounds.

The structure was specifically designed for the future installation of complete air conditioning and a concrete tunnel was constructed under the roadway between the building and the Assembly Plant where the necessary equipment would be installed.[6]

The administration building featured a showroom in the north-east corner which had main stairs accessing the first floor where the executive offices were accommodated. A turn table was included in the showroom floor. The facing of the walls of the main stairs opening out to the Showroom is in Scagliola by Melocco Bros. Pty. Ltd. with Verona marble skirtings, stringers, trims and to the ends of the treads and risers. Special ceiling lighting was provided in the showroom for the illumination of the cars displayed on the first floor to be viewed from the outside by the public at night.

A servery was provided on the first floor. Lavatories and cloakroom accommodation for males was located on the ground floor and for females on the first floor. A projection room for the showing of cinematograph films was provided on the first floor, with accommodation for approximately 50 people.[7]

Club House/Canteen Building

Also, constructed in the initial phase was the club house/canteen building to the south. The club house was erected at a cost of 75,000 pounds and was designed specifically for the welfare and comfort of the staff and employees. It comprised a gas meter room, gardener's store, sports store, library, cloakrooms, lavatories, office for social secretary, dining room and kitchen. Accommodation for 300 was provided and the building could be employed for concerts, recreational purposes and social functions in addition to its function as a cafeteria. The tables were of Queensland Maple, with sheet leather tops. The library was equipped with pressed steel shelving.

The ground floor throughout was of concrete laid on the solid, with hardwood joists embedded at 16" centres. The floor was of tallow wood, sanded and wax polished. The internal wall finish was of setting plaster with Queensland Maple veneer dado 6' high in the dining room and passages. The ceiling over the offices and kitchen was of similar construction to those over the first floor in the administration building.

Tennis courts were provided adjacent. A concrete pergola was erected to connect this building with the administration building and a similar one was erected at the southern end of the structure. On three sides of the building, the paving of the paths and terrace was done in flagstone paving.

Additions to the Canteen building to the south in 1952 (cost 109,000 pounds) increased its floor area and seating capacity. [8]

Assembly Plant and Warehouse Building.

The main plant with distinctive corner pillars and the no. 2 bond store (original warehouse building) were also constructed in the original phase of development. Offices in the main factory building housed the personnel department, supply and engineering in addition to manufacturing personnel. The structural steel frame of the main factory building consists of sawtooth construction, 500'x520', with a warehouse annexe 360'x65' 6' centre to centre measurements -total area was 283,400 square feet. The structural steelwork throughout was bolted, with the exception of certain heavy girders adjacent to the warehouse. Erection was carried out by two steam railway cranes.[9]

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[6] Building, 3/1940
[7] Ibid.
[8] Ibid.
[9] Ibid.

Figure 16 – c1940. GMH plant nearing completion viewed from south west.

Source: http://www.hrc.org.au/memories/photographs.html

Figure 17 – 1940. GMH (General Motors Holden) viewed from the north-east.

Source: GMH People Volume 15 Number 7 1963

Figure 18 – c1940. GMH (General Motors Holden) viewed from the north.

Source: *http://www.hrc.org.au/memories/photographs.html*

Figure 19 – 1940. First official photo taken after the completion of the plant.

Source: *http://www.hrc.org.au/memories/photographs.html*

The first car was completed in the new plant on January 19th 1940.[10] For a brief period the plant assembled Vauxhall, Chevrolet, Pontiac and Bedford Vehicles before it was converted for defence needs. One of the first jobs for the plant was producing equipment for military use such as 25 pounder field pieces, wings for De Havilland Mosquito and munitions.

After the war the plant manufactured Frigidaire refrigerators and resumed the assembly of GMH vehicle products. Holden assembly started at Pagewood with the introduction of the all Australian Car in November, 1948. The Pagewood plant was one of the first plants to produce Holdens.

[10] Construction, 3/1940

In 1956, Frigidaire operations were transferred to Dandenong and the body and vehicle assembly activities were further expanded.

Between the 40s and 60s the headquarters grew from a small 98,000sq. ft. Assembly Plant on a 6 ½ acre site to the largest GMH body and vehicle and assembly plant. During the 1950s and 1960s Pagewood was expended with new and bigger buildings. Specifically, the primary sawtooth structure was expanded in 1952, 1955[11] and again in 1959[12]. The expansion in 1952 saw the plant expanded from 283,000sq ft to 447,745 sq ft under an 11-million-pound expansion programme.[13] By 1954 the rear (southern) façade of the no. 2 bond store had been removed to allow for the expansion of the factory.

By 1963 the plant covered a built area of 15.65 acres on a 34 acre site and an additional 19 acres had been acquired adjacent for further development. At that time, it had the yearly capacity to assemble, paint and trim 65,280 bodies and produce 55,680 complete vehicles.

In 1980 the plant was closed during Holden's restructuring and rationalisation of plants throughout Australia. The Pagewood plant produced the 1,500,000 and 3,000,000th Holdens.

3.4. CLOSURE OF THE PLANT

A total of 1,200 workers lost their jobs when the plant was closed. They were offered work at three other plants in Australia. The decision was made as the plant was considered outdated and the upgrade costs were estimated to have been over $100 million.[14]

3.5. BRITISH AMERICAN TOBACCO AUSTRALIA

Since 1982 the plant has been used to manufacture tobacco products for British American Tobacco Australia (BATA). The site was sold by BATA in April 2015 for $90 million.[15]

3.6. DATE OF CONSTRUCTION

The original section of the plant was opened in February 1940. Later additions are as set out below.

3.7. ALTERATIONS AND ADDITIONS

The following table constitutes a record of the development applications relevant to the site which are held by Bayside Council and which are evident from the graphic evidence.

Table 2 – Record of applications for alterations and additions.

DATE	WORKS	REFERENCE
1952	Extension of the sawtooth structure south from the original.	
1952	Extension of the canteen in the administration building. Cost of 190,000 pounds.	
1955	Extension of the sawtooth structure south.	
1959	Extension of the sawtooth structure south.	

[11] The Inverell Times, 8/1954
[12] The Cumberland Argus, 4/1958
[13] The Sunday Herald, 6/1953
[14] State Library of South Australia, GMH Pagewood Plant closure (video recording) transcript
[15] RPdata.

DATE	WORKS	REFERENCE
2000	Internal modifications to existing commercial and industrial buildings.	00/404
2002	Change of use to part of the existing factory building from a tobacco production area to be a tobacco storage area.	02/147
2003	Replacement of existing hot and cold servery equipment and erection of new partition wall to existing staff cafeteria.	04/226
2011	Development Application for alterations and additions to the existing industrial development including: • Partial demolition of the existing factory buildings and structures to facilitate the reduction of the existing tobacco manufacturing operations to the north-east portion of the site; • External alterations and additions and the internal fitout of the remaining factory buildings; • Subdivision of the subject site into two (2) lots; and • Construction of an internal road to connect to Bunnerong Road, at 128 Bunnerong Road, Pagewood.	11/272

4. HERITAGE SIGNIFICANCE

The following statement of significance has been taken from the previous comprehensive HIS completed by Urbis in March 2017.

4.1. STATEMENT OF SIGNIFICANCE

The subject site is historically associated with General Motors Holden. The plant represents a significant phase of growth in the history of the company and is an exemplar of the growth of the Australian vehicle manufacturing industry generally.

The administration building in the north-east corner of the site is the most intact building (despite changes to internal fitout) and the most prominent from the public domain. The building is also a fine example of the Functionalist style. Characteristics of the style comprised in the building include a predominant horizontality offset by a prominent vertical element (clocktower), pronounced string courses and rhythmic fenestration.

Further, the plant building is indicative of the former function of the site and the remnant Functionalist corner pillars are indicative of the quality associated with the plant.

It is considered that while the site generally has historic significance, the most significant fabric on the site constitutes the former administration building, and the remnant original and distinctive fabric associated with the plant building.

5. IMPACT ASSESSMENT

5.1. HERITAGE LISTING

The subject property is not a listed heritage item under the Botany Bay LEP, nor is it located within a heritage conservation area. It is noted that the previous HIS identified that the administration building in the north-east corner of the site has elements that have been assessed as having historic, associative and aesthetic significance at a local level.

The site is also located in the general vicinity of Jellicoe Park (Item 155) and Harris Reserve (Item 66), items of local heritage significance. As such, the below assessment has considered the heritage impact of the Planning Proposal on the identified significance of the site and the proximate heritage items.

Figure 20 – Heritage map indicating the extents of the subject site (blue).

Source – Botany Bay LEP 2013 Heritage Map Sheet 4.

Figure 21 – Heritage map indicating the extents of the subject site (blue).

Source – Botany Bay LEP 2013 Heritage Map Sheet 5.

5.2. STATUTORY CONTROLS

5.2.1. Local Environmental Plan

It is important to note that the subject site is NOT an item or state or local heritage significance. The below impact assessment assesses the revised proposal on the items of local heritage significance within the vicinity. As elements of the site had previously been identified as having heritage significance, the assessment below includes mitigation options which would enable this significance to be acknowledged and reinterpreted.

The proposed works are addressed in the table below in relation to the relevant clauses in the Botany Bay LEP 2013.

Table 3 – Local Environmental Plan

CLAUSE	DISCUSSION
5.10 Heritage conservation Note. Heritage items (if any) are listed and described in Schedule 5. Heritage conservation areas (if any) are shown on the Heritage Map as well as being described in Schedule 5. (1) Objectives The objectives of this clause are as follows: (a) to conserve the environmental heritage of Botany Bay, (b) to conserve the heritage significance of heritage items and heritage conservation areas, including associated fabric, settings and views,	This report has been prepared in order to consider the revised Planning Proposal in relationship to the heritage conservation objectives set out in the Botany Bay LEP 2013. In summary, it is considered that the revised planning proposal does not impact on the heritage significance of the items within the vicinity. Furthermore, the previous comprehensive HIS identified elements of the site as having heritage significance. This assessment includes mitigation recommendations which would also for this significance to be acknowledged and reinterpreted.

(c) to conserve archaeological sites, (d) to conserve Aboriginal objects and Aboriginal places of heritage significance.	
(2) Requirement for consent Development consent is required for any of the following: (a) demolishing or moving any of the following or altering the exterior of any of the following (including, in the case of a building, making changes to its detail, fabric, finish or appearance): (i) a heritage item, (ii) an Aboriginal object, (iii) a building, work, relic or tree within a heritage conservation area, (b) altering a heritage item that is a building by making structural changes to its interior or by making changes to anything inside the item that is specified in Schedule 5 in relation to the item, (c) disturbing or excavating an archaeological site while knowing, or having reasonable cause to suspect, that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed, (d) disturbing or excavating an Aboriginal place of heritage significance, (e) erecting a building on land: (i) on which a heritage item is located or that is within a heritage conservation area, or (ii) on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance, (f) subdividing land: (i) on which a heritage item is located or that is within a heritage conservation area, or (ii) on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance.	The subject property is not a listed heritage item under the Botany Bay LEP, nor is it located within a heritage conservation area. The site is located in the vicinity of two heritage items as identified above. As such, this assessment has considered the heritage impact of the planning proposal on the proximate heritage items and the historic elements on the site which were previously assessed as having some heritage qualities.
(4) Effect of proposed development on heritage significance	The planning proposal is generally considered to respect the identified heritage significance of the

The consent authority must, before granting consent under this clause in respect of a heritage item or heritage conservation area, consider the effect of the proposed development on the heritage significance of the item or area concerned. This subclause applies regardless of whether a heritage management document is prepared under subclause (5) or a heritage conservation management plan is submitted under subclause (6).	items of local heritage significance within the vicinity.
(5) Heritage assessment The consent authority may, before granting consent to any development: (a) on land on which a heritage item is located, or (b) on land that is within a heritage conservation area, or (c) on land that is within the vicinity of land referred to in paragraph (a) or (b), require a heritage management document to be prepared that assesses the extent to which the carrying out of the proposed development would affect the heritage significance of the heritage item or heritage conservation area concerned.	This report has been prepared in order to fulfil this condition.

5.3. IMPACT ASSESSMENT

The earlier comprehensive HIS acknowledged that the rezoning of the site will include the change of use from industrial to residential. While this will end the general historic use, it is appreciated that an industrial use on the site is no longer feasible or required. Further, it should be noted that the significant historic industrial use is specifically the car manufacturing/assembly industry. This industry has not been associated with the site since the 1980s.

The site has had a continuous industrial use since it was developed at the start of the 20th century. However, the character of the area generally is changing and the existing industrial use is no longer required in the now suburban area.

The Planning Proposal (and revised proposal) will facilitate development in the area currently occupied by the original buildings associated with General Motors Holden. However, it is understood that the retention of all early elements on site would not provide for the practical redevelopment of the site for residential use. Further, much of the fabric on site has been highly altered and its original character diminished.

There is no statutory requirement to retain any of the fabric on the site, from a heritage perspective, as the site has no statutory heritage listing.

Notwithstanding this, the earlier HIS did identify a number of the built elements on the site as having a degree of heritage significance. These elements include the former Administration Building and the remnant, original and distinctive fabric associated with the plant building pillars.

It was understood that these building elements were, at that point, to be retained. This revised proposal and complying development approval confirm that these built elements are now to be removed.

To mitigate the loss of this heritage significance it is considered that the following be undertaken prior to demolition:

1. Photographic archival of the Administration Building, Canteen Building and general vistas incorporating the remaining buildings and elements collectively.
2. Salvage Report, completed by a suitably qualified heritage specialist, to identify building materials, decorative elements and other items which should be salvaged for re-use prior to demolition.

An Interpretation Plan should be developed as part of a future development application which interprets the former industrial use of the site and specifically its connection to the Australian car manufacturing industry. Elements salvaged from the site may be utilised in this interpretation plan.

6. CONCLUSION AND RECOMMENDATIONS

The subject site, 128 Bunnerong Road, Pagewood, previously formed part of a larger site which was constructed for General Motors Holden and from 1980 was occupied by British American Tobacco Australasia (BATA) facility. BATA have since vacated the site and most of the site has been zoned and is under construction for a residential/mixed use precinct, in line with prevailing planning strategies.

The subject site has no statutory heritage listings. The site is located in the general vicinity of Jellicoe Park (Item 155) and Harris Reserve (Item 66), both items of local heritage significance listed within Schedule 5 of the *Botany Bay Local Environmental Plan 2013 (LEP)*.

The client has liaised with Bayside Council who have advised they have no objection to the demolition of all buildings on the site. The site received approval under complying development for the demolition of all existing buildings located on the site. A number of other modifications to the original planning proposal have also been approved.

The comprehensive Heritage Impact Statement completed by Urbis (March 2017) for the original planning proposal concluded that there would be no negative heritage impacts on the items in the nearby vicinity. This remains unchanged with the modified proposal.

The earlier HIS also identified a number of built elements remaining on the site that have a degree of local heritage significance. These elements include the former Administration Building and the remnant original and distinctive fabric associated with the plant building pillars.

As outlined above the local council do not object to the demolition and a complying development certificate for demolition of all existing buildings has been issued for the site.

Recommendations:

To mitigate loss of identified heritage significance on the site it is recommended that the following be undertaken prior to demolition:

1. Photographic archival of the Administration Building, Canteen Building and general vistas incorporating the remaining buildings and elements collectively.

2. Salvage Report, completed by a suitably qualified heritage specialist, to identify building materials, decorative elements and other items which should be salvaged for re-use prior to demolition.

An Interpretation Plan should be developed as part of a future development application which interprets the former industrial use of the site and specifically its connection to the Australian car manufacturing industry. Elements salvaged from the site may be utilised in this interpretation plan.

It is recommended that the above recommendations and mitigation measures are implemented to mitigate heritage impacts on the site.

7. BIBLIOGRAPHY AND REFERENCES

7.1. BIBLIOGRAPHY

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7.2. REFERENCES

Apperly, R., Irving, R. and Reynolds, P. (eds) 2002, A Pictorial Guide to Identifying Australian Architecture: Styles and Terms from 1788 to the Present, Angus and Robertson, Pymble.

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[Note: Some government departments have changed their names over time and the above publications state the name at the time of publication.]

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This report has been prepared with due care and diligence by Urbis and the statements and opinions given by Urbis in this report are given in good faith and in the reasonable belief that they are correct and not misleading, subject to the limitations above.

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COMPLYING DEVELOPMENT CERTIFICATE

NO.1423.92-01-2018-CDC

23 July 2018

AEDGROUP
Innovation & expertise in building regulations

DESCRIPTION	*Demolition of existing industrial building*
PROPERTY	*128 Bunnerong Road, Pagewood*

This certificate is issued by a Certifying Authority and gives the applicant permission to carry out the development in accordance with any conditions set out in the certificate and the plans and specifications that have been approved.

1. DETAILS OF THE APPLICANT

MR ☐ MS ☐ MRS ☐ DR ☐ COMPANY ☒ OTHER ☐

APPLICANT	*Karimbla Constructions Services (NSW) Pty Ltd*				
ADDRESS	*Level 11, Meriton Tower, 528 Kent Street*				
SUBURB	*Sydney*	STATE	*NSW*	POSTCODE	*2000*
POSTAL	*As above*				
MOBILE	*0477 991 805*	EMAIL	*eliasm@meriton.com.au*		

DATE APPLICATION RECEIVED	*18/02/2016*

2. OWNERS DETAILS

MR ☐ MS ☐ MRS ☐ DR ☐ COMPANY ☒ OTHER ☐

OWNER	*Karimbla Properties (No.39) Pty Ltd*				
ADDRESS	*Level 11, Meriton Tower, 528 Kent Street*				
SUBURB	*Sydney*	STATE	*NSW*	POSTCODE	*2000*
POSTAL	*As above*				

3. DETAILS OF THE LAND TO BE DEVELOPED

ADDRESS	*128 Bunnerong Road*				
SUBURB	*Pagewood*	STATE	*NSW*	POSTCODE	*2035*
LOT NO.	*1*	DP/MPS NO.	*1187426*		

BCA / Certifiers

BCA CLASSIFICATION/s *N/A – demolition only* ASSESSED UNDER BCA *N/A – demolition only*

APPROVED USE *N/A* LAND USE ZONE *1N1 General Industrial*

APPLICATION MADE UNDER THE FOLLOWING PLANNING INSTRUMENT

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008

4. DESCRIPTION OF THE WORK PROPOSED

TYPE OF WORK PROPOSED:

☒ BUILDING

☐ SUBDIVISION

DESCRIPTION OF THE WORK:

Demolition of existing industrial building

ESTIMATED VALUE OF THE WORK:

$500,000.00

5. DECISION OF THE CERTIFYING AUTHORITY

☒ APPROVED

☐ REFUSED (if refused provide reason/s)

Works approved under this complying development certificate:

Demolition of existing industrial building

CERTIFICATE DATE: *23/07/2018*

DATE CERTIFICATE WILL EXPIRE: *24/07/2023*

This certificate is issued:

☒ subject to the conditions listed in **Attachment A**

Endorsement of Plans:

The issue of this certificate has been endorsed on the plans and specifications that were lodged with the application.

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AEDGROUP

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Plan No/Specifications Approved

AT&L

	Title	Drawing No.	Revision	Date
1.	Marked up Demolition Plan	C003	N	10/12/15

6. INFORMATION ATTACHED TO THIS DECISION

	Document	Issued By		Date
1.	Application for Complying Development Certificate	Karimbla Constructions Services (NSW) Pty Ltd		18/02/16
2.	Section 149 Planning Certificate No.2015/7434	City of Botany Bay Council		04/01/16
3.	Existing Underground Services Plans Job No.6633715	Dial Before You Dig		23/08/13
4.	Survey Plan Ref.124815	JBW Surveyors P/l		08/09/14
5.	Existing Site Survey Plans	JBW Surveyors		
	Title	Drawing No.	Revision	Date
	1. Sheet 1	A-101	---	04/03/14
	2. Sheet 2	A-102	---	04/03/14
	3. Sheet 3	A-103	---	04/03/14
	4. Sheet 4	A-104	---	04/03/14
	5. Sheet 5	A-105	---	04/03/14
	6. Sheet 6	A-106	---	04/03/14
6.	Demolition Company's Demolition Statement re Conditions 7.1 & 7.3	Earthworx Grop		19/07/18
7.	Sediment Control Plan No. E-3000-CS Rev.A	Karimbla Construction Services (NSW) P/L		March 2017
8.	Record of Inspection – Pre-CDC	AED (Trenton Jones)		18/07/18

7. CERTIFICATION

I, Trenton Jones, for AED,

Certify that:

☒ The approved development is a complying development and (if carried out as specified in this certificate) will comply with all development standards applicable to the development and with such other requirements prescribed by the Environmental Planning & Assessment Regulation 2000.

COMPLYING DEVELOPMENT CERTIFICATE NO. ***1423.92-01-2018-CDC***

DATE ***23/07/2018***

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8. SIGNATURE

For this certificate to be valid, it must be signed by the certifying Authority.

SIGNATURE

NAME	*Trenton Jones, for AED*				
ADDRESS	*Suite 3.04, 55 Miller Street*				
SUBURB	*Pyrmont*	STATE	*NSW*	POSTCODE	*2009*
TELEPHONE	*(02) 9571 8433*	MOBILE	*0430 754 888*	EMAIL	*trenton@aedconsulting.com.au*
ACCREDITATION BODY OF THE CERTIFIER	*Department of Planning – Building Professionals Board (BPB)*				
ACCREDITATION NO. OF THE CERTIFIER	*BPB0203*				

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Required Inspections for this Project

INSPECTION NO.	REQUIRED ☒	INSPECTION TYPE	TO BE INSPECTED BY
1.	☒	**Prior to issue of CC/CDC** (for existing buildings and all complying development)	AED (PCA)
2.	☒	**Final inspection** (after the building work has been completed and prior to occupation)	AED (PCA)

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FILE NUMBER: 1423.92-01-2018-CDC

BCA / Certifiers

Division 2A Conditions of complying development certificate

136A Compliance with Building Code of Australia and insurance requirements under the Home Building Act 1989 (cf clauses 78 and 78A of EP&A Regulation 1994)

(1) A complying development certificate for development that involves any building work must be issued subject to the following conditions:

(a) that the work must be carried out in accordance with the requirements of the *Building Code of Australia*,

(b) in the case of residential building work for which the *Home Building Act 1989* requires there to be a contract of insurance in force in accordance with Part 6 of that Act, that such a contract of insurance must be entered into and be in force before any building work authorised to be carried out by the certificate commences.

(1A) A complying development certificate for a temporary structure that is used as an entertainment venue must be issued subject to the condition that the temporary structure must comply with Part B1 and NSW Part H102 of Volume One of the *Building Code of Australia* (as in force on the date the application for the relevant complying development certificate is made).

(2) This clause does not limit any other conditions to which a complying development certificate may be subject, as referred to in section 4.28 (6) (a) of the Act.

(3) This clause does not apply:

(a) to the extent to which an exemption is in force under clause 187 or 188, subject to the terms of any condition or requirement referred to in clause 187 (6) or 188 (4), or

(b) to the erection of a temporary building, other than a temporary structure that is used as an entertainment venue.

(4) In this clause, a reference to the *Building Code of Australia* is a reference to that Code as in force on the date the application for the relevant complying development certificate is made.

Note. There are no relevant provisions in the Building Code of Australia in respect of temporary structures that are not entertainment venues.

136AA Condition relating to fire safety systems in class 2–9 buildings

(1) A complying development certificate for building work involving the installation, extension or modification of any relevant fire safety system in a class 2, 3, 4, 5, 6, 7, 8 or 9 building, as defined in the *Building Code of Australia*, must be issued subject to the condition required by this clause.

(2) The condition required by this clause is that the building work involving the installation, modification or extension of the relevant fire safety system cannot commence unless:

(a) plans have been submitted to the principal certifying authority that show:

(i) in the case of building work involving the installation of the relevant fire safety system—the layout, extent and location of key components of the relevant fire safety system, or

(ii) in the case of building work involving the modification or extension of the relevant fire safety system—the layout, extent and location of any new or modified components of the relevant fire safety system, and

(b) specifications have been submitted to the principal certifying authority that:

(i) describe the basis for design, installation and construction of the relevant fire safety system, and

(ii) identify the provisions of the *Building Code of Australia* upon which the design of the system is based, and

(c) those plans and specifications:

(i) have been certified by a compliance certificate referred to in section 6.4 (e) of the Act as complying with the relevant provisions of the *Building Code of Australia*, or

(ii) unless they are subject to an exemption under clause 164B, have been endorsed by a competent fire safety practitioner as complying with the relevant provisions of the *Building Code of Australia*, and

(d) if those plans and specifications were submitted before the complying development certificate was issued—each of them was endorsed by the certifying authority with a statement that the certifying authority is satisfied that it correctly identifies both the performance requirements and the deemed-to-satisfy provisions of the *Building Code of Australia*, and

(e) if those plans and specifications were not submitted before the complying development certificate was issued—each of them was endorsed by the principal certifying authority with a statement that the principal certifying authority is satisfied that it correctly identifies both the performance requirements and the deemed-to-satisfy provisions of the *Building Code of Australia*.

(3) In this clause:

relevant fire safety system means any of the following:

(a) a hydraulic fire safety system within the meaning of clause 165,

(b) a fire detection and alarm system,

(c) a mechanical ducted smoke control system.

136AB Notice to neighbours

(1) A complying development certificate for development on land that is in a category 1 local government area and that is not in a residential release area and that involves:

(a) a new building, or

(b) an addition to an existing building, or

(c) the demolition of a building,

must be issued subject to a condition that the person having the benefit of the complying development certificate must give at least 7 days' notice in writing of the person's intention to commence the work authorised by the certificate to the occupier of each dwelling that is located on a lot that has a boundary within 20 metres of the boundary of the lot on which the work is to be carried out.

(2) A complying development certificate for development on land that is in a category 2 local government area or a

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residential release area and that involves:

(a) a new building, or

(b) an addition to an existing building, or

(c) the demolition of a building,

must be issued subject to a condition that the person having the benefit of the complying development certificate must give at least 2 days' notice in writing of the person's intention to commence the work authorised by the certificate to the occupier of each dwelling that is located on a lot that has a boundary within 20 metres of the boundary of the lot on which the work is to be carried out.

(3) In this clause:

category 1 local government area means any of the local government areas of Ashfield, City of Auburn, City of Bankstown, City of Blacktown, City of Blue Mountains, City of Botany Bay, Burwood, Camden, City of Campbelltown, Canada Bay, City of Canterbury, City of Fairfield, City of Hawkesbury, City of Holroyd, Hornsby, Hunter's Hill, City of Hurstville, City of Kogarah, Ku-ring-gai, Lane Cove, Leichhardt, City of Liverpool, Manly, Marrickville, Mosman, North Sydney, City of Parramatta, City of Penrith, Pittwater, City of Randwick, City of Rockdale, City of Ryde, Strathfield, Sutherland Shire, City of Sydney, The Hills Shire, Warringah, Waverley, City of Willoughby, Wingecarribee, Wollondilly or Woollahra.

category 2 local government area means any local government area that is not a category 1 local government area.

residential release area means any land within:

(a) an urban release area identified within a local environmental plan that adopts the applicable mandatory provisions of the Standard Instrument, or

(b) a land release area identified under the *Eurobodalla Local Environmental Plan 2012*, or

(c) any land subject to *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*, or

(d) any area included in Parts 6, 26, 27, 28 and 29 of Schedule 3 to *State Environmental Planning Policy (Major Development) 2005*.

136B Erection of signs

(1) A complying development certificate for development that involves any building work, subdivision work or demolition work must be issued subject to a condition that the requirements of subclauses (2) and (3) are complied with.

(2) A sign must be erected in a prominent position on any site on which building work, subdivision work or demolition work is being carried out:

(a) showing the name, address and telephone number of the principal certifying authority for the work, and

(b) showing the name of the principal contractor (if any) for any building work and a telephone number on which that person may be contacted outside working hours, and

(c) stating that unauthorised entry to the site is prohibited.

(3) Any such sign is to be maintained while the building work, subdivision work or demolition work is being carried out, but must be removed when the work has been completed.

(4) This clause does not apply in relation to building work, subdivision work or demolition work that is carried out inside an existing building, that does not affect the external walls of the building.

(5) This clause does not apply in relation to Crown building work that is certified, in accordance with section 6.28 of the Act, to comply with the technical provisions of the State's building laws.

(6) This clause applies to a complying development certificate issued before 1 July 2004 only if the building work, subdivision work or demolition work involved had not been commenced by that date.

Note. Principal certifying authorities and principal contractors must also ensure that signs required by this clause are erected and maintained (see clause 227A which currently imposes a maximum penalty of $1,100).

136C Notification of Home Building Act 1989 requirements

(1) A complying development certificate for development that involves any residential building work within the meaning of the *Home Building Act 1989* must be issued subject to a condition that the work is carried out in accordance with the requirements of this clause.

(2) Residential building work within the meaning of the *Home Building Act 1989* must not be carried out unless the principal certifying authority for the development to which the work relates (not being the council) has given the council written notice of the following information:

(a) in the case of work for which a principal contractor is required to be appointed:

(i) the name and licence number of the principal contractor, and

(ii) the name of the insurer by which the work is insured under Part 6 of that Act,

(b) in the case of work to be done by an owner-builder:

(i) the name of the owner-builder, and

(ii) if the owner-builder is required to hold an owner-builder permit under that Act, the number of the owner-builder permit.

(3) If arrangements for doing the residential building work are changed while the work is in progress so that the information notified under subclause (2) becomes out of date, further work must not be carried out unless the principal certifying authority for the development to which the work relates (not being the council) has given the council written notice of the updated information.

(4) This clause does not apply in relation to Crown building work that is certified, in accordance with section 6.28 of the Act, to comply with the technical provisions of the State's building laws.

136D Fulfilment of BASIX commitments

(1) This clause applies to the following development:

(a) BASIX affected development,

(b) any BASIX optional development in relation to which a person has made an application for a complying development certificate that has been accompanied by a BASIX certificate or BASIX certificates (despite there being no obligation under clause 4A of Schedule 1 for it to be so accompanied).

(2) A complying development certificate for development to which this clause applies must be issued subject to a condition that the commitments listed in each relevant

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BASIX certificate for the development must be fulfilled.

136E Development involving bonded asbestos material and friable asbestos material

(1) A complying development certificate for development that involves building work or demolition work must be issued subject to the following conditions:

(a) work involving bonded asbestos removal work (of an area of more than 10 square metres) or friable asbestos removal work must be undertaken by a person who carries on a business of such removal work in accordance with a licence under clause 458 of the *Work Health and Safety Regulation 2011*,

(b) the person having the benefit of the complying development certificate must provide the principal certifying authority with a copy of a signed contract with such a person before any development pursuant to the complying development certificate commences,

(c) any such contract must indicate whether any bonded asbestos material or friable asbestos material will be removed, and if so, must specify the landfill site (that may lawfully receive asbestos) to which the bonded asbestos material or friable asbestos material is to be delivered,

(d) if the contract indicates that bonded asbestos material or friable asbestos material will be removed to a specified landfill site, the person having the benefit of the complying development certificate must give the principal certifying authority a copy of a receipt from the operator of the landfill site stating that all the asbestos material referred to in the contract has been received by the operator.

(2) This clause applies only to a complying development certificate issued after the commencement of this clause.

(3) In this clause, ***bonded asbestos material***, ***bonded asbestos removal work***, ***friable asbestos material*** and ***friable asbestos removal work*** have the same meanings as in clause 317 of the *Occupational Health and Safety Regulation 2001*.

Note 1. Under clause 317 removal work refers to work in which the bonded asbestos material or friable asbestos material is removed, repaired or disturbed.

Note 2. The effect of subclause (1) (a) is that the development will be a workplace to which the Occupational Health and Safety Regulation 2001 applies while removal work involving bonded asbestos material or friable asbestos material is being undertaken.

Note 3. Information on the removal and disposal of asbestos to landfill sites licensed to accept this waste is available from the Office of Environment and Heritage.

Note 4. Demolition undertaken in relation to complying development under the State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 must be carried out in accordance with Australian Standard AS 2601—2001, Demolition of structures.

136F, 136G (Repealed)

136H Condition relating to shoring and adequacy of adjoining property

(1) A complying development certificate for development must be issued subject to a condition that if the development involves an excavation that extends below the level of the base of the footings of a building, structure or work (including any structure or work within a road or rail corridor) on adjoining land, the person having the benefit of the certificate must at the person's own expense:

(a) protect and support the building, structure or work from possible damage from the excavation, and

(b) where necessary, underpin the building, structure or work to prevent any such damage.

(2) The condition referred to in subclause (1) does not apply if the person having the benefit of the complying development certificate owns the adjoining land or the owner of the adjoining land has given consent in writing to that condition not applying.

136I Traffic generating development

If an application for a complying development certificate is required to be accompanied by a certificate of Roads and Maritime Services as referred to in clause 4 (1) (j1) or (k) of Schedule 1, the complying development certificate must be issued subject to a condition that any requirements specified in the certificate of Roads and Maritime Services must be complied with.

136J Development on contaminated land

(1) If an application for a complying development certificate is required to be accompanied by a statement of a qualified person as referred to in clause 4 (1) (l) of Schedule 1, the complying development certificate must be issued subject to a condition that any requirements specified in the statement must be complied with.

(2) Subclause (1) does not apply to complying development carried out under the complying development provisions of *State Environmental Planning Policy (Three Ports) 2013* in the Lease Area within the meaning of clause 4 of that Policy.

136K When complying development certificates must be subject to section 4.28 (9) condition

(1) This clause applies if a council's contributions plan provides for the payment of a monetary section 7.11 contribution or section 7.12 levy in relation to development for a particular purpose (whether or not it is classed as complying development under the contributions plan).

(2) The certifying authority must issue the relevant complying development certificate authorising development for that purpose subject to a condition requiring payment of such contribution or levy, as required by section 4.28 (9) of the Act.

(3) Subclause (2) applies despite any provision to the contrary in the council's contributions plan.

136L Contributions and levies payable under section 4.28 (9) must be paid before work commences

(1) A complying development certificate issued subject to a condition required by section 4.28 (9) of the Act must be issued subject to a condition that the contribution or levy must be paid before any work authorised by the certificate commences.

(2) Subclause (1) applies despite any provision to the contrary in the council's contributions plan.

136M Condition relating to payment of security

(1) This clause applies to a complying development certificate authorising the carrying out of development if:

(a) the development is demolition of a work or building, erection of a new building or an addition to an existing building and the estimated cost of the development (as specified in the application for the certificate) is $25,000 or more, and

(b) the development is to be carried out on land adjacent to a public road, and

(c) at the time the application for the certificate is made, there is specified on the website of the council for the area in which the development is to be carried out an amount of security determined by the council that must be paid in relation to:

(i) development of the same type or description, or

(ii) development carried out in the same circumstances, or

(iii) development carried out on land of the same size or description.

(2) A complying development certificate to which this clause applies must be issued subject to a condition that the amount of security referred to in subclause (1) is to be provided, in accordance with this clause, to the council before any building work or subdivision work authorised by the certificate commences.

(3) The security may be provided, at the applicant's choice, by way of:

(a) deposit with the council, or

(b) a guarantee satisfactory to the council.

(4) The funds realised from a security may be paid out to meet the cost of making good any damage caused to any property of the council as a consequence of doing anything (or not doing anything) authorised or required by the complying development certificate, including the cost of any inspection to determine whether damage has been caused.

(5) Any balance of the funds realised from a security remaining after meeting the costs referred to in subclause (4) is to be refunded to, or at the direction of, the person who provided the security.

136N Principal certifying authority to be satisfied that preconditions met before commencement of work

(1) This clause applies to building work or subdivision work that is the subject of a complying development certificate.

(2) A principal certifying authority for building work or subdivision work to be carried out on a site, and over which the principal certifying authority has control, is required to be satisfied that any preconditions in relation to the work and required to be met before the work commences have been met before the work commences.

Schedule 9 Conditions applying to complying development certificates under the Demolition Code

(Clause 7.3)

Note 1. Complying development under the Demolition Code must comply with the requirements of the Act, the Environmental Planning and Assessment Regulation 2000 and the conditions listed in this Schedule.

Note 2. Division 2A of Part 7 of the Environmental Planning and Assessment Regulation 2000 specifies conditions to which certain complying development certificates are subject.

Note 3. In addition to the requirements specified for development to be complying development under this Policy, adjoining owners' property rights, applicable common law and other legislative requirements for approvals, licences, permits and authorities still apply.

Note 4. If the development is in the proximity of infrastructure (including water, stormwater or sewer mains, electricity power lines and telecommunications facilities), the relevant infrastructure authority should be contacted before commencing the development.

Note 5. Under section 4.29 of the Environmental Planning and Assessment Act 1979 a complying development certificate lapses 5 years after the date endorsed on the certificate, unless the development has physically commenced on the land during that period.

Part 1 Conditions applying before works commence

1 Protection of adjoining areas

A temporary hoarding or temporary construction site fence must be erected between the work site and adjoining lands before the works begin, and must be kept in place until after the completion of works, if the works:

(a) could cause a danger, obstruction or inconvenience to pedestrian or vehicular traffic, or

(b) could cause damage to adjoining lands by falling objects, or

(c) involve the enclosure of a public place or part of a public place.

Note. Clauses 2.67 and 2.68 of this Policy specify which scaffolding, hoardings and temporary construction site fences are exempt development and state the applicable standards for that development.

2 Toilet facilities

(1) Toilet facilities must be available or provided at the work site before works begin, and must be maintained until the works are completed, at a ratio of one toilet plus one additional toilet for every 20 persons employed at the site.

(2) Each toilet must:

(a) be a standard flushing toilet connected to a public sewer, or

(b) have an on-site effluent disposal system approved under the Local Government Act 1993, or

(c) be a temporary chemical closet approved under the Local Government Act 1993.

3 Waste management

(1) A waste management plan for the work must be prepared before work commences on the site.

(2) The waste management plan must:

(a) identify all waste (including excavation, demolition and construction waste material) that will be generated by the work on the site, and

(b) identify the quantity of waste material, in tonnes and cubic metres, to be:

(i) reused on-site, and

(ii) recycled on-site and off-site, and

(iii) disposed of off-site, and

(c) if waste material is to be reused or recycled on-site—specify how the waste material will be reused or recycled on-site, and

(d) if waste material is to be disposed of or recycled off-site—specify the contractor who will be transporting the material and the waste facility or recycling outlet to which the material will be taken.

(3) A garbage receptacle must be provided at the work site before works begin and must be maintained until the works are completed.

(4) The garbage receptacle must have a tight fitting lid and be suitable for the reception of food scraps and papers.

4 Adjoining wall dilapidation report

(1) If a building to be demolished is within 900mm of a boundary, and there is a wall (the ***adjoining wall***) on the lot adjoining that boundary that is less than 900mm from that boundary, the person having the benefit of the complying development certificate must obtain a dilapidation report on the adjoining wall.

AE&D Pty Ltd A: Suite 3.04, 55 Miller Street, Pyrmont NSW 2009
Southern Highlands A: Unit 10, 19 Lyell Street, Mittagong NSW 2575
Sutherland Shire A: Suite 20, Level 1 Regus, 29 Kiora Road, Miranda NSW 2228
P: (02) 9571 8433 E: admin@aedconsulting.com.au
W: www.aedconsulting.com.au ABN: 15 149 587 495

FILE NUMBER: 1423.92-01-2018-CDC

BCA / Certifiers

(2) If the person preparing the report is denied access to the adjoining lot for the purpose of inspecting the adjoining wall, the report may be prepared from an external inspection of the adjoining wall.

5 Run-off and erosion controls

Run-off and erosion controls must be implemented to prevent soil erosion, water pollution or the discharge of loose sediment on the surrounding land by:

(a) diverting uncontaminated run-off around cleared or disturbed areas, and

(b) erecting a silt fence and providing any other necessary sediment control measures that will prevent debris escaping into drainage systems, waterways or adjoining properties, and

(c) preventing the tracking of sediment by vehicles onto roads, and

(d) stockpiling top soil, excavated materials, construction and landscaping supplies and debris within the lot.

Part 2 Conditions applying during the works

Note. The Protection of the Environment Operations Act 1997 and the Protection of the Environment Operations (Noise Control) Regulation 2008 contain provisions relating to noise.

6 Hours for demolition

Demolition may only be carried out between 7.00 am and 5.00 pm on Monday to Saturday and no demolition is to be carried out at any time on a Sunday or a public holiday.

7 Compliance with plans

Works must be carried out in accordance with the plans and specifications to which the complying development certificate relates.

8 Demolition

Any demolition must be carried out in accordance with AS 2601—2001, *The demolition of structures*.

9 Maintenance of site

(1) All materials and equipment must be stored wholly within the work site unless an approval to store them elsewhere is held.

(2) Waste materials (including excavation, demolition and construction waste materials) must be managed on the site and then disposed of at a waste management facility.

(3) Copies of receipts stating the following must be given to the principal certifying authority:

(a) the place to which waste materials were transported,

(b) the name of the contractor transporting the materials,

(c) the quantity of materials transported off-site and recycled or disposed of.

(4) Any run-off and erosion control measures required must be maintained within their operating capacity until the completion of the works to prevent debris escaping from the site into drainage systems, waterways, adjoining properties and roads.

(5) During construction:

(a) all vehicles entering or leaving the site must have their loads covered, and

(b) all vehicles, before leaving the site, must be cleaned of dirt, sand and other materials, to avoid tracking these materials onto public roads.

(6) At the completion of the works, the work site must be left clear of waste and debris.

10 Aboriginal objects discovered during excavation

If an Aboriginal object (including evidence of habitation or remains) is discovered during the course of the work:

(a) all excavation or disturbance of the area must stop immediately, and

(b) the person making the discovery must advise the Chief Executive (within the meaning of the *National Parks and Wildlife Act 1974*) of the discovery in accordance with section 89A of that Act.

Note. If an Aboriginal object is discovered, an Aboriginal heritage impact permit may be required under the National Parks and Wildlife Act 1974.

AEDGROUP
AE&D Pty Ltd A: Suite 3.04, 55 Miller Street, Pyrmont NSW 2009
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Sutherland Shire A: Suite 20, Level 1 Regus, 29 Kiora Road, Miranda NSW 2228
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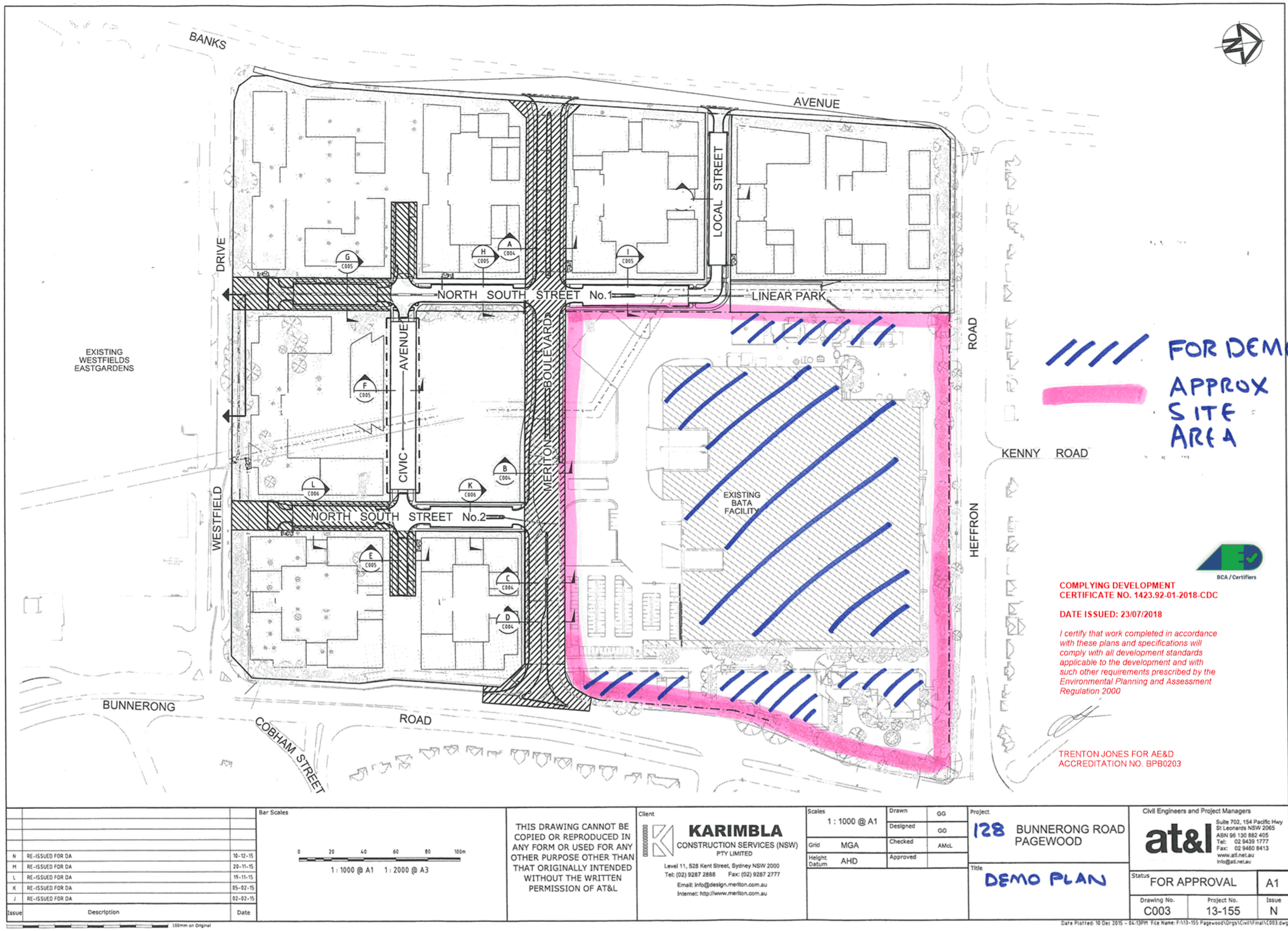
W: www.aedconsulting.com.au ABN: 15 149 587 495


BANKS
AVENUE
DRIVE
WESTFIELD
EXISTING WESTFIELDS EASTGARDENS
NORTH SOUTH STREET No.1
LINEAR PARK
LOCAL STREET
CIVIC AVENUE
MERITON BOULEVARD
NORTH SOUTH STREET No.2
EXISTING BATA FACILITY
HEFFRON ROAD
KENNY ROAD
BUNNERONG ROAD
COBHAM STREET
FOR DEMO
APPROX SITE AREA
COMPLYING DEVELOPMENT CERTIFICATE NO. 1423.92-01-2018-CDC
DATE ISSUED: 23/07/2018
I certify that work completed in accordance with these plans and specifications will comply with all development standards applicable to the development and with such other requirements prescribed by the Environmental Planning and Assessment Regulation 2000
TRENTON JONES FOR AE&D
ACCREDITATION NO. BPB0203
BCA / Certifiers
N RE-ISSUED FOR DA 10-12-15
M RE-ISSUED FOR DA 20-11-15
L RE-ISSUED FOR DA 19-11-15
K RE-ISSUED FOR DA 05-02-15
J RE-ISSUED FOR DA 02-02-15
Issue Description Date
Bar Scales
1 : 1000 @ A1 1 : 2000 @ A3
THIS DRAWING CANNOT BE COPIED OR REPRODUCED IN ANY FORM OR USED FOR ANY OTHER PURPOSE OTHER THAN THAT ORIGINALLY INTENDED WITHOUT THE WRITTEN PERMISSION OF AT&L
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Tel: (02) 9287 2888 Fax: (02) 9287 2777
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Internet: http://www.meriton.com.au
Scales 1 : 1000 @ A1
Grid MGA
Height Datum AHD
Drawn GG
Designed GG
Checked AMcL
Approved
Project
128 BUNNERONG ROAD PAGEWOOD
Title
DEMO PLAN
Civil Engineers and Project Managers
at&l
Status FOR APPROVAL A1
Drawing No. C003
Project No. 13-155
Issue N

Australian Government

Department of Infrastructure, Regional Development and Cities

File reference: F17/87-03

TO	CC	FROM
Matthew Lennartz Meriton Group matthewl@meriton.com.au	**Sydney Airport** airspaceprotection@syd.com.au **Civil Aviation Safety Authority** airspace.protection@casa.gov.au **Airservices Australia** airport.developments@airservicesaustralia.com ifp@airservicesaustralia.com **Bayside Council** council@bayside.nsw.gov.au	Flysafe **Airspace Protection** flysafe@infrastructure.gov.au

DECISION UNDER THE AIRPORTS (PROTECTION OF AIRSPACE) REGULATIONS 1996

Proposed Activity:	Construction of multi-storey buildings
Location:	Stage 2 – 130-150 Bunnerong Road, Pagewood NSW
MGA 94 Coordinates:	E 336024; N 6242977
Proponent:	Meriton Group

I refer to the application from Meriton Group (the Proponent), received by the Department of Infrastructure, Regional Development and Cities (the Department) on 4 January 2019 from Sydney Airport Corporation Limited (SACL). This application (SACL Ref: 18/0627a) sought approval under the Airports (Protection of Airspace) Regulations 1996 (the Regulations) for the intrusion of multi-storey buildings at 130-150 Bunnerong Road, Pagewood NSW (the site) into airspace which, under the Regulations, is prescribed airspace for Sydney Airport.

This application seeks approval for multiple building intrusions across the site to a height of **91 metres** above the Australian Height Datum (AHD). Development on the adjacent parcel of land was previously approved by the Department on 23 January 2017 for a maximum height of 91 metres AHD.

Under regulation 6(1), 'prescribed airspace' includes 'the airspace above any part of either an Obstacle Limitation Surface (OLS) or Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS) surface for the airport'.

The Inner Horizontal Surface of the OLS above this site is at a height of 51 metres above the Australian Height Datum (AHD) and hence prescribed airspace above the site commences at

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51 metres AHD. At a maximum height of 91 metres AHD, the buildings will penetrate the OLS by up to 40 metres.

Accordingly, the construction of buildings on the site constitute a "controlled activity" under Section 182 of the *Airports Act 1996* (the Act). Section 183 of the Act specifies that controlled activities cannot be carried out without approval. Details of the penetration of prescribed airspace are provided in Table 1.

Table 1: Height and location of the proposed activity that will intrude into prescribed airspace for Sydney Airport.

Activity	MGA 94 Coordinates	Maximum height (AHD)	Penetration of prescribed airspace
Buildings	E 336024; N 6242977	91 metres	40 metres

Regulation 14 provides that a proposal to carry out a controlled activity must be approved unless carrying out the controlled activity would interfere with the safety, efficiency or regularity of existing or future air transport operations into or out of the airport concerned. Regulation 14(1)(b) provides that an approval may be granted subject to conditions.

Under the Regulations, the Secretary of the Department is empowered to make decisions in relation to the approval of controlled activities, and impose conditions on the approval. I am the Secretary's Delegate for the purposes of the Regulations.

Decision

In accordance with regulation 14, **I approve** the controlled activity for the intrusion of multi-storey buildings at 130-150 Bunnerong Road, Pagewood NSW (as described at Appendix A (Option 2A) of the Aeronautical Impact Assessment dated 7 August 2018 – Attachment A) into prescribed airspace for Sydney Airport to a **maximum height of 91 metres AHD**.

In making my decision, I have taken into consideration the opinions of the Proponent, the Civil Aviation Safety Authority, Airservices Australia's advice number SY-CA-197 P5, airlines and SACL.

In accordance with regulation 14(1)(b), I impose the following conditions on my approval:

1. The buildings **must not exceed** a maximum height of **91 metres AHD**, inclusive of all lift over-runs, vents, chimneys, aerials, antennas, lightning rods, any roof top garden plantings, exhaust flues etc.

2. Separate approval **must be sought** under the Regulations for any equipment (i.e. cranes) required to construct the buildings. Construction cranes may be required to operate at a height significantly higher than that of the proposed controlled activity and consequently, may not be approved under the Regulations. Therefore, it is advisable that approval to operate construction equipment (i.e. cranes) be obtained prior to any commitment to construct.

3. Buildings D and E on the AIA Final Version 1.0 25 July 2018 (the two 20 storey buildings closest to Heffron Road) **must be obstacle lit** by medium intensity steady red lighting during the hours of darkness at the highest point of the buildings. Obstacle lights are to be arranged to ensure the building can be observed in a 360 degree radius as per subsection

9.4.3 of the Manual of Standards Part 139 - Aerodromes (MOS). Characteristics for medium intensity lights are stated in subsection 9.4.7 of Part 139 of the MOS.

4. The obstacle lighting system **must incorporate** a built-in alarm system that will provide remote monitoring to notify the person responsible for the maintenance of the obstacle lighting. The designated person must be available 24 hours per day, 7 days per week.

   Immediate action **must be taken** to repair the obstacle lighting **and notify** Sydney Airport of any outage. The contact details of the person responsible for the maintenance of the obstacle lighting **must be sent** to Sydney Airport prior to the completion of the building and must be kept up to date.

   In the event of the obstacle lighting being inoperable, the person responsible for the maintenance of the obstacle lighting is to **immediately contact** the Sydney Airport Airfield Operations Supervisor on 0419 278 208 or 9667 9824.

5. Following completion of each building, the Proponent **must advise** SACL, in writing, that the future owner(s)/manager(s) have been informed of their obligation to maintain the obstacle lighting in accordance with conditions of this approval.

6. The Proponent **must advise** Airservices Australia at least three business days prior to the controlled activity commencing by emailing *<ifp@airservicesaustralia.com>* and quoting SY-CA-197 P5.

7. Within 7 days of construction completion of each building, the Proponent **must provide** the airfield design manager with a written report from a certified surveyor on the finished height of the building.

Breaches of approval conditions are subject to significant penalties under Sections 185 and 187 of the Act.

Yours sincerely

Sharyn Owen
Director, Airport Safeguarding
Aviation and Airports Division

30 January 2019

3

ATTACHMENT A

Appendix A: Building Site Layout – Option 2A

Site Layout (Source: Meriton)

Douglas Partners
Geotechnics / Environment / Groundwater

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Meriton Properties
Level 11 Meriton Tower
528 Kent Street
Sydney NSW 2000

Project 85009.02
85009.02.R.001.Rev0
21 November 2018
PMM:mm

Attention: Mr Matthew Lennartz

Email: matthewl@meriton.com.au

Dear Sirs

Summary of Previous Investigations
Pagewood Part II
128, 130-150 Bunnerong Road, Pagewood

1. Introduction

This report presents the results of a contamination desktop study of part of 128, 130-150 Bunnerong Road, Pagewood, referred to herein as Pagewood Part II (or "the site"), as shown on the attached Drawing 1. The site comprises Lot 1 in DP1187426 (Lot 1) and Lot 24 in DP1242288 (Lot 24) and covers an area of approximately 8.95 hectares (ha).

Preparation of this report was commissioned by Mr Matthew Lennartz of Meriton via email on 11 January 2017 and undertaken in general accordance with Douglas Partners Pty Ltd (DP) standard conditions of engagement. It is understood that the report will be used for due diligence purposes and in support of a rezoning application for mixed uses including residential (refer to proposed Masterplan layout shown on Drawing 1).

The objective of the desktop study was to assess the likely contamination conditions at the site and to identify issues (based on reviewed information) that may be detrimental to the proposed development layout.

2. Site Description and Geology

The site is bound by Heffron Road to the north, Bunnerong Road to the east, Banks Avenue to the west and an internal road (Meriton Boulevard) to the south. At the time of preparing this report, the eastern portion of the site was occupied by commercial / industrial buildings and pavements and was being used for storage. The western portion was occupied by a large warehouse building and was being utilised for materials storage associated with the ongoing development of Pagewood Part I (refer attached Drawing 1).

Reference to the Sydney 1:100,000 Series Geological Sheet indicates that the site is underlain by Quaternary alluvial deposits, which typically comprise fine to medium grained "marine" sands with podsols. Hawkesbury Sandstone, comprising medium to coarse grained quartz sandstone with minor shale and laminite lenses, underlies the site at depth.

The site is located over the Botany Sand Aquifer, a shallow unconfined to semi-confined groundwater system. The average saturated thickness of the Botany Sands Aquifer is 15 - 20 m. Hydraulic conductivity within the sand beds is highly variable and is typically around 20 m/day in clean sand.

3. Previous Reports

Douglas Partners Pty Ltd (DP) has completed a number of environmental and contamination investigations across the site since 2011. The attached Drawing 3 (Project 71631.01) and Drawing 3 (Project 71631.02) show the previous CPT, bore and groundwater monitoring well locations.

The general sequence of subsurface materials encountered in the previous investigations is described below in increasing depth order:

FILLING:	Sand filling to typical depths of 1.0 m to 2.5 m, generally well compacted in the upper metre. In isolated locations the filling was as shallow as 0.3 m and as deep as 4.6 m;
SAND	Medium dense and medium dense to dense sand to depths of 5 – 7 m, becoming dense and very dense with occasional thin (<0.5m) clay and peat bands to depths of 21 – 38 m. The base of the alluvial sand unit was found to be up to 44 m in isolated locations;
CLAY/SAND:	Residual clayey sand and sandy clay of 0.4 – 2.0 m thick. In most locations no residual soil was encountered and in some isolated locations it was 4 – 8 m thick; and
SANDSTONE:	Hawkesbury sandstone was encountered at depths of between 21 – 49 m depth.

Groundwater levels varied from a depth of 5.9 m to 7.8 m bgl or an RL of 14.2 m AHD to 16.6 m AHD. Based on these measured groundwater levels the inferred direction of groundwater flow is south to south west, i.e. towards Botany Bay and the groundwater extraction exclusion zone.

4. Background

The site and the remainder of Lot 1 have been the subject of a number of environmental investigations by DP and others. The aspects of the previous investigations relevant to the site are presented in this section.

Site history information indicated that the site and the remainder of Lot 24 was originally formed in the 1930s through reclamation of virgin marshland. Since its reclamation a number of parcels along the eastern boundary were used mainly for residential/rural purposes (possibly including paddocks and poultry farming) from at least 1929 (the year the records start) to 1938/1939.

The site and remainder of Lot 24 was owned by General Motors Holden (GMH) and was operated as an automobile assembly plant from 1939 to 1982 when the plant was closed down. The land parcel was subsequently purchased by Quintilis Pty Ltd (a subsidiary of British American Tobacco Australia) in 1982. Quintilis Pty Ltd was incorporated into British American Tobacco Services Limited in 1989 and BATA in 2001.

The GMH factory was officially opened on 15 February 1940 by Prime Minister Menzies. The factory assisted in manufacturing of car bodies during WWII. Afterwards, the facility was used for the assembly and distribution of Holden vehicles. The manufacturing areas were largely concentrated in the north-eastern portion of the GMH owned land parcel.

BATA operated within the western and southern portions of the site and remainder of Lot 24, either as owner or tenant, until July 2014. The main factory building is used for the manufacturing and packaging of various cigarette products. Several ancillary buildings were located around the main factory building including corporate, administration, security, and IT buildings. Utility buildings (flavour room, boiler house, electrical substation, etc.), a technical centre and a canteen are other buildings detached from the main factory building and were located generally along the eastern portion of the operation. A large warehouse type building (No. 1 Bond Store) located on the western portion of the site still exists at the time of preparing this report. The south western portion of the site and remainder of Lot 24 was used for car parking by BATA staff and visitors.

4.1 Phase 1 and Phase 2 Assessments

Based on the historical information examined it appears that the site (and the remainder of Lot 24) was originally formed in the 1930's through reclamation of virgin marshland. Since its reclamation a number of parcels along the facility's eastern boundary were used mainly for residential/rural purposes (possibly including paddocks and poultry farming) from at least 1929 (the year the records start) to 1938/1939. The site was owned by General Motors Holden (GMH) and was operated as an automobile assembly plant from 1939 to 1982 when the plant was closed down. Most of the facility was subsequently purchased by Quintilis Pty Ltd (a subsidiary of British American Tobacco Australia) in 1982. A small parcel along the southern boundary of the site was owned from 1982 to 1986 by Amaretto Pty Ltd. Quintilis Pty Ltd was incorporated into British American Tobacco Services Limited in 1989 and BATA in 2001.

The site was used by BATA or the manufacturing and distribution of cigarettes. The main factory building occupied the greater portion of the site (and the remainder of Lot 24). Several ancillary buildings were located around the main factory building including corporate, administration, security, and IT buildings. Utility buildings (flavour room, boiler house, electrical substation, etc.), a technical centre and a canteen were detached from the main factory building and located generally along the eastern portion of the site adjacent to Bunnerong Road. A large warehouse type building (Bond no. 3) was used for storing raw tobacco and is located on the north western portion of the site (still remaining). Car parks occupied the south western portion of the site and the remainder of Lot 24.

Based on the history information, the areas of environmental concern (AEC) identified for the site (and the remainder of Lot 24) included filling, underground storage tanks (USTs), above ground storage tanks (AGSTs), the use of solvents, electrical substations, former spray painting booths, former engine and car assembly works, battery storage and disposal, former soldering booths, storage areas (dangerous and hazardous goods), former bus depot and car parking areas, and buildings (hazardous materials).

The Phase 2 contamination assessments conducted across the site and the remainder of Lot 24 in 2011 and 2012 included a review of the previous investigations undertaken at the site, the drilling and sampling of a total of nine cone penetration tests (CPT1 to CPT 9), the drilling and sampling of 144 test bores, and the installation and sampling of groundwater monitoring wells in 37 of the test bores. All relevant bore and well locations are shown on the attached Drawing 3 (Project 71631.01) and Drawing 3 (Project 71631.02).

Given the introduction of NEPC (2013), DP updated the Phase 2 contamination assessment in 2013. The main objective of the subsequent report (DP, 2013) was to update previously reported data (in regards to site contamination assessment) to then current guidelines and supplement the earlier data with additional soil sampling and testing to better characterise the contamination status of Lot 24, and to inform the preparation of a revised Remediation Action Plan (RAP) for Lot 1 that identifies areas of soil requiring remediation on this basis of the re-assessment of the data.

The updated assessment (labelled a Detailed Site Investigation (DSI) in keeping with the terminology used in NEPC, 2013) included the excavation of 63 test pits for asbestos assessment, additional testing to conduct a preliminary ecological risk assessment (ERA), the drilling and sampling of 16 test bores for further delineation of chemical contamination, the drilling of four test bores in the former corporate office.

Soil samples from the bores were analysed for a variety of potential contaminants including heavy metals, PAH, TPH, BTEX, PAH, OCP, OPP, PCB, VOC, phenols, synthetic pyrethroids, hexavalent chromium, cyanide, ammonia and asbestos. Analytical results for soil samples were compared to site assessment criteria (SAC) applicable for residential (western portion of the site) and commercial and industrial (eastern portion of the site) land uses. The concentrations of contaminants in soil were within the SAC for all samples and analytes with the following general exceptions:

- Elevated TPH in soil at MW110 and BH39; and
- Marginally elevated lead and OCP at BH46.

Recovered groundwater samples were analysed for potential contaminants including heavy metals, PAH, TPH, BTEX, PAH, OCP, OPP, PCB, VOC, phenols, hexavalent chromium, cyanide and ammonia. Groundwater analyses were compared predominantly to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, (ANZECC 2000) guidelines for marine water for the protection of 95% of species.

Elevated concentrations of tetrachloroethene (PCE) were found in groundwater at a number of wells in the eastern portion of the site, namely MW18, MW108, MW109, MW110 and MW112, with only two locations (MW18 and MW110) exceeding the adopted assessment criteria. The generally clustered results are an indication of a potential dissolved phase PCE plume, and possible source sites, in this area. Elevated concentrations of TPH were also found in groundwater at MW18, MW106, MW109, MW110, MW111 and MW114. The source around MW18 and MW109 to MW111 may be one or a number of the former USTs located in the eastern portion of the site, whilst the detections at MW106 and MW114 may be attributed to a former UST located along the northern access road, or localised spills or leaks within the main building.

DP concluded that based on the results of the assessment that the site can be rendered suitable for the proposed land uses subject to the findings of additional investigations, monitoring and validation works.

4.2 Passive Soil Gas Assessment (Draft)

DP conducted a passive soil gas survey in the south eastern portion of the site in an attempt to assess potential source sites for the chlorinated solvents and petroleum hydrocarbons concentrations in groundwater, the extent of associated groundwater contamination plumes (if present) and the potential for migration of the contaminants on to site from off-site sources. The assessment included the installation of 39 passive soil gas samplers, the retrieval of the PSG samples, semi-volatile organic compounds (SVOC) and VOC analysis (of the passive soil gas samplers) and the preparation of isopleth maps.

PCE, TCE, xylenes and trimethylbenzene (TMB) were detected in the PSG samplers (as well as other VOC), however the concentrations were typically low. The following conclusions were drawn from the results of the PSG assessment:

1. No significant on or off-site potential contamination source had been identified through the distribution and/or the soil vapour measurements reported; and
2. Although the soil vapour distribution identified some of the highest soil vapour measurements at or close to the fringes of the study area, an extension of the study area was not considered necessary as the measurements were low and not considered to represent a source within the study area. Groundwater results beyond the study area do not suggest a likely source of significant groundwater contamination elsewhere within the site.

Based on the findings of the PSG assessment the following recommendations were made:

- Installation of soil vapour ports for active soil vapour sampling, nominally in locations of highest detected groundwater and passive soil vapour concentrations, and one up-gradient of the study area for background purposes;
- An additional round of groundwater monitoring across Lot 1 to obtain current concentrations to use in a human health risk assessment, if considered appropriate; and
- Based on the outcomes of the above complete a human health risk assessment considering industrial, residential and construction worker receptors.

4.3 Active Soil Vapour Assessment (Draft)

An active soil vapour assessment was undertaken within a portion of the proposed Industrial Zone (the study area) in the vicinity of MW118 and MW110. The location of the ASVA was designed to target previous comparatively elevated petroleum hydrocarbon and chlorinated solvent concentrations detected in groundwater and passive soil vapour samples.

The assessment included the review of the previous reports and the installation of a six nested active soil vapour sampling ports (with sample depths of 1 m, 4 m and 7 m below ground level) and one shallow active soil vapour sampling port (1 m bgl) and collection of soil vapour samples for VOC analysis and general gases.

DP provided the following conclusions in the report:

(i) The report quantifies the concentrations of VOC in soil gas in the target locations;

(ii) The results indicate that it is unlikely that there is a significant off-site source of VOC or petroleum hydrocarbon contamination and no significant on-site source of VOC or petroleum hydrocarbon contamination such that active remediation and/or management is required. The results from sample location ASV1 suggest that there may be a previously unidentified (minor) on-site source of VOC (PCE/TCE) in the vicinity of ASV1 or that a narrow vapour/groundwater plume migrates onto the site from up-gradient sources to the north east of the site near the northern side of the canteen block. However if this was a significant off-site source it would be expected it would have been reflected in the groundwater and/or passive soil vapour assessment but there was no indications of a significant off-site source in these; and

(iii) The three data sets, passive soil vapour, active soil vapour and groundwater generally do not show a strong correlation.

DP concluded that the significance or otherwise of the detected soil vapour concentrations be determined via the site specific human health risk assessment. DP also recommended that following completion of the human health risk assessment it is possible that a period of groundwater and soil vapour monitoring will be recommended such that a suitable data base of groundwater and soil vapour results can be established to show that concentrations of the contaminants of concern are either stable or falling over time.

5. Conclusion and Recommendations

State Environmental Planning Policy (SEPP) No. 55 refers to the planning and development control process as provided for in the Environmental Planning and Assessment Act 1979 (EP&A Act) plays an important role in the management of land contamination. The integration of land contamination management into the planning and development control process will:

- Ensure that changes of land use will not increase the risk to health or the environment;
- Avoid inappropriate restrictions on land use; and
- Provide information to support decision making and to inform the community.

SEPP55 also specifies that:

Essentially, the Guidelines recommend that rezonings, development control plans and development applications (DAs) are backed up by information demonstrating that the land is suitable for the proposed use or can be made suitable, either by remediation or by the way the land is used. Where remediation has already occurred but residual contamination is above the recommended thresholds, it may be necessary to restrict the land uses allowed. This approach may also be appropriate for cases where investigation shows that only some land uses would be suitable. In situations where the land is not suitable for the proposed use and cannot be rendered suitable for technical or practical reasons, the proposal should be refused.

Based on Figure 2 of SEPP55 – Options Available in the Rezoning Process where the Specific End Use is Known, DP provides the following responses:

1. *Is information sufficient for decision making*? Yes – see previous sections on various documents reviewed above which provide a reasonable amount of information on site contamination.

2. *Has land been proven suitable for proposed uses without need for further testing or treatment*? No. Recommendations are provided below.

3. *Remediation or further investigation required – consider need for provisions in LEP/REP to ensure investigation or remediation occurs before development of land*? Yes – see specified documents and recommendations listed below.

4. *Proceed with process of rezoning*? Yes.

5. Record decision and information.

On this basis, DP considers that the site is suitable for rezoning for mixed uses (including residential), and can be made suitable for the proposed development contingent on the following additional investigations and documents being prepared and provided to Council and the Site Auditor, prior to development consent:

- Additional soil, groundwater and soil vapour investigations to meet the NSW EPA sampling guidelines and with reference to the intended site use as residential and to supplement the previous works undertaken from 2011-2013;
- Preparation of a Remediation Action Plan (RAP);
- Preparation of an Asbestos Management Plan (AMP);
- Site Remediation and Validation reporting; and
- Preparation of a Site Audit Statement (Part A).

In accordance with the NSW EPA hierarchy for remediation, the preferred remediation strategy is likely to comprise the retention and management of contaminated soils on site, either through relocation to less sensitive areas and/or physical encapsulation or capping, therefore reducing the need to remove large volumes of soil to landfill. Any design configuration that supports this strategy (e.g. no basement excavations) would be preferred. Furthermore, large excavations could impact on the groundwater dynamics and make it more difficult to isolate and/or manage any identified contaminated groundwater.

6. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at 128 and 130-150 Bunnerong Road, Pagewood in accordance with DP's proposal dated 11 January 2017 and acceptance received from Mr Matthew Lennartz dated 11 January 2017. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Meriton for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Paula Maurici
Environmental Scientist

Reviewed by

PP

Paul Gorman
Environmental Manager, Principal

Attachments: About this Report
Drawing 1 (Rev2)
Drawing 3 (Project 71631.01)
Drawing 3 (Project 71631.02)

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

July 2010

About this Report

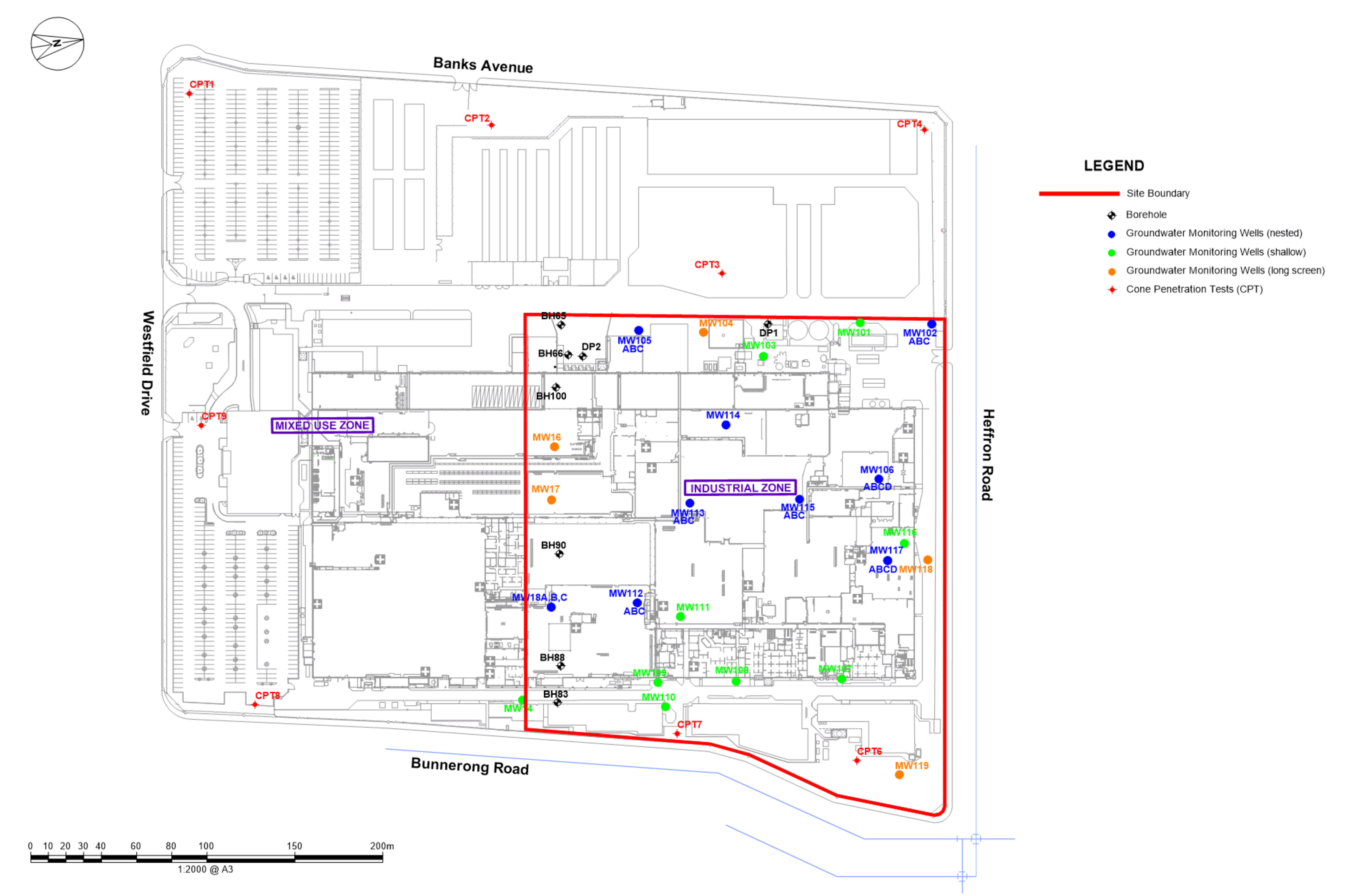
Site Anomalies
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Meriton		TITLE: Pagewood Part II - Due Diligence	PROJECT No:	85009.02
	OFFICE: Sydney	DRAWN BY: NW	128, 130-150 Bunnerong Road, Pagewood	DRAWING No:	1
	SCALE: As shown	DATE: 20 Nov 2018		REVISION:	2

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: A	TITLE: **Phase 2 Sampling Locations**	PROJECT No: 71631.01
	OFFICE: Sydney / DRAWN BY: PSCH	**Remediation Action Plan**	DRAWING No: 3
	SCALE: As shown / DATE: MARCH 2012	**Part Lot 1 DP776089, Westfield Drive, Eastgardens**	REVISION: A



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Brittish American Tobacco Australia Ltd	TITLE: **Test Bore Locations**	PROJECT No: 71631.02
	OFFICE: Sydney / DRAWN BY: PSCH	**Phase 2 Contamination Assessment**	DRAWING No: 3
	SCALE: As shown / DATE: JULY 2012	**Part Lot 1 DP776089, Westfield Drive, Eastgardens**	REVISION: 0

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128 & 130-150 Bunnerong Road, Pagewood

Pagewood Part II - Due Diligence Report

Author: Michael Guinane

Approver: Michael Guinane

Report no: 13-155-7002 **Revision:** 02 **Date:** November 2018

This report has been prepared for Meriton Properties in accordance with the terms and conditions of appointment. AT&L (ABN 96 130 882 405) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

This report is based upon a desktop review and relies upon information supplied by utility providers and Council. To the extent that the report incorporates such material, AT&L takes no responsibility for any loss or damage caused by any error or omission arising from reliance on it.

Please note that utility providers reserve the right to change their decision in relation to network deployment within the development without prior notice. Additionally it is our experience that utility providers will not reserve capacity. For this reason, they operate on a first come first serve basis.

Document information

Level 7, 153 Walker Street, North Sydney, NSW 2060

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Document registration

Document title	Pagewood Part II – Due Diligence Report
Document file name	13-155- 7002-02-Civil-DD Report.docx
Section	Civil Engineering
Document author	Michael Guinane

Finalisation signatures

The design described in this report is considered to have been finalised.

Signature	Date
Michael Guinane Civil Engineer (Author)	21/11/18
Frank Xie Lead Designer	21/11/18
Anthony McLandsborough Director	21/11/18

Notes: The finalisation signatures shown above do not provide evidence of approval to the design. Approval signatures are shown on the title sheet of the design plans.

Contents

1 Introduction

The development of the site is within the Bayside City Council Local Government Area (LGA). The site was previously owned by British American Tobacco (BATA) is classified as the land bound by Bunnerong Road to the east, Banks Avenue to the west, Westfield Drive to the south and Heffron Road to the north.

This report is intended to support a planning approval to rezone the site from part IN1 General Industrial Zone and part R3 Medium Density Residential Zone to the R4 High Density Residential.".

The site is approximately 8.95 Ha in area and consists of Lot 1 DP 1187426 & Lot 24 DP 1242288 or 128 & 130-150 Bunnerong Road, Pagewood.

This Due Diligence Report addresses the following Civil Infrastructure items, Stormwater Management, Water Quality and Utilities and has been prepared to satisfy Bayside Council (formerly Botany Bay City Council) requirements for the proposed development of the civil works on the site.

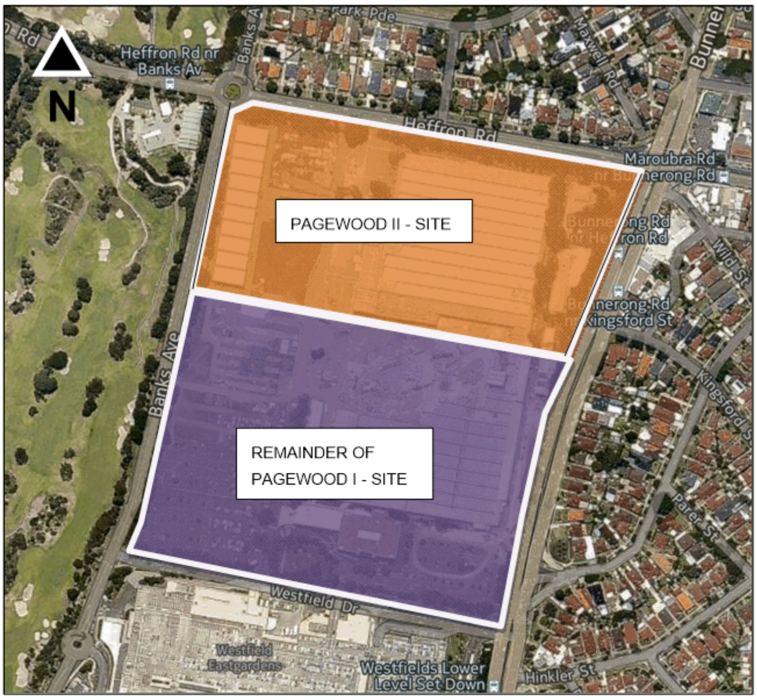

Figure 1 Location Plan

1.1 Existing Site

The entirety of the site currently comprises factory buildings and bitumen carpark which results in the entire site being an impermeable area.

A survey carried out by Denny Linker & Co in May 2011 indicates levels throughout the site are generally flat with a gentle fall towards Heffron Road.

Stormwater from the site currently drains to the north west of the site towards a trunk stormwater pipe network and ultimately to discharge into an existing Sydney Water culvert (2.44m wide by 1.21m high) which drains through the site in a south east direction. No external catchment drains into the site.

1.2 Proposed Development

A Masterplan illustrating the type of development facilitated by the Planning Proposal is provided in Figure 2 below.

No actual physical works are proposed as part of the planning proposal.

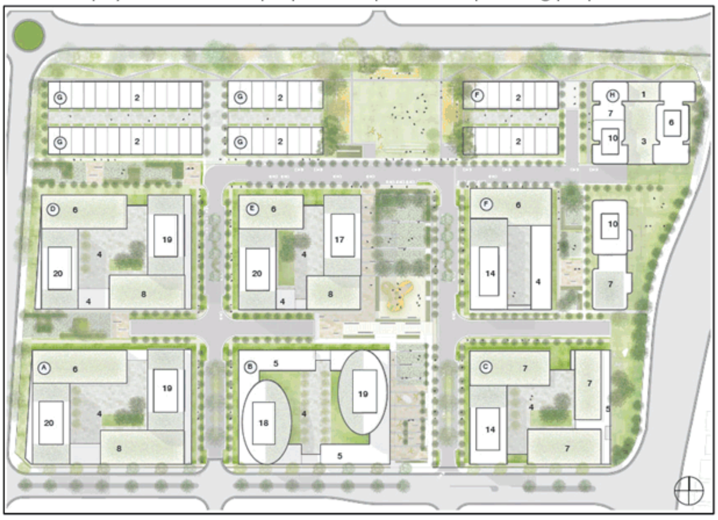

Figure 2 Master Plan

2 Road Geometry

This report should be read in conjunction with the Transport Impact Assessment prepared by ARUP Dated July 2018.

2.1 General Design Principles

The roads will be generally designed in accordance with:

- City of Botany Bay Part 9D British American Tobacco Australasia (BATA) Site Development Control Plan –2013.
- Austroads Guide to Road Design Part 3: Geometric Design

2.2 Access

The site has proposed vehicular access from Meriton Boulevard, connecting to Banks Avenue and Bunnerong Road.

2.3 Horizontal and Vertical Geometry

The internal roads will be designed generally in accordance with Councils DCP, AS2890.1, AS1428.1 and NSW Fire Brigades Policy to accommodate 8.8m Garbage Truck, 12.5m Bus and Fire Truck Aerial Appliance Access.

2.3.1 Road Cross Sections

North South Street 1

- 20m wide Road Reserve
- 13m wide Carriageway (2.5m Parking, 3.0m Lane)
- 2m wide Median Swale

North South Street 2

- 18m wide Road Reserve
- 13m wide Carriageway (2.5m Parking, 3.0m Lane)
- 2m wide Median Swale

2m wide Median

Local Street

- 16m wide Road Reserve
- 11m wide Carriageway (2.5m Parking, 3.0m Lane)

All alterations to lane widths from the Council DCP may be proposed in accordance with the relevant Standards and advice from Traffic Consultant. Minimum traffic lane widths are utilised to discourage speeding through Local Streets and encourage pedestrian safety.

2.4 Pavement

Pavement will be designed based on the requirements of:

- Austroads Pavement Design Guide – Part 2 - Pavements Structural Design, 2012 (AGPT02-12),
- Concrete Masonry Association Guidelines (MA44 and T45); and
- Site specific CBR values and traffic ESAs.

3 Stormwater & WSUD Management

3.1 General Design Principles

The stormwater management plan for the site will be generally designed in accordance with the following codes and guidelines:

- City of Botany Bay Technical Guidelines on British American Tobacco Australasia (BATA) Site – July 2013.
- Stormwater Management and Flooding Report, Rezoning of Lot 1 DP 776089 Eastgardens. Report Ref 211530 , 10 October 2011 Revision 8 by Aurecon
- Flood Study Report, Rezoning of Lot 1 DP 776089 Eastgardens. Report Ref 211530 FSR , 02 November 2011 Revision 1 by Aurecon
- Utility Services Infrastructure Report, Rezoning of Lot 1 DP 776089 Eastgardens. Report Ref 211530 , 8 August 2011 Revision 2 by Aurecon
- Australian Standards - AS 3500.3 National Plumbing and Drainage Code - Part 3 – Stormwater Drainage
- Australia publication "Australian Rainfall and Runoff, Volumes 1 and 2 (AR&R)

3.2 Stormwater Management

3.2.1 Hydrology

- Pipe drainage within the site shall be designed to accommodate the 20-year ARI storm event
- The combined piped and overland flow paths shall be designed to accommodate the 100-year ARI storm event
- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flowpath capable of carrying the total 100-year ARI storm event shall be provided. Alternatively the pipe and inlet system may be upgraded to accommodate the 100 year ARI storm event
- Rainfall intensities shall be as per the Intensity-Frequency-Duration table in accordance with the Australian Rainfall and Runoff volume 2
- Times of concentration for each subcatchment shall be determined using the kinematic wave equation
- Runoff coefficients shall be calculated in accordance with the AR&R. The fraction impervious shall be determined from analysis of the subcatchments

- Flow width in gutter shall not exceed 1.5m for the minor design storm event.
- Velocity depth rations shall not exceed 0.4 for all storms up to and including the 100 year ARI event
- Blockage factors of 20% and 50% shall be adopted for pits on grade and at sags respectively for all storm events
- The maximum spacing between pits shall be 60m
- The minimum lintel size for any road drainage pit shall be 2.4m (3.6m for East-West Boulevard)

3.2.2 Hydraulics

- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design. The HGL shall be shown on all drainage long sections
- The minimum pipe size shall be 375mm diameter
- The minimum pipe grade shall be 0.5%
- All pipes shall be Rubber Ring jointed
- The minimum cover over pipes shall be 500mm
- All trafficable pipes shall be Class 3 Reinforced Concrete Pipes or Fibre Reinforced Cement equivalent
- The pipe friction coefficients to be adopted shall be:

Materials	Mannings – n	Colebrook-White – k	Min. Pipe Class
RCP	0.012	0.3	3
FRC	0.01	0.15	3

Table 1 - Pipe Details

- All pipes shall be designed for the ultimate service loads and where applicable, construction loads will be designed for
- Where the tailwater level is unknown 150mm freeboard shall be adopted
- Pit Loss coefficients shall be calculated in accordance with Missouri Charts
- A minimum 150mm freeboard shall be maintained between pit HGL and pit surface levels
- Overland flowpaths shall maintain a minimum of 500mm freeboard to all habitable floor levels
- Pits deeper than 1.2m shall contain step irons at 300mm centres

at&l

3.3 Proposed Stormwater

Within Section 2.2 of the *Stormwater Management and Flooding Report* by Aurecon is the clause *"Discussions with Sydney Water indicate that surface water from the new rezoned area (i.e. new proposed residential and retail area) will continue to discharge into the Sydney Water culvert after flow reductions have been achieved through on-site detention."*

Stormwater from the proposed building lots will drain via internal OSD tanks (Some with Infiltration) with water quality devices prior to discharging into the surrounding street network and ultimately the Sydney Water Culvert.

As part of the Initial Pagewood Development, and due to the existing flat gradient of the existing Sydney Water culvert it was proposed to replace the existing 1050mm diameter pipe in the northern portion of the site and box culvert with a new 1200mm diameter pipe laid at a steeper gradient. This new pipe will connect the majority of the Pagewood Part II Development.

Based on the City of Botany Bay Technical Guidelines on the BATA site a maximum Permissible Site Discharge (PSD) of 5,849L/second needs to be achieved. Further to this requirement Sydney Water imposed PSD of 3,657L/sec for water discharging into the Sydney Water Culvert; under the Case Number 124768. Also a minimum Site Storage Requirement (SSR) of 2,970m^3 is required across the site. Refer Appendix A for Sydney Water requirements.

Through DRAINs modelling the above most onerous conditions have been achieved:

- PSD = 3,657 L/s

Refer Table 2 below for summary of PSD vs Post Developed Discharge and Appendix D for DRAINs results.

	PSD (m^3/s)	Discharge (m^3/s)
Outlet	3.65	3.56

Table 2 – PSD vs Post Developed Discharge

Refer to Sketch within Appendix C for proposed stormwater networks.

3.4 On-Site Detention (OSD)

On Site Detention tanks will be placed in building lots to detain flows for all storms up to the 100 year ARI events. These tanks will:

- Reduce runoff volumes by infiltration to sub-soils (if allowable); and
- Delay runoff peaks by providing detention storage capacity

To achieve the required minimum OSD volume of 2,970m^3, detention tanks are proposed within each building which will be pro-rated across all buildings, as outlined in Table 3. It is noted the minimum OSD volume is exceeded, in order to achieve the PSD. This is as a result of the Open Space and Road reserve flows bypassing the OSD.

Building No.	Lot Area (Ha)	OSD Volume (m^3)	Method of OSD
Urban Block A	0.773	500	HED
Urban Block B	0.865	560	HED
Urban Block C	0.756	450	HED
Urban Block D	0.735	495	HED
Urban Block E	0.557	405	HED
Urban Block Fa	0.372	180	HED
Urban Block Fb	0.410	260	HED
Urban Block Ga	0.384	370	HED
Urban Block Gb	0.567	450	HED
Urban Block H	0.823	460	HED
Urban Block 1	1.218	517	HED
Urban Block 2	0.451	197	HED
Urban Block 3	0.749	366	HED
Urban Block 4	0.640	324	PUMP
Urban Block 5 East	1.000	355	HED
Urban Block 5 West	1.014	512	HED
Urban Block 5 Central	0.799	336	HED

Table 3 – Minimum OSD Requirements

3.4.1 Infiltration

The infiltration rate for the site has be determined to be $7x10^{-5}$ by Coffey. Refer Geotechnical Report GEOTLCOV24928AE-AH Dated 26 October 2016.

The tanks have been sized to ensure 100% infiltration into the subgrade with zero outflow. This has the benefit of reducing the required pipe size in the surrounding roadways as well as negating the need to OSD on the Open Space lots.

3.5 Water Sensitive Urban Design (WSUD)

3.5.1 Policy and Guidelines

The stormwater design considers the following guidelines:

- Australian Rainfall Quality (2006)
- Department of Environment and Climate Change NSW (DECC), Management Urban Stormwater: Urban Design (Consultation Draft, 2008)
- Botany Bay Catchment Water Quality Improvement Plan (WQIP)
- Botany Bay Local Environmental Plan (LEP) 2013

3.5.2 Music Modeling Parameters

Climate Date

Rainfall Station 66037 Sydney with 6 minute timestep was used in the MUSIC model.

Pollutant Concentration Parameters

Stormwater pollutant parameters used in the MUSIC model will be adopted from the following guidelines:

- NSW MUSIC Modeling Guidelines (CMA, 2010)
- Using MUSIC in Sydneys Drinking Water Catchment (SCA, 2012)

Pollutant concentration parameters for each land-use type adopted in the MUSIC model are shown in Table 4a and 4b below.

Catchment Type	TSS (mg/L)		TP (mg/L)		TN (mg/L)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Residential/Commercial	1.200	0.170	-0.850	0.190	0.110	0.120
Sealed Roads	1.200	0.170	-0.850	0.190	0.110	0.120

Table 4a Adopted base flow concentration parameters

Catchment Type	TSS (mg/L)		TP (mg/L)		TN (mg/L)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Residential/Commercial	2.15	0.32	-0.60	0.25	0.30	0.19
Sealed Roads	2.43	0.32	-0.30	0.25	0.34	0.19

Table 4b Adopted storm flow concentration parameters

3.5.3 Objectives

These stormwater management objectives will be applied to treating stormwater runoff from the development to meet pollution reduction targets outlined in Table 5.

Pollutants	Retention Objectives
Total Suspended Solids (TSS)	85%
Total Phosphorus	60%
Total Nitrogen (TN)	45%
Gross Pollutants	90%

Table 5 Pollutant Retention

The proposed stormwater management for this development will also ensure the Botany Bay LEP clause 6.3 (as stated below) on Stormwater Management is met.

(c) avoids any significant adverse impacts of stormwater runoff on adjoining properties, native bushland and receiving waters, or if that impact cannot be reasonably avoided, minimises and mitigates the impact

In order to achieve these reductions, a treatment train approach will be implemented into the development where the following treatment measures will be used:

- Rainwater Tanks – used for stormwater re-use from roofed areas
- On Site Detention - stormwater will be captured and detained in OSD tanks (with infiltration if required) to capture water and slow the discharge rates
- Gross Pollutant Traps (GPTs) – used to reduce the gross pollutants from the stormwater runoff
- Tertiary Treatment Devices – used to reduce TSS, TN and TP.
- Vegetated Swales – used to remove coarse and medium sized sediments from roadways and overland flow

3.5.4 Stormwater Quality Improvement Devices (SQIDS)

Proposed SQIDs used in the proposed development are described in Table 7 below.

Element	Water Quality Function	Description	Preliminary Specification
Rainwater Tank (RWT)	Stormwater Harvesting for re-use as Irrigartion and/or grey water	10kL tank min. to be included to collect roof runoff for each Block	Properties assumed for modeling purposes: Volume below pipe: 10kL Depth above overflow pipe: 0.2m Surface Area: 10sq.m Re-use: 5kL/day
On-Site Detention Tank (OSD)	Provide temporary storage and control of stormwater generated within the site	OSD tanks to be included to collect all runoff from each Block	OSD tank properties for modeling purposes: Surface Area: DRAINs Extended detention depth: 1.5m Exfiltration Rate: 0mm/hr Evaporative Loss % of PET: 100%
Pit Inserts (i.e. Enviropods or Similar)	Captures trash, debris, and other pollutants by catch basin inserts installed in stormwater pits	Pit inserts to be installed in all pits on site.	Treatement efficiencies of the pit inserts based on the Enviropod treatement node provided by Stormwater 360: TSS: 55% retention TN: 20% retention TP: 30% retention Gross Pollutant: 100% retention
Primary Gross Pollutant Traps – GPT (i.e. Humeguard or Similar)	Removal of gross pollutants and course sediments of low flow events	Humeguard Unit to be included to collect roof runoff for each Block	Treatment efficiencies of the GPT based on Humeguard node provided by Humes: TSS: 50% retention TN: 20% retention TP: 20% retention Gross Pollutant: 85% retention
Tertiary Gross Pollutant Trap – GPT (i.e. Jellyfish or Similar)	Removal of fine solids, soluble heavy metals, oil and nutrients through filtration of low flow events	Jellyfish Unit to be included to collect roof runoff for each Block	Treatment efficiencies of the GPT based on Jellyfish node provided by Humes: TSS: 85% retention TN: 51% retention TP: 59% retention Gross Pollutant: 99% retention
Swales	Removal of gross pollutants and course sediments of low flow events	Swales to be included to collect runoff from roads and open space	Swale properties for modeling purposes: K (m/yr) 8000, C* (mg/L), C** (mg/L) TSS: 6000, 20.000, 14.000 TP: 500, 0.130, 0.130 TN: 1.400, 1.400

Table 7 Statistics – Summary of proposed SQIDs

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3.5.5 Sediment and Erosion Control (Construction)

Stormwater runoff generated from within the works area during construction will likely contain sediments and oils from construction machinery. A number of options are available for the removal of these contaminants from stormwater, some of which include:

- Wheel wash down/cattle grid at site access
- Sediment fence at downstream boundary
- Stabilisation of finished areas

Erosion and Sedimentation controls are to be installed and maintained in accordance with Department of Housing (1998), *Managing Urban Stormwater, Soils and Construction*, Fourth Edition. Following are possible levels of control that are to be constructed.

- Silt fences shall be installed along the base of excavated slopes and stockpiles to prevent runoff.
- Kerb inlet sediment traps are to be installed at the completion of the drainage works. Whilst works are underway, geotextile filter fabric fences are to be installed around open pits.

3.6 Flooding and Overland Flows

The Stormwater Management and Flooding Report by Aurecon outlines the flooding affects of the development. Section 4.2 states:

"The proposed stormwater management strategy outlined in this report will lead to a reduction in the peak runoff from the site through the inclusion of a number of techniques:"

- *Increase in permeable surface area by 15% of total site area*
- *On-site detention tanks*

"Our preliminary analysis, based on the rezoning Masterplan, has resulted in the reduction of peak flows for all storms up to the ARI 100-year storm. Detailed analysis is required at the Development Application stage when the building footprint, external access roads and parking and landscaping is detailed to a stage that permits the location of the required vegetated swales and underground pipe system."

Within Section 4.3 of the report Aurecon summarise that with the increase of permeable areas and inclusion of on-site detention basins, the peak stormwater flows off site post development will be less than pre developed rates. This is stated in Section 4.3 as follows:

"The reduction of the existing site discharge to less than the Sydney Water requirement will lead to a reduction in the runoff of stormwater from the site onto

the external roads and the collection of this water into the stormwater pipe system that serves these roads."

3.6.1 Flood Levels

External Flood Levels along Bunnerong Road and Heffron Road have been determined by the Aurecon Report and are to be adopted when setting habitable floor levels with adequate freeboard. Refer to Figure 3 below for extract of Flood levels.

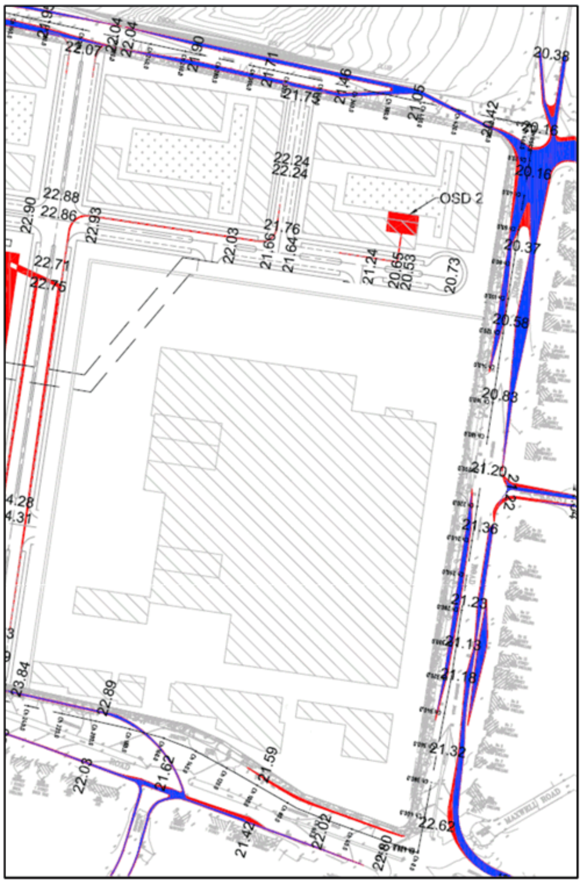

Figure 3 – Flood Levels (*Appendix D – Aurecon Flood Report*)

Car park entry levels and habitable floor levels are to be 300mm above the adjacent top of kerb as per Part 8(v) of the DCP.

4 Utilities

4.1 Aurecon Utilities Report

A Utility Services Infrastructure Report Rezoning of Lot 1 DP 776089 Eastgardens, Report Ref: 211530, 8 August 2011 Revision 2 by Aurecon discusses all utility services across the site and proposed works required to service the development.

Based on the Aurecon Report and the MotMacdonald Feasibility Application the following works are required for each utility to service the development:

4.1.1 Potable Water (WSC MotMacdonald)

The water servicing coordinator will determine if there is enough capacity within the existing water main to service the proposed development. For the internal water reticulation of the site the following will likely be required:

- A water main extension must be constructed along proposed roads to provide frontage to all lots
- New 200mm Diameter mains have been installed within the road reserves of Stage 1 that can provide connections to the proposed additional Urban Blocks.
- A proposed 200mm Diameter main may need to be required to interconnect the two existing water mains in Heffron and Meriton Blv.

A feasibility application under Case Number 160744 has been lodged. The development will be subject to Section 73 Application by Water Servicing Coordinator.

4.1.2 Recycled Water (WSC MotMacdonald)

Based on advice from Sydney Water there is no proposal to provide recycled water to the development from outside sources. Rainwater tanks and grey-water treatment tanks may be incorporated during detailed design to reduce the requirement of potable water.

4.1.3 Sewer (WSC MotMacdonald)

It is anticipated based on previous advice from Sydney Water that there is adequate capacity within the existing sewer to connect the development.

As part of the previous stage of works a section of the existing Sydney Water sewer pipe traversing the site has been relocated to avoid future lots. The existing 375mm Diameter main running through the site may need to be adjusted to suit the proposed layout and sewer reticulation mains extended to service the individual Urban Blocks, subject to Sydney Water requirements.

A feasibility application under Case Number 160744 has been lodged. The development will be subject to Section 73 Application by Water Servicing Coordinator.

4.1.4 Electricity (By Others)

Agreement will need to be reached with Ausgrid for any HV lead in services.

Any reticulation within the development will include the normal cabling, ducting, road crossings, HV substations, lot connection boxes and street lighting. It is anticipated any electrical cables will be installed within a shared trench with gas and telecommunications.

Subject to ASP1 design and Ausgrid Approval.

4.1.5 Telecommunications

This development will require the upgrading of all future telecommunications infrastructure to optical fibre in order to comply with the requirements of the Federal Governments NSW Policy. The extent of these upgrade works will need to be confirmed with Telstra.

4.1.6 Gas

Based on advice from Jemena there is adequate gas supply within the existing gas infrastructure to service the development. Gas mains (PE), compressors, vents and lot connections will be installed as required by Jemena.

5 CONCLUSION

This report has demonstrated that a storm water system consistent with good management practices can be provided for the proposed development and can achieve the target requirements for Council and Sydney Waters OSD and WSUD principles.

The Aurecon Utility report indicates all other required services for the development are within the vicinity. All supply and connections will need to be confirmed with the relevant authorities.

Appendix A

Sydney Water Correspondence

Appendix
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ABN 96 130 882 405
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From: ORTEGA, FERNANDO [mailto:FERNANDO.ORTEGA@sydneywater.com.au]
Sent: Monday, March 31, 2014 12:07 PM
To: Anthony McLandsborough
Cc: JEYADEVAN, JEYA
Subject: RE: Pagewood Stormwater Options

Good morning Anthony

We are comfortable with Option 3. However, please note this site was part of a previous development application to Sydney Water for Subdivision of Lot 1 DP 776089.

Sydney Water's requirements must be met. Please refer to Case Number 124768 and/or attached Terms of Reply for stormwater which were included in the NOR.

OSD is required for this site. As per Sydney Waters requirements on Case Number 124768 for the proposed subdivision of Lot 1 DP776089 OSD is required for the discharge of stormwater into Sydney Water system.

- OSD of 18 cubic meter / 1000 square meters
- Permissible Site Discharge of 35 litres per second per 1000 square meters
- Must comply with Councils OSD requirements

Water Sensitive Urban Design

Direct Connections to Sydney Waters stormwater system must meet the following stormwater water quality targets, as per WSUD MUSIC model.

90% Gross Pollutants

85% Total Suspended Solids

60% Total Phosphorous

45% Total Nitrogen.

Flood Study, please refer to the flood study for Subdivision of Lot 1 DP 776089.

Stormwater Easement requirements

I will be happy to meet and discuss these with Jeya as he was involved in previous discussions later in the week preferably Thursday afternoon at 1.30 pm or morning

Regards

Fernando Ortega | Senior Asset Planner, Land and Waterways

Liveable City Solutions | Sydney Water
Level 10, 1 Smith St Parramatta NSW 2150
PO Box 399 Parramatta NSW 2124
T 02 8849 5207 | M 0407 702 994
fernando.ortega@sydneywater.com.au | sydneywater.com.au

Appendix
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Appendix B

Removed From Report

Appendix
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Appendix C

Civil Stormwater Plans

Appendix
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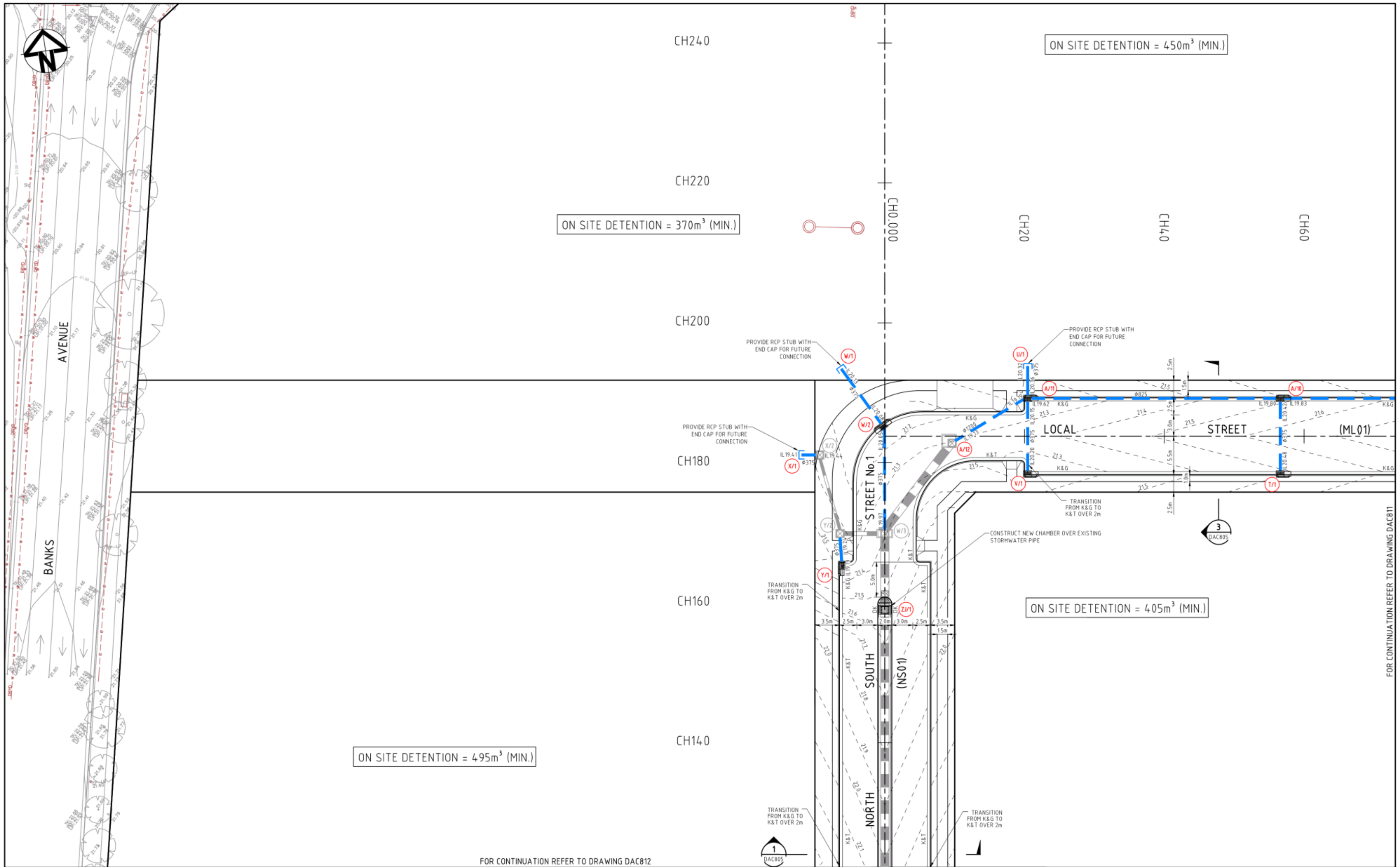

Issue	Description	Date
A	ISSUED FOR APPROVAL	13-08-18

Bar Scales

1 : 250 @ A1 1 : 500 @ A3

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Client

KARIMBLA
CONSTRUCTION SERVICES (NSW) PTY LIMITED
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Scales	1 : 250	Drawn	JH
		Designed	FX
Grid	MGA	Checked	
Height Datum	AHD	Approved	AM

Project: 130-150 BUNNERONG ROAD PAGEWOOD STAGE 2

Title: SITEWORKS AND STORMWATER DRAINAGE PLAN SHEET 1

Civil Engineers and Project Managers

at&l
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Status: FOR APPROVAL NOT TO BE USED FOR CONSTRUCTION — A1

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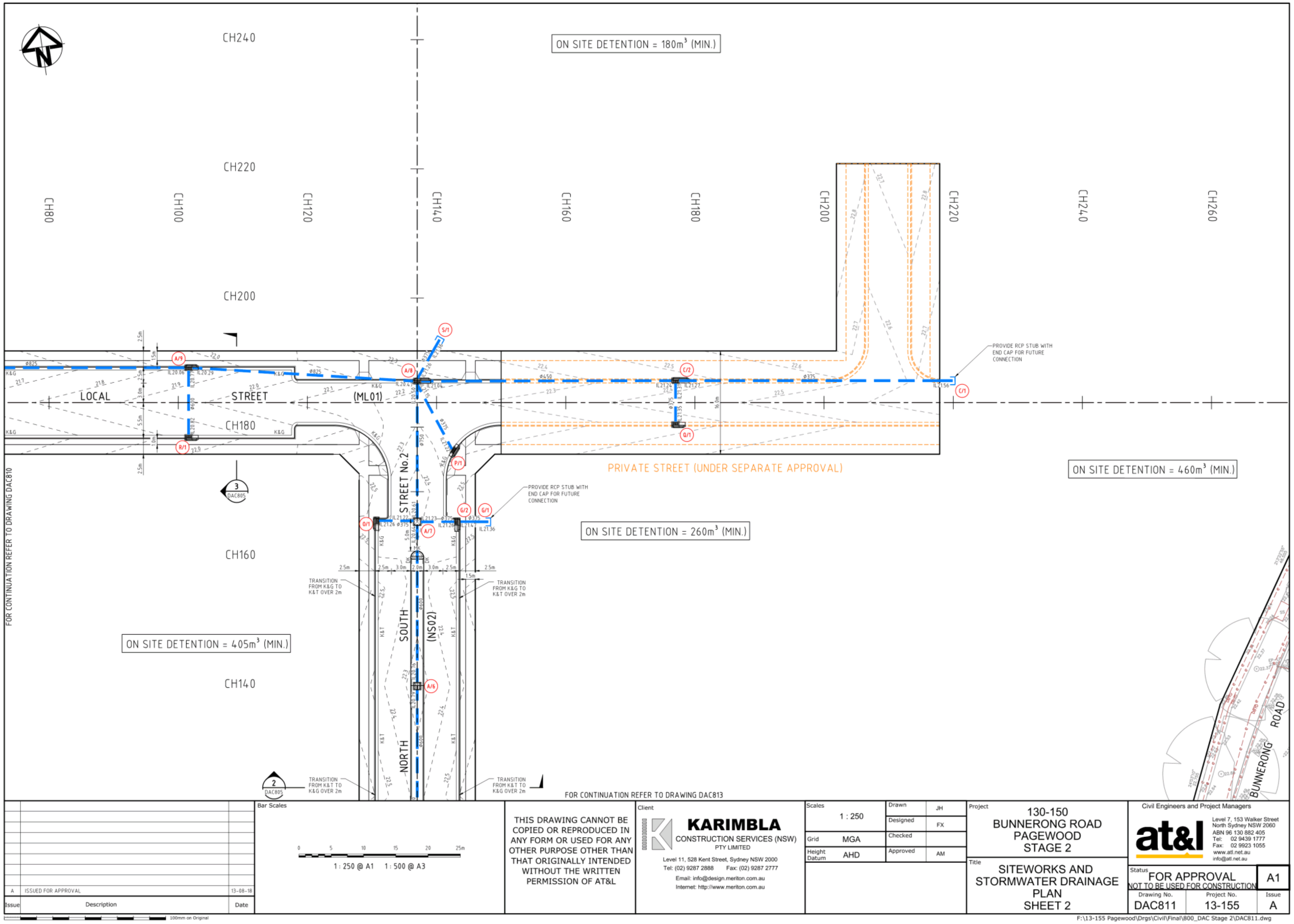
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ON SITE DETENTION = 460m³ (MIN.)
ON SITE DETENTION = 260m³ (MIN.)
ON SITE DETENTION = 405m³ (MIN.)
CH240
CH220
CH200
CH180
CH160
CH140
LOCAL STREET
(ML01)
STREET No.2
SOUTH (NS02)
NORTH
PRIVATE STREET (UNDER SEPARATE APPROVAL)
PROVIDE RCP STUB WITH END CAP FOR FUTURE CONNECTION
TRANSITION FROM K&G TO K&T OVER 2m
TRANSITION FROM K&T TO K&G OVER 2m
FOR CONTINUATION REFER TO DRAWING DAC810
FOR CONTINUATION REFER TO DRAWING DAC813
BUNNERONG ROAD
A ISSUED FOR APPROVAL 13-08-18
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Bar Scales
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Scales 1 : 250
Grid MGA
Height Datum AHD
Drawn JH
Designed FX
Checked
Approved AM
Project 130-150 BUNNERONG ROAD PAGEWOOD STAGE 2
Title SITEWORKS AND STORMWATER DRAINAGE PLAN SHEET 2
Civil Engineers and Project Managers
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A1
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Project No. 13-155
Issue A
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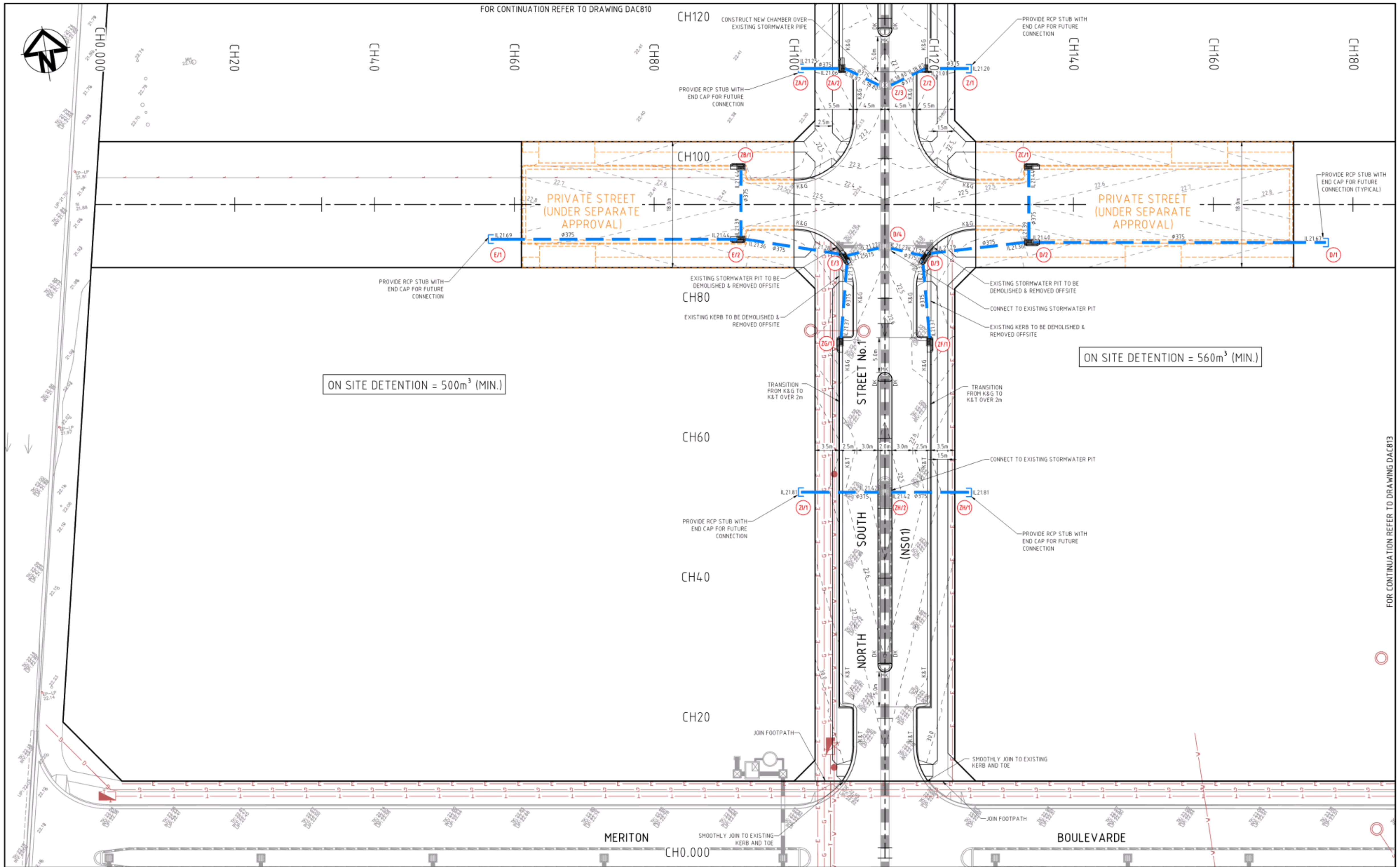

Issue	Description	Date
A	ISSUED FOR APPROVAL	13-08-18

Bar Scales: 1 : 250 @ A1 1 : 500 @ A3

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Grid	MGA	Designed	FX
Height Datum	AHD	Checked	
		Approved	AM

Project: 130-150 BUNNERONG ROAD PAGEWOOD STAGE 2

Title: SITEWORKS AND STORMWATER DRAINAGE PLAN SHEET 3

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Status: FOR APPROVAL — NOT TO BE USED FOR CONSTRUCTION — A1

Drawing No.	Project No.	Issue
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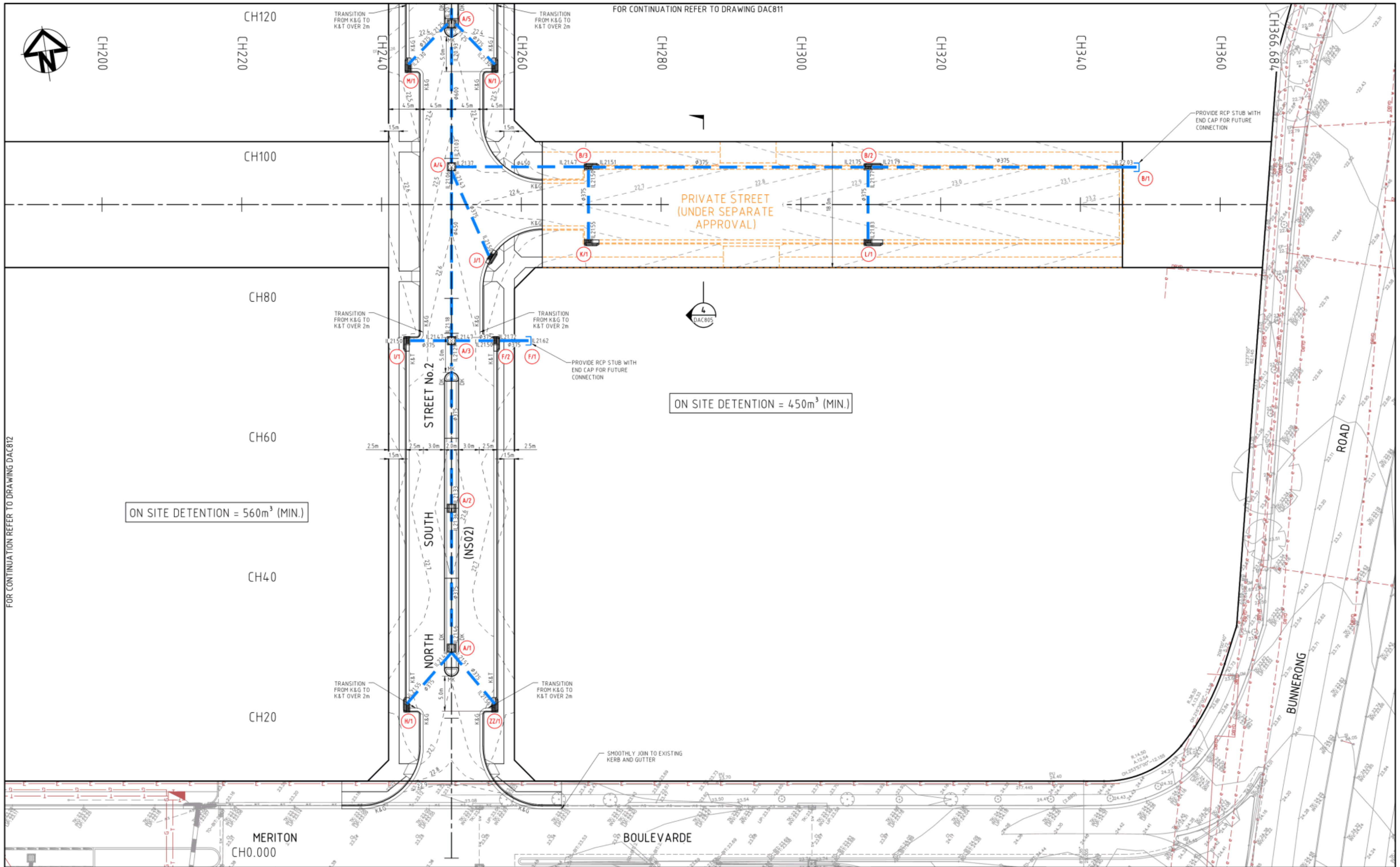

Issue	Description	Date
A	ISSUED FOR APPROVAL	13-08-18

Bar Scales

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Scales	1 : 250	Drawn	JH
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Height Datum	AHD	Approved	AM

Project: 130-150 BUNNERONG ROAD PAGEWOOD STAGE 2

Title: SITEWORKS AND STORMWATER DRAINAGE PLAN SHEET 4

Civil Engineers and Project Managers
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Status: FOR APPROVAL — NOT TO BE USED FOR CONSTRUCTION — A1

Drawing No.	Project No.	Issue
DAC813	13-155	A

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Appendix
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REVISION 02

Appendix D

DRAINs Model and Results

Appendix
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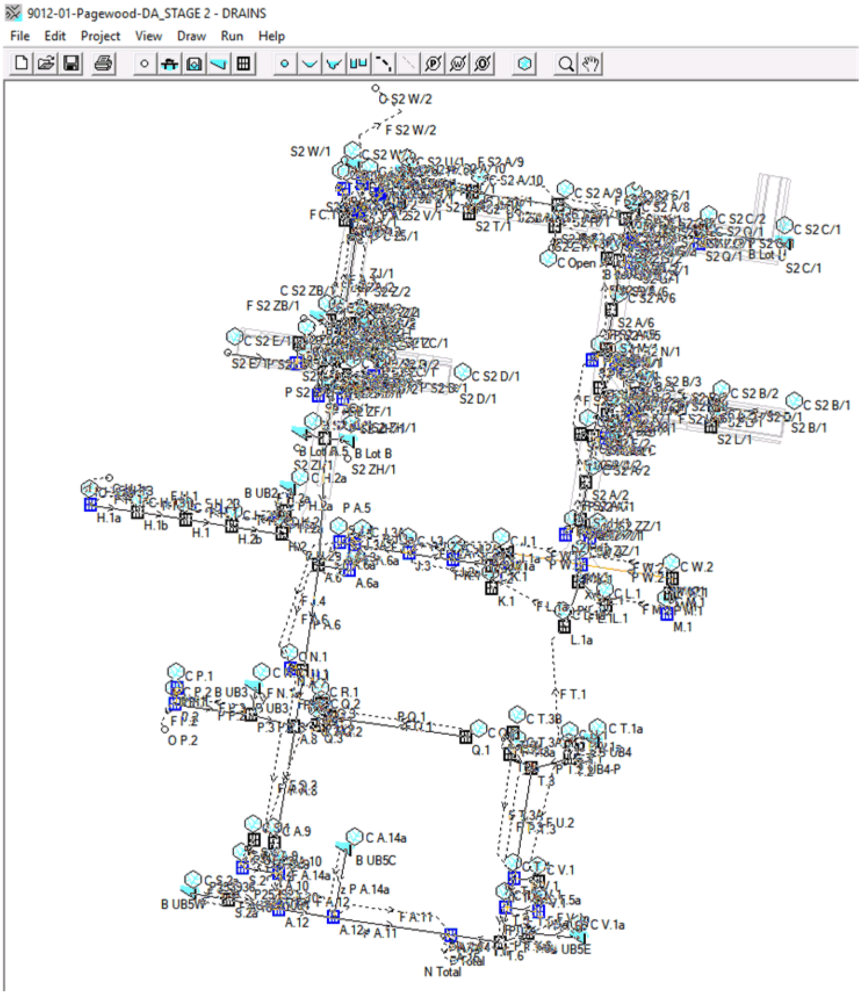
REVISION 02

DRAINSs Model

9012-01-Pagewood-DA_STAGE 2.drn



Appendix

AT&L

ABN 96 130 882 405

REVISION 02

PIT / NODE DETAILS **Version 13**

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is
H.2a	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		0.2	22.971		0	0.2	335910.1	6242872	No	50206828	1 x Ku	No	New
H.2	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		0.9	22.624		0	0.2	335908.3	6242860	No	50206827	1 x Ku	No	New
A.6	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.1	22.926		0	0.2	335927.1	6242844	No	50206807	1 x Ku	No	New
A.7	OnGrade	GRATED KI	2.4m LINTEL LEFT		0.5	22.393		0	0.2	335919.1	6242789	No	50206808	1 x Ku	No	New
A.8	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		0.5	22.245		0	0.2	335914.7	6242761	No	50206809	1 x Ku	No	New
A.9	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.5	21.564		0	0.2	335904.7	6242700	No	50206810	1 x Ku	No	New
A.10	Sag	GRATED KI	2.4m LINTE	30	0.5	21.32	0.3	0	0.5	335906.8	6242685	No	50206811	1 x Ku	No	New
A.12	Sag	JUNCTION	1.2 x 1.2 IN	30	2	21.6	0.2	0	0.5	335907	6242666	No	50206812	1 x Ku	No	New
A.12a	Sag	JUNCTION	1.2 x 1.2 IN	30	0.5	21.6	0.2	0	0.5	335934.8	6242662	No	1.81E+08	1 x Ku	No	New
A.14	Sag	JUNCTION	1.2 x 1.2 IN	15	2	21.8	0.15	0	0.5	335996	6242653	No	50206813	1 x Ku	No	New
A.15	Node					22.15		0		335996.2	6242646		50206814		No	
P.3	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.4	22.25		0	0.2	335892.5	6242766	No	50206842	1 x Ku	No	New
S.2a	OnGrade	JUNCTION	0.6 x 0.6 INFILL LID		0.2	21.83		0	0.2	335880.5	6242671	No	50206849	1 x Ku	No	New
T.6a	OnGrade	GROSS POI	HUMEGUARD		1.6	22.126		0	0.2	336035.6	6242654	No	1.65E+08	1 x Ku	No	New
T.6	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		4.6	22		0	0.2	336021.5	6242649	No	50206853	1 x Ku	No	New
H.1a	Sag	JUNCTION	0.9 x 0.9 G	15	2.6	21.988	0.15	0	0.5	335809.2	6242875	No	50206825	1 x Ku	No	New
H.1b	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		1.2	22.132		0	0.2	335833.5	6242871	No	1.08E+08	1 x Ku	No	New
H.1	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		0.9	22.309		0	0.2	335858.8	6242867	No	50206826	1 x Ku	No	New
H.2b	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		0.7	22.486		0	0.2	335882.6	6242864	No	1.08E+08	1 x Ku	No	New
K.1	OnGrade	GRATED KI	3.0m LINTEL RIGHT		2.6	22.852		0	0.2	336017.1	6242832	No	50206834	1 x Ku	No	New
J.2	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.7	23.29		0	0.2	336017.1	6242844	No	50206831	1 x Ku	No	New
J.2a	Sag	JUNCTION	0.9 x 0.9 G	15	0.2	22.887	0.15	0	0.5	335996.9	6242847	No	1.1E+08	1 x Ku	No	New
J.3	Sag	JUNCTION	0.9 x 0.9 G	15	0.2	22.643	0.15	0	0.5	335974.3	6242850	No	50206832	1 x Ku	No	New
J.3a	Sag	JUNCTION	0.9 x 0.9 G	30	0.3	22.5	0.5	0	0.5	335946	6242854	No	1.1E+08	1 x Ku	No	New
J.4	Sag	JUNCTION	0.9 x 0.9 G	30	0.7	22.578	0.5	0	0.5	335938.4	6242855	No	50206833	1 x Ku	No	New
L.1	OnGrade	GRATED KI	3.0m LINTEL LEFT		2.5	23.2		0	0.2	336076	6242823	No	50206835	1 x Ku	No	New
X.1	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.4	23.412		0	1	336061.9	6242835	No	50206863	1 x Ku	No	New
W.3	Sag	GRATED KI	3.0m LINTE	15	1.8	23.041	0.12	0	0.5	336063.3	6242844	No	50206862	1 x Ku	No	New
J.1a	OnGrade	JUNCTION	0.9 x 0.9 INFILL LID		0	23.157		0	1	336025.1	6242850	No	50206829	1 x Ku	No	New
J.1	OnGrade	GRATED KI	3.0m LINTEL LEFT		1	23.157		0	0.2	336022.3	6242850	No	50206830	1 x Ku	No	New
L.1a	OnGrade	JUNCTION	0.6 x 0.6 GRATED SUR		2.5	23.15		0	0.2	336054.4	6242812	No	50206836	1 x Ku	No	New
M.1	Sag	GRATED KI	3.0m LINTE	15	3.2	23.408	0.15	0	0.5	336107.5	6242818	No	50206837	1 x Ku	No	New
W.1	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		0.2	23.88		0	1	336109.1	6242829	No	50206860	1 x Ku	No	New
W.2	OnGrade	GRATED KI	3.0m LINTEL SAG RIGH		2.6	23.525		0	0.2	336110.3	6242837	No	50206861	1 x Ku	No	New
N.1	Sag	JUNCTION	0.6 x 0.6 G	30	5.9	22.164	0.23	0	0.2	335912.6	6242790	No	50206839	1 x Ku	No	New
P.1	Sag	GRATED KI	2.4m LINTE	15	5.9	21.789	0.15	0	0.5	335854.2	6242780	No	50206840	1 x Ku	No	New
P.2	Sag	GRATED KI	2.4m LINTE	20	0	21.711	0.2	0	0.5	335852.9	6242772	No	50206841	1 x Ku	No	New
T.3b	OnGrade	GRATED KI	0.9m LINTEL LEFT		5.9	23.502		0	0.2	336027.8	6242757	No	50206843	1 x Ku	No	New
T.3a	OnGrade	GRATED KI	0.9m LINTEL LEFT		7.9	23.442		0	0.2	336026.2	6242746	No	50206844	1 x Ku	No	New
T.3	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.8	23.477		0	0.2	336037.2	6242739	No	50206850	1 x Ku	No	New
T.4	Sag	GRATED KI	2.4m LINTE	15	0	21.893	0.15	0	0.5	336028.4	6242682	No	50206851	1 x Ku	No	New
T.5	Sag	GRATED KI	2.4m LINTE	25	0.2	21.871	0.2	0	0.5	336024.2	6242667	No	50206852	1 x Ku	No	New
R.1	OnGrade	GRATED KI	0.9m LINTEL LEFT		5.9	22.087		0	0.2	335928.6	6242772	No	50206846	1 x Ku	No	New
Q.3	OnGrade	GRATED KI	0.9m LINTEL LEFT		4.1	22.087		0	0.2	335927	6242761	No	50206845	1 x Ku	No	New
S.1	OnGrade	GRATED KI	2.4m LINTEL RIGHT		5.9	21.565		0	0.2	335893.9	6242702	No	50206847	1 x Ku	No	New
S.2	Sag	GRATED KI	2.4m LINTE	15	1.4	21.36	0.15	0	0.5	335887.7	6242687	No	50206848	1 x Ku	No	New
T.5a	Sag	GRATED KI	0.9m LINTE	20	5.9	21.705	0.17	0	0.5	336041.3	6242664	No	50206854	1 x Ku	No	New
T.1	OnGrade	GRATED KI	2.4m LINTEL RIGHT		7.9	23.731		0	0.2	336058	6242750	No	50206856	1 x Ku	No	New
T.2	OnGrade	GRATED KI	2.4m LINTEL LEFT		2.6	23.731		0	0.2	336057.1	6242744	No	50206857	1 x Ku	No	New
V.1	OnGrade	GRATED KI	2.4m LINTEL LEFT		5.9	21.982		0	0.2	336041	6242680	No	50206859	1 x Ku	No	New
O H.1a	Node					21.988		0		335818.7	6242889		50206867		No	
O P.2	Node					21.711		0		335847.5	6242759		50206868		No	
N Total	Node					22		0		335996.7	6242639		50207035		No	
A.6a	Sag	STUB (FUTI	CAP SEAL A	30	3	22.776	0.15	0	0	335943.5	6242841	No	50207219	1 x Ku	No	New
Q.1	OnGrade	DISH DRAI	0.6 x 0.9 V GRATE		5.9	23.359		0	0.2	336003.6	6242755	No	1.41E+08	1 x Ku	No	New
Q.2	OnGrade	DISH DRAI	0.6 x 0.9 V GRATE		4.4	22.399		0	0.2	335933.2	6242765	No	1.41E+08	1 x Ku	No	New
S2 B/1	Node					23.038		0		336169.8	6242921		1.83E+08		No	
S2 B/2	OnGrade	GRATED KI	2.4m LINTEL LEFT		2.2	22.8		0	0.2	336131.8	6242926	No	1.83E+08	1 x Ku	No	New
S2 B/3	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.6	22.52		0	0.2	336092.3	6242932	No	1.83E+08	1 x Ku	No	New
S2 A/4	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.4	22.536		0	0.2	336072.9	6242935	No	1.83E+08	1 x Ku	No	New
S2 A/5	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		1.1	22.393		0	0.2	336075.9	6242955	No	1.83E+08	1 x Ku	No	New
S2 A/6	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		0	22.248		0	0.2	336079	6242976	No	1.83E+08	1 x Ku	No	New
S2 A/7	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.2	22.425		0	0.2	336082.7	6243001	No	1.83E+08	1 x Ku	No	New
S2 A/8	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.6	22.127		0	0.2	336086	6243023	No	1.83E+08	1 x Ku	No	New
S2 A/9	OnGrade	GRATED KI	2.4m LINTEL LEFT		0.7	21.791		0	0.2	336051.3	6243030	No	1.83E+08	1 x Ku	No	New
S2 A/10	OnGrade	GRATED KI	2.4m LINTEL LEFT		0.4	21.449		0	0.2	336006.8	6243037	No	1.83E+08	1 x Ku	No	New
S2 A/11	OnGrade	GRATED KI	2.4m LINTEL LEFT		0.7	21.174		0	0.2	335971	6243042	No	1.83E+08	1 x Ku	No	New
A.1	Sag	JUNCTION	0.9 x 0.9 IN	20	0	21.378	0.25	0	0.5	335959.1	6243036	Yes	50206802	1 x Ku	No	New
A.2	Sag	JUNCTION	0.9 x 0.9 IN	15	0.9	21.464	0.3	0	0.5	335948	6243026	Yes	50206803	1 x Ku	No	New
ZJ/1	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		0.3	21.6		0	0.2	335946.5	6243015	No	1.83E+08	1 x Ku	No	New
A.3	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1	22.123		0	0.2	335939.1	6242967	No	50206804	1 x Ku	No	New
A.4	OnGrade	GRATED KI	2.4m LINTEL RIGHT		1.1	22.427		0	0.2	335935.7	6242944	No	50206805	1 x Ku	No	New
A.5	OnGrade	GRATED KI	0.9m LINTEL LEFT		1.7	22.628		0	0.2	335930.6	6242909	No	50206806	1 x Ku	No	New
S2 C/1	Node					22.609		0		336166.7	6243003		1.83E+08		No	
S2 D/1	Node					22.681		0		335998.2	6242935		1.83E+08		No	
S2 D/2	Sag	GRATED KI	2.4m LINTE	20	0.7	22.408	0.15	0	0.5	335956.2	6242942	No	1.83E+08	1 x Ku	No	New
S2 D/3	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.2	22.508		0	0.2	335941.2	6242942	No	1.83E+08	1 x Ku	No	New
S2 E/1	Node					22.701		0		335880.1	6242954		1.83E+08		No	
S2 E/2	Sag	GRATED KI	2.4m LINTE	20	0.6	22.448	0.15	0	0.5	335915.5	6242948	No	1.83E+08	1 x Ku	No	New
S2 E/3	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.3	22.508		0	0.2	335929.7	6242943	No	1.83E+08	1 x Ku	No	New
S2 F/1	Node					22.726		0		336080.1	6242908		1.83E+08		No	
S2 G/1	Node					22.491		0		336092.7	6242997		1.83E+08		No	
S2 H/1	Sag	GRATED KI	2.4m LINTE	20	3.3	22.528	0.2	0	0.5	336055	6242860	No	1.83E+08	1 x Ku	No	New
S2 A/1	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		1.5	22.668		0	0.2	336062.7	6242867	No	1.83E+08	1 x Ku	No	New
S2 A/2	OnGrade	JUNCTION	0.9 x 0.9 GRATED SUR		1.1	22.528		0	0.2	336065.6	6242887	No	1.83E+08	1 x Ku	No	New
S2 A/3	OnGrade	JUNCTION	1.2 x 1.2 INFILL LID		1.8	22.695		0	0.2	336069.2	6242911	No	1.83E+08	1 x Ku	No	New
S2 I/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		3.3	22.474		0	0.2	336062.8	6242912	No	1.83E+08	1 x Ku	No	New
S2 J/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		3.6	22.633		0	0.2	336076.7	6242921	No	1.83E+08	1 x Ku	No	New
S2 K/1	Sag	GRATED KI	2.4m LINTE	20	3.5	22.52	0.15	0	0.5	336090.6	6242921	No	1.83E+08	1 x Ku	No	New
S2 L/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		4	22.8		0	0.2	336130.2	6242916	No	1.83E+08	1 x Ku	No	New
S2 M/1	Sag	GRATED KI	2.4m LINTE	20	3.3	22.27	0.15	0	0.5	336068.8	6242950	No	1.83E+08	1 x Ku	No	New
S2 N/1	Sag	GRATED KI	2.4m LINTE	20	3.3	22.27	0.15	0	0.5	336081.2	6242948	No	1.83E+08	1 x Ku	No	New
S2 O/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		3.8	22.223		0	0.2	336076.4	6243002	No	1.83E+08	1 x Ku	No	New
S2 P/1	Sag	GRATED KI	2.4m LINTE	20	3.9	22.358	0.2	0	0.5	336090.2	6243011	No	1.83E+08	1 x Ku	No	New
S2 Q/1	Sag	GRATED KI	2.4m LINTE	15	3.3	22.319	0.5	0	0.5	336124.5	6243010	No	1.83E+08	1 x Ku	No	New
S2 C/2	OnGrade	GRATED KI	2.4m LINTEL LEFT		2.2	22.32		0	0.2	336125.5	6243017	No	1.83E+08	1 x Ku	No	New
S2 S/1	Node					22.37		0		336091.1	6243039		1.83E+08		No	
S2 T/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		3.3	21.449		0	0.2	336005.1	6243026	No	1.83E+08	1 x Ku	No	New
S2 U/1	Node					21.37		0		335974.4	6243053		1.83E+08		No	
S2 V/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		3.3	21.174		0	0.2	335969.4	6243031	No	1.83E+08	1 x Ku	No	New
S2 W/1	Node					21.135		0		335940.4	6243053		1.83E+08		No	
S2 X/1	Node					21.363		0		335937.8	6243039		1.83E+08		No	
B.1	Sag	GRATED KI	2.4m LINTE	30	1	21.506	0.2	0	0.5	335940.5	6243038	No	50206816	1 x Ku	No	New
C.1	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.8	21.587		0	0.2	335941.5	6243027	No	50206818	1 x Ku	No	New
S2 Y/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		2	21.251		0	0.2	335941	6243022	No	1.83E+08	1 x Ku	No	New
S2 Z/1	Node					22.297		0		335956.6	6242963		1.83E+08		No	
S2 ZA/1	Node					22.297		0		335919.3	6242971		1.83E+08		No	
S2 ZB/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		5.9	22.408		0	0.2	335917	6242959	No	1.83E+08	1 x Ku	No	New
S2 ZC/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		5.9	22.426		0	0.2	335957.8	6242952	No	1.83E+08	1 x Ku	No	New
S2 ZF/1	Sag	GRATED KI	2.4m LINTE	20	2	22.39	0.15	0	0.5	335940.1	6242930	No	1.83E+08	1 x Ku	No	New
S2 ZG/1	Sag	GRATED KI	2.4m LINTE	20	2	22.39	0.15	0	0.5	335927.3	6242932	No	1.83E+08	1 x Ku	No	New
S2 ZH/1	Node					22.849		0		335942.3	6242899		1.83E+08		No	
S2 ZI/1	Node					22.849		0		335916.3	6242904		1.83E+08		No	
S2 ZZ/1	Sag	GRATED KI	2.4m LINTE	20	3.3	22.547	0.2	0	0.5	336067.6	6242858	No	1.83E+08	1 x Ku	No	New
O S2 W/2	Node					21.098		0		335956.7	6243090		1.83E+08		No	
O S2 Z/2	Node					21.97		0		335950.7	6242973		1.83E+08		No	
O S2 ZA/2	Node					21.97		0		335938.3	6242975		1.83E+08		No	
S2 F/2	Sag	GRATED KI	2.4m LINTE	20	0.2	22.474	0.2	0	0.5	336075.6	6242910	No	1.83E+08	1 x Ku	No	New
S2 G/2	Sag	GRATED KI	2.4m LINTE	20	0.2	22.241	0.2	0	0.5	336088.9	6243000	No	1.83E+08	1 x Ku	No	New
S2 W/2	Sag	GRATED KI	2.4m LINTE	40	1	21.098	0.25	0	0.5	335949.9	6243041	No	1.83E+08	1 x Ku	No	New
S2 Z/2	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.4	21.97		0	0.2	335945.7	6242968	No	1.83E+08	1 x Ku	No	New
S2 ZA/2	OnGrade	GRATED KI	2.4m LINTEL LEFT		1.4	21.97		0	0.2	335933.3	6242970	No	1.83E+08	1 x Ku	No	New
S2 ZY/1	Node					21.8		0		336048	6243008		1.9E+08		No	
S2 R/1	OnGrade	GRATED KI	2.4m LINTEL LEFT		1	21.791		0	0.2	336049.6	6243019	No	1.83E+08	1 x Ku	No	New

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Typ	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id
B UB2	21.11	2		Orifice		140	21.61			335912.4	6242883	Yes	22.81	4	1960740
	21.61	2													
	21.71	152													
	22.11	152													
	22.61	152													
	23.11	152													
B UB3	19.5	2		Orifice		180	20			335894	6242780	Yes	21.5	4	1960746
	19.85	2													
	20	2													
	20.15	243													
	21	243													
	21.8	243													
B UB5W	18.94	2		Orifice		195	19.74			335860.9	6242674	Yes	20.75	4	1960750
	19.74	2													
	19.75	280													
	20.75	280													
	21.75	280													
B UB5E	19	2		Orifice		155	19.93			336062.2	6242651	Yes	21.75	4	1960755
	19.75	2													
	19.76	170													
	20.76	170													
	21.76	170													
	22.76	170													
B UB4	18.5	2		None						336069.4	6242753	No			1960760
	19.29	2													
	19.3	10													
	19.46	109													
	21.3	109													
	22.55	109													
B UB5C	19	2		Orifice		245	19.5			335941.1	6242697	Yes	20.7	3	1960786
	19.49	2													
	19.5	2													
	19.7	254													
	21	254													
	21.8	254													
B Lot C	21.39	2		Orifice		170	21.89			336080.1	6242909	Yes	22.9	4	1.84E+08
	21.89	2													
	21.9	250													
	22.9	250													
	23.7	250													
B Lot Fa	21.13	2		Orifice		120	21.63			336093.8	6242999	Yes	22.64	4	1.84E+08
	21.63	2													
	21.64	170													
	22.64	170													
	23.44	170													
B Lot H	21.24	2		Orifice		190	21.74			336168.3	6243010	Yes	22.75	4	1.84E+08
	21.74	2													
	21.75	260													
	22.75	260													
	23.55	260													
B Lot Fb	21.04	2		Orifice		150	21.54			336090.6	6243028	Yes	22.55	4	1.86E+08
	21.54	2													
	21.55	155													
	22.55	155													
	23.35	155													
B Lot Gb	20.04	2		Orifice		170	20.54			335971.8	6243046	Yes	21.54	4	1.86E+08
	20.54	2													
	20.55	250													
	21.55	250													
	22.35	250													
B Lot Ga	19.8	2		Orifice		170	20.3			335945.6	6243050	Yes	21.3	4	1.86E+08
	20.3	2													
	20.31	250													
	21.31	250													
	22.01	250													
B Lot E	18.65	2		Orifice		150	19.15			335951.6	6242968	Yes	20.15	4	1.86E+08
	19.14	2													
	19.15	230													
	20.15	230													
	20.95	230													
B Lot B	18.59	2		Orifice		220	19			335942.6	6242908	Yes	20	4	1.87E+08
	18.99	2													
	19	310													
	20	310													
	20.8	310													
B Lot D	18.65	2		Orifice		200	19.15			335927.6	6242971	Yes	20.15	4	1.87E+08
	19.14	2													
	19.15	290													
	20.15	290													
	20.95	290													
B Lot A	18.59	2		Orifice		210	19			335918.4	6242911	Yes	20	4	1.87E+08
	18.99	2													
	19	290													
	20	290													
	20.8	290													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough
C H.2a	B UB2	0.451	55	45	0	10	15	0								
C H.2	H.2	0.0223	85	15	0	5	10	0								
C A.9	A.9	0.0899	90	10	0	5	10	0								
C A.10	A.10	0.0365	90	10	0	5	10	0								
C N.1a	B UB3	0.7496	55	45	0	10	10	0								
C S.2a	B UB5W	1	55	45	0	10	15	0								
C V.1a	B UB5E	0.7995	55	45	0	10	10	0								
C T.1a	B UB4	0.6406	55	45	0	10	10	0								
C A.14a	B UB5C	1.014	55	45	0	10	15	0								
C H.1a	H.1a	0.0825	85	15	0	5	10	0								
C H.1B	H.1b	0.0825	85	15	0	5	10	0								
C H.1	H.1	0.0746	85	15	0	5	10	0								
C H.2B	H.2b	0.0746	85	15	0	5	10	0								
C K.1	K.1	0.088	90	10	0	5	10	0								
C J.2A	J.2a	0.0042	90	10	0	5	10	0								
C J.3	J.3	0.0042	90	10	0	5	10	0								
C J.3A	J.3a	0.1417	85	15	0	5	10	0								
C J.4	J.4	0.0354	85	15	0	5	10	0								
C L.1	L.1	0.0796	90	10	0	5	10	0								
C W.3	W.3	0.0739	90	10	0	5	10	0								
C J.1	J.1	0.0843	90	10	0	5	10	0								
C L.1a	L.1a	0.2064	90	10	0	5	10	0								
C M.1	M.1	0.1218	90	10	0	5	10	0								
C W.2	W.2	0.0646	90	10	0	5	10	0								
C N.1	N.1	0.1965	90	10	0	5	10	0								
C P.1	P.1	0.0608	90	10	0	5	10	0								
C P.2	P.2	0.0557	90	10	0	5	10	0								
C T.3B	T.3b	0.052	90	10	0	5	10	0								
C T.3A	T.3a	0.05	90	10	0	5	10	0								
C T.4	T.4	0.0839	90	10	0	5	10	0								
C T.5	T.5	0.0221	90	10	0	5	10	0								
C R.1	R.1	0.052	90	10	0	5	10	0								
C Q.3	Q.3	0.05	90	10	0	5	10	0								
C S.1	S.1	0.0888	90	10	0	5	10	0								
C S.2	S.2	0.0375	90	10	0	5	10	0								
C T.5a	T.5a	0.0224	90	10	0	5	10	0								
C U.1	T.1	0.0953	90	10	0	5	10	0								
C U.2	T.2	0.0923	90	10	0	5	10	0								
C V.1	V.1	0.0883	90	10	0	5	10	0								
C A.6a	A.6a	0.7979	10	90	0	10	20	0								

C Q.1	Q.1	0.0512	80	20	0	5	10	0
C Q.2	Q.2	0.0407	80	20	0	5	10	0
C S2 B/1	S2 B/1	0.0371	20	80	0	5	10	0
C S2 B/2	S2 B/2	0.0318	90	10	0	5	10	0
C S2 B/3	S2 B/3	0.0362	90	10	0	5	10	0
C S2 A/6	S2 A/6	0.0691	90	10	0	5	10	0
C S2 A/8	S2 A/8	0.0315	90	10	0	5	10	0
C S2 A/9	S2 A/9	0.0288	90	10	0	5	10	0
C S2 A/10	S2 A/10	0.036	90	10	0	5	10	0
C S2 A/11	S2 A/11	0.0281	90	10	0	5	10	0
C ZI/1	ZI/1	0.071	90	10	0	5	10	0
C A.4	A.4	0.0916	90	10	0	5	10	0
C S2 D/1	S2 D/1	0.1251	90	10	0	5	10	0
C S2 D/2	S2 D/2	0.0346	90	10	0	5	10	0
C S2 D/3	S2 D/3	0.0282	90	10	0	5	10	0
C S2 E/1	S2 E/1	0.1099	20	80	0	5	10	0
C S2 E/2	S2 E/2	0.0273	90	10	0	5	10	0
C S2 E/3	S2 E/3	0.0295	90	10	0	5	10	0
C S2 H/1	S2 H/1	0.0299	90	10	0	5	10	0
C S2 A/2	S2 A/2	0.0461	90	10	0	5	10	0
C S2 I/1	S2 I/1	0.0107	90	10	0	5	10	0
C S2 J/1	S2 J/1	0.0264	90	10	0	5	10	0
C S2 K/1	S2 K/1	0.0362	90	10	0	5	10	0
C S2 L/1	S2 L/1	0.0318	90	10	0	5	10	0
C S2 M/1	S2 M/1	0.0428	90	10	0	5	10	0
C S2 N/1	S2 N/1	0.0373	90	10	0	5	10	0
C S2 O/1	S2 O/1	0.0079	90	10	0	5	10	0
C S2 P/1	S2 P/1	0.0369	90	10	0	5	10	0
C S2 Q/1	S2 Q/1	0.1503	90	10	0	5	10	0
C S2 C/2	S2 C/2	0.1245	90	10	0	5	10	0
C S2 T/1	S2 T/1	0.0361	90	10	0	5	10	0
C S2 V/1	S2 V/1	0.029	90	10	0	5	10	0
C S2 X/1	S2 X/1	0.1558	80	20	0	5	10	0
C B.1	B.1	0.0378	90	10	0	5	10	0
C S2 ZB/1	S2 ZB/1	0.0273	90	10	0	5	10	0
C S2 ZC/1	S2 ZC/1	0.0345	90	10	0	5	10	0
C S2 ZF/1	S2 ZF/1	0.0102	90	10	0	5	10	0
C S2 ZG/1	S2 ZG/1	0.0102	90	10	0	5	10	0
C S2 ZZ/1	S2 ZZ/1	0.0299	90	10	0	5	10	0
C S2 F/1	B Lot C	0.7567	90	10	0	5	10	0
C S2 F/2	S2 F/2	0.0106	90	10	0	5	10	0
C S2 G/1	B Lot Fa	0.4103	90	10	0	5	10	0
C S2 G/2	S2 G/2	0.0079	90	10	0	5	10	0
C S2 C/1	B Lot H	0.8235	90	10	0	5	10	0
C S2 S/1	B Lot Fb	0.3726	90	10	0	5	10	0
C S2 U/1	B Lot Gb	0.7519	90	10	0	5	10	0
C S2 W/1	B Lot Ga	0.6364	90	10	0	5	10	0
C S2 W/2	S2 W/2	0.0885	90	10	0	5	10	0
C S2 Z/1	B Lot E	0.5572	90	10	0	5	10	0
C S2 Z/2	S2 Z/2	0.0369	90	10	0	5	10	0
C S2 ZH/1	B Lot B	0.866	90	10	0	5	10	0
C S2 ZA/1	B Lot D	0.7353	90	10	0	5	10	0
C S2 ZA/2	S2 ZA/2	0.0383	90	10	0	5	10	0
C S2 ZI/1	B Lot A	0.7732	90	10	0	5	10	0
C Open A	S2 ZY/1	0.5572	10	90	0	5	10	0
C S2 R/1	S2 R/1	0.0331	90	10	0	5	10	0

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	RI (m)
z P H.2a	B UB2	H.2a	2.5	21.423	21.398	1	RCP	375	375	0.3	NewFixed	1	B UB2	0	0	22.971
P H.2a	H.2a	H.2	11.917	21.398	21.278	1.01	RCP	375	375	0.3	New	1	H.2a	0	0	22.971
P H.2	H.2	A.6	24.831	19.611	19.363	1	RCP	450	450	0.3	New	1	H.2	0	0	22.624
P A.6	A.6	A.7	55.224	18.22	17.984	0.43	RCP	1200	1200	0.3	New	1	A.6	0	0	22.926
P A.7	A.7	A.8	28.988	17.964	17.864	0.34	RCP	1200	1200	0.3	New	1	A.7	0	0	22.393
P A.8	A.8	A.9	61.105	17.844	17.601	0.4	RCP	1200	1200	0.3	New	1	A.8	0	0	22.245
P A.9	A.9	A.10	15.837	17.581	17.517	0.4	RCP	1200	1200	0.3	New	1	A.9	0	0	21.564
P A.10	A.10	A.12	18.621	17.497	17.398	0.53	RCP	1200	1200	0.3	New	1	A.10	0		
P A.12	A.12	A.12a	28	17.36	17.248	0.4	RCP	1200	1200	0.3	New	1	A.12	0		
P A.11	A.12a	A.14	70.625	17.248	16.966	0.4	RCP	1200	1200	0.3	New	1	A.12a	0		
P A.14	A.14	A.15	10	16.966	16.902	0.64	Box Culver 2.44W x 1.21H			0.3	Existing	1	A.14	0		
P UB3	B UB3	P.3	5	19.85	19.8	1	RCP	375	375	0.3	NewFixed	1	B UB3	0	0	22.25
P P.3	P.3	A.8	22.911	19.78	19.55	1	RCP	375	375	0.3	New	1	P.3	0	0	22.25
P2S3936	B UBSW	S.2a	30	19.44	19.061	1.26	RCP	600	600	0.3	NewFixed	1	B UBSW	0	0	21.511
P2S3921	S.2a	A.12	16	19.061	18.88	1.13	RCP	600	600	0.3	NewFixed	1	S.2a	0	0	21.511
P T.6b	B UBSE	T.6a	26.8	19.7	19.45	0.93	RCP	375	375	0.3	NewFixed	1	B UBSE	0	0	22.126
P T.6a	T.6a	T.6	10.76	19.11	19.04	0.65	RCP	375	375	0.3	New	1	T.6a	0	0	21.705
P T.6	T.6	A.14	25.849	19.04	18.782	1	RCP	525	525	0.3	New	1	T.6	0		
z P A.14a	B UBSC	A.12a	10	19.35	19.25	1	RCP	375	375	0.3	NewFixed	1	B UBSC	0		
P H.1a	H.1a	H.1b	25.557	20.713	20.457	1	RCP	375	375	0.3	New	1	H.1a	0	0	21.988
P H.1b	H.1b	H.1	24.606	20.427	20.181	1	RCP	375	375	0.3	New	1	H.1b	0	0	21.988
P H.1	H.1	H.2b	24.509	20.151	19.906	1	RCP	375	375	0.3	New	1	H.1	0	0	22.309
P H.2b	H.2b	H.2	25.505	19.886	19.631	1	RCP	375	375	0.3	New	1	H.2b	0	0	22.309
P K.1	K.1	J.2	11.632	21.125	21.003	1.05	RCP	375	375	0.3	New	1	K.1	0	0	22.852
P J.2a	J.2	J.2a	18.497	20.778	20.593	1	RCP	525	525	0.3	New	1	J.2	0	0	23.29
P J.2	J.2a	J.3	24.772	20.563	20.315	1	RCP	525	525	0.3	New	1	J.2a	0	0	23.29
P J.3a	J.3	J.3a	26.004	20.285	20.025	1	RCP	525	525	0.3	New	1	J.3	0	0	22.643
P J.3	J.3a	J.4	10.273	20.025	19.922	1	RCP	525	525	0.3	New	1	J.3a	0	0	22.643
P J.4	J.4	A.6	16.126	19.892	19.731	1	RCP	525	525	0.3	New	1	J.4	0	0	22.541
P L.1	L.1	X.1	18.624	21.73	21.598	0.71	RCP	375	375	0.3	New	1	L.1	0	0	23.2
P X.1	X.1	W.3	8.934	21.585	21.496	1	RCP	375	375	0.3	Existing	1	X.1	0	0	23.412
P W.3	W.3	J.1a	38.674	21.397	21.01	1	RCP	450	450	0.3	Existing	1	W.3	0	0	23.041
P J.1a	J.1a	J.1	2.801	21.008	20.98	1	RCP	525	525	0.3	New	1	J.1a	0	0	23.151
P J.1	J.1	J.2	8.541	20.98	20.905	0.88	RCP	525	525	0.3	New	1	J.1	0	0	23.157
P L.1a	L.1a	X.1	24.896	21.718	21.594	0.5	RCP	375	375	0.3	New	1	L.1a	0	0	23.15
P M.1	M.1	W.1	10.6	22.225	22.119	1	RCP	375	375	0.3	New	1	M.1	0	0	23.408
P W.1	W.1	W.2	8.193	22.119	22.023	1.17	RCP	375	375	0.3	Existing	1	W.1	0	0	23.88
P W.2	W.2	W.3	47.58	21.923	21.447	1	RCP	375	375	0.3	Existing	1	W.2	0	0	23.525
P N.1	N.1	A.7	6.575	20.4	20.27	1.98	RCP	375	375	0.3	New	1	N.1	0	0	22.164
P P.1	P.1	P.2	8.498	20.6	20.515	1	RCP	375	375	0.3	New	1	P.1	0	0	21.789
P P.2	P.2	P.3	39.993	20.495	20.095	1	RCP	375	375	0.3	New	1	P.2	0	0	21.711
P T.3b	T.3b	T.3a	6	21.719	21.599	2	RCP	375	375	0.3	New	1	T.3b	0	0	23.147
P T.3a	T.3a	T.3	10.288	21.569	21.363	2	RCP	375	375	0.3	New	1	T.3a	0		
P T.3	T.3	T.4	57.274	21.343	20.197	2	RCP	375	375	0.3	New	1	T.3	0	0	23.477
P T.4	T.4	T.5	15.691	20.177	20.021	0.99	RCP	525	525	0.3	New	1	T.4	0	0	21.893
P T.5	T.5	T.6	18.387	20.001	19.817	1	RCP	525	525	0.3	New	1	T.5	0		
P R.1	R.1	Q.3	6	20.607	20.487	2	RCP	375	375	0.3	New	1	R.1	0	0	22.03
P Q.3	Q.3	A.8	7.692	19.689	19.535	2	RCP	375	375	0.3	New	1	Q.3	0	0	21.967
P S.1	S.1	S.2	15.78	20.5	20.342	1	RCP	375	375	0.3	New	1	S.1	0	0	21.565
P S.2	S.2	A.10	19.25	20.117	19.929	0.98	RCP	450	450	0.3	New	1	S.2	0	0	21.36
P T.5a	T.5a	T.5	17.25	20.226	20.053	1	RCP	375	375	0.3	New	1	T.5a	0	0	21.705
P T.1	T.1	T.2	6	21.9	21.84	1	RCP	375	375	0.3	New	1	T.1	0	0	23.731
P T.2	T.2	T.3	20.603	21.82	21.614	1	RCP	375	375	0.3	New	1	T.2	0	0	23.731
P V.1	V.1	T.4	12.751	20.551	20.424	1	RCP	375	375	0.3	New	1	V.1	0	0	21.982
P A.6a	A.6a	A.6	16.126	20.089	19.96	0.8	RCP	450	450	0.3	New	1	A.6a	0	0	22.541
P Q.1	Q.1	Q.2	76.793	21.4	19.864	2	RCP	375	375	0.3	New	1	Q.1	0	0	23.074
P Q.2	Q.2	Q.3	6.759	19.844	19.709	2	RCP	375	375	0.3	New	1	Q.2	0		
P S2 B/1	S2 B/1	S2 B/2	38.403	22.028	21.793	0.61	RCP	375	375	0.3	New	1	S2 B/1	0	0	23.038
P S2 B/2	S2 B/2	S2 B/3	40	21.745	21.513	0.58	RCP	375	375	0.3	New	1	S2 B/2	0	0	22.8
P S2 B/3	S2 B/3	S2 A/4	19.6	21.465	21.367	0.5	RCP	450	450	0.3	New	1	S2 B/3	0	0	22.52
P S2 A/4	S2 A/4	S2 A/5	20.431	21.028	20.926	0.5	RCP	600	600	0.3	New	1	S2 A/4	0	0	22.536
P S2 A/5	S2 A/5	S2 A/6	20.683	20.896	20.793	0.5	RCP	600	600	0.3	New	1	S2 A/5	0	0	22.393
P S2 A/6	S2 A/6	S2 A/7	25.437	20.763	20.636	0.5	RCP	600	600	0.3	New	1	S2 A/6	0	0	22.248
P S2 A/7	S2 A/7	S2 A/8	21.87	20.606	20.496	0.5	RCP	750	750	0.3	New	1	S2 A/7	0	0	22.425
P S2 A/8	S2 A/8	S2 A/9	35.463	20.466	20.289	0.5	RCP	825	825	0.3	New	1	S2 A/8	0	0	22.127
P S2 A/9	S2 A/9	S2 A/10	45	20.059	19.834	0.5	RCP	825	825	0.3	New	1	S2 A/9	0	0	21.791
P S2 A/10	S2 A/10	S2 A/11	36.152	19.804	19.623	0.5	RCP	825	825	0.3	New	1	S2 A/10	0	0	21.449
P S2 A/11	S2 A/11	A.1	12.837	19.194	19.13	0.5	RCP	1200	1200	0.3	New	1	S2 A/11	0	0	21.174
P A.1	A.1	A.2	11.992	19.1	19.052	0.4	RCP	1200	1200	0.3	New	1	A.1	0	0	20.788
P A.2a	A.2	ZI/1	11	19.032	18.988	0.4	RCP	1200	1200	0.3	New	1	A.2	0	0	21.072
P A.2	ZI/1	A.3	48.389	18.988	18.794	0.4	RCP	1200	1200	0.3	New	1	ZI/1	0	0	21.072
P A.3	A.3	A.4	24.386	18.774	18.684	0.37	RCP	1200	1200	0.3	New	1	A.3	0	0	21.922
P A.4	A.4	A.5	26.784	18.664	18.537	0.47	RCP	1200	1200	0.3	New	1	A.4	0	0	22.276
P A.5	A.5	A.6	72.354	18.537	18.24	0.41	RCP	1200	1200	0.3	New	1	A.5	0	0	22.533
P S2 D/1	S2 D/1	S2 D/2	42.487	21.671	21.401	0.64	RCP	375	375	0.3	New	1	S2 D/1	0	0	22.681
P S2 D/2	S2 D/2	S2 D/3	14.937	21.36	21.286	0.5	RCP	375	375	0.3	New	1	S2 D/2	0	0	22.408
P S2 D/3	S2 D/3	A.4	6.015	21.256	21.225	0.52	RCP	375	375	0.3	New	1	S2 D/3	0	0	22.508
P S2 E/1	S2 E/1	S2 E/2	35.769	21.691	21.441	0.7	RCP	375	375	0.3	New	1	S2 E/1	0	0	22.701
P S2 E/2	S2 E/2	S2 E/3	15.001	21.355	21.28	0.5	RCP	375	375	0.3	New	1	S2 E/2	0	0	22.448
P S2 E/3	S2 E/3	A.4	6.019	21.25	21.22	0.5	RCP	375	375	0.3	New	1	S2 E/3	0	0	22.508
P S2 H/1	S2 H/1	S2 A/1	10.738	21.546	21.492	0.5	RCP	375	375	0.3	New	1	S2 H/1	0	0	22.528
P S2 A/1	S2 A/1	S2 A/2	20	21.462	21.362	0.5	RCP	375	375	0.3	New	1	S2 A/1	0	0	22.668
P S2 A/2	S2 A/2	S2 A/3	23.95	21.332	21.213	0.5	RCP	375	375	0.3	New	1	S2 A/2	0	0	22.528
P S2 A/3	S2 A/3	S2 A/4	24.85	21.183	21.058	0.5	RCP	450	450	0.3	New	1	S2 A/3	0	0	22.695
P S2 I/1	S2 I/1	S2 A/3	6.5	21.504	21.472	0.49	RCP	375	375	0.3	New	1	S2 I/1	0	0	22.474
P S2 J/1	S2 J/1	S2 A/4	14.218	21.502	21.431	0.5	RCP	375	375	0.3	New	1	S2 J/1	0	0	22.633
P S2 K/1	S2 K/1	S2 B/3	11	21.55	21.495	0.5	RCP	375	375	0.3	New	1	S2 K/1	0	0	22.52
P S2 L/1	S2 L/1	S2 B/2	11	21.83	21.775	0.5	RCP	375	375	0.3	New	1	S2 L/1	0	0	22.8
P S2 M/1	S2 M/1	S2 A/5	8.945	21.297	21.252	0.5	RCP	375	375	0.3	New	1	S2 M/1	0	0	22.27
P S2 N/1	S2 N/1	S2 A/5	8.946	21.297	21.252	0.5	RCP	375	375	0.3	New	1	S2 N/1	0	0	22.27
P S2 O/1	S2 O/1	S2 A/7	6.422	21.256	21.224	0.5	RCP	375	375	0.3	New	1	S2 O/1	0	0	22.223
P S2 P/1	S2 P/1	S2 A/8	12.401	21.222	21.147	0.6	RCP	375	375	0.3	New	1	S2 P/1	0	0	22.358
P S2 Q/1	S2 Q/1	S2 C/2	7	21.349	21.314	0.5	RCP	375	375	0.3	New	1	S2 Q/1	0	0	22.319
P S2 C/2	S2 C/2	S2 A/8	40	21.243	21.043	0.5	RCP	450	450	0.3	New	1	S2 C/2	0	0	22.32
P S2 T/1	S2 T/1	S2 A/10	11	20.479	20.424	0.5	RCP	375	375	0.3	New	1	S2 T/1	0	0	21.449
P S2 V/1	S2 V/1	S2 A/11	11	20.204	20.149	0.5	RCP	375	375	0.3	New	1	S2 V/1	0	0	21.174
P S2 X/1	S2 X/1	B.1	2.6	19.438	19.412	1	RCP	375	375	0.3	New	1	S2 X/1	0	0	21.363
P B.1	B.1	C.1	17.968	19.372	19.192	1	RCP	450	450	0.3	New	1	B.1	0	0	20.844
P C.1	C.1	A.2	13	19.162	19.032	1	RCP	525	525	0.3	New	1	C.1	0	0	21.204
P S2 Y/1	S2 Y/1	C.1	4.53	19.237	19.192	0.99	RCP	375	375	0.3	New	1	S2 Y/1	0	0	21.251
P S2 ZB/1	S2 ZB/1	S2 E/2	10.55	21.438	21.385	0.5	RCP	375	375	0.3	New	1	S2 ZB/1	0	0	22.408
P S2 ZC/1	S2 ZC/1	S2 D/2	10.803	21.444	21.39	0.5	RCP	375	375	0.3	New	1	S2 ZC/1	0	0	22.426
P S2 ZF/1	S2 ZF/1	S2 D/3	12.046	21.371	21.311	0.5	RCP	375	375	0.3	New	1	S2 ZF/1	0	0	22.39
P S2 ZG/1	S2 ZG/1	S2 E/3	12.046	21.371	21.311	0.5	RCP	375	375	0.3	New	1	S2 ZG/1	0	0	22.39
P S2 ZZ/1	S2 ZZ/1	S2 A/1	10.603	21.563	21.51	0.5	RCP	375	375	0.3	New	1	S2 ZZ/1	0	0	22.547
P S2 F/1	B Lot C	S2 F/2	4.5	21.716	21.622	2.09	RCP	375	375	0.3	NewFixed	1	B Lot C	0	0	22.726
P S2 F/2	S2 F/2	S2 A/3	6.5	21.504	21.472	0.49	RCP	375	375	0.3	New	1	S2 F/2	0	0	22.474
P S2 G/1	B Lot Fa	S2 G/2	4.73	21.475	21.356	2.52	RCP	375	375	0.3	NewFixed	1	B Lot Fa	0	0	22.491
P S2 G/2	S2 G/2	S2 A/7	6.27	21.26	21.228	0.51	RCP	375	375	0.3	New	1	S2 G/2	0	0	22.241
P S2 C/1	B Lot H	S2 C/2	42.904	21.56	21.273	0.67	RCP	375	375	0.3	NewFixed	1	B Lot H	0	0	22.609
P S2 S/1	B Lot Fb	S2 A/8	7.201	21.358	21.262	1.33	RCP	375	375	0.3	NewFixed	1	B Lot Fb	0	0	22.37
P S2 U/1	B Lot Gb	S2 A/11	4.5	20.358	20.319	0.87	RCP	375	375	0.3	NewFixed	1	B Lot Gb	0	0	21.37
P S2 W/1	B Lot Ga	S2 W/2	10.018	20.125	20.075	0.5	RCP	375	375	0.3	NewFixed	1	B Lot Ga	0	0	21.135
P S2 W/2	S2 W/2	A.2	15.442	20.045	19.968	0.5	RCP	375	375	0.3	New	1	S2 W/2	0	0	21.098
P S2 Z/1	B Lot E	S2 Z/2	5.73	18.957	18.9	0.99	RCP	375	375	0.3	NewFixed	1	B Lot E	0	0	22.297
P S2 Z/2	S2 Z/2	A.3	6.7	18.867	18.8	1	RCP	375	375	0.3	New	1	S2 Z/2	0	0	21.97
P S2 ZH/1	B Lot B	A.5	12.001	18.72	18.6	1	RCP	375	375	0.3	NewFixed	1	B Lot B	0	0	22.849
P S2 ZA/1	B Lot D	S2 ZA/2	5.727	18.957	18.9	1	RCP	375	375	0.3	NewFixed	1	B Lot D	0	0	22.297
P S2 ZA/2	S2 ZA/2	A.3	6.701	18.867	18.8	1	RCP	375	375	0.3	New	1	S2 ZA/2	0	0	21.97
P S2 ZI/1	B Lot A	A.5	12	18.72	18.6	1	RCP	375	375	0.3	NewFixed	1	B Lot A	0	0	22.849
P S2 ZY/1	S2 ZY/1	S2 R/1	11	20.876	20.821	0.5	RCP	600	600	0.3	New	1	S2 ZY/1	0	0	21.791
P S2 R/1	S2 R/1	S2 A/9	11	20.821	20.766	0.5	RCP	600	600	0.3	New	1	S2 R/1	0	0	21.791

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg	Bottom	Height of S	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc

CHANNEL DETAILS

Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Widtl	L.B. Slope	R.B. Slope	Manning	Depth	Roofed
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)	

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Stor (m)	SafeDepth Minor Stor (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id	U/S IL	D/S IL
F H.2a	B UB2	H.2	1	23.11	2	1.6	7.5 m road	0.14	0.14	0.6	1	0	774528	22.971	22.624
F H.2	H.2	H.2b	1				7.5 m road	0.14	0.14	0.4	1	0	50206991	22.624	22.309
F A.6	A.6	N.1	1				7.5 m road	0.14	0.14	0.4	1	0	50206973	22.926	22.164
F A.7	A.7	A.8	1				7.5 m road	0.14	0.14	0.4	1	0	50206974	22.393	22.245
F A.8	A.8	A.9	1				7.5 m road	0.14	0.14	0.4	0.8	0	50206975	22.245	21.564
F A.9	A.9	A.10	1				7.5 m road	0.14	0.14	0.4	0.8	0	50206976	21.564	21.32
F A.10	A.10	A.12	1				7.5 m road	0.14	0.14	0.4	1	0	50206977	21.32	22.16
F A.12	A.12	A.12a	1				7.5 m road	0.14	0.14	0.4	1	0	50206978	22.16	22.102
F A.11	A.12a	A.14	1				7.5 m road	0.14	0.14	0.4	1	0	1.81E+08	22.16	22.102
F A.14	A.14	A.15	1				7.5 m road	0.14	0.14	0.4	1	0	50206979		
F Total	A.15	N Total	1				7.5 m road	0.3	0.15	0.4	1	0	333		
F N.1a	B UB3	P.3	1	22.43	2	1.6	7.5 m road	0.14	0.14	0.6	1	0	774514	22.585	22.164
F P.3	P.3	P.2	1				7.5 m road	0.14	0.14	0.4	0.7	0	50207004	22.25	21.711
F S.2a	B UB5W	S.2a	1	21.93	2	1.6	7.5 m road	0.14	0.14	0.6	0.8	0	774485	21.511	21.36
OF241084	S.2a	A.12	1				7.5 m road	0.14	0.14	0.4	0.8	0	1.64E+08	21.36	21.32
F V.1a	B UB5E	T.6a	1	22.36	2	1.6	7.5 m road	0.14	0.14	0.6	2.3	0	774498	22.126	21.982
F T.6a	T.6a	T.6	1				7.5 m road	0.14	0.14	0.6	1	0	1.65E+08	21.705	22.19
F T.6	T.6	A.14	1				7.5 m road	0.14	0.14	0.4	1	0	50207014		
F T.1a	B UB4	T.2	0.1	24	2	1.6	4 m wide p	0.3	0.15	0.4	2.5	0	774506	22.3	22
F A.14a	B UB5C	A.12a	1	22.2	2	1.6	7.5 m road	0.14	0.14	0.6	1	0	50206980	22	22.102
F H.1a	H.1a	O H.1a	1				7.5 m road	0.14	0.14	0.6	1	0	50206989		
F H.1B	H.1b	H.1a	1				7.5 m road	0.14	0.14	0.4	1	0	1.08E+08	22.309	21.988
F H.1	H.1	H.1b	1				7.5 m road	0.14	0.14	0.4	1	0	50206990	22.309	21.988
F H.2B	H.2b	H.1	1				7.5 m road	0.14	0.14	0.4	1	0	1.08E+08	22.624	22.309
F K.1	K.1	J.3	1				7.5 m road	0.14	0.14	0.4	1	0	50206997	22.852	22.643
F J.2	J.2	J.2a	1				7.5 m road	0.14	0.14	1	1	0	50206994	23.29	22.643
F J.2A	J.2a	J.3	1				7.5 m road	0.14	0.14	1	1	0	1.1E+08	23.29	22.643
F J.3	J.3	J.3a	1				7.5 m road	0.14	0.14	1	1	0	50206995	22.643	22.541
F J.3A	J.3a	J.4	1				7.5 m road	0.14	0.14	1	1	0	1.1E+08	22.643	22.541
F J.4	J.4	N.1	1				7.5 m road	0.14	0.14	0.4	1	0	50206996	22.541	22.164
F L.1	L.1	L.1a	1				7.5 m road	0.14	0.14	0.4	1	0	50206998	23.2	23.15
F X.1	X.1	W.3	1				7.5 m road	0.14	0.14	0.4	1	0	50207023	23.412	23.041
F W.3	W.3	J.1	1				7.5 m road	0.14	0.14	0.4	1	0	50207022	23.041	23.157
F J.1a	J.1a	J.1	1				7.5 m road	0.14	0.14	0.6	1	0	50206992	23.151	23.157
F J.1	J.1	J.3	1				7.5 m road	0.14	0.14	0.4	1	0	50206993	23.157	22.643
F L.1a	L.1a	K.1	1				7.5 m road	0.14	0.14	0.6	1	0	50206999	23.15	22.852
F M.1	M.1	L.1	1				7.5 m road	0.14	0.14	0.4	1	0	50207000	23.408	23.2
F W.1	W.1	W.2	1				7.5 m road	0.14	0.14	0.4	1	0	50207020	23.88	23.525
F W.2	W.2	W.3	1				7.5 m road	0.14	0.14	0.4	1	0	50207021	23.525	23.041
F N.1	N.1	A.7	1				7.5 m road	0.14	0.14	0.4	0.6	0	50207001	22.164	22.393
F P.1	P.1	P.2	1				7.5 m road	0.14	0.14	0.4	0.7	0	50207002	21.789	21.711
F P.2	P.2	O P.2	1				7.5 m road	0.14	0.14	0.4	1	0	50207003		
F T.3B	T.3b	T.3a	1				7.5 m road	0.14	0.14	0.4	2.7	0	50207005	23.147	22.03
F T.3A	T.3a	T.4	1				7.5 m road	0.14	0.14	0.4	2.7	0	1.41E+08	23.147	22.03
F T.3	T.3	T.4	1				7.5 m road	0.14	0.14	0.4	3	0	50207011	23.477	21.893
F T.4	T.4	T.5	1				7.5 m road	0.14	0.14	0.4	0.8	0	50207012	21.893	21.871
F T.5	T.5	T.6	1				7.5 m road	0.14	0.14	0.4	1	0	50207013	21.871	22.19
F R.1	R.1	Q.3	1				7.5 m road	0.14	0.14	0.4	1	0	50207008	22.03	22.164
F Q.3	Q.3	A.9	1				7.5 m road	0.14	0.14	0.4	0.8	0	50207007	21.967	21.564
F S.1	S.1	S.2	1				7.5 m road	0.14	0.14	0.4	0.8	0	50207009	21.565	21.36
F S.2	S.2	A.10	1				7.5 m road	0.14	0.14	0.4	0.8	0	50207010	21.36	21.32
F T.5a	T.5a	T.5	1				7.5 m road	0.14	0.14	0.6	1	0	50207015	21.705	22.19
F T.1	T.1	L.1a	1				7.5 m road	0.14	0.14	0.4	1	0	50207017	23.731	23.15
F U.2	T.2	V.1	1				7.5 m road	0.14	0.14	0.4	2.3	0	50207018	23.731	21.982
F V.1	V.1	T.5a	1				7.5 m road	0.14	0.14	0.4	0.8	0	50207019	21.982	21.705
z F A.6a	A.6a	A.6	1				7.5 m road	0.3	0.15	0.4	1	0	50207225		
F Q.1	Q.1	Q.2	1				7.5 m road	0.14	0.14	0.4	2.7	0	50207006	23.074	21.967
F Q.2	Q.2	Q.3	1				7.5 m road	0.14	0.14	0.4	2.7	0	1.42E+08	23.074	21.967
F S2 B/2	S2 B/2	S2 B/3	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.8	22.52
F S2 B/3	S2 B/3	S2 N/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.52	22.27
F S2 A/5	S2 A/5	S2 A/6	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.393	22.248
F S2 A/6	S2 A/6	S2 O/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.248	22.223
F S2 A/8	S2 A/8	S2 A/9	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.127	21.791
F S2 A/9	S2 A/9	S2 A/11	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	21.791	21.174
F S2 A/10	S2 A/10	S2 A/11	1				7.5 m road	0.14	0.14	0.6	1	0	1.96E+08	21.449	21.174
F S2 A/11	S2 A/11	S2 W/2	1				7.5 m road	0.3	0.14	0.6	1	0	1.83E+08	21.174	21.098
F A.1	A.1	B.1	1				7.5 m road	0.14	0.14	0.4	1	0	50206968	20.788	20.83
F A.2	A.2	A.1	1				7.5 m road	0.14	0.14	0.4	0.6	0	50206969	21.072	20.788
F A.2a	ZJ/1	A.2	1				7.5 m road	0.14	0.14	0.4	0.6	0	1.89E+08	21.072	20.788
F A.3	A.3	ZJ/1	1				Swale with	0.45	0.3	1	1	0	1.86E+08	22.508	21.97
F A.4	A.4	A.3	1				Swale with	0.45	0.3	1	1	0	1.85E+08	22.508	21.97
F S2 D/2	S2 D/2	S2 D/3	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.408	22.508
F S2 D/3	S2 D/3	S2 Z/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.508	21.97
F S2 E/2	S2 E/2	S2 E/3	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.448	22.508
F S2 E/3	S2 E/3	S2 ZA/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.508	21.97
F S2 H/1	S2 H/1	S2 A/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.528	22.668
F S2 A/1	S2 A/1	S2 A/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.668	22.528
F S2 A/2	S2 A/2	S2 I/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.528	22.474
F S2 I/1	S2 I/1	S2 M/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.474	22.27
F S2 J/1	S2 J/1	S2 N/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.633	22.27
F S2 K/1	S2 K/1	S2 J/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.52	22.633
F S2 L/1	S2 L/1	S2 K/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.8	22.52
F S2 M/1	S2 M/1	S2 A/5	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.27	22.393
F S2 N/1	S2 N/1	S2 A/5	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.27	22.393
F S2 O/1	S2 O/1	S2 R/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.223	21.791
F S2 P/1	S2 P/1	S2 A/8	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.358	22.127
F S2 Q/1	S2 Q/1	S2 P/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.319	22.358
F S2 C/2	S2 C/2	S2 A/8	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.32	22.127
F S2 T/1	S2 T/1	S2 V/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	21.449	21.174
F S2 V/1	S2 V/1	S2 W/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	21.174	21.098
F C.1	C.1	B.1	1				7.5 m road	0.14	0.14	0.4	1	0	50206982	21.204	20.83
F S2 Y/1	S2 Y/1	S2 W/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	21.251	21.098
F S2 ZB/1	S2 ZB/1	S2 ZA/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.408	21.97
F S2 ZC/1	S2 ZC/1	S2 Z/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.426	21.97
F S2 ZF/1	S2 ZF/1	S2 D/3	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.39	22.508
F S2 ZG/1	S2 ZG/1	S2 E/3	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.39	22.508
F S2 ZZ/1	S2 ZZ/1	S2 A/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.547	22.668
F S2 F/2	S2 F/2	S2 J/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.474	22.633
F S2 G/2	S2 G/2	S2 P/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	22.241	22.358
F S2 W/2	S2 W/2	O S2 W/2	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08		
F S2 Z/2	S2 Z/2	ZJ/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08		
F S2 ZA/2	S2 ZA/2	ZJ/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08		
F S2 R/1	S2 R/1	S2 T/1	1				7.5 m road	0.14	0.14	0.6	1	0	1.83E+08	21.791	21.449

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover	Cover (m)	
z P H.2a	RCP	375	0.6	0.91	
P H.2a	RCP	375	0.6	0.94	
P H.2	RCP	450	0.6	2.51	
P A.6	RCP	1200	0.6	3.12	
P A.7	RCP	1200	0.6	2.97	
P A.8	RCP	1200	0.6	2.68	
P A.9	RCP	1200	0.6	2.52	
P A.10	RCP	1200	0.6	2.54	
P A.12	RCP	1200	0.6	2.95	
P A.11	RCP	1200	0.6	3.07	
P A.14	Box Culver	0	0.6	3.52	
P UB3	RCP	375	0.6	1.24	
P P.3	RCP	375	0.6	2.04	
P253936	RCP	600	0.6	0.66	
P253921	RCP	600	0.6	1.63	
P T.6b	RCP	375	0.6	1.64	
P T.6a	RCP	375	0.6	2.18	
P T.6	RCP	525	0.6	2.39	
z P A.14a	RCP	375	0.6	0.94	
P H.1a	RCP	375	0.6	0.86	
P H.1b	RCP	375	0.6	1.14	
P H.1	RCP	375	0.6	1.75	
P H.2b	RCP	375	0.6	2.01	
P K.1	RCP	375	0.6	1.32	
P J.2a	RCP	525	0.6	1.71	
P J.2	RCP	525	0.6	1.75	
P J.3a	RCP	525	0.6	1.79	
P J.3	RCP	525	0.6	1.91	
P J.4	RCP	525	0.6	2.08	
P L.1	RCP	375	0.6	1.01	
P X.1	RCP	375	0.6	1.13	
P W.3	RCP	450	0.6	1.15	
P J.1a	RCP	525	0.6	1.57	
P J.1	RCP	525	0.6	1.5	
P L.1a	RCP	375	0.6	1.02	
P M.1	RCP	375	0.6	0.77	
P W.1	RCP	375	0.6	1.09	
P W.2	RCP	375	0.6	1.17	
P N.1	RCP	375	0.6	1.35	
P P.1	RCP	375	0.6	0.78	
P P.2	RCP	375	0.6	0.81	
P T.3b	RCP	375	0.6	0.99	
P T.3a	RCP	375	0.6	1.46	
P T.3	RCP	375	0.6	1.28	
P T.4	RCP	525	0.6	1.15	
P T.5	RCP	525	0.6	1.3	
P R.1	RCP	375	0.6	1	
P Q.3	RCP	375	0.6	1.87	
P S.1	RCP	375	0.6	0.61	
P S.2	RCP	450	0.6	0.75	
P T.5a	RCP	375	0.6	1.07	
P T.1	RCP	375	0.6	1.42	
P T.2	RCP	375	0.6	1.29	
P V.1	RCP	375	0.6	0.97	
P A.6a	RCP	450	0.6	1.96	
P Q.1	RCP	375	0.6	1.26	
P Q.2	RCP	375	0.6	1.97	
P S2 B/1	RCP	375	0.6	0.6	
P S2 B/2	RCP	375	0.6	0.6	
P S2 B/3	RCP	450	0.6	0.55	Unsafe
P S2 A/4	RCP	600	0.6	0.82	
P S2 A/5	RCP	600	0.6	0.81	
P S2 A/6	RCP	600	0.6	0.84	
P S2 A/7	RCP	750	0.6	0.82	
P S2 A/8	RCP	825	0.6	0.62	
P S2 A/9	RCP	825	0.6	0.73	
P S2 A/10	RCP	825	0.6	0.67	
P S2 A/11	RCP	1200	0.6	0.69	
P A.1	RCP	1200	0.6	0.4	Unsafe
P A.2a	RCP	1200	0.6	0.75	
P A.2	RCP	1200	0.6	0.8	
P A.3	RCP	1200	0.6	1.86	
P A.4	RCP	1200	0.6	2.33	
P A.5	RCP	1200	0.6	2.71	
P S2 D/1	RCP	375	0.6	0.6	
P S2 D/2	RCP	375	0.6	0.64	
P S2 D/3	RCP	375	0.6	0.69	
P S2 E/1	RCP	375	0.6	0.6	
P S2 E/2	RCP	375	0.6	0.68	
P S2 E/3	RCP	375	0.6	0.7	
P S2 H/1	RCP	375	0.6	0.57	Unsafe
P S2 A/1	RCP	375	0.6	0.76	
P S2 A/2	RCP	375	0.6	0.79	
P S2 A/3	RCP	450	0.6	0.99	
P S2 I/1	RCP	375	0.6	0.56	Unsafe
P S2 J/1	RCP	375	0.6	0.57	Unsafe
P S2 K/1	RCP	375	0.6	0.56	Unsafe
P S2 L/1	RCP	375	0.6	0.56	Unsafe
P S2 M/1	RCP	375	0.6	0.56	Unsafe
P S2 N/1	RCP	375	0.6	0.56	Unsafe
P S2 O/1	RCP	375	0.6	0.56	Unsafe
P S2 P/1	RCP	375	0.6	0.57	Unsafe
P S2 Q/1	RCP	375	0.6	0.56	Unsafe
P S2 C/2	RCP	450	0.6	0.58	Unsafe
P S2 T/1	RCP	375	0.6	0.56	Unsafe
P S2 V/1	RCP	375	0.6	0.56	Unsafe
P S2 X/1	RCP	375	0.6	1.52	
P B.1	RCP	450	0.6	0.98	
P C.1	RCP	525	0.6	1.38	
P S2 Y/1	RCP	375	0.6	1.59	
P S2 ZB/1	RCP	375	0.6	0.56	Unsafe
P S2 ZC/1	RCP	375	0.6	0.57	Unsafe
P S2 ZF/1	RCP	375	0.6	0.6	
P S2 ZG/1	RCP	375	0.6	0.6	
P S2 ZZ/1	RCP	375	0.6	0.57	Unsafe
P S2 F/1	RCP	375	0.6	0.44	Unsafe
P S2 F/2	RCP	375	0.6	0.56	Unsafe
P S2 G/1	RCP	375	0.6	0.45	Unsafe
P S2 G/2	RCP	375	0.6	0.57	Unsafe
P S2 C/1	RCP	375	0.6	0.6	
P S2 S/1	RCP	375	0.6	0.45	Unsafe
P S2 U/1	RCP	375	0.6	0.44	Unsafe
P S2 W/1	RCP	375	0.6	0.6	
P S2 W/2	RCP	375	0.6	0.64	
P S2 Z/1	RCP	375	0.6	0.78	
P S2 Z/2	RCP	375	0.6	2.69	
P S2 ZH/1	RCP	375	0.6	0.87	
P S2 ZA/1	RCP	375	0.6	0.78	
P S2 ZA/2	RCP	375	0.6	2.69	
P S2 ZI/1	RCP	375	0.6	0.87	
P S2 ZY/1	RCP	600	0.6	0.27	Unsafe
P S2 R/1	RCP	600	0.6	0.33	Unsafe

This model has no pipes with non-return valves

DRAINS results prepared from Version 2018.06 **20 YEAR**

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
H.2a	21.54		0		1.44		None
H.2	20.39		0.013		2.24	0	Inlet Capacity
A.6	20.22		0		2.71	0	None
A.7	19.93		0		2.47	0	None
A.8	19.78		0		2.47	0	None
A.9	19.51		0.067		2.06	0.012	Inlet Capacity
A.10	19.13	21.38	0.033	0.2	2.19	0	Inlet Capacity
A.12	18.95	21.6	0	0	2.65	0	None
A.12a	18.33	21.6	0	0	3.27	0	None
A.14	17.67	21.8	0	0	4.13	0	None
A.15	17.28		0				
P.3	20.12		0		2.13	0	None
S.2a	19.22		0		2.61	0	None
T.6a	20.16		0		1.97	0	None
T.6	20.11		0		1.89	0	None
H.1a	20.92	22.05	0.053	0.3	1.07	0	Inlet Capacity
H.1b	20.81		0.053		1.32	0.005	Inlet Capacity
H.1	20.73		0.048		1.58	0.005	Inlet Capacity
H.2b	20.59		0.044		1.9	0.004	Inlet Capacity
K.1	21.41		0.101		1.44	0.02	Inlet Capacity
J.2	21.32		0		1.97	0	None
J.2a	20.98	22.89	0.002	0	1.9	0	Inlet Capacity
J.3	20.83	22.68	0.027	0.2	1.81	0	Inlet Capacity
J.3a	20.65	22.59	0.083	0.2	1.85	0	Inlet Capacity
J.4	20.51	22.61	0.021	0.1	2.07	0	Inlet Capacity
L.1	22.04		0.047		1.16	0.004	Inlet Capacity
X.1	22.01		0		1.41	0	None
W.3	21.9	23.11	0.046	0.4	1.14	0	Inlet Capacity
J.1a	21.45		0		1.71	0	None
J.1	21.44		0.05		1.71	0.004	Inlet Capacity
L.1a	22.11		0.135		1.04	0.049	Inlet Capacity
M.1	22.46	23.5	0.072	0.5	0.95	0	Inlet Capacity
W.1	22.29		0		1.59	0	None
W.2	22.24		0.038		1.29	0.002	Inlet Capacity
N.1	20.74	22.38	0.117	2.1	1.43	0	Inlet Capacity
P.1	20.8	21.85	0.036	0.3	0.99	0	Inlet Capacity
P.2	20.64	21.77	0.033	0.3	1.07	0	Inlet Capacity
T.3b	22.04		0.031		1.47	0.007	Inlet Capacity
T.3a	21.92		0.037		1.52	0.009	Inlet Capacity
T.3	21.75		0		1.73	0	None
T.4	20.5	21.98	0.059	0.5	1.39	0	Inlet Capacity
T.5	20.36	21.9	0.013	0.2	1.51	0	Inlet Capacity
R.1	20.77		0.031		1.32	0.007	Inlet Capacity
Q.3	19.98		0.047		2.1	0.014	Inlet Capacity
S.1	20.74		0.053		0.83	0.007	Inlet Capacity
S.2	20.32	21.42	0.03	0.2	1.04	0	Inlet Capacity
T.5a	20.38	21.78	0.023	0.4	1.32	0	Inlet Capacity
T.1	22.33		0.057		1.4	0.009	Inlet Capacity
T.2	22.25		0.055		1.48	0.008	Inlet Capacity
V.1	20.76		0.061		1.22	0.01	Inlet Capacity
A.6a	20.74	22.84	0.253	0.6	2.04	0	Inlet Capacity
Q.1	21.55		0.03		1.81	0.009	Inlet Capacity
Q.2	20.06		0.033		2.33	0.01	Inlet Capacity
S2 B/1	22.11		0.018				
S2 B/2	21.93		0.019		0.87	0.001	Inlet Capacity
S2 B/3	21.7		0.022		0.82	0.001	Inlet Capacity
S2 A/4	21.51		0		1.03		None
S2 A/5	21.43		0		0.96	0	None
S2 A/6	21.35		0.041		0.89	0.003	Inlet Capacity
S2 A/7	21.31		0		1.11		None

S2 A/8	21.26		0.035		0.86	0.002	Inlet Capacity
S2 A/9	21.11		0.019		0.68	0.001	Inlet Capacity
S2 A/10	20.89		0.021		0.56	0.001	Inlet Capacity
S2 A/11	20.73		0.018		0.45	0.001	Inlet Capacity
A.1	20.7	21.38	0	0	0.68	0	None
A.2	20.69	21.56	0.005	0.2	0.78	0	Inlet Capacity
ZJ/1	20.63		0.047		0.97	0.005	Inlet Capacity
A.3	20.58		0.008		1.54	0.005	Inlet Capacity
A.4	20.5		0.054		1.92	0.008	Inlet Capacity
A.5	20.39		0		2.24		None
S2 D/1	21.84		0.074				
S2 D/2	21.67	22.45	0.021	0.2	0.73	0	Inlet Capacity
S2 D/3	21.6		0.017		0.91	0.001	Inlet Capacity
S2 E/1	21.83		0.053				
S2 E/2	21.61	22.48	0.016	0.2	0.84	0	Inlet Capacity
S2 E/3	21.54		0.018		0.97	0.001	Inlet Capacity
S2 H/1	21.68	22.57	0.018	0.2	0.85	0	Inlet Capacity
S2 A/1	21.64		0		1.03	0	None
S2 A/2	21.62		0.027		0.91	0.002	Inlet Capacity
S2 A/3	21.59		0		1.1		None
S2 I/1	21.6		0.008		0.87	0	None
S2 J/1	21.61		0.016		1.03	0.001	Inlet Capacity
S2 K/1	21.73	22.57	0.022	0.3	0.79	0	Inlet Capacity
S2 L/1	21.98		0.019		0.82	0.001	Inlet Capacity
S2 M/1	21.47	22.32	0.025	0.3	0.8	0	Inlet Capacity
S2 N/1	21.47	22.32	0.023	0.3	0.8	0	Inlet Capacity
S2 O/1	21.34		0.008		0.88	0	None
S2 P/1	21.35	22.4	0.022	0.2	1.01	0	Inlet Capacity
S2 Q/1	21.88	22.44	0.089	0.2	0.44	0	Inlet Capacity
S2 C/2	21.76		0.074		0.56	0.016	Inlet Capacity
S2 T/1	20.9		0.022		0.55	0.001	Inlet Capacity
S2 V/1	20.74		0.018		0.44	0.001	Inlet Capacity
S2 X/1	20.75		0.09				
B.1	20.74	21.55	0.022	0.3	0.76		Inlet Capacity
C.1	20.71		0		0.88	0	None
S2 Y/1	20.71		0		0.54	0	None
S2 ZB/1	21.63		0.016		0.78	0.001	Inlet Capacity
S2 ZC/1	21.69		0.02		0.74	0.001	Inlet Capacity
S2 ZF/1	21.6	22.41	0.006	0.1	0.79	0	Inlet Capacity
S2 ZG/1	21.54	22.41	0.006	0.1	0.85	0	Inlet Capacity
S2 ZZ/1	21.69	22.59	0.018	0.2	0.86	0	Inlet Capacity
S2 F/2	21.7	22.49	0.006	0.1	0.77	0	Inlet Capacity
S2 G/2	21.39	22.25	0.005	0.1	0.85	0	Inlet Capacity
S2 W/2	20.76	21.18	0.054	0.6	0.34	0	Inlet Capacity
S2 Z/2	20.58		0.023		1.39	0.001	Inlet Capacity
S2 ZA/2	20.57		0.024		1.4	0.001	Inlet Capacity
S2 ZY/1	21.24		0.261				
S2 R/1	21.21		0.02		0.58	0.001	Inlet Capacity

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C H.2a	0.192	0.13	0.067	10	15	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C H.2	0.013	0.012	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C A.9	0.053	0.049	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C A.10	0.022	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C N.1a	0.368	0.216	0.152	10	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S.2a	0.425	0.288	0.149	10	15	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C V.1a	0.393	0.23	0.163	10	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C T.1a	0.315	0.185	0.13	10	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C A.14a	0.431	0.292	0.151	10	15	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C H.1a	0.048	0.043	0.006	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C H.1B	0.048	0.043	0.006	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C H.1	0.044	0.039	0.005	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C H.2B	0.044	0.039	0.005	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1

C K.1	0.052	0.048	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C J.2A	0.002	0.002	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C J.3	0.002	0.002	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C J.3A	0.083	0.073	0.01	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C J.4	0.021	0.018	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C L.1	0.047	0.044	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C W.3	0.044	0.041	0.003	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C J.1	0.05	0.046	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C L.1a	0.123	0.113	0.009	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C M.1	0.072	0.067	0.006	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C W.2	0.038	0.035	0.003	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C N.1	0.117	0.108	0.009	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C P.1	0.036	0.033	0.003	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C P.2	0.033	0.031	0.003	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C T.3B	0.031	0.029	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C T.3A	0.03	0.027	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C T.4	0.05	0.046	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C T.5	0.013	0.012	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C R.1	0.031	0.029	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C Q.3	0.03	0.027	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S.1	0.053	0.049	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S.2	0.022	0.021	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C T.5a	0.013	0.012	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C U.1	0.057	0.052	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C U.2	0.055	0.051	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C V.1	0.052	0.048	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C A.6a	0.253	0.035	0.22	10	20	0	AR&R 20 year, 1.5 hours storm, average 55.6 mm/h, Zone 1
C Q.1	0.03	0.025	0.005	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C Q.2	0.024	0.02	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 B/1	0.018	0.005	0.013	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 B/2	0.019	0.017	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 B/3	0.022	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 A/6	0.041	0.038	0.003	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 A/8	0.019	0.017	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 A/9	0.017	0.016	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 A/10	0.021	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 A/11	0.017	0.015	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C ZJ/1	0.042	0.039	0.003	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C A.4	0.054	0.05	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 D/1	0.074	0.069	0.006	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 D/2	0.021	0.019	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 D/3	0.017	0.015	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 E/1	0.053	0.013	0.04	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 E/2	0.016	0.015	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 E/3	0.018	0.016	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 H/1	0.018	0.016	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 A/2	0.027	0.025	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 I/1	0.006	0.006	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 J/1	0.016	0.014	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 K/1	0.022	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 L/1	0.019	0.017	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 M/1	0.025	0.023	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 N/1	0.022	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 O/1	0.005	0.004	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 P/1	0.022	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 Q/1	0.089	0.083	0.007	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 C/2	0.074	0.068	0.006	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 T/1	0.021	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 V/1	0.017	0.016	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 X/1	0.09	0.076	0.014	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C B.1	0.022	0.021	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZB/1	0.016	0.015	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZC/1	0.02	0.019	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZF/1	0.006	0.006	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZG/1	0.006	0.006	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZZ/1	0.018	0.016	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1

C S2 F/1	0.45	0.415	0.034	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 F/2	0.006	0.006	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 G/1	0.244	0.225	0.019	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 G/2	0.005	0.004	0	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 C/1	0.489	0.452	0.037	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 S/1	0.221	0.205	0.017	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 U/1	0.447	0.413	0.034	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 W/1	0.378	0.349	0.029	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 W/2	0.053	0.049	0.004	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 Z/1	0.331	0.306	0.025	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 Z/2	0.022	0.02	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZH/1	0.514	0.475	0.039	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZA/1	0.437	0.404	0.033	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZA/2	0.023	0.021	0.002	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 ZI/1	0.459	0.424	0.035	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C Open A	0.261	0.034	0.227	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
C S2 R/1	0.02	0.018	0.001	5	10	0	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1

Outflow Volumes for Total Catchment (12.6 impervious + 4.58 pervious = 17.2 total ha)

Storm	Total Rainf cu.m	Total Runo cu.m (Runc	Impervious cu.m (Runc	Pervious Runoff cu.m (Runoff %)
AR&R 20 y	3001.14	2355.13 (7	2061.22 (9	293.91 (36.7%)
AR&R 20 y	4687.85	3888.20 (8	3290.02 (9	598.18 (47.8%)
AR&R 20 y	6022.32	5099.31 (8	4262.21 (9	837.10 (52.1%)
AR&R 20 y	7124.84	6101.14 (8	5065.42 (9	1035.71 (54.5%)
AR&R 20 y	8061.27	6933.80 (8	5747.63 (9	1186.17 (55.1%)
AR&R 20 y	8865.96	7648.18 (8	6333.88 (9	1314.29 (55.6%)
AR&R 20 y	10786.06	9353.59 (8	7732.74 (9	1620.85 (56.3%)
AR&R 20 y	12216.04	10621.06 (	8775.32 (9	1845.74 (56.6%)
AR&R 20 y	14330.01	12840.62 (	10366.85 (	2473.77 (64.7%)
AR&R 20 y	15841.75	14267.22 (	11483.10 (	2784.12 (65.9%)
AR&R 20 y	18092.75	16293.02 (	13139.21 (	3153.81 (65.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
z P H.2a	0.048	1.41	21.553	21.536	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P H.2a	0.048	1.58	21.518	21.398	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P H.2	0.235	1.48	20.306	20.216	AR&R 20 year, 15 minutes storm, average 140.2 mm/h, Zone 1
P A.6	2.019	1.78	20.039	19.928	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.7	2.107	1.86	19.839	19.777	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.8	2.337	2.07	19.668	19.506	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.9	2.383	2.11	19.173	19.129	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.10	2.475	2.19	19.002	18.948	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.12	2.565	2.38	18.56	18.334	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.11	2.708	3.07	18.12	17.868	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.14	3.091	3.35	17.344	17.281	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P UB3	0.084	0.95	20.13	20.122	AR&R 20 year, 20 minutes storm, average 124.4 mm/h, Zone 1
P P.3	0.15	2.77	19.964	19.78	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P253936	0.091	1.93	19.573	19.221	AR&R 20 year, 1 hour storm, average 71.1 mm/h, Zone 1
P253921	0.091	1.86	19.198	19.018	AR&R 20 year, 1 hour storm, average 71.1 mm/h, Zone 1
P T.6b	0.089	0.81	20.198	20.16	AR&R 20 year, 20 minutes storm, average 124.4 mm/h, Zone 1
P T.6a	0.092	0.83	20.131	20.11	AR&R 20 year, 15 minutes storm, average 140.2 mm/h, Zone 1
P T.6	0.405	2.66	19.564	19.13	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
z P A.14a	0.144	2.09	19.574	19.474	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P H.1a	0.05	1.6	20.836	20.813	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P H.1b	0.093	0.85	20.785	20.733	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P H.1	0.129	1.17	20.673	20.59	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P H.2b	0.161	1.46	20.514	20.386	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P K.1	0.075	1.22	21.329	21.316	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.2a	0.369	2.81	21.084	20.983	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.2	0.367	2.18	20.944	20.833	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.3a	0.397	1.84	20.807	20.655	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.3	0.461	2.13	20.585	20.508	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.4	0.478	2.29	20.409	20.216	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1

P L.1	0.041	0.46	22.014	22.007 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P X.1	0.118	1.07	21.952	21.902 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P W.3	0.259	2.13	21.718	21.451 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.1a	0.258	1.33	21.451	21.445 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P J.1	0.299	2.22	21.294	21.316 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P L.1a	0.082	0.77	22.062	22.007 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P M.1	0.068	3.07	22.32	22.29 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P W.1	0.068	1.61	22.271	22.24 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P W.2	0.102	2.38	22.077	21.902 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P N.1	0.085	2.37	20.535	20.406 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P P.1	0.033	1.38	20.702	20.64 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P P.2	0.064	1.7	20.635	20.236 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P T.3b	0.039	0.66	21.919	21.92 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P T.3a	0.07	1.11	21.777	21.752 AR&R 20 year, 2 hours storm, average 46.1 mm/h, Zone 1
P T.3	0.22	3.15	21.57	20.499 AR&R 20 year, 15 minutes storm, average 140.2 mm/h, Zone 1
P T.4	0.325	2.33	20.499	20.362 AR&R 20 year, 15 minutes storm, average 140.2 mm/h, Zone 1
P T.5	0.338	2.57	20.308	20.124 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P R.1	0.024	1.66	20.678	20.558 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P Q.3	0.099	5.15	19.776	19.777 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S.1	0.045	1.55	20.617	20.458 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S.2	0.07	1.87	20.246	20.067 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P T.5a	0.017	0.47	20.361	20.362 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P T.1	0.048	0.43	22.27	22.249 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P T.2	0.159	2.5	22.03	21.853 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P V.1	0.049	6.5	20.596	20.546 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.6a	0.252	2.17	20.538	20.269 AR&R 20 year, 1.5 hours storm, average 55.6 mm/h, Zone 1
P Q.1	0.02	1.56	21.465	20.065 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P Q.2	0.043	1.14	19.984	19.984 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 B/1	0.018	0.99	22.11	21.934 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 B/2	0.053	1.79	21.863	21.701 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 B/3	0.09	2.07	21.609	21.556 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/4	0.235	1.1	21.451	21.434 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/5	0.271	1.11	21.38	21.355 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/6	0.304	1.08	21.355	21.315 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/7	0.362	0.87	21.279	21.264 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/8	0.65	1.41	21.128	21.107 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/9	0.902	1.69	21.015	20.893 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/10	0.971	1.82	20.837	20.728 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/11	1.068	0.94	20.701	20.696 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.1	1.073	0.95	20.696	20.689 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.2a	1.216	1.08	20.639	20.633 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.2	1.232	1.09	20.615	20.578 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.3	1.273	1.13	20.521	20.504 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.4	1.432	1.27	20.418	20.392 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P A.5	1.49	1.32	20.275	20.216 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 D/1	0.074	1.5	21.842	21.673 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 D/2	0.109	1.27	21.632	21.596 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 D/3	0.128	1.88	21.479	21.487 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 E/1	0.053	1.42	21.83	21.607 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 E/2	0.081	1.21	21.574	21.542 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 E/3	0.101	1.59	21.46	21.443 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 H/1	0.016	0.67	21.648	21.643 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/1	0.033	0.73	21.621	21.617 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/2	0.054	0.63	21.603	21.594 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 A/3	0.133	1.12	21.499	21.507 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 I/1	0.008	0.39	21.594	21.594 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 J/1	0.015	2.09	21.546	21.51 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 K/1	0.02	0.47	21.703	21.701 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 L/1	0.018	0.69	21.938	21.934 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 M/1	0.023	0.59	21.438	21.434 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 N/1	0.021	0.54	21.437	21.434 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 O/1	0.008	0.64	21.318	21.315 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 P/1	0.02	1.75	21.283	21.264 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 Q/1	0.088	0.8	21.769	21.759 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 C/2	0.222	1.77	21.613	21.375 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 T/1	0.025	0.23	20.896	20.893 AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1

P S2 V/1	0.018	0.16	20.733	20.728	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 X/1	0.09	0.82	20.752	20.745	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P B.1	0.11	0.69	20.727	20.711	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P C.1	0.106	0.49	20.692	20.689	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 Y/1	0.004	0.04	20.71	20.711	AR&R 20 year, 1 hour storm, average 71.1 mm/h, Zone 1
P S2 ZB/1	0.015	0.31	21.606	21.607	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 ZC/1	0.019	0.28	21.673	21.673	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 ZF/1	0.006	0.09	21.597	21.596	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 ZG/1	0.006	0.12	21.542	21.542	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 ZZ/1	0.016	0.83	21.651	21.643	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 F/1	0.069	2.28	21.836	21.742	AR&R 20 year, 1.5 hours storm, average 55.6 mm/h, Zone 1
P S2 F/2	0.073	1.41	21.682	21.656	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 G/1	0.033	1.98	21.554	21.434	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 G/2	0.037	1.22	21.38	21.353	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 C/1	0.085	1.03	21.822	21.759	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 S/1	0.052	1.78	21.475	21.378	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 U/1	0.068	0.62	20.733	20.728	AR&R 20 year, 1.5 hours storm, average 55.6 mm/h, Zone 1
P S2 W/1	0.065	0.58	20.77	20.762	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 W/2	0.111	1	20.721	20.689	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 Z/1	0.051	0.47	20.578	20.578	AR&R 20 year, 10 minutes storm, average 163.7 mm/h, Zone 1
P S2 Z/2	0.062	0.56	20.578	20.578	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 ZH/1	0.112	1.02	20.387	20.392	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 ZA/1	0.088	0.8	20.571	20.574	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 ZA/2	0.097	0.88	20.574	20.578	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 ZI/1	0.103	0.93	20.388	20.392	AR&R 20 year, 5 minutes storm, average 209.6 mm/h, Zone 1
P S2 ZY/1	0.26	1.45	21.24	21.212	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1
P S2 R/1	0.279	1.92	21.127	21.107	AR&R 20 year, 25 minutes storm, average 112.6 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
F H.2a	0	0	0	0	0	0	0	
F H.2	0	0	0	0	0	0	0	
F A.6	0	0	0	0	0	0	0	
F A.7	0	0	0	0	0	0	0	
F A.8	0	0	0	0	0	0	0	
F A.9	0.012	0.012	0	0.053	0.03	0.9	0.65	AR&R 20 year, 25 minutes storm, average 112.6 m
F A.10	0	0	0	0	0	0	0	
F A.12	0	0	0	0	0	0	0	
F A.11	0	0	0	0	0	0	0	
F A.14	0	0	0	0	0	0	0	
F Total	3.091	3.091	0	0.318	0.73	8.54	2.3	AR&R 20 year, 25 minutes storm, average 112.6 m
F N.1a	0	0	0	0	0	0	0	
F P.3	0	0	0	0	0	0	0	
F S.2a	0	0	0	0	0	0	0	
OF241084	0	0	0	0	0	0	0	
F V.1a	0	0	0	0	0	0	0	
F T.6a	0	0	0	0	0	0	0	
F T.6	0	0	1.701	0	0	0	0	
UB4-P	0.065	0						AR&R 20 year, 5 minutes storm, average 209.6 mm
F T.1a	0	0	0	0	0	0	0	
F A.14a	0	0	0	0	0	0	0	
F H.1a	0	0	0	0	0	0	0	
F H.1B	0.005	0.005	0.295	0.04	0.02	0.46	0.59	AR&R 20 year, 25 minutes storm, average 112.6 m
F H.1	0.005	0.005	0	0.038	0.02	0.44	0.56	AR&R 20 year, 25 minutes storm, average 112.6 m
F H.2B	0.004	0.004	0	0.035	0.02	0.4	0.54	AR&R 20 year, 25 minutes storm, average 112.6 m
F K.1	0.02	0.02	0	0.061	0.05	1.18	0.76	AR&R 20 year, 25 minutes storm, average 112.6 m
F J.2	0	0	0	0	0	0	0	
F J.2A	0	0	0	0	0	0	0	
F J.3	0	0	0	0	0	0	0	
F J.3A	0	0	0	0	0	0	0	
F J.4	0	0	0	0	0	0	0	
F L.1	0.004	0.004	0	0.035	0.02	0.4	0.52	AR&R 20 year, 25 minutes storm, average 112.6 m

F X.1	0	0	0	0	0	0	0	
F W.3	0	0	0	0	0	0	0	
F J.1a	0	0	0	0	0	0	0	
F J.1	0.004	0.004	0	0.037	0.02	0.42	0.55	AR&R 20 year, 25 minutes storm, average 112.6 mı
F L.1a	0.049	0.049	0	0.082	0.07	1.86	0.85	AR&R 20 year, 25 minutes storm, average 112.6 mı
F M.1	0	0	0	0	0	0	0	
F W.1	0	0	0	0	0	0	0	
F W.2	0.002	0.002	0	0.027	0.01	0.31	0.46	AR&R 20 year, 25 minutes storm, average 112.6 mı
F N.1	0	0	0	0	0	0	0	
F P.1	0	0	0	0	0	0	0	
F P.2	0	0	0	0	0	0	0	
F T.3B	0.007	0.007	0	0.037	0.03	0.42	0.9	AR&R 20 year, 25 minutes storm, average 112.6 mı
F T.3A	0.009	0.009	0	0.04	0.04	0.47	0.97	AR&R 20 year, 25 minutes storm, average 112.6 mı
F T.3	0	0	1.1	0	0	0	0	
F T.4	0	0	0	0	0	0	0	
F T.5	0	0	0.5	0	0	0	0	
F R.1	0.007	0.007	0	0.044	0.03	0.58	0.63	AR&R 20 year, 25 minutes storm, average 112.6 mı
F Q.3	0.014	0.014	0	0.056	0.04	0.99	0.65	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S.1	0.007	0.007	0.56	0.046	0.03	0.65	0.6	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S.2	0	0	0	0	0	0	0	
F T.5a	0	0	0.602	0	0	0	0	
F T.1	0.009	0.009	0.09	0.047	0.03	0.69	0.67	AR&R 20 year, 25 minutes storm, average 112.6 mı
F U.2	0.008	0.008	0	0.04	0.04	0.47	0.88	AR&R 20 year, 25 minutes storm, average 112.6 mı
F V.1	0.01	0.01	0	0.05	0.03	0.8	0.62	AR&R 20 year, 25 minutes storm, average 112.6 mı
z F A.6a	0	0	0	0	0	0	0	
F Q.1	0.009	0.009	0	0.041	0.04	0.48	0.99	AR&R 20 year, 25 minutes storm, average 112.6 mı
F Q.2	0.01	0.01	0	0.042	0.04	0.52	1.03	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 B/2	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 B/3	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 30 minutes storm, average 103.2 mı
F S2 A/5	0	0	0	0	0	0	0	
F S2 A/6	0.003	0.003	0	0.033	0.02	0.38	0.52	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 A/8	0.002	0.002	0	0.026	0.01	0.29	0.44	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 A/9	0.001	0.001	0	0.018	0.01	0.2	0.34	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 A/10	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 20 minutes storm, average 124.4 mı
F S2 A/11	0.001	0.001	0	0.018	0.01	0.2	0.34	AR&R 20 year, 25 minutes storm, average 112.6 mı
F A.1	0	0	0	0	0	0	0	
F A.2	0	0	0	0	0	0	0	
F A.2a	0.005	0.005	0	0.041	0.02	0.5	0.46	AR&R 20 year, 25 minutes storm, average 112.6 mı
F A.3	0.005	0.005	0	0.061	0.02	0.49	0.32	AR&R 20 year, 25 minutes storm, average 112.6 mı
F A.4	0.008	0.008	0	0.075	0.03	0.6	0.36	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 D/2	0	0	0	0	0	0	0	
F S2 D/3	0.001	0.001	0	0.017	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 E/2	0	0	0	0	0	0	0	
F S2 E/3	0.001	0.001	0	0.018	0.01	0.2	0.33	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 H/1	0	0	0	0	0	0	0	
F S2 A/1	0	0	0	0	0	0	0	
F S2 A/2	0.002	0.002	0	0.027	0.01	0.31	0.45	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 I/1	0	0	0	0	0	0	0	
F S2 J/1	0.001	0.001	0	0.017	0.01	0.2	0.32	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 K/1	0	0	0	0	0	0	0	
F S2 L/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 M/1	0	0	0	0	0	0	0	
F S2 N/1	0	0	0	0	0	0	0	
F S2 O/1	0	0	0	0	0	0	0	
F S2 P/1	0	0	0	0	0	0	0	
F S2 Q/1	0	0	0	0	0	0	0	
F S2 C/2	0.016	0.016	0	0.056	0.04	1.01	0.74	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 T/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 15 minutes storm, average 140.2 mı
F S2 V/1	0.001	0.001	0	0.018	0.01	0.2	0.34	AR&R 20 year, 25 minutes storm, average 112.6 mı
F C.1	0	0	0	0	0	0	0	
F S2 Y/1	0	0	0	0	0	0	0	
F S2 ZB/1	0.001	0.001	0	0.017	0.01	0.2	0.34	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 ZC/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 ZF/1	0	0	0	0	0	0	0	
F S2 ZG/1	0	0	0	0	0	0	0	
F S2 ZZ/1	0	0	0	0	0	0	0	

F S2 F/2	0	0	0	0	0	0	0	
F S2 G/2	0	0	0	0	0	0	0	
F S2 W/2	0	0	0	0	0	0	0	
F S2 Z/2	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 ZA/2	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı
F S2 R/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 20 year, 25 minutes storm, average 112.6 mı

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B UB2	22.52	130.2	0.048	0.048	0
B UB3	20.97	212.8	0.084	0.084	0
B UB5W	20.9	325.3	0.091	0.091	0
B UB5E	21.3	263.9	0.089	0.089	0
B UB4	21.18	197	0.065	0	0.065
B UB5C	20.52	228.7	0.144	0.144	0
B Lot C	23.1	303	0.069	0.069	0
B Lot Fa	22.67	177.5	0.033	0.033	0
B Lot H	22.92	305.3	0.085	0.085	0
B Lot Fb	22.24	108.1	0.052	0.052	0
B Lot Gb	21.75	302.5	0.068	0.068	0
B Lot Ga	21.25	237.4	0.065	0.065	0
B Lot E	20.31	268.7	0.051	0.051	0
B Lot B	20.14	356.3	0.112	0.112	0
B Lot D	20.24	316.8	0.088	0.088	0
B Lot A	20.09	318.3	0.103	0.103	0

CONTINUITY CHECK for AR&R 20 year, 1.5 hours storm, average 55.6 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
B UB2	317.69	300.64	15.8	0.4
H.2a	300.64	300.38	0	0.1
H.2	564.54	563.44	0	0.2
A.6	8084.54	8067.35	0	0.2
A.7	8225.39	8211.98	0	0.2
A.8	8954.5	8939.34	0	0.2
A.9	9016.2	8998.48	0	0.2
A.10	9128.79	9121.95	0	0.1
A.12	9753.23	9742.4	0	0.1
A.12a	10455.63	10438.74	0	0.2
A.14	11755.67	11745.92	0	0.1
A.15	11745.92	11742.04	0	0
B UB3	528.5	502.33	24.82	0.3
P.3	595.57	594.88	0	0.1
B UB5W	704.42	632.54	68.13	0.5
S.2a	632.54	631.29	0	0.2
B UB5E	563.69	467.21	93.27	0.6
T.6a	467.21	466.99	0	0
T.6	1317.73	1316.94	0	0.1
B UB4	451.65	450.12	1.53	0
B UB5C	714.28	713.24	0.77	0
H.1a	67.81	67.9	0	-0.1
H.1b	135.21	135.61	0	-0.3
H.1	193.37	193.2	0	0.1
H.2b	249.12	249.02	0	0
K.1	108.96	108.89	0	0.1
J.2	567.44	567.68	0	0
J.2a	571.04	571.27	0	0
J.3	584.44	584.95	0	-0.1
J.3a	696.09	696.33	0	0
J.4	724.1	724.47	0	-0.1
L.1	63.49	63.47	0	0
X.1	192.37	192.37	0	0
W.3	400.46	402.13	0	-0.4
J.1a	402.13	401.23	0	0.2

J.1	468.46	468.37	0	0
L.1a	169.39	169.3	0	0.1
M.1	97.14	97.33	0	-0.2
W.1	97.33	97.37	0	0
W.2	148.89	149.15	0	-0.2
N.1	156.72	158.04	0.01	-0.8
P.1	48.49	48.61	0	-0.2
P.2	93.03	93.24	0	-0.2
T.3b	41.47	41.46	0	0
T.3a	81.34	81.33	0	0
T.3	670.31	670.76	0	-0.1
T.4	810.84	811.06	0	0
T.5	849.89	850.73	0	-0.1
R.1	41.47	41.48	0	0
Q.3	152.28	152.77	0	-0.3
S.1	70.82	70.83	0	0
S.2	100.74	101.19	0	-0.4
T.5a	20.95	21.2	0	-1.2
T.1	76.01	76	0	0
T.2	596.57	594.79	0	0.3
V.1	73.29	73.3	0	0
O H.1a	0	0	0	0
O P.2	0	0	0	0
N Total	11742.04	11742.04	0	0
A.6a	363.72	360.06	0.15	1
Q.1	39.48	39.51	0	-0.1
Q.2	70.9	70.92	0	0
S2 B/1	22.72	22.96	0	-1
S2 B/2	73.42	73.34	0	0.1
S2 B/3	131.46	131.48	0	0
S2 A/4	757.1	756.06	0	0.1
S2 A/5	820.72	820.07	0	0.1
S2 A/6	875.18	874.42	0	0.1
S2 A/7	1131.79	1130.54	0	0.1
S2 A/8	2284.84	2280.18	0	0.2
S2 A/9	2656.09	2653.3	0	0.1
S2 A/10	2710.46	2708.3	0	0.1
S2 A/11	3253.61	3254.96	0	0
A.1	3254.77	3254.26	0	0
A.2	3921.54	3917.17	0.2	0.1
ZJ/1	3976.25	3973.17	0	0.1
A.3	4865.19	4857.5	0	0.2
A.4	5256.71	5251.7	0	0.1
A.5	6449.36	6436.55	0	0.2
S2 C/1	0	0	0	0
S2 D/1	99.78	99.7	0	0.1
S2 D/2	154.49	154.73	0	-0.2
S2 D/3	185.43	185.48	0	0
S2 E/1	67.32	67.36	0	-0.1
S2 E/2	110.73	110.97	0	-0.2
S2 E/3	142.69	142.69	0	0
S2 F/1	0	0	0	0
S2 G/1	0	0	0	0
S2 H/1	23.85	23.94	0	-0.4
S2 A/1	47.86	47.95	0	-0.2
S2 A/2	84.71	84.73	0	0
S2 A/3	606.43	605.03	0	0.2
S2 I/1	9.32	9.3	0	0.2
S2 J/1	21.06	21.06	0	0
S2 K/1	29.11	29.25	0	-0.5
S2 L/1	25.36	25.34	0	0.1
S2 M/1	34.14	34.29	0	-0.4
S2 N/1	30.23	30.37	0	-0.5
S2 O/1	8.43	8.43	0	0
S2 P/1	29.43	29.53	0	-0.3
S2 Q/1	119.88	119.82	0	0

S2 C/2	806.73	804.83	0	0.2
S2 S/1	0	0	0	0
S2 T/1	29.06	29	0	0.2
S2 U/1	0	0	0	0
S2 V/1	23.49	23.45	0	0.2
S2 W/1	0	0	0	0
S2 X/1	120.14	120.25	0	-0.1
B.1	150.4	150.4	0	0
C.1	150.58	150.03	0	0.4
S2 Y/1	0	0.18	0	0
S2 Z/1	0	0	0	0
S2 ZA/1	0	0	0	0
S2 ZB/1	21.77	21.73	0	0.2
S2 ZC/1	27.52	27.5	0	0.1
S2 ZF/1	8.14	8.2	0	-0.8
S2 ZG/1	8.14	8.19	0	-0.7
S2 ZH/1	0	0	0	0
S2 ZI/1	0	0	0	0
S2 ZZ/1	23.85	23.92	0	-0.3
O S2 W/2	0	0	0	0
O S2 Z/2	0	0	0	0
O S2 ZA/2	0	0	0	0
B Lot C	603.52	504.99	96.63	0.3
S2 F/2	513.44	513.19	0	0
B Lot Fa	327.24	244.92	80.17	0.7
S2 G/2	251.22	251.07	0	0.1
B Lot H	656.8	587.61	66.6	0.4
B Lot Fb	297.18	294.82	1.26	0.4
B Lot Gb	599.69	499.45	98.26	0.3
B Lot Ga	507.58	444.02	61.79	0.3
S2 W/2	514.99	514.79	0	0
B Lot E	444.41	324.55	117.63	0.5
S2 Z/2	354.45	353.91	0	0.2
B Lot B	690.7	633.99	55.26	0.2
B Lot D	586.46	508.25	76.65	0.3
S2 ZA/2	539.12	538.54	0	0.1
B Lot A	616.68	566.47	48.82	0.2
S2 ZY/1	326.57	326.63	0	0
S2 R/1	353.03	353.22	0	-0.1

Run Log for 9012 run at 16:48:21 on 9/8/2018
No water upwelling from any pit. Freeboard was adequate at all pits.
The maximum flow in these overflow routes is unsafe: F Total

DRAINS results prepared from Version 2018.06 **100 YEAR**

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
H.2a	21.54		0		1.43		None
H.2	20.93		0.015		1.7	0.001	Inlet Capacity
A.6	20.67		0		2.26	0	None
A.7	20.35		0.045		2.05	0.005	Inlet Capacity
A.8	20.17		0.005		2.07	0.003	Inlet Capacity
A.9	19.86		0.081		1.71	0.018	Inlet Capacity
A.10	19.41	21.39	0.044	0.3	1.91	0	Inlet Capacity
A.12	19.19	21.6	0	0	2.41	0	None
A.12a	18.46	21.6	0	0	3.14	0	None
A.14	17.72	21.8	0	0	4.08	0	None
A.15	17.3		0				
P.3	20.42		0		1.83	0	None
S.2a	19.24		0		2.59	0	None
T.6a	20.33		0		1.8	0	None
T.6	20.29		0		1.71	0	None
H.1a	21.72	22.06	0.064	0.4	0.27	0	Inlet Capacity
H.1b	21.66		0.063		0.47	0.007	Inlet Capacity
H.1	21.53		0.057		0.78	0.006	Inlet Capacity
H.2b	21.29		0.052		1.2	0.005	Inlet Capacity
K.1	22.34		0.142		0.51	0.04	Inlet Capacity
J.2	22.24		0		1.05	0	None
J.2a	21.78	22.9	0.003	0	1.1	0	Inlet Capacity
J.3	21.58	22.7	0.047	0.3	1.06	0	Inlet Capacity
J.3a	21.32	22.6	0.098	0.3	1.18	0	Inlet Capacity
J.4	21.1	22.62	0.025	0.1	1.48	0	Inlet Capacity
L.1	23.1		0.056		0.1	0.006	Inlet Capacity
X.1	23.06		0		0.35	0	None
W.3	22.96	23.11	0.055	0.5	0.08	0	Inlet Capacity
J.1a	22.4		0		0.76	0	None
J.1	22.39		0.059		0.77	0.007	Inlet Capacity
L.1a	23.14		0.163		0.01	0.083	Inlet Capacity
M.1	23.38	23.51	0.085	0.6	0.03	0	Inlet Capacity
W.1	23.28		0		0.6	0	None
W.2	23.26		0.045		0.26	0.003	Inlet Capacity
N.1	20.76	22.39	0.138	2.4	1.4	0.045	Inlet Capacity
P.1	20.82	21.86	0.043	0.4	0.97	0	Inlet Capacity
P.2	20.65	21.78	0.039	0.3	1.06	0	Inlet Capacity
T.3b	22.06		0.036		1.44	0.009	Inlet Capacity
T.3a	21.97		0.044		1.47	0.012	Inlet Capacity
T.3	21.82		0		1.66	0	None
T.4	20.52	21.99	0.071	0.6	1.37	0	Inlet Capacity
T.5	20.43	21.91	0.015	0.2	1.45	0	Inlet Capacity
R.1	20.78		0.036		1.31	0.009	Inlet Capacity
Q.3	20.38		0.057		1.71	0.018	Inlet Capacity
S.1	20.75		0.062		0.81	0.011	Inlet Capacity
S.2	20.34	21.42	0.037	0.3	1.02	0	Inlet Capacity
T.5a	20.45	21.8	0.031	0.6	1.26	0	Inlet Capacity
T.1	22.43		0.067		1.31	0.013	Inlet Capacity
T.2	22.33		0.065		1.41	0.012	Inlet Capacity
V.1	20.78		0.074		1.2	0.015	Inlet Capacity
A.6a	21.2	22.85	0.342	0.7	1.58	0	Inlet Capacity
Q.1	21.56		0.035		1.8	0.012	Inlet Capacity
Q.2	20.42		0.039		1.98	0.013	Inlet Capacity
S2 B/1	22.3		0.022				
S2 B/2	22.32		0.022		0.48	0.001	Inlet Capacity
S2 B/3	22.18		0.026		0.34	0.001	Inlet Capacity
S2 A/4	22.19		0		0.35		None
S2 A/5	22.15		0		0.25	0	None
S2 A/6	22.02		0.048		0.23	0.005	Inlet Capacity
S2 A/7	21.98		0		0.44		None

S2 A/8	21.92		0.044		0.21	0.004	Inlet Capacity
S2 A/9	21.72		0.024		0.07	0.001	Inlet Capacity
S2 A/10	21.43		0.025		0.02	0.002	Inlet Capacity
S2 A/11	21.17		0.021		0	0.117	Outlet System
A.1	21.14	21.38	0	0	0.24	0	None
A.2	21.14	21.61	0.006	0.4	0.33	0	Inlet Capacity
ZJ/1	21.08		0.058		0.52	0.006	Inlet Capacity
A.3	21.03		0.012		1.09	0.007	Inlet Capacity
A.4	20.96		0.064		1.47	0.012	Inlet Capacity
A.5	20.84		0		1.78		None
S2 D/1	21.86		0.088				
S2 D/2	21.76	22.46	0.024	0.3	0.65	0	Inlet Capacity
S2 D/3	21.66		0.02		0.85	0.001	Inlet Capacity
S2 E/1	21.84		0.064				
S2 E/2	21.65	22.49	0.019	0.2	0.8	0	Inlet Capacity
S2 E/3	21.59		0.021		0.92	0.001	Inlet Capacity
S2 H/1	22.39	22.57	0.021	0.2	0.13	0	Inlet Capacity
S2 A/1	22.39		0		0.27	0	None
S2 A/2	22.39		0.032		0.14	0.002	Inlet Capacity
S2 A/3	22.35		0		0.34		None
S2 I/1	22.35		0.01		0.13	0	None
S2 J/1	22.17		0.018		0.46	0.001	Inlet Capacity
S2 K/1	22.25	22.57	0.026	0.3	0.27	0	Inlet Capacity
S2 L/1	22.33		0.022		0.47	0.001	Inlet Capacity
S2 M/1	22.16	22.33	0.03	0.3	0.11	0	Inlet Capacity
S2 N/1	22.16	22.32	0.027	0.3	0.11	0	Inlet Capacity
S2 O/1	22		0.01		0.23	0	None
S2 P/1	21.93	22.41	0.026	0.2	0.42	0	Inlet Capacity
S2 Q/1	22.34	22.46	0.105	0.2	0	0	Outlet System
S2 C/2	22.23		0.087		0.09	0.021	Inlet Capacity
S2 T/1	21.43		0.049		0.02	0.01	Inlet Capacity
S2 V/1	21.17		0.025		0	0.016	Outlet System
S2 X/1	21.25		0.107				
B.1	21.24	21.56	0.026	0.3	0.27		Inlet Capacity
C.1	21.18		0		0.41	0	None
S2 Y/1	21.18		0		0.07	0	None
S2 ZB/1	21.67		0.019		0.74	0.001	Inlet Capacity
S2 ZC/1	21.77		0.024		0.66	0.001	Inlet Capacity
S2 ZF/1	21.66	22.41	0.007	0.1	0.73	0	Inlet Capacity
S2 ZG/1	21.59	22.41	0.007	0.1	0.8	0	Inlet Capacity
S2 ZZ/1	22.41	22.59	0.021	0.2	0.14	0	Inlet Capacity
S2 F/2	22.39	22.5	0.007	0.1	0.09	0	Inlet Capacity
S2 G/2	21.98	22.26	0.006	0.1	0.26	0	Inlet Capacity
S2 W/2	21.18	21.29	0.188	1.9	0	0	Outlet System
S2 Z/2	21.04		0.027		0.93	0.001	Inlet Capacity
S2 ZA/2	21.02		0.028		0.95	0.001	Inlet Capacity
S2 ZY/1	21.82		0.317				
S2 R/1	21.79		0.023		0	0.026	Outlet System

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C H.2a	0.24	0.157	0.088	10	15	0	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone
C H.2	0.015	0.014	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C A.9	0.063	0.058	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C A.10	0.026	0.024	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C N.1a	0.449	0.26	0.189	10	10	0	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone
C S.2a	0.531	0.347	0.195	10	15	0	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone
C V.1a	0.479	0.278	0.201	10	10	0	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone
C T.1a	0.384	0.223	0.161	10	10	0	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone
C A.14a	0.539	0.352	0.197	10	15	0	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone
C H.1a	0.057	0.05	0.007	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C H.1B	0.057	0.05	0.007	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C H.1	0.052	0.045	0.006	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C H.2B	0.052	0.045	0.006	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone

C K.1	0.062	0.057	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C J.2A	0.003	0.003	0	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C J.3	0.003	0.003	0	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C J.3A	0.098	0.086	0.012	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C J.4	0.025	0.022	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C L.1	0.056	0.051	0.004	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C W.3	0.052	0.048	0.004	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C J.1	0.059	0.054	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C L.1a	0.145	0.133	0.011	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C M.1	0.085	0.079	0.007	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C W.2	0.045	0.042	0.004	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C N.1	0.138	0.127	0.011	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C P.1	0.043	0.039	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C P.2	0.039	0.036	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C T.3B	0.036	0.034	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C T.3A	0.035	0.032	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C T.4	0.059	0.054	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C T.5	0.015	0.014	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C R.1	0.036	0.034	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C Q.3	0.035	0.032	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S.1	0.062	0.057	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S.2	0.026	0.024	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C T.5a	0.016	0.014	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C U.1	0.067	0.061	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C U.2	0.065	0.06	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C V.1	0.062	0.057	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C A.6a	0.342	0.043	0.299	10	20	0	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
C Q.1	0.035	0.029	0.006	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C Q.2	0.028	0.023	0.004	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 B/1	0.022	0.005	0.016	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 B/2	0.022	0.021	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 B/3	0.025	0.023	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 A/6	0.048	0.045	0.004	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 A/8	0.022	0.02	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 A/9	0.02	0.019	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 A/10	0.025	0.023	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 A/11	0.02	0.018	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C ZJ/1	0.05	0.046	0.004	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C A.4	0.064	0.059	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 D/1	0.088	0.081	0.007	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 D/2	0.024	0.022	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 D/3	0.02	0.018	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 E/1	0.064	0.016	0.049	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 E/2	0.019	0.018	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 E/3	0.021	0.019	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 H/1	0.021	0.019	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 A/2	0.032	0.03	0.003	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 I/1	0.007	0.007	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 J/1	0.018	0.017	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 K/1	0.025	0.023	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 L/1	0.022	0.021	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 M/1	0.03	0.028	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 N/1	0.026	0.024	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 O/1	0.006	0.005	0	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 P/1	0.026	0.024	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 Q/1	0.105	0.097	0.008	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 C/2	0.087	0.08	0.007	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 T/1	0.025	0.023	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 V/1	0.02	0.019	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 X/1	0.107	0.089	0.017	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C B.1	0.026	0.024	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZB/1	0.019	0.018	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZC/1	0.024	0.022	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZF/1	0.007	0.007	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZG/1	0.007	0.007	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZZ/1	0.021	0.019	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone

C S2 F/1	0.53	0.488	0.042	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 F/2	0.007	0.007	0.001	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 G/1	0.287	0.265	0.023	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 G/2	0.006	0.005	0	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 C/1	0.577	0.531	0.046	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 S/1	0.261	0.24	0.021	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 U/1	0.527	0.485	0.042	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 W/1	0.446	0.411	0.035	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 W/2	0.062	0.057	0.005	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 Z/1	0.39	0.36	0.031	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 Z/2	0.026	0.024	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZH/1	0.607	0.559	0.048	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZA/1	0.515	0.475	0.041	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZA/2	0.027	0.025	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 ZI/1	0.542	0.499	0.043	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C Open A	0.317	0.04	0.277	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone
C S2 R/1	0.023	0.021	0.002	5	10	0	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone

Outflow Volumes for Total Catchment (12.6 impervious + 4.58 pervious = 17.2 total ha)

Storm	Total Rainf cu.m	Total Runo cu.m (Runc	Impervious cu.m (Runc	Pervious Runoff cu.m (Runoff %)
AR&R 100	3844.49	3156.66 (8	2675.63 (9	481.03 (46.9%)
AR&R 100	6045.23	5178.62 (8	4278.91 (9	899.71 (55.8%)
AR&R 100	7822.15	6808.82 (8	5573.44 (9	1235.37 (59.2%)
AR&R 100	9301.24	8163.51 (8	6650.91 (9	1512.60 (60.9%)
AR&R 100	10559.97	9303.47 (8	7568.00 (9	1735.47 (61.6%)
AR&R 100	11658.05	10300.34 (	8367.89 (9	1932.45 (62.1%)
AR&R 100	14239.95	12639.77 (	10248.92 (	2390.86 (62.9%)
AR&R 100	16168.5	14382.93 (	11655.31 (	2727.62 (63.2%)
AR&R 100	18969.03	17403.83 (	13762.28 (	3641.54 (71.9%)
AR&R 100	20996.38	19383.47 (	15260.18 (	4123.30 (73.6%)
AR&R 100	23917.48	22090.50 (	17409.72 (	4680.78 (73.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
z P H.2a	0.051	1.44	21.557	21.54	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P H.2a	0.051	1.61	21.522	21.402	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P H.2	0.271	1.7	20.804	20.669	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.6	2.208	1.95	20.467	20.347	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.7	2.3	2.03	20.242	20.172	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.8	2.543	2.25	20.043	19.856	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.9	2.598	2.3	19.46	19.409	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.10	2.722	2.41	19.257	19.191	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.12	2.804	2.48	18.564	18.46	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.11	2.947	3.1	18.286	17.908	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.14	3.381	3.45	17.368	17.304	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P UB3	0.097	0.88	20.421	20.415	AR&R 100 year, 30 minutes storm, average 135.7 mm/h, Zone 1
P P.3	0.166	1.5	20.283	20.172	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P253936	0.111	2.05	19.588	19.238	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P253921	0.111	1.98	19.213	19.191	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P T.6b	0.088	0.79	20.35	20.327	AR&R 100 year, 10 minutes storm, average 211.1 mm/h, Zone 1
P T.6a	0.094	0.85	20.3	20.291	AR&R 100 year, 10 minutes storm, average 211.1 mm/h, Zone 1
P T.6	0.437	2.68	19.564	19.152	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
z P A.14a	0.159	2.14	19.589	19.489	AR&R 100 year, 1 hour storm, average 94.1 mm/h, Zone 1
P H.1a	0.061	0.55	21.68	21.659	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P H.1b	0.114	1.03	21.594	21.529	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P H.1	0.164	1.48	21.424	21.29	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P H.2b	0.209	1.89	21.157	20.928	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P K.1	0.093	0.85	22.256	22.237	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P J.2a	0.428	1.98	21.903	21.784	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P J.2	0.43	1.99	21.744	21.579	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P J.3a	0.466	2.15	21.527	21.323	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P J.3	0.558	2.58	21.218	21.103	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P J.4	0.581	2.69	20.862	20.669	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1

P L.1	0.054	0.49	23.073	23.063	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P X.1	0.144	1.31	22.979	22.956	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P W.3	0.297	1.86	22.654	22.4	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P J.1a	0.295	1.36	22.399	22.392	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P J.1	0.343	1.58	22.271	22.237	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P L.1a	0.096	0.87	23.083	23.063	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P M.1	0.08	0.73	23.296	23.281	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P W.1	0.083	0.75	23.276	23.264	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P W.2	0.121	1.1	23.107	22.956	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P N.1	0.093	2.42	20.542	20.414	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P P.1	0.04	1.42	20.712	20.655	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P P.2	0.076	1.79	20.649	20.415	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.3b	0.045	0.59	21.962	21.975	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.3a	0.07	0.86	21.828	21.817	AR&R 100 year, 1 hour storm, average 94.1 mm/h, Zone 1
P T.3	0.228	3.49	21.558	20.521	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.4	0.346	2.3	20.521	20.426	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.5	0.374	2.24	20.379	20.291	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P R.1	0.027	1.72	20.683	20.563	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P Q.3	0.113	1.02	20.189	20.172	AR&R 100 year, 15 minutes storm, average 182.1 mm/h, Zone 1
P S.1	0.051	1.6	20.625	20.466	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S.2	0.084	1.97	20.258	20.08	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.5a	0.024	0.41	20.423	20.426	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.1	0.054	0.49	22.329	22.325	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P T.2	0.172	2.16	22.135	21.868	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P V.1	0.057	6.94	20.599	20.555	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.6a	0.338	2.12	20.686	20.669	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P Q.1	0.023	1.63	21.47	20.418	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P Q.2	0.047	0.43	20.379	20.376	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P S2 B/1	0.046	0.54	22.301	22.316	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 B/2	0.08	0.72	22.276	22.179	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 B/3	0.119	0.75	22.164	22.189	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 A/4	0.272	0.96	22.153	22.145	AR&R 100 year, 30 minutes storm, average 135.7 mm/h, Zone 1
P S2 A/5	0.33	1.17	22.099	22.019	AR&R 100 year, 30 minutes storm, average 135.7 mm/h, Zone 1
P S2 A/6	0.358	1.27	22.019	21.98	AR&R 100 year, 30 minutes storm, average 135.7 mm/h, Zone 1
P S2 A/7	0.416	0.94	21.942	21.916	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P S2 A/8	0.705	1.32	21.79	21.725	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P S2 A/9	1.012	1.89	21.605	21.427	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 A/10	1.056	1.98	21.353	21.174	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 A/11	1.095	0.97	21.146	21.143	AR&R 100 year, 15 minutes storm, average 182.1 mm/h, Zone 1
P A.1	1.099	0.97	21.143	21.139	AR&R 100 year, 15 minutes storm, average 182.1 mm/h, Zone 1
P A.2a	1.296	1.15	21.086	21.082	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.2	1.326	1.17	21.063	21.033	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P A.3	1.304	1.15	20.976	20.961	AR&R 100 year, 10 minutes storm, average 211.1 mm/h, Zone 1
P A.4	1.534	1.36	20.869	20.844	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P A.5	1.565	1.38	20.727	20.669	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 D/1	0.086	1.5	21.865	21.756	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 D/2	0.128	1.17	21.731	21.658	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 D/3	0.152	1.67	21.571	21.512	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 E/1	0.064	1.5	21.845	21.651	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 E/2	0.098	1.18	21.618	21.586	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 E/3	0.122	1.88	21.463	21.475	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 H/1	0.023	0.21	22.39	22.394	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 A/1	0.048	0.44	22.384	22.387	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 A/2	0.077	0.7	22.367	22.354	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 A/3	0.153	0.96	22.286	22.189	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 I/1	0.014	0.12	22.347	22.354	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 J/1	0.022	0.2	22.173	22.189	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 K/1	0.039	0.35	22.23	22.179	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 L/1	0.023	0.21	22.328	22.316	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 M/1	0.031	0.28	22.149	22.145	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 N/1	0.028	0.26	22.148	22.145	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 O/1	0.013	0.11	21.996	21.98	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P S2 P/1	0.027	0.24	21.923	21.916	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 Q/1	0.103	0.93	22.237	22.229	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 C/2	0.245	1.54	22.04	21.916	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 T/1	0.086	0.78	21.422	21.427	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1

P S2 V/1	0.047	0.42	21.174	21.174	AR&R 100 year, 15 minutes storm, average 182.1 mm/h, Zone 1
P S2 X/1	0.106	0.96	21.247	21.238	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P B.1	0.129	0.81	21.205	21.181	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P C.1	0.134	0.62	21.147	21.139	AR&R 100 year, 20 minutes storm, average 162.4 mm/h, Zone 1
P S2 Y/1	0.004	0.04	21.181	21.181	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 ZB/1	0.018	0.28	21.651	21.651	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 ZC/1	0.022	0.23	21.756	21.756	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 ZF/1	0.008	0.09	21.659	21.658	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 ZG/1	0.007	0.1	21.586	21.586	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 ZZ/1	0.023	0.21	22.4	22.394	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 F/1	0.083	0.75	22.39	22.387	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 F/2	0.085	0.77	22.384	22.354	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 G/1	0.038	0.35	21.99	21.984	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 G/2	0.044	0.4	21.983	21.98	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 C/1	0.1	0.91	22.264	22.229	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 S/1	0.053	0.48	21.921	21.916	AR&R 100 year, 30 minutes storm, average 135.7 mm/h, Zone 1
P S2 U/1	0.082	0.75	21.176	21.174	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 W/1	0.074	0.67	21.185	21.183	AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1
P S2 W/2	0.171	1.55	21.154	21.139	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 Z/1	0.057	0.51	21.031	21.035	AR&R 100 year, 1 hour storm, average 94.1 mm/h, Zone 1
P S2 Z/2	0.066	0.59	21.035	21.033	AR&R 100 year, 5 minutes storm, average 268.5 mm/h, Zone 1
P S2 ZH/1	0.122	1.1	20.827	20.844	AR&R 100 year, 1 hour storm, average 94.1 mm/h, Zone 1
P S2 ZA/1	0.096	0.87	21.016	21.021	AR&R 100 year, 1 hour storm, average 94.1 mm/h, Zone 1
P S2 ZA/2	0.101	0.91	21.021	21.033	AR&R 100 year, 5 minutes storm, average 268.5 mm/h, Zone 1
P S2 ZI/1	0.109	0.99	20.829	20.844	AR&R 100 year, 1 hour storm, average 94.1 mm/h, Zone 1
P S2 ZY/1	0.317	1.12	21.82	21.791	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1
P S2 R/1	0.34	1.2	21.734	21.725	AR&R 100 year, 25 minutes storm, average 147.5 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
F H.2a	0	0	0	0	0	0	0	
F H.2	0.001	0.001	0	0.019	0.01	0.22	0.35	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.6	0	0	0	0	0	0	0	
F A.7	0.005	0.005	0	0.038	0.02	0.44	0.56	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.8	0.003	0.003	0	0.033	0.02	0.38	0.46	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.9	0.018	0.018	0	0.061	0.04	1.18	0.69	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.10	0	0	0	0	0	0	0	
F A.12	0	0	0	0	0	0	0	
F A.11	0	0	0	0	0	0	0	
F A.14	0	0	0	0	0	0	0	
F Total	3.381	3.381	0	0.328	0.78	8.79	2.37	AR&R 100 year, 25 minutes storm, average 147.5 n
F N.1a	0	0	0	0	0	0	0	
F P.3	0	0	0	0	0	0	0	
F S.2a	0	0	0	0	0	0	0	
OF241084	0	0	0	0	0	0	0	
F V.1a	0	0	0	0	0	0	0	
F T.6a	0	0	0	0	0	0	0	
F T.6	0	0	1.466	0	0	0	0	
UB4-P	0.065	0						AR&R 100 year, 5 minutes storm, average 268.5 mı
F T.1a	0	0	0	0	0	0	0	
F A.14a	0	0	0	0	0	0	0	
F H.1a	0	0	0	0	0	0	0	
F H.1B	0.007	0.007	0.291	0.043	0.03	0.56	0.64	AR&R 100 year, 25 minutes storm, average 147.5 n
F H.1	0.006	0.006	0	0.041	0.02	0.48	0.6	AR&R 100 year, 25 minutes storm, average 147.5 n
F H.2B	0.005	0.005	0	0.04	0.02	0.46	0.59	AR&R 100 year, 25 minutes storm, average 147.5 n
F K.1	0.04	0.04	0	0.077	0.06	1.69	0.83	AR&R 100 year, 25 minutes storm, average 147.5 n
F J.2	0	0	0	0	0	0	0	
F J.2A	0	0	0	0	0	0	0	
F J.3	0	0	6.74E+22	0	0	0	0	
F J.3A	0	0	0	0	0	0	0	
F J.4	0	0	0	0	0	0	0	
F L.1	0.006	0.006	0	0.041	0.02	0.48	0.6	AR&R 100 year, 25 minutes storm, average 147.5 n

F X.1	0	0	0	0	0	0	0	
F W.3	0	0	0	0	0	0	0	
F J.1a	0	0	0	0	0	0	0	
F J.1	0.007	0.007	0	0.043	0.03	0.56	0.63	AR&R 100 year, 25 minutes storm, average 147.5 n
F L.1a	0.083	0.083	0	0.096	0.09	2.34	0.94	AR&R 100 year, 25 minutes storm, average 147.5 n
F M.1	0	0	0	0	0	0	0	
F W.1	0	0	0	0	0	0	0	
F W.2	0.003	0.003	0	0.033	0.02	0.38	0.51	AR&R 100 year, 25 minutes storm, average 147.5 n
F N.1	0.045	0.045	0	0.086	0.06	2.01	0.68	AR&R 100 year, 25 minutes storm, average 147.5 n
F P.1	0	0	0	0	0	0	0	
F P.2	0	0	0	0	0	0	0	
F T.3B	0.009	0.009	0	0.04	0.04	0.47	0.98	AR&R 100 year, 25 minutes storm, average 147.5 n
F T.3A	0.012	0.012	0	0.045	0.05	0.62	1.05	AR&R 100 year, 25 minutes storm, average 147.5 n
F T.3	0	0	1	0	0	0	0	
F T.4	0	0	0	0	0	0	0	
F T.5	0	0	0.45	0	0	0	0	
F R.1	0.009	0.009	0	0.047	0.03	0.71	0.67	AR&R 100 year, 25 minutes storm, average 147.5 n
F Q.3	0.018	0.018	0	0.061	0.04	1.18	0.68	AR&R 100 year, 25 minutes storm, average 147.5 n
F S.1	0.011	0.011	0.543	0.052	0.03	0.86	0.63	AR&R 100 year, 25 minutes storm, average 147.5 n
F S.2	0	0	0	0	0	0	0	
F T.5a	0	0	0.485	0	0	0	0	
F T.1	0.013	0.013	0.08	0.052	0.04	0.88	0.72	AR&R 100 year, 25 minutes storm, average 147.5 n
F U.2	0.012	0.012	0	0.045	0.04	0.62	1.01	AR&R 100 year, 25 minutes storm, average 147.5 n
F V.1	0.015	0.015	0	0.058	0.04	1.05	0.67	AR&R 100 year, 25 minutes storm, average 147.5 n
z F A.6a	0	0	0	0	0	0	0	
F Q.1	0.012	0.012	0	0.044	0.05	0.58	1.05	AR&R 100 year, 25 minutes storm, average 147.5 n
F Q.2	0.013	0.013	0	0.045	0.05	0.63	1.08	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 B/2	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 20 minutes storm, average 162.4 n
F S2 B/3	0.001	0.001	0	0.019	0.01	0.22	0.35	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 A/5	0	0	0	0	0	0	0	
F S2 A/6	0.005	0.005	0	0.038	0.02	0.44	0.57	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 A/8	0.004	0.004	0	0.035	0.02	0.4	0.53	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 A/9	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 30 minutes storm, average 135.7 n
F S2 A/10	0.002	0.002	0	0.028	0.01	0.32	0.46	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 A/11	0.117	0.117	0	0.108	0.11	2.72	1	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.1	0	0	0	0	0	0	0	
F A.2	0	0	0	0	0	0	0	
F A.2a	0.006	0.006	0	0.044	0.02	0.6	0.5	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.3	0.007	0.007	0	0.071	0.02	0.57	0.35	AR&R 100 year, 25 minutes storm, average 147.5 n
F A.4	0.012	0.012	0	0.085	0.03	0.68	0.4	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 D/2	0	0	0	0	0	0	0	
F S2 D/3	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 E/2	0	0	0	0	0	0	0	
F S2 E/3	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 15 minutes storm, average 182.1 n
F S2 H/1	0	0	0	0	0	0	0	
F S2 A/1	0	0	0	0	0	0	0	
F S2 A/2	0.002	0.002	0	0.029	0.01	0.34	0.49	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 I/1	0	0	0	0	0	0	0	
F S2 J/1	0.001	0.001	0	0.018	0.01	0.2	0.34	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 K/1	0	0	0	0	0	0	0	
F S2 L/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 20 minutes storm, average 162.4 n
F S2 M/1	0	0	0	0	0	0	0	
F S2 N/1	0	0	0	0	0	0	0	
F S2 O/1	0	0	0	0	0	0	0	
F S2 P/1	0	0	0	0	0	0	0	
F S2 Q/1	0	0	0	0	0	0	0	
F S2 C/2	0.021	0.021	0	0.063	0.05	1.22	0.76	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 T/1	0.01	0.01	0	0.049	0.03	0.75	0.68	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 V/1	0.016	0.016	0	0.057	0.04	1.03	0.74	AR&R 100 year, 25 minutes storm, average 147.5 n
F C.1	0	0	0	0	0	0	0	
F S2 Y/1	0	0	0	0	0	0	0	
F S2 ZB/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 ZC/1	0.001	0.001	0	0.018	0.01	0.2	0.35	AR&R 100 year, 10 minutes storm, average 211.1 n
F S2 ZF/1	0	0	0	0	0	0	0	
F S2 ZG/1	0	0	0	0	0	0	0	
F S2 ZZ/1	0	0	0	0	0	0	0	

F S2 F/2	0	0	0	0	0	0	0	
F S2 G/2	0	0	0	0	0	0	0	
F S2 W/2	0	0	0	0	0	0	0	
F S2 Z/2	0.001	0.001	0	0.02	0.01	0.23	0.36	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 ZA/2	0.001	0.001	0	0.022	0.01	0.25	0.38	AR&R 100 year, 25 minutes storm, average 147.5 n
F S2 R/1	0.026	0.026	0	0.067	0.05	1.35	0.79	AR&R 100 year, 25 minutes storm, average 147.5 n

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B UB2	23.06	211.8	0.051	0.051	0
B UB3	21.54	352	0.097	0.097	0
B UB5W	21.52	499.2	0.111	0.111	0
B UB5E	22.24	424.2	0.088	0.088	0
B UB4	22.34	323.5	0.065	0	0.065
B UB5C	21.14	385.9	0.159	0.159	0
B Lot C	23.66	443.1	0.083	0.083	0
B Lot Fa	23.15	258	0.038	0.038	0
B Lot H	23.48	451.1	0.1	0.1	0
B Lot Fb	22.66	173.5	0.053	0.053	0
B Lot Gb	22.32	445.3	0.082	0.082	0
B Lot Ga	21.76	363.7	0.074	0.074	0
B Lot E	20.89	401.3	0.057	0.057	0
B Lot B	20.78	554.7	0.122	0.122	0
B Lot D	20.85	493.8	0.096	0.096	0
B Lot A	20.72	500.1	0.109	0.109	0

CONTINUITY CHECK for AR&R 100 year, 1.5 hours storm, average 73.6 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
B UB2	439.1	367.76	68.99	0.5
H.2a	367.76	367.34	0	0.1
H.2	720.82	718.98	0	0.3
A.6	10113.04	10081.65	0	0.3
A.7	10289.54	10267	0	0.2
A.8	11194.99	11170.7	0	0.2
A.9	11276.93	11249.23	0	0.2
A.10	11422.33	11411.26	0	0.1
A.12	12190.86	12174.11	0	0.1
A.12a	13159.2	13132.77	0	0.2
A.14	14751.05	14729	0	0.1
A.15	14729	14722.85	0	0
B UB3	730.47	612.26	115.64	0.4
P.3	735.89	734.29	0	0.2
B UB5W	973.62	781.31	186.51	0.6
S.2a	781.31	779.6	0	0.2
B UB5E	779.09	571.11	202.74	0.7
T.6a	571.11	570.51	0	0.1
T.6	1622.08	1618.27	0	0.2
B UB4	624.25	527.58	96.87	0
B UB5C	987.26	985.09	1.25	0.1
H.1a	92	91.61	0	0.4
H.1b	182.78	182.6	0	0.1
H.1	259.96	259.66	0	0.1
H.2b	334.17	333.73	0	0.1
K.1	153.09	153.17	0	-0.1
J.2	751.93	750.77	0	0.2
J.2a	755.25	755.12	0	0
J.3	778.99	778.67	0	0
J.3a	928.05	927.38	0	0.1
J.4	964.7	963.73	0	0.1
L.1	84.97	84.89	0	0.1
X.1	252.16	251.91	0	0.1
W.3	529.17	528.42	0	0.1
J.1a	528.42	528.13	0	0.1

J.1	618.11	618.13	0	0
L.1a	229.8	229.55	0	0.1
M.1	130.01	129.58	0	0.3
W.1	129.58	129.59	0	0
W.2	198.54	198.37	0	0.1
N.1	209.75	207.89	0	0.9
P.1	64.9	64.63	0	0.4
P.2	124.08	123.63	0	0.4
T.3b	55.51	55.44	0	0.1
T.3a	108.81	108.81	0	0
T.3	816.96	812.78	0	0.5
T.4	1001.76	999.35	0	0.2
T.5	1053.11	1051.57	0	0.1
R.1	55.51	55.49	0	0
Q.3	204.35	203.98	0	0.2
S.1	94.79	94.74	0	0
S.2	134.77	134.12	0	0.5
T.5a	30.58	30.17	0	1.3
T.1	101.73	101.51	0	0.2
T.2	721.26	720.04	0	0.2
V.1	100.1	100.04	0	0.1
O H.1a	0	0	0	0
O P.2	0	0	0	0
N Total	14722.85	14722.85	0	0
A.6a	508.39	506.06	0.24	0.4
Q.1	53.29	53.25	0	0.1
Q.2	95.61	95.48	0	0.1
S2 B/1	32.7	32.82	0	-0.3
S2 B/2	100.18	99.78	0	0.4
S2 B/3	177.28	176.82	0	0.3
S2 A/4	942.55	940.86	0	0.2
S2 A/5	1026.62	1025.12	0	0.1
S2 A/6	1098.88	1097.46	0	0.1
S2 A/7	1403.27	1400.69	0	0.2
S2 A/8	2844.04	2836.69	0	0.3
S2 A/9	3377.9	3371.28	0	0.2
S2 A/10	3447.58	3442.46	0	0.1
S2 A/11	4101.69	4099.35	0	0.1
A.1	4098.96	4094.92	0	0.1
A.2	4922.75	4913.22	0.35	0.2
ZJ/1	4993.78	4983.37	0	0.2
A.3	6027.67	6009.87	0	0.3
A.4	6546.95	6534.8	0	0.2
A.5	7948.97	7924.34	0	0.3
S2 C/1	0	0	0	0
S2 D/1	133.54	133.32	0	0.2
S2 D/2	206.5	206.13	0	0.2
S2 D/3	247.02	246.91	0	0
S2 E/1	96.88	96.79	0	0.1
S2 E/2	154.69	154.47	0	0.1
S2 E/3	196.75	196.56	0	0.1
S2 F/1	0	0	0	0
S2 G/1	0	0	0	0
S2 H/1	31.92	31.75	0	0.5
S2 A/1	63.48	63.36	0	0.2
S2 A/2	112.57	112.33	0	0.2
S2 A/3	740.62	738.58	0	0.3
S2 I/1	13	12.92	0	0.6
S2 J/1	28.18	28.04	0	0.5
S2 K/1	39.09	38.85	0	0.6
S2 L/1	33.94	33.87	0	0.2
S2 M/1	45.69	45.36	0	0.7
S2 N/1	40.71	40.4	0	0.8
S2 O/1	11.72	11.65	0	0.6
S2 P/1	39.39	39.09	0	0.8
S2 Q/1	160.44	160.08	0	0.2

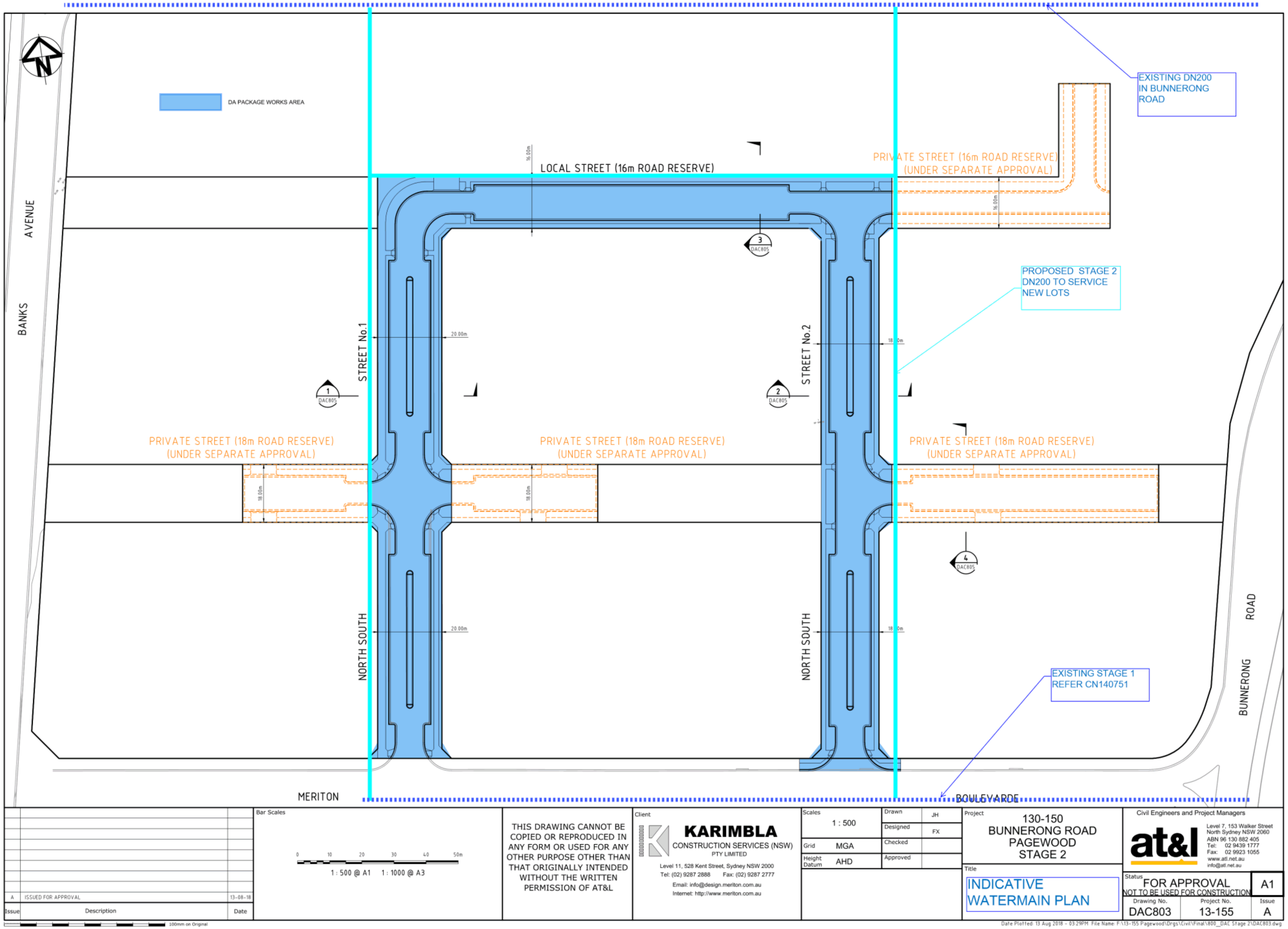
S2 C/2	1007.84	1003.56	0	0.4
S2 S/1	0	0	0	0
S2 T/1	39.02	38.89	0	0.3
S2 U/1	0	0	0	0
S2 V/1	31.56	31.46	0	0.3
S2 W/1	0	0	0	0
S2 X/1	162.17	162.24	0	0
B.1	202.59	201.92	0	0.3
C.1	201.81	200.52	0	0.6
S2 Y/1	0	-0.11	0	0
S2 Z/1	0	0	0	0
S2 ZA/1	0	0	0	0
S2 ZB/1	29.14	29.08	0	0.2
S2 ZC/1	36.83	36.78	0	0.1
S2 ZF/1	10.89	10.79	0	0.9
S2 ZG/1	10.89	10.79	0	0.9
S2 ZH/1	0	0	0	0
S2 ZI/1	0	0	0	0
S2 ZZ/1	31.92	31.74	0	0.6
O S2 W/2	0	0	0	0
O S2 Z/2	0	0	0	0
O S2 ZA/2	0	0	0	0
B Lot C	807.73	606.01	199.06	0.3
S2 F/2	617.33	616.95	0	0.1
B Lot Fa	437.97	289.3	145.6	0.7
S2 G/2	297.74	297.45	0	0.1
B Lot H	879.04	714.87	160.26	0.4
B Lot Fb	397.73	367.06	28.9	0.4
B Lot Gb	802.61	597.78	202.09	0.3
B Lot Ga	679.32	529.44	147.24	0.4
S2 W/2	624.71	623.29	0	0.2
B Lot E	594.78	368.74	223.12	0.5
S2 Z/2	409.01	407.89	0	0.3
B Lot B	924.4	751.38	170.63	0.3
B Lot D	784.89	595.82	187.3	0.2
S2 ZA/2	637.41	636.04	0	0.2
B Lot A	825.34	668.51	154.62	0.3
S2 ZY/1	476.38	476.49	0	0
S2 R/1	511.83	510.95	0	0.2

Run Log for 9012 run at 16:52:59 on 9/8/2018
Upwelling occurred at: S2 R/1, S2 A/11
Freeboard was less than 0.15m at S2 ZZ/1, S2 Y/1, S2 W/2, S2 V/1, S2 T/1, S2 Q/1, S2 N/1, S2 M/1, S2 I/1, S2 H/1, S2 F/2, S2 C/2, S2 A/10, S2 A

Appendix E

Sewer & Water

Appendix
AT&L
ABN 96 130 882 405
REVISION 02


DA PACKAGE WORKS AREA
LOCAL STREET (16m ROAD RESERVE)
PRIVATE STREET (16m ROAD RESERVE)
(UNDER SEPARATE APPROVAL)
EXISTING DN200
IN BUNNERONG
ROAD
PROPOSED STAGE 2
DN200 TO SERVICE
NEW LOTS
STREET No.1
STREET No.2
PRIVATE STREET (18m ROAD RESERVE)
(UNDER SEPARATE APPROVAL)
NORTH SOUTH
EXISTING STAGE 1
REFER CN140751
BANKS AVENUE
BUNNERONG ROAD
MERITON BOULEVARDE
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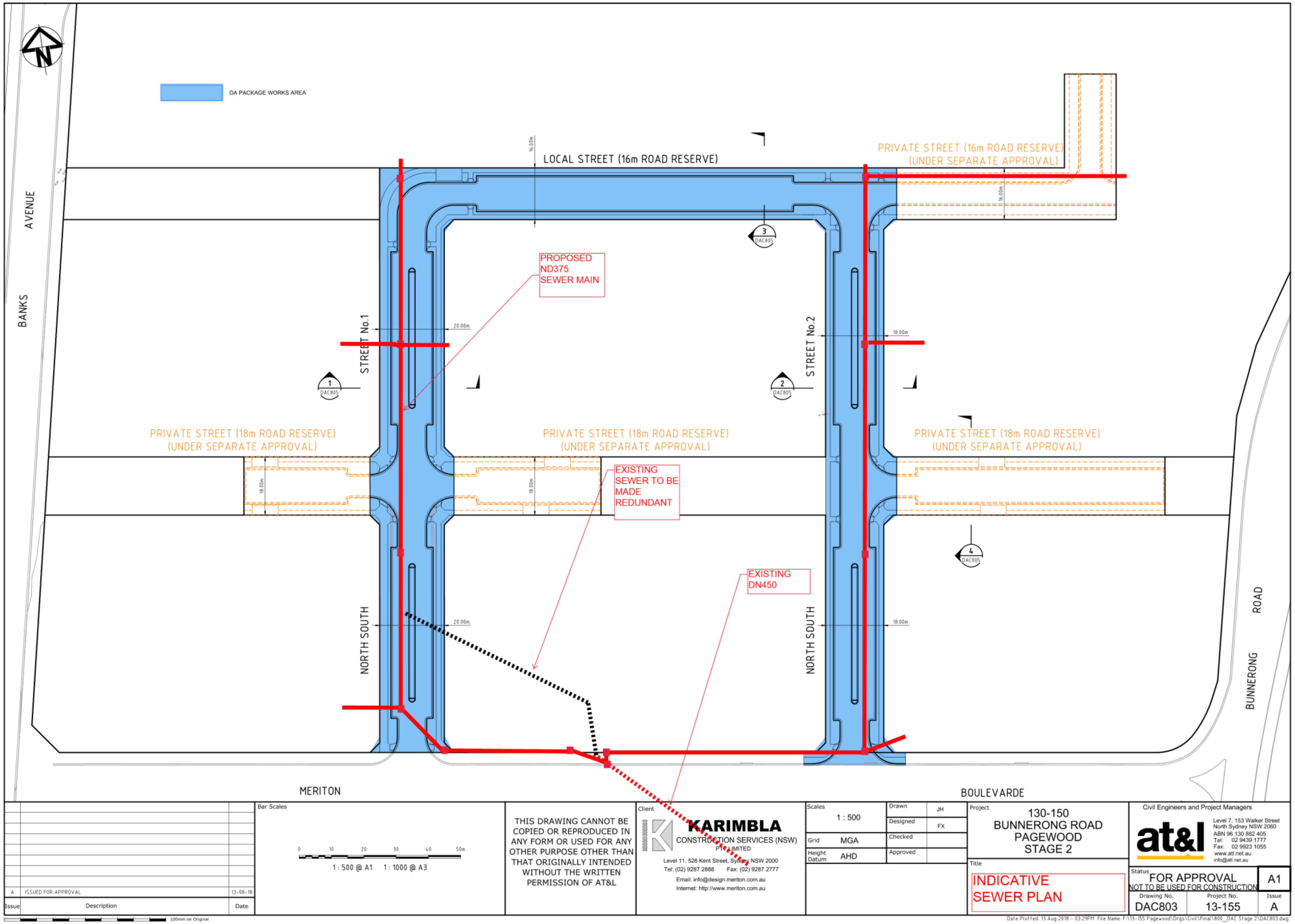
KARIMBLA
CONSTRUCTION SERVICES (NSW) PTY LIMITED
Level 11, 528 Kent Street, Sydney NSW 2000
1 : 500
MGA
AHD
130-150
BUNNERONG ROAD
PAGEWOOD
STAGE 2
INDICATIVE
WATERMAIN PLAN
FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION
A1
DAC803
13-155
A
A ISSUED FOR APPROVAL 13-08-18


DA PACKAGE WORKS AREA
LOCAL STREET (16m ROAD RESERVE)
PRIVATE STREET (16m ROAD RESERVE)
(UNDER SEPARATE APPROVAL)
PROPOSED
ND375
SEWER MAIN
STREET No.1
STREET No.2
PRIVATE STREET (18m ROAD RESERVE)
(UNDER SEPARATE APPROVAL)
EXISTING
SEWER TO BE
MADE
REDUNDANT
EXISTING
DN450
NORTH SOUTH
BANKS AVENUE
BUNNERONG ROAD
MERITON BOULEVARDE
Bar Scales
1 : 500 @ A1 1 : 1000 @ A3
THIS DRAWING CANNOT BE COPIED OR REPRODUCED IN ANY FORM OR USED FOR ANY OTHER PURPOSE OTHER THAN THAT ORIGINALLY INTENDED WITHOUT THE WRITTEN PERMISSION OF AT&L
KARIMBLA
CONSTRUCTION SERVICES (NSW) PTY LIMITED
Level 11, 528 Kent Street, Sydney NSW 2000
Tel: (02) 9287 2888 Fax: (02) 9287 2777
Email: info@design.meriton.com.au
Internet: http://www.meriton.com.au
Scales 1 : 500
Grid MGA
Height Datum AHD
Drawn JH
Designed FX
Checked
Approved
Project
130-150
BUNNERONG ROAD
PAGEWOOD
STAGE 2
Title
INDICATIVE
SEWER PLAN
Civil Engineers and Project Managers
at&l
Level 7, 153 Walker Street North Sydney NSW 2060
ABN 96 130 882 405
Tel: 02 9439 1777
Fax: 02 9923 1055
www.atl.net.au
info@atl.net.au
Status FOR APPROVAL A1
NOT TO BE USED FOR CONSTRUCTION
Drawing No. DAC803
Project No. 13-155
Issue A
A ISSUED FOR APPROVAL 13-08-18
Issue Description Date

MERITON

15 March 2019

Ms Clare Harley
Manager Strategic Planning
Bayside Council
444-446 Princes Highway
ROCKDALE NSW 2216

Dear Ms Harley

RESPONSE TO CONSULTATION ISSUES – PAGEWOOD GREEN (PART II)

Further to our discussions, we have provided a response to the post-exhibition issues raised by Council received via email on 14 February 2019. As outlined below, most of the issues raised primarily relate to the design and layout for the future development which is not necessarily controlled via the provisions under the LEP Amendment and are more appropriately addressed during the Stage 1 Development Application (Stage 1 DA).

Notwithstanding, we have addressed what we can and will take on board other matters raised in finalising the Stage 1 DA.

Building Height and Density:

Comment: The proposal includes 4-5 storeys of podium car parking for each block. There is the potential that basements may be able to accommodate some of the car parking proposed to be in podiums. As such, there may be potential to reduce the overall height and potentially the bulk of the development and reduce overshadowing impacts to the south and east of the site.

Response: As per the sketches in **Attachment A,** Meriton is considering options for alternative podium design which may provide opportunities for building height articulation, alternative podium heights, provide a lower-scale street edge or provide articulation to mitigate the perceived visual impact of a podium. This may vary between urban blocks and frontages depending on the location within the development with more relief considered outside of the central and southern portions of the site. It should be noted that this relief can be considered under the proposed parking rates however would be compromised by any significant increase in parking. This will be further considered in finalising the Stage 1 DA.

Furthermore, above-ground parking has a range of other sustainability and urban design outcomes as it:

- Can be mitigated by design and articulation of the podium structure
- Can save substantial and unnecessary volumes of spoil being transferred to landfill and its associated truck movements. As per Table 1, based on the estimated 2,436 parking

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spaces in the Urban Design Report, a scenario where all proposed parking is transferred into basements could generate as much as 325,000 tonnes of spoil that would require almost 23,000 truck movements, travelling over a total of 2,327,126 kilometres and generating almost 2,000 tonnes of carbon to dispose of the material at a landfill site. Obviously, any substantial increase in parking would exacerbate this scenario.

Table 1 – Conversion of all parking to basement parking

Scenario - 128 Bunnerong Road, Pagewood	
2,438	**Total No. of Car Spots**
324,455	m3 spoil (avg 133m3 per car psace)
22,376	truck movements (14.5T of spoil per truck)
104	km per movement (avg 52km each direction to waste/tip)
2,327,126	truck km travelled
850	g/km (carbon truck emission)*
1,978,057,174	total g (carbon)
1,978,057	total kg (carbon)
1,978	total T (carbon)

- Allows for a higher degree of natural ventilation that cannot be provided in basement parking areas
- Avoids potential flooding and drainage issues associated with subsurface areas when there is major flooding and/or failure of drainage systems.
- Avoids unknown subsurface conditions including the disturbance of acid sulphate soils which exist on the site
- Enhances amenity and security by creating elevated and secured communal open space on podium tops that can achieve better solar access and can only be accessed via residents and their guests
- Creates a street edge with good passive surveillance of surrounding streets and open space areas

Eastern Edge/Interface:

Comment: It has been noted that submissions have requested a similar transition in height to what is proposed at the northern edge/interface be explored as well as a consistent setback along this boundary.

Response: The proposed heights and setbacks on the eastern edge are generally consistent with the heights and setbacks already established under urban Block 4 and 5E in stage 1 of the Pagewood Green development which reflect its location adjoining a major arterial road. In fact, the concept Masterplan increases setback and makes provision for a public reserves and tree retention not provided in the existing development.

The heights and setbacks presented in the concept masterplan have also been designed in accordance with the comments by the Sydney Planning Panel during the Pre-Gateway Review process to avoid overshadowing to residential properties to the east. This has been addressed via the inclusion of a specific requirement in proposed Clause 6.12(t) of the LEP Amendment to ensure there is no overshadowing of residential properties on the eastern side of Bunnerong Road in mid-winter. Compliance with this provision has been demonstrated in the concept design as being achievable. Accordingly, this matter will be addressed under the Stage 1 DA.

Overshadowing:

Comment: It is noted that the proposed open space within the subject site receives adequate sunlight as demonstrated in the solar insolation diagrams (part 6.1 of the urban design report and masterplan). However, concern is raised in relation to overshadowing to the south, particularly to the Pagewood Green Park. The overshadowing diagrams contained within part 6.3 of the urban design report and masterplan does not clearly demonstrate what was considered 'public open space' for the purposes of the overshadowing analysis and percentage calculations.

Response: More detailed shadow analysis of the Central Park is provided in **Attachment B**. It demonstrates that between 10am and 1pm (3hrs) the Central Park receives in excess of 50% of sunlight which is well above industry standards. Furthermore, as per Section 6.3 of the Urban Design Report, the 3ha of Open Space across the entire precinct will achieve between 67%-91% solar access for the entire day in the winter solstice. This is a significant achievement for new open space in a brownfield urban precinct.

Open Space:

Comment: The provision (amount) and usability of open space within the subject site, particularly the function of 'link park' areas that may become non-functional and inactive spaces.

Response: To the contrary the design of the link parks are an integrated component of the public open space design and distribution across the site. They provide informal passive areas and enhance pedestrian mobility through the site that complement the larger civic, play and recreation spaces. A draft Landscape Masterplan that is being prepared for the Stage 1 DA is provided in **Attachment C**. This scheme will be further developed to address these concerns and lodged with the Stage 1 DA.

Car Parking:

Comment: The proposed car parking rates are below the amount required by the Botany Bay DCP and below those approved as part of Stage 1 BATA. Reduced car parking rates are unlikely to be supported, however this will be considered in detail as part of a future DA.

Response: This is acknowledged and has been addressed in the Traffic Impact Assessment (TIA) supporting the proposal since lodgement in May 2017. As with other issues, parking is not controlled by the LEP Amendment and will be further addressed as part of the Stage 1 DA.

Notwithstanding there are a range of factors influencing a reduction in demand for parking and private vehicle usage across Sydney and a reduction in parking rates is supported by key Government transport agencies.

In addition, Meriton is actively working with Transport for NSW (TfNSW) which has already enhanced a range of bus services for the area and we are expecting direct bus services to Tingwell Blvd to commence in the following months. TfNSW has advised that:

> *Over the past 18 months TfNSW has introduced new and additional services serving the Pagewood area, most of which operate adjacent to Pagewood Green. These include the following key initiatives:*

- *Changes to route 400 (Sydney Airport to Bondi Junction via Eastgardens), and new route 420 (Eastgardens to Burwood), effectively doubling service frequency on the busy Eastgardens – Sydney Airport corridor seven days a week*
- *New overnight services on routes 400N (Eastgardens to Bondi Junction) and 420N (Eastgardens to Burwood), seven days a week*
- *Additional weekday shoulder peak services on routes 392 and X92 between Eastgardens, Kingsford and the City*
- *Additional and later evening services on route 353 between Eastgardens, Maroubra and Bondi Junction seven days a week*
- *New route 307 between Port Botany, Eastgardens and Mascot Station seven days a week, as part of service changes introduced along the Botany Road corridor (this service replaced previous route 310)*

These routes operate either along the Bunnerong Road frontage to Pagewood Green, or via the bus interchange at Eastgardens, all within close walking distance of residents at Pagewood Green.

TfNSW are also working on enhancing public transport services under the follow-on studies for SE Sydney from the 2056 Transport Strategy. We understand that this study will further enhance public transport and other transport initiatives in the area.

Furthermore, the mixed-use nature of the development provides for a range of supportive uses and services within the site or on directly adjoining land. This will minimise the need for vehicle usage and parking.

We note the concerns of the Council and will ensure that this is further addressed in more detail as part of the Stage 1 DA.

Traffic and Public Transport:

Comment: As noted below, we will discuss these issues once comments have been received from TfNSW and RMS.

Response: As discussed, Meriton and ARUP have been independently working with TfNSW and RMS. The issues raised by respective agencies have now been addressed and issued so they can finalise their referral response.

We trust that this addresses the issues raised and please contact me on 9287 2691 should Council require anything further.

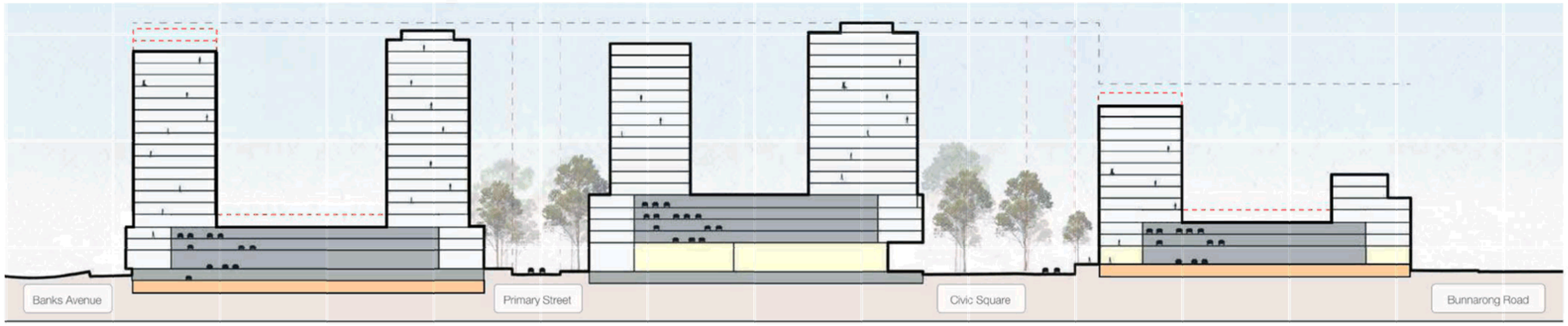
Yours faithfully
MERITON GROUP

Matthew Lennartz
Executive Manager – Planning and Government

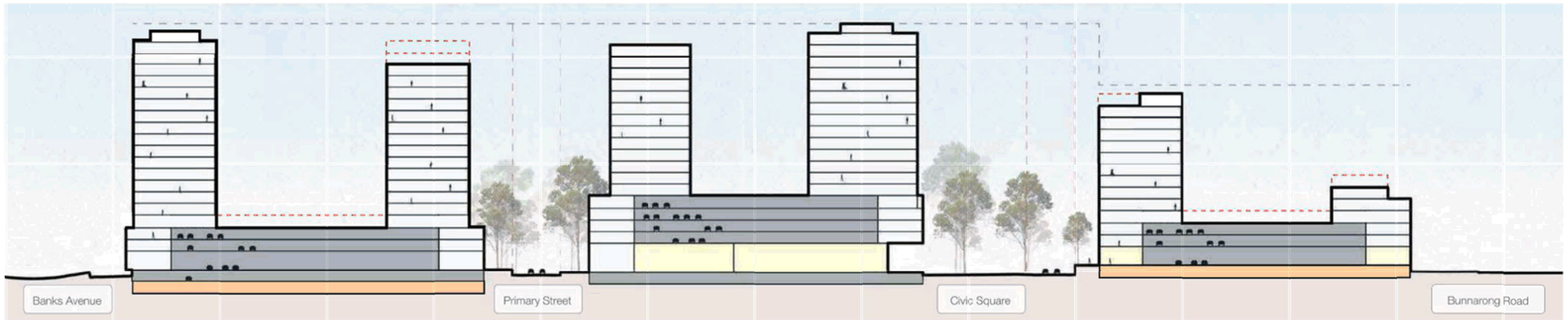
Attachment A – Alternative Podium/Basement Sections

Proposed Masterplan

Tower Articulation Sections



Potential tower articulation option 1



Potential tower articulation option 2

KEY

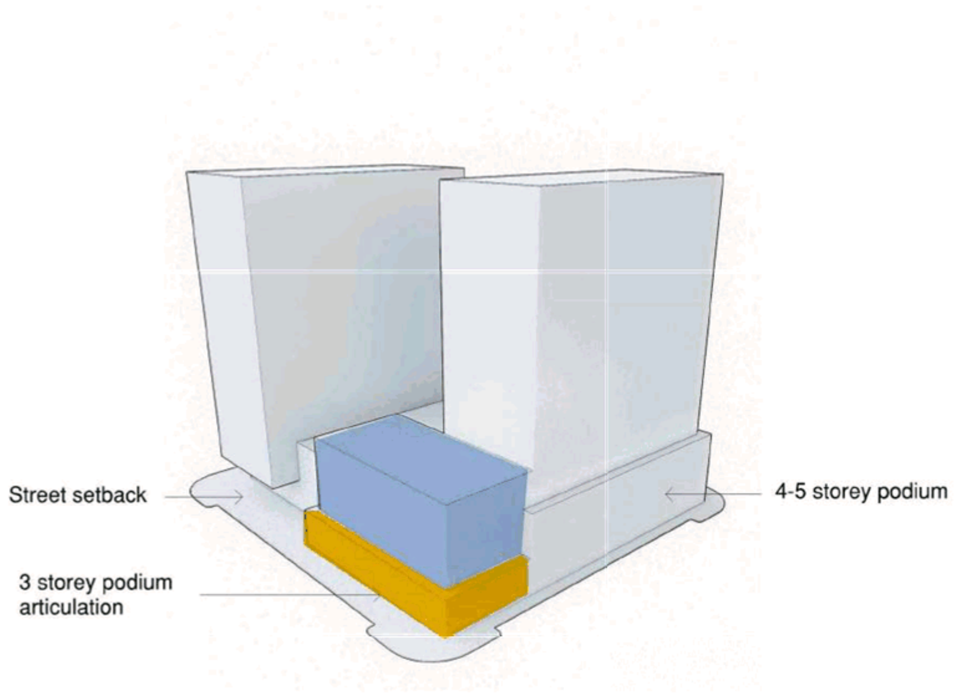
Potential additional basement

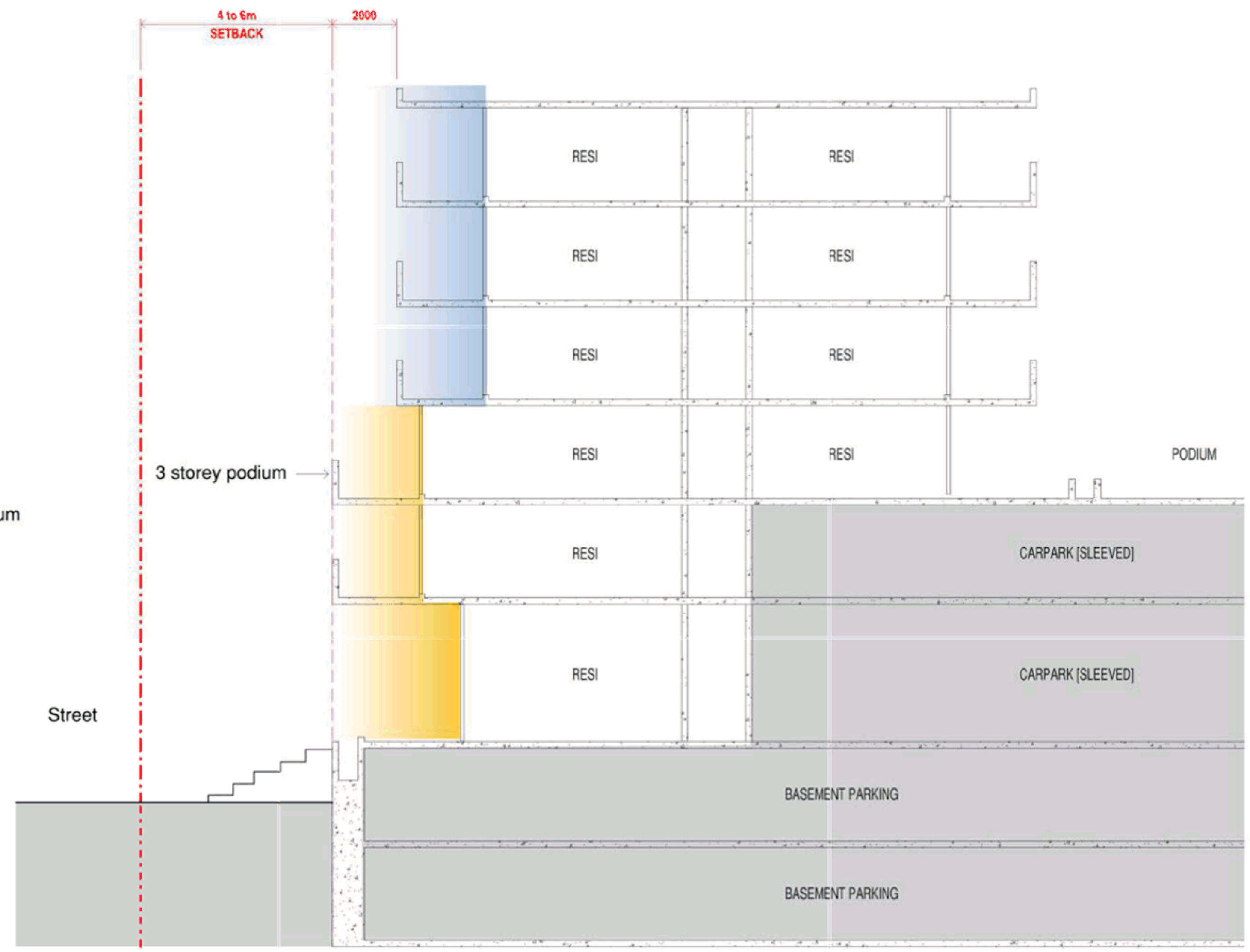
Potential building massing reduction (subject to future design development)

Pagewood Green (Stage 2)

Proposed Masterplan

Lower Podium / Tower Articulation





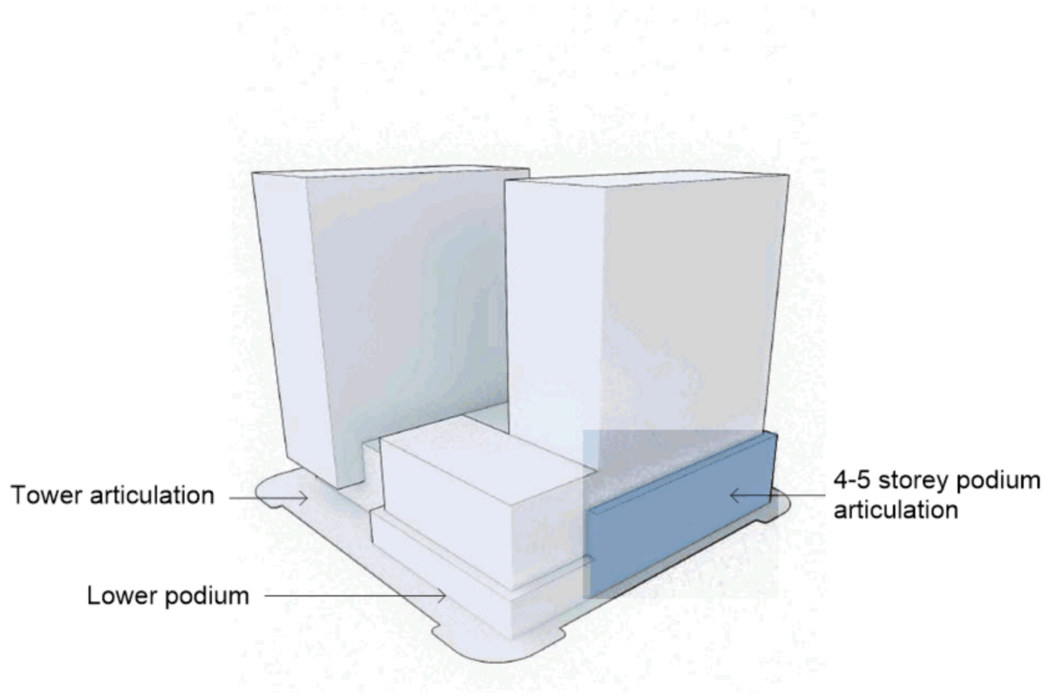
KEY

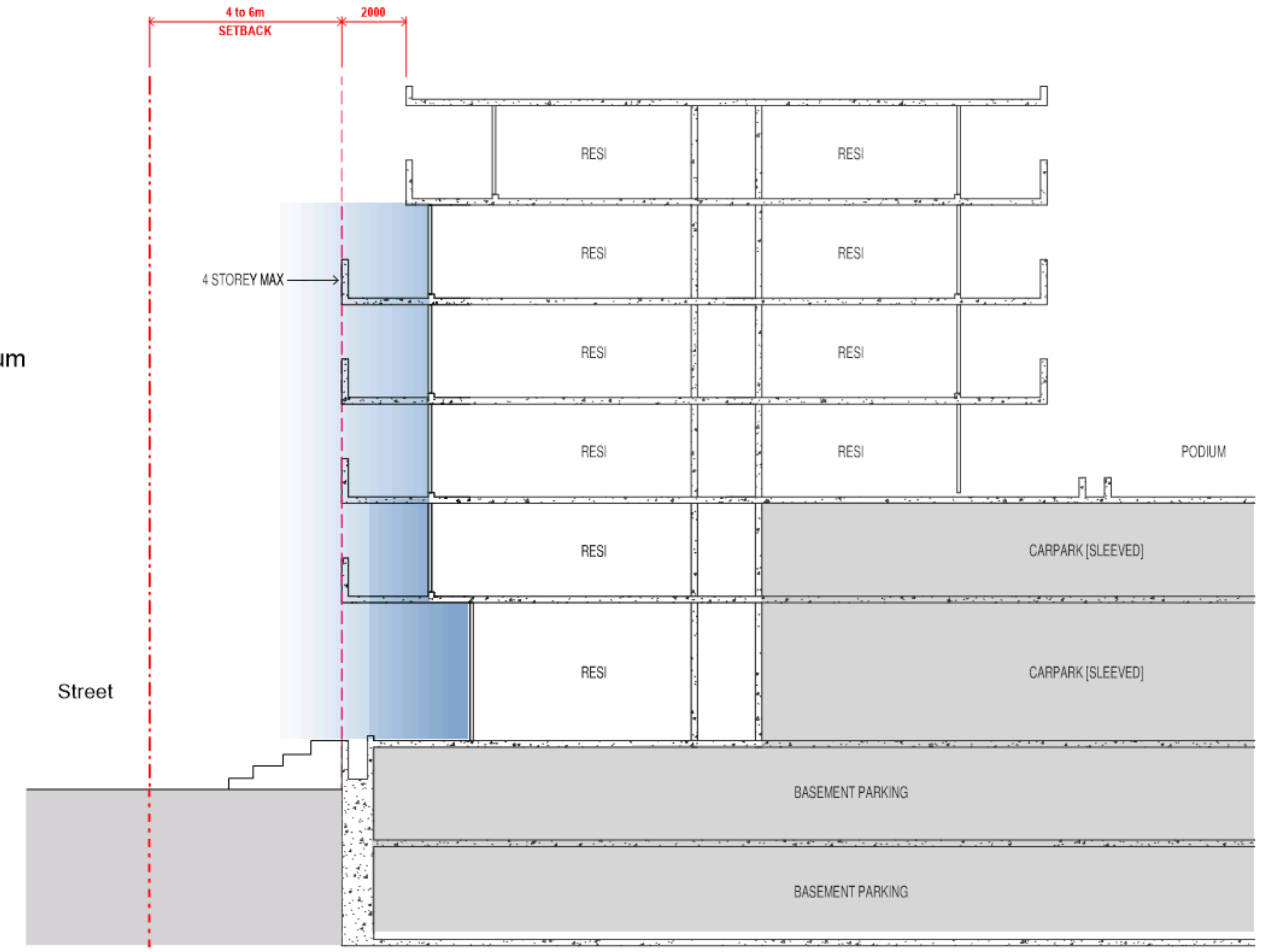
- Lower podium articulation
- Tower setback

Pagewood Green (Stage 2)

Proposed Masterplan

4 - 5 Storey Podium Articulation

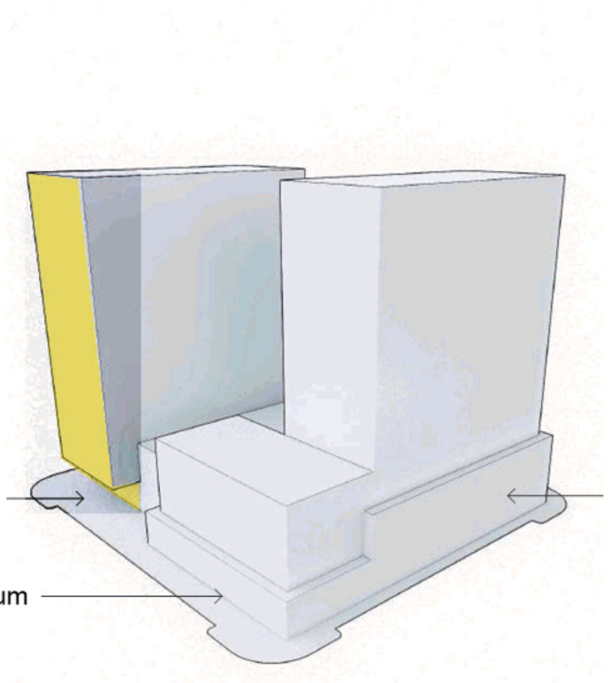


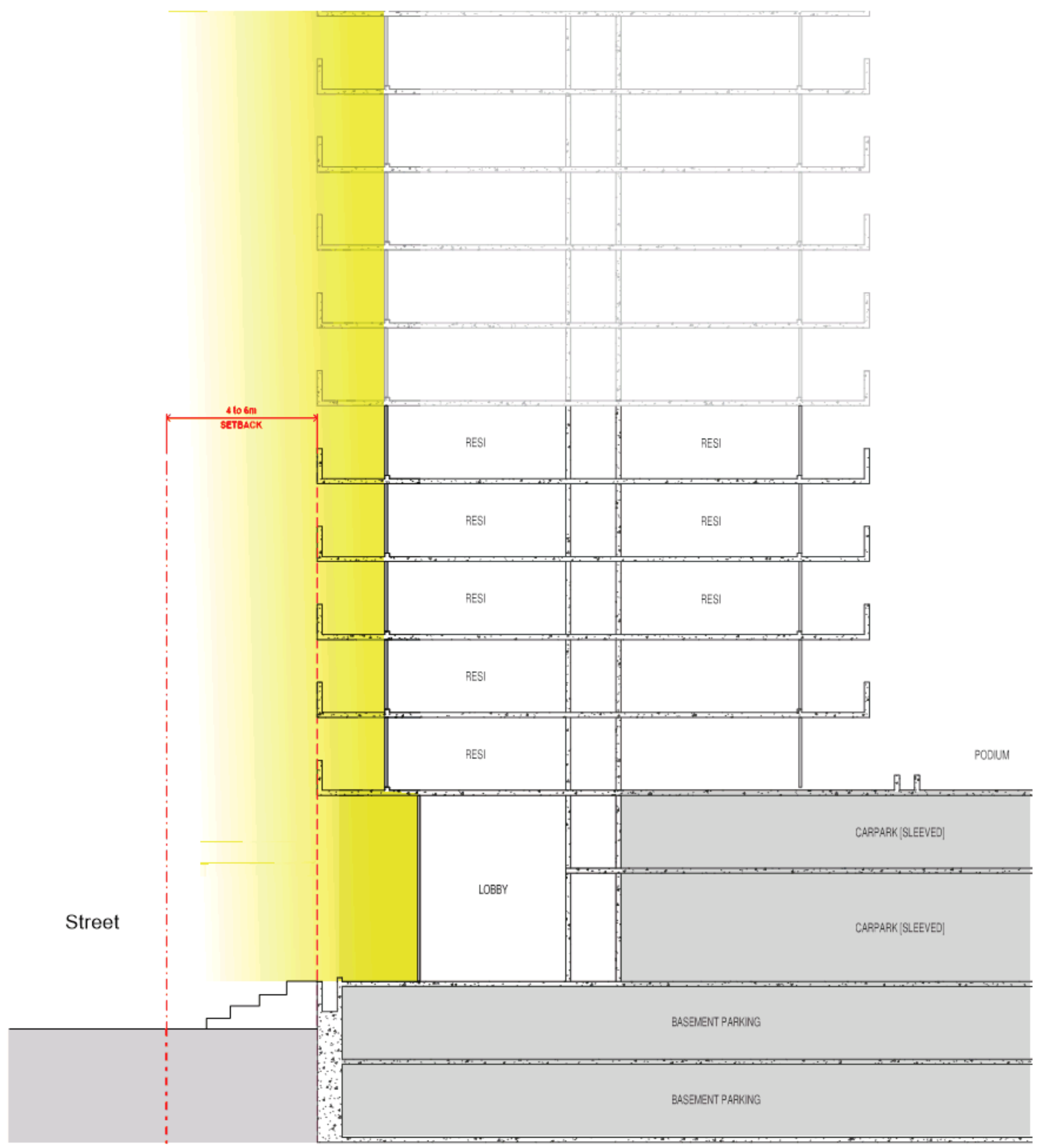


Pagewood Green (Stage 2)

Proposed Masterplan

Tower Articulation

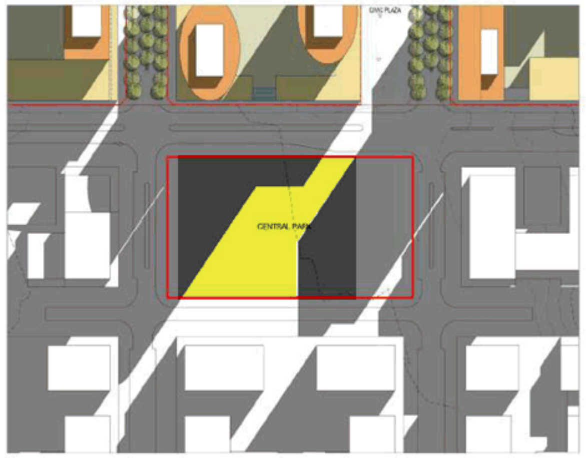




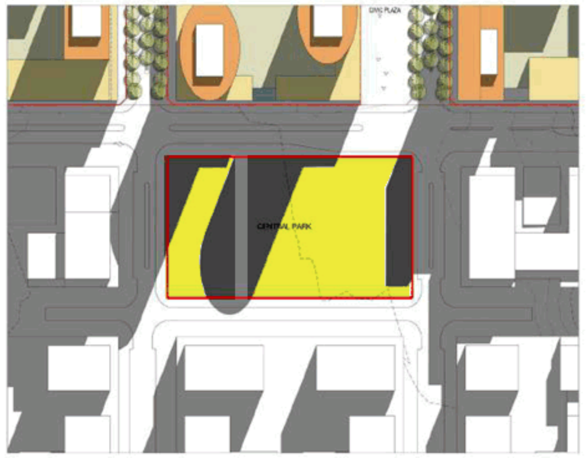
Pagewood Green (Stage 2)

Attachment B – Solar Access Analysis – Central Park (BATA I)

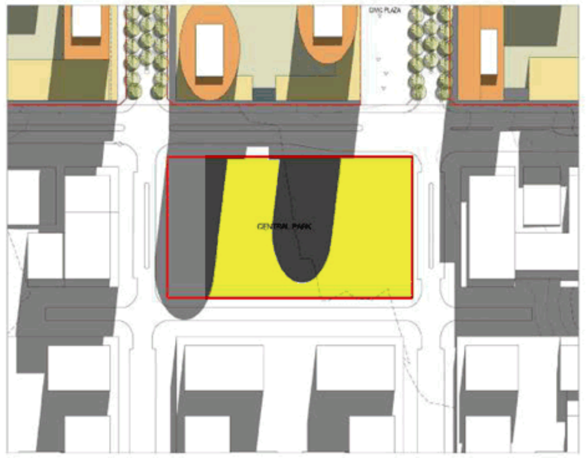
Solar study



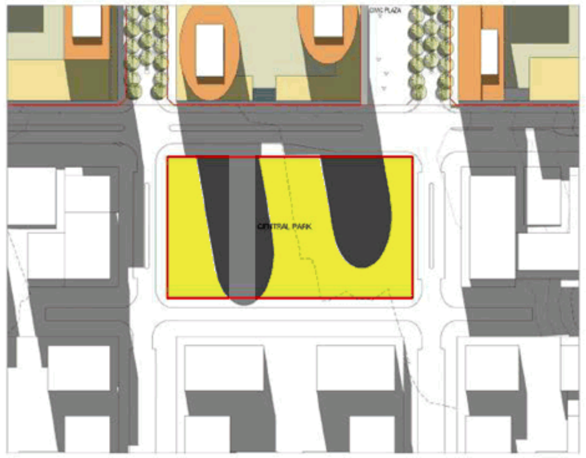
0900 - 33% Direct Solar



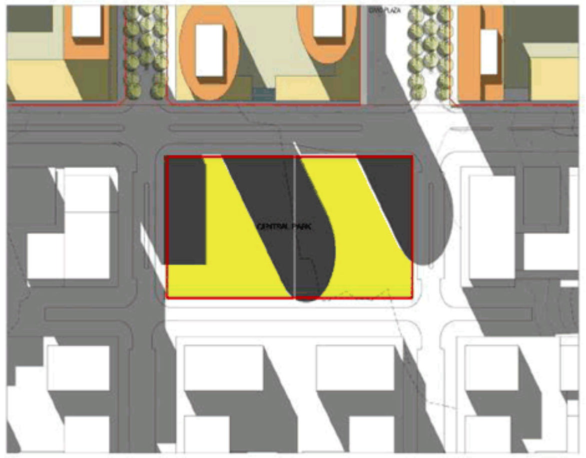
1000 - 66% Direct Solar



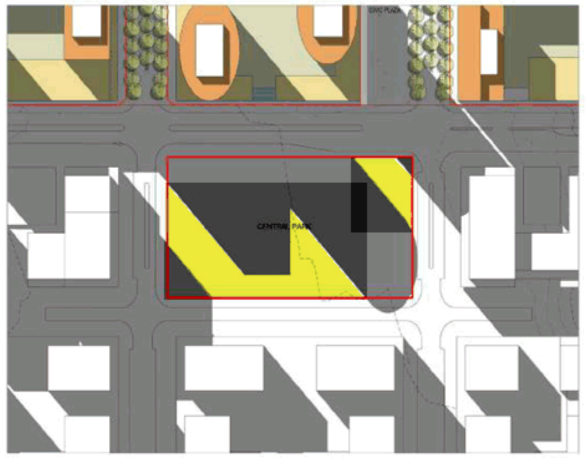
1100 - 68% Direct Solar



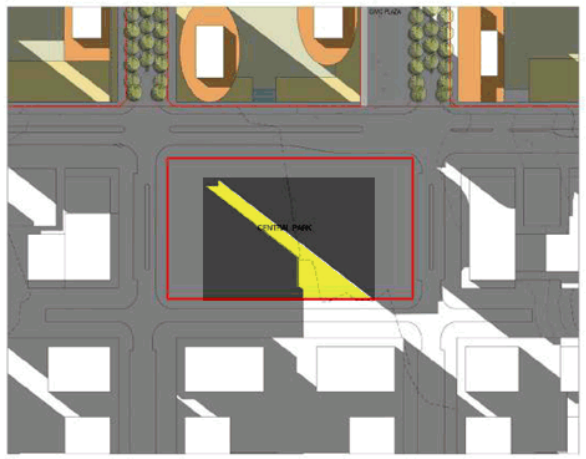
1200 - 68% Direct Solar



1300 - 51% Direct Solar



1400 - 30% Direct Solar



1500 - 10% Direct Solar

Figure 05: 50% of open space achieves 2hours direct solar between 9am-3pm

Attachment C – Draft Landscape Masterplan (Urbis)

URBIS

PAGEWOOD STAGE 2 PUBLIC DOMAIN MASTER PLAN

DEVELOPMENT APPLICATION

PREPARED FOR
MERITON

4TH SEPTEMBER 2018

URBIS.COM.AU

CONTENTS

1.0 INTRODUCTION

This Landscape Architectural report has been prepared for the Pagewood BATA Stage 2 precinct and presents the landscape design philosophy and intent for the public domain and open space for this site.

The design report and associated landscape plan have been prepared after review and in compliance with Bayside Council's DCP and Development application checklist. The philosophies also references both the existing Pagewood Stage 1 Open Space Master Plan document and current detailed public domain and private lot interfaces.

SITE CONTEXT

The 8.95ha site is located in Sydney's Eastern City District, 8km from the CBD and within 6km of major employment centres, such as Sydney Airport, Port Botany, Randwick, UNSW, Centennial and Moore Parks.

Boarded by Banks Avenue, Heffron Road and Bunnerong Road the development connects the existing Stage 1 works to the south.

The site was originally the former British American Tobacco Australian (BATA) manufacturing facility. Prior to this it was used as the General Motors Holden Factory.

DEVELOPMENT PROPOSAL

The development is Stage 2 of the overall existing Pagewood development master plan. The Open Space Master Plan will provide a framework for creating a strong sense of character and active vibrant streets that leads to a 'village feel'.

The development will include a diverse range of build form from multi-storey mixed use residential towers with ground level retail activation, possible Aged Care facilities and lower level town houses addressing the existing Heffron Road character.

The open space will include new public and private streetscape typologies, civic square, community park, recreational park, pedestrian through link parks and public domain setback to Heffron Road and Bunnerong Road. The open space will provide a series of rich and diverse networks which will tie the precinct together.

Bunnerong Road

Heffron Road

Banks Avenue

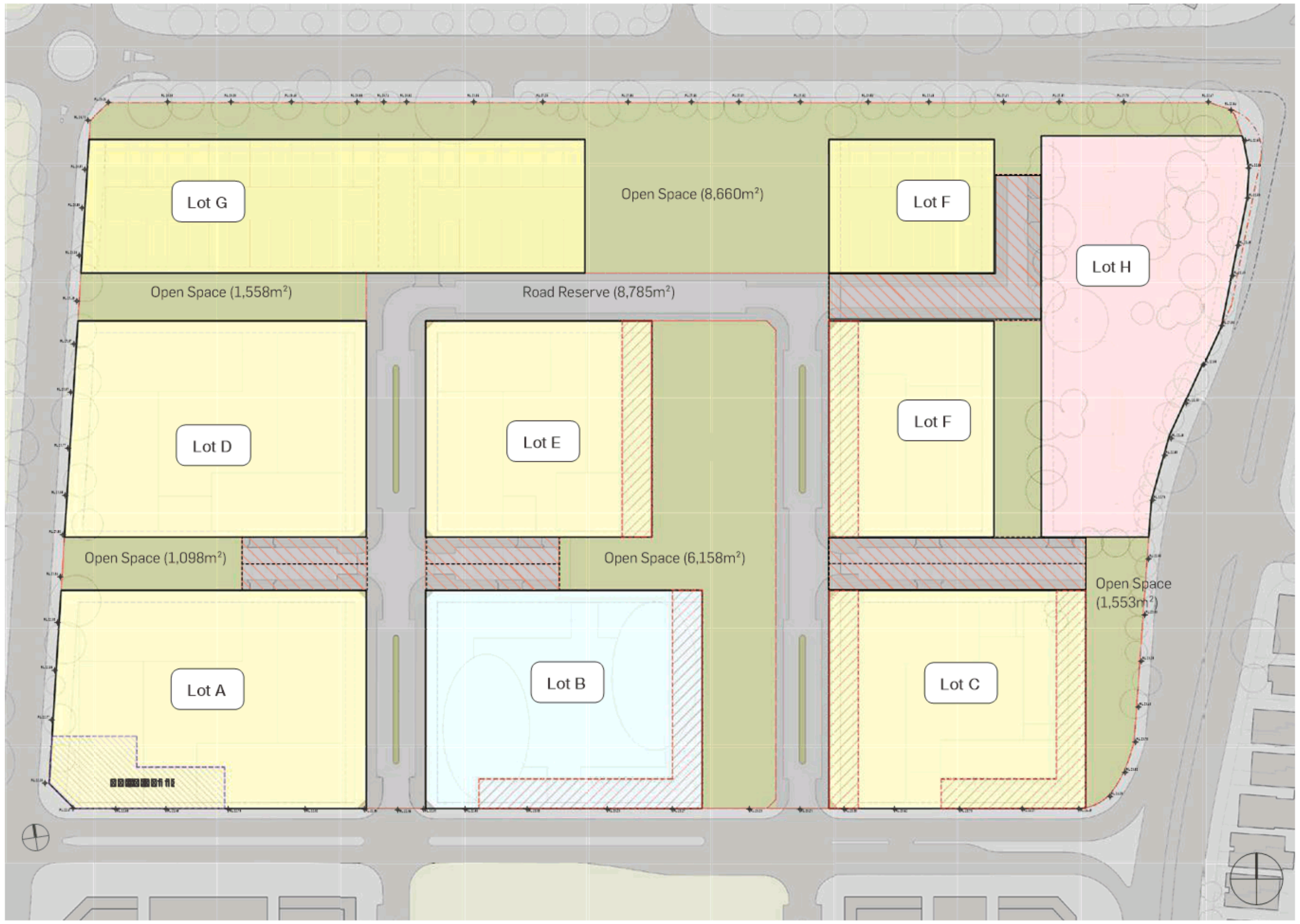
1.1 EXISTING SITE CONDITIONS

1.2 PRECINCT PLAN

Key

- Residential
- Residential (Low Rise)
- Mixed Use
- Aged Care
- Public Road
- Private Road*
- Open Space
- Retail/Childcare
- Site Boundary

*All private roads are associated with respective lot boundaries, all of them include public access easements for pedestrians to increase the permeability of the site.

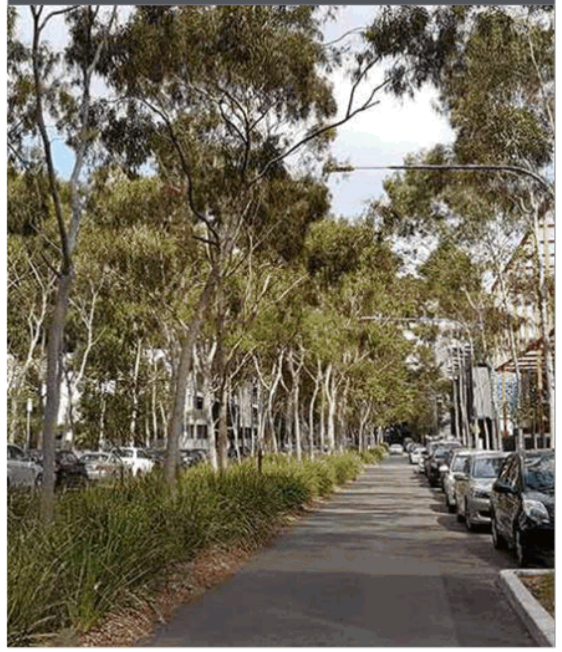


Subdivision Plan - Image: SJB Architects

2.0 PUBLIC DOMAIN DESIGN RESPONSE

2.1 PUBLIC DOMAIN PRINCIPLES

INTEGRATION

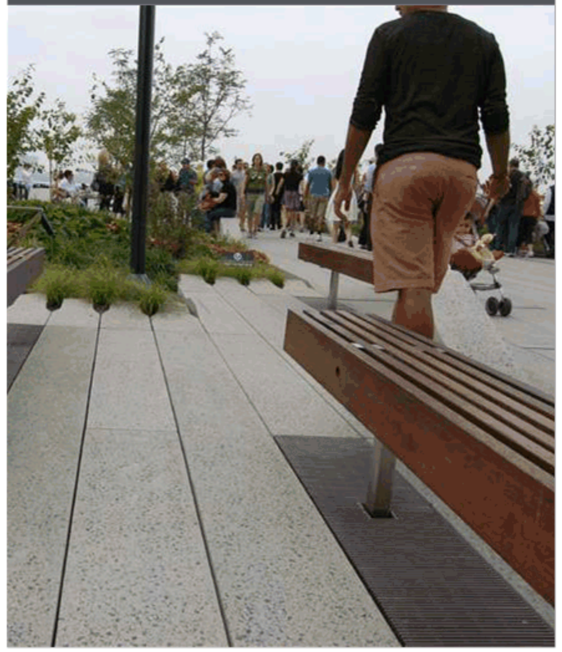


- Integrate green infrastructure to create an urban community that delivers quality of life
- Create balanced green recreational and functional open spaces that strengthen wider environmental, social and economic benefits
- Integrate green spaces into the built form
- Maintain existing trees where possible, particularly on the periphery, provide for adequate compensatory planting in new public spaces as part of an open and accessible precinct

CONNECTIVITY

- Create a series of shared spaces that promote meaningful connections with the community
- Strengthen green streets and community access to local and regional green open spaces

MULTIFUNCTIONALITY



- Connect and enhances the development through high quality and high performing green spaces
- Deliver an open space that contributes to the value and understanding of place
- Design spaces that foster integration, community identity, sense of connectedness and community capacity

PARTICIPATION

- Engage the stakeholders to create community value
- Embrace diversity of activities to encourage community engagement
- Create places that cater to all ages and abilities

Note: Public Domain Principles referenced from 'Greener Places' document prepared by Government Architects New South Wales

2.2 DESIGN RESPONSE

METHODOLOGY

Streetscape

- Water Sensitive Urban Design (WSUD) principles, integrating stormwater into landscape verges and central medians.
- Attractive and comfortable streetscapes for pedestrians & cyclists to activate streets.
- High quality paving, furniture & planting in accordance with Bayside Council DCP.
- Direct and convenient connections to existing external and Stage 1 pedestrian networks.
- Extension of Stage 1 street tree canopy structure.

Civic Square

- Activated public square responding to primary retail frontage
- Opportunities for temporary cafe carts or stages for community events.
- Open Civic lawn with integrated seating benches as an informal dining/retail space extension space.
- Mix of medium and large evergreen and deciduous canopy trees, providing shade and build form relief.

Community Park

- Alfresco Retail/dining opportunities, framed by structural planting and tree canopies.
- All inclusive play space, focused on adventure and sculptural play.
- Large open community lawn providing opportunities for larger events.
- Mix of formal and Informal quality furniture & fixtures.
- Integrated WSUD principles into structured planting.

Recreational park

- Flexible open community 'kick-about' lawn.
- Circulation path providing opportunities for children bike/scooter riding.
- BBQ Pavilions with picnic tables and chairs.
- Passive seating retreats.
- Integrated amphitheater seating walls.
- Lush native tree and groundcover buffer planting to screen adjacent built form.

Reserve Park

- Flexible open community 'kick-about' lawn.
- Shade Pavilions with picnic tables and chairs.
- Passive seating retreats under large canopy trees.
- Screen planting from Bunnerong Road.
- Fitness Station providing formal and informal activities.
- Lush native tree and groundcover buffer planting to screen adjacent built form.

Link Parks

- Series of smaller passive retreat lawns and seating areas which are strengthened by structural tree canopies and shrub/groundcover planting.
- Feature tree bosques and seating areas for smaller community gatherings.
- Paths connecting external pedestrian networks with Stage 2 development.

SAFETY AND SECURITY

An integrated approach to safety will improve actual and perceived personal security in pedestrian public domain areas;

- All paths are overlooked from adjoining buildings and adjacent streets which will provide a high level of passive surveillance;
- All external spaces will have multiple clear sight lines without obstacles, proposed shrub planting is low level which will prevent places to hide;
- All paths will be well lit at night time and designed to meet relevant Australian Lighting Standards;
- Signage will be provided across the precinct to assist with wayfinding and navigation through the site.
- All planting + retaining / planter walls to be low at road intersections to ensure vehicular sight lines are not obstructed

DRAINAGE & WATERING STRATEGY

:

- Water Sensitive Urban Design (WSUD) principles have been realised into the landscape design in a way that celebrates a sustainable water cycle.
- All irrigation systems will comprise of subsurface drip systems and automatic timers with rainwater / soil moisture sensor controls;
- Where possible storm water runoff will be directed to the lawn and garden beds; via basement rainwater storage tanks
- Irrigation will be provided to all soft landscape areas and will be specified within the tender package;
- Low water demand shrub planting is proposed.

LIGHTING

- All external areas will be designed to meet relevant Australian Lighting Standards. Integrated landscape lighting is proposed to all the landscape elements.

2.3 TREE RETENTION STRATEGY

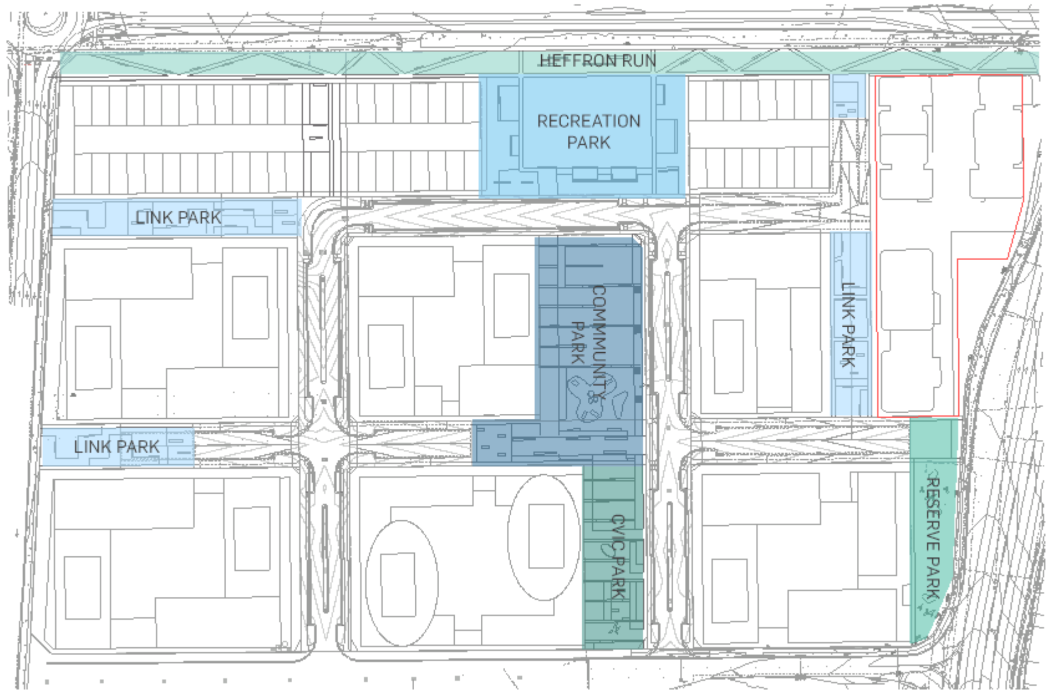
Tree Retention strategy

- Refer to Jackson Nature Works Arboricultural Assessment report for full tree assessments and recommendations.
- Trees inside property boundaries (excluding set back zons) are to be removed. Trees within set back are to be retained where possible and in accordance with Jackson Nature Works Arborist Report
- Tree removal should be carried out as per Jackson Nature Works Arborist Report recommendations and use appropriate TPZ's and follow DCP guidelines.
- Compensation planting to be provided in new open space areas to offset any tree loss within the site.

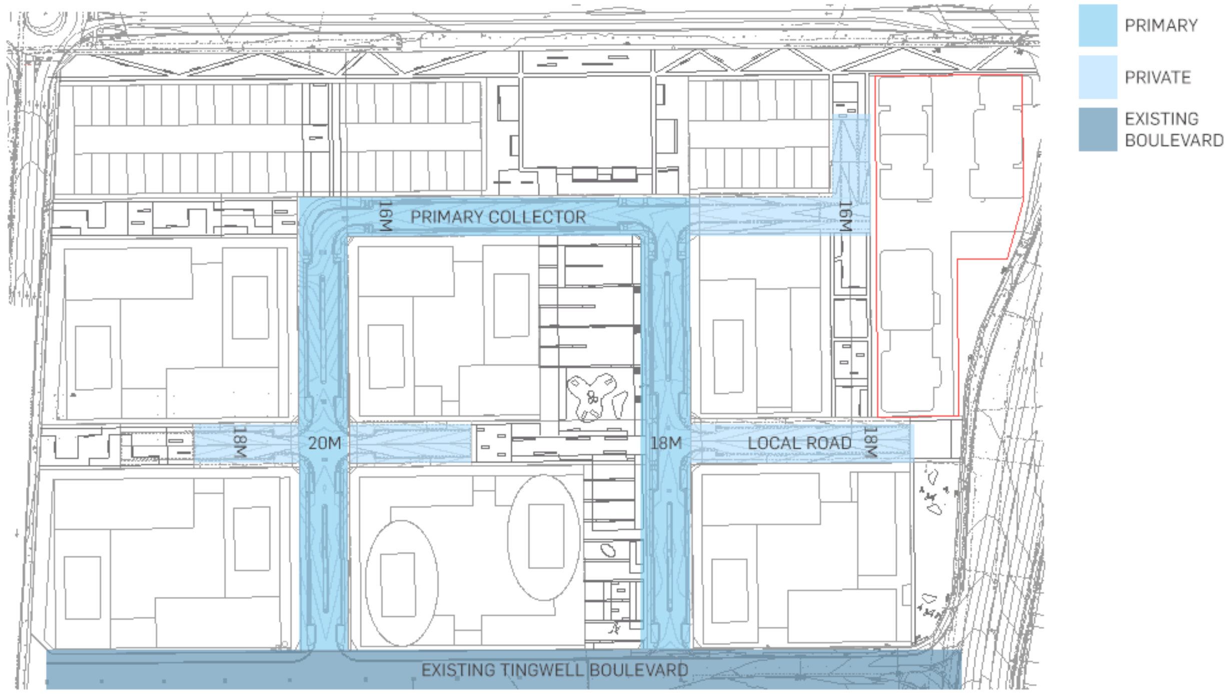
10 **Pagewood Stage 2 Master Plan** - Public Domain Development Application

2.4 DESIGN DRIVERS

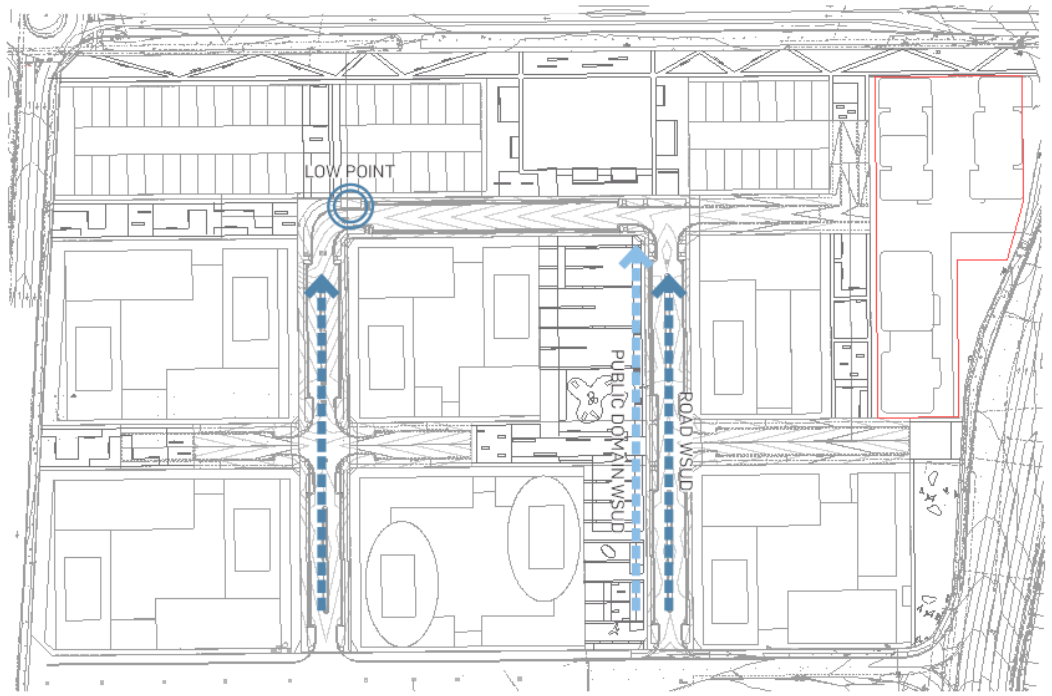
PUBLIC DOMAIN TYPOLOGIES



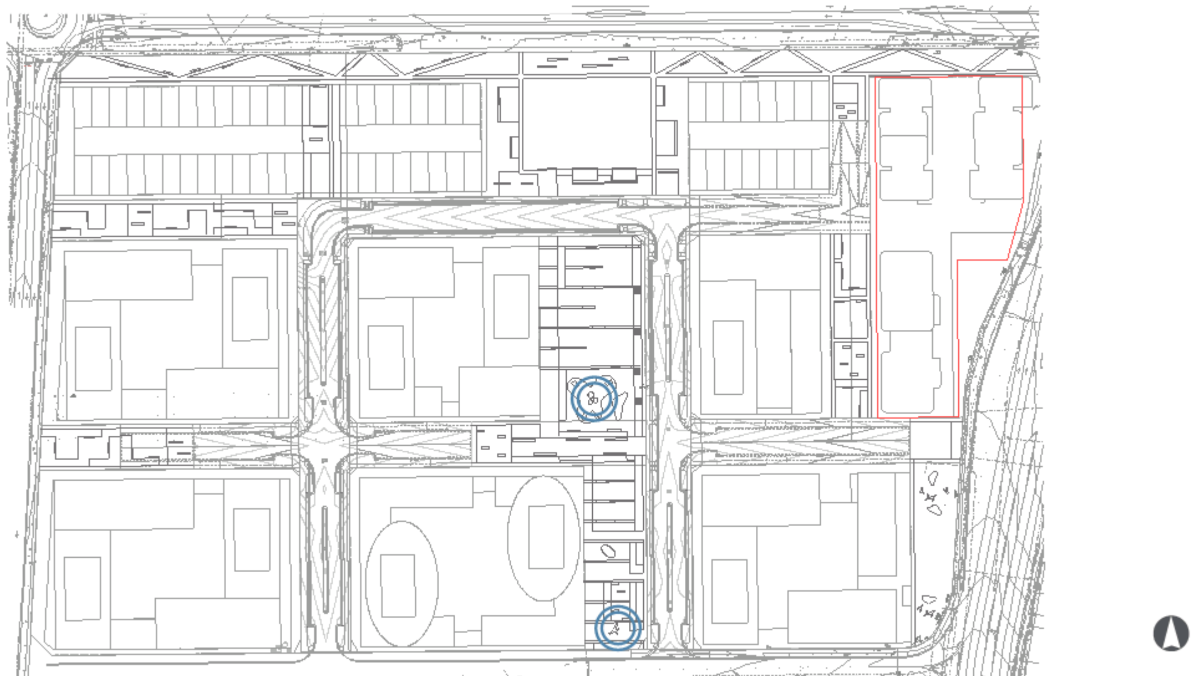
STREET TYPOLOGIES

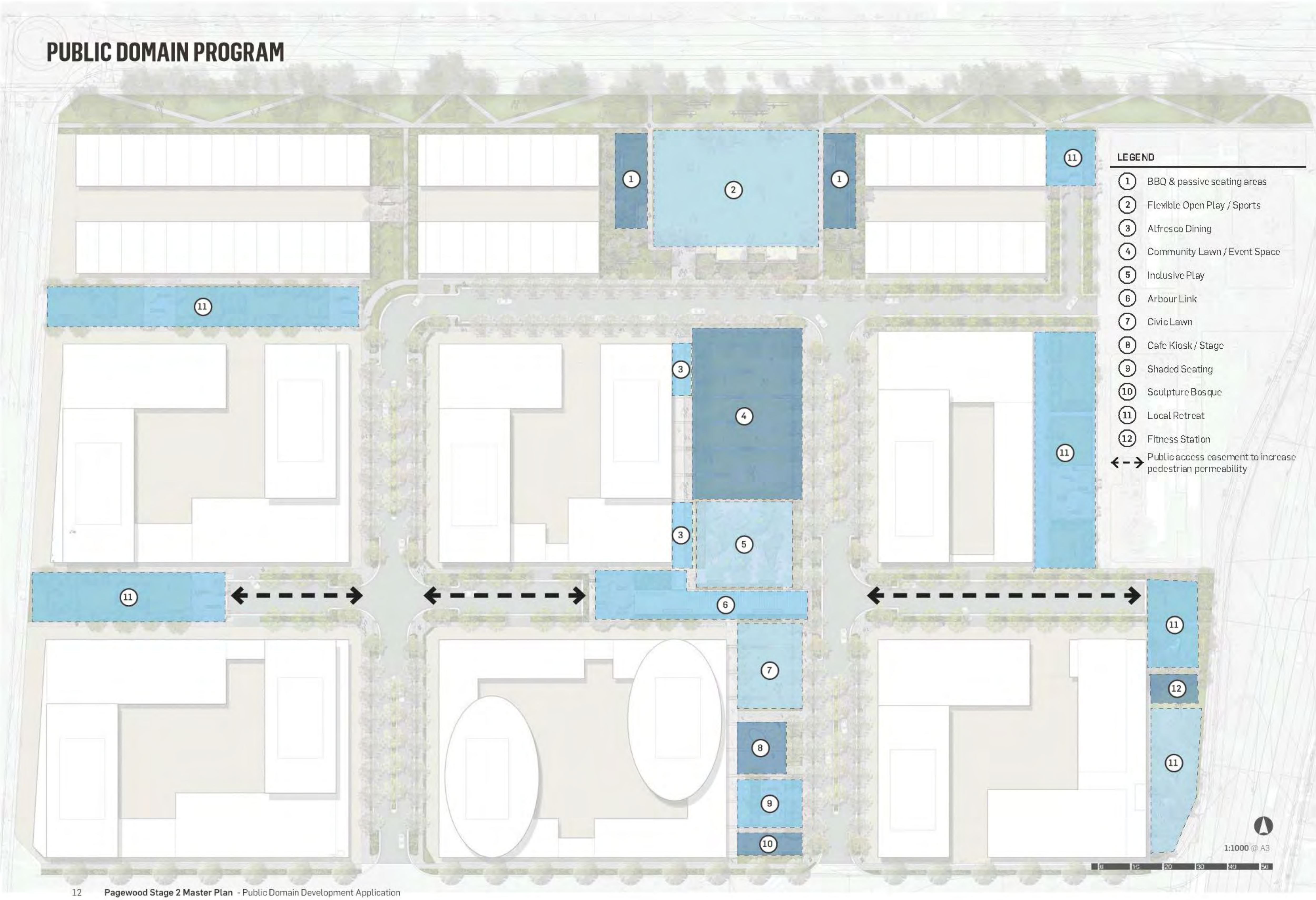


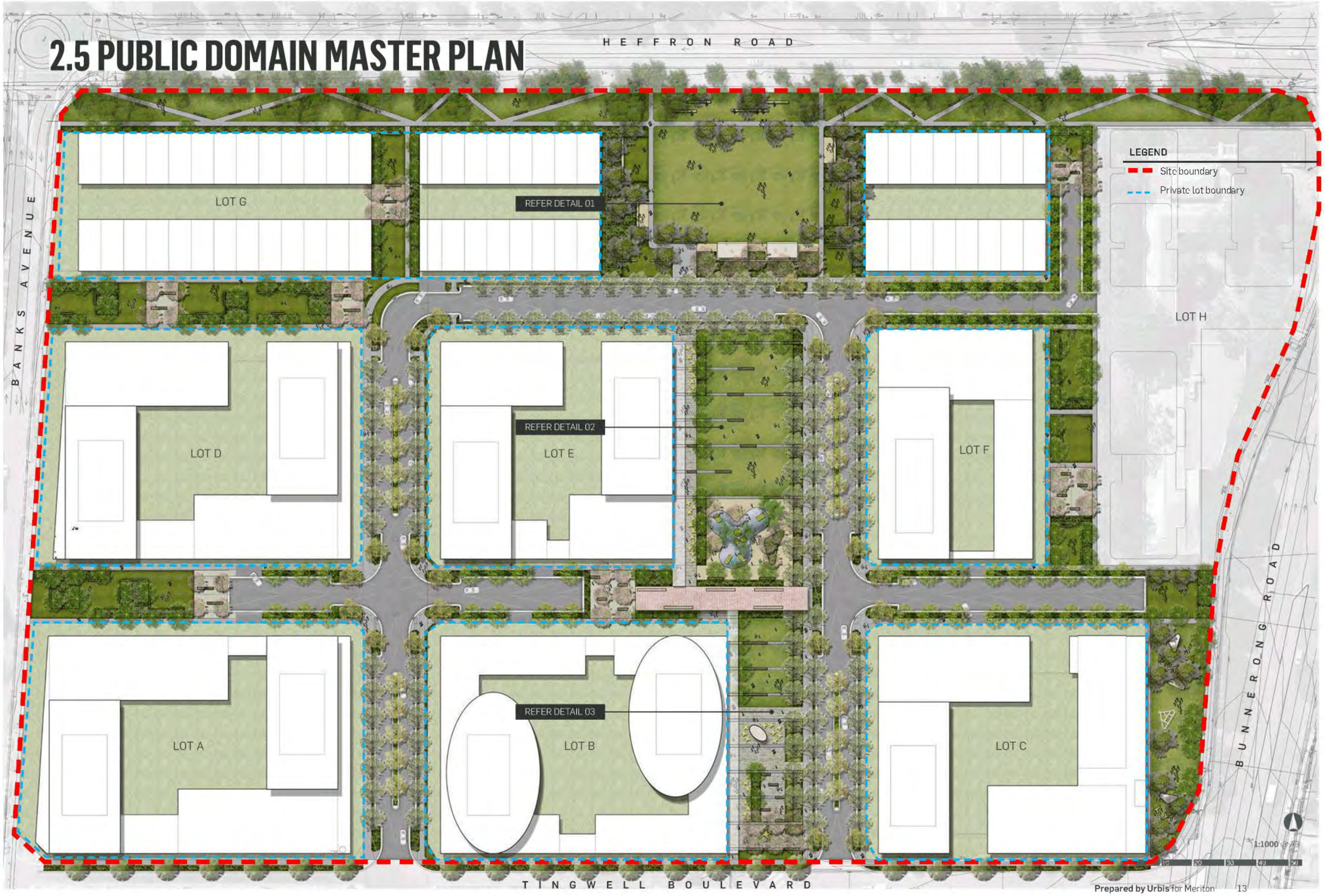
WSUD STRATEGY



PUBLIC ART OPPORTUNITIES




PUBLIC DOMAIN PROGRAM
LEGEND
1 BBQ & passive seating areas
2 Flexible Open Play / Sports
3 Alfresco Dining
4 Community Lawn / Event Space
5 Inclusive Play
6 Arbour Link
7 Civic Lawn
8 Cafe Kiosk / Stage
9 Shaded Seating
10 Sculpture Bosque
11 Local Retreat
12 Fitness Station
Public access easement to increase pedestrian permeability
1:1000 @ A3
12 Pagewood Stage 2 Master Plan - Public Domain Development Application


2.5 PUBLIC DOMAIN MASTER PLAN
HEFFRON ROAD
BANKS AVENUE
BUNNERONG ROAD
TINGWELL BOULEVARD
LEGEND
Site boundary
Private lot boundary
LOT G
LOT H
LOT D
LOT E
LOT F
LOT A
LOT B
LOT C
REFER DETAIL 01
REFER DETAIL 02
REFER DETAIL 03
1:1000
Prepared by Urbis for Meriton
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DETAIL PLAN 1

LEGEND

1. BBQ Pavilions
2. Flexible Open Play/ Sports
3. Public open space circulation path
4. Seating Lawn
5. Existing Vegetation
6. Screen planting to private lot
7. Passive seating retreats
8. Seating walls

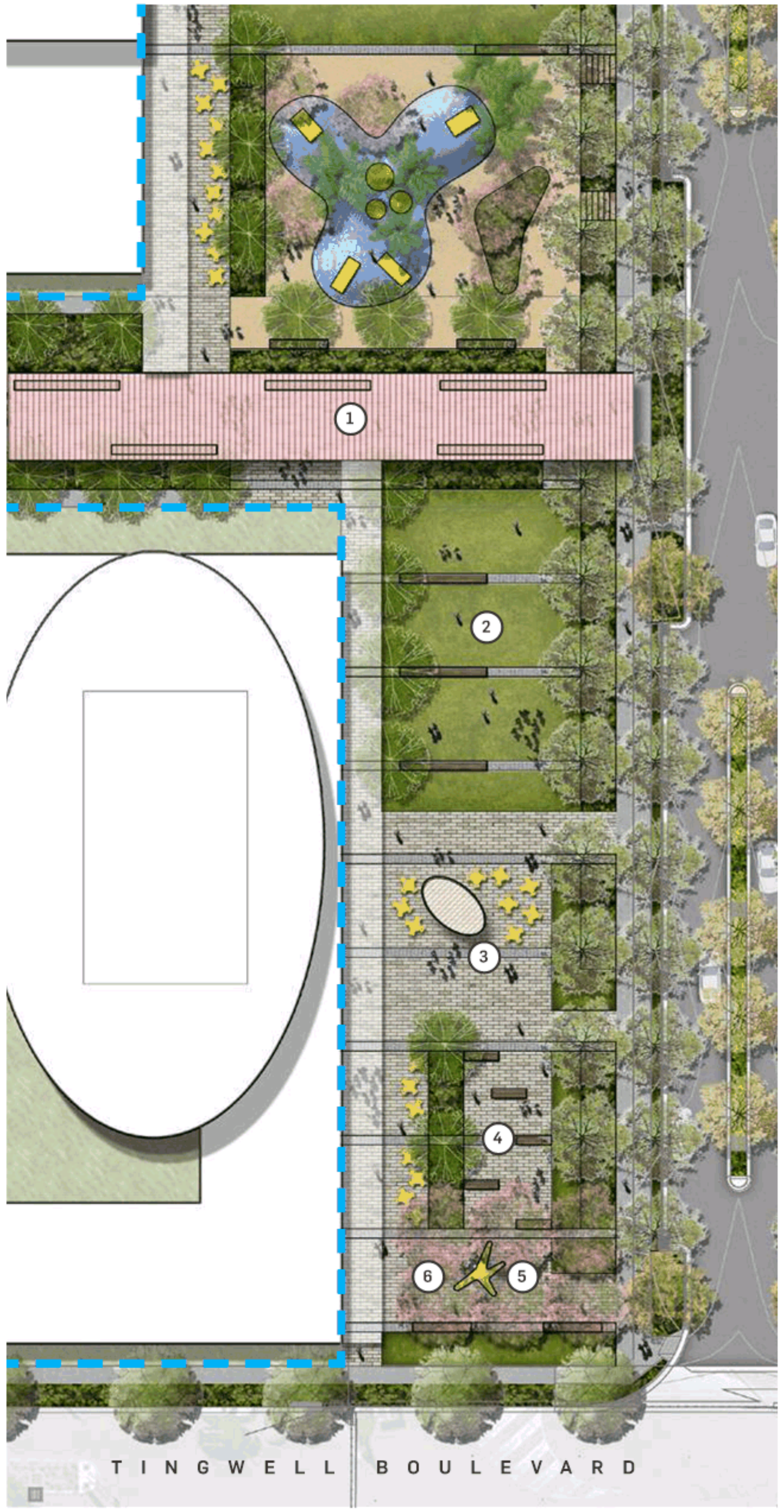
14 **Pagewood Stage 2 Master Plan** - Public Domain Development Application

DETAIL PLAN 2

LEGEND

1. Alfresco Dining
2. Awning Over
3. Feature Paving Banding
4. Community Lawn / Event Space
5. Inclusive Play
6. 3m Wide Promenade
7. Feature Tree Planting

1:500 @ A3



DETAIL PLAN 3

LEGEND

1. Arbour Link
2. Civic Lawn
3. Cafe Kiosk / Stage
4. Shaded Seating
5. Shaded Tree Bosque
6. Public Art (Lump)

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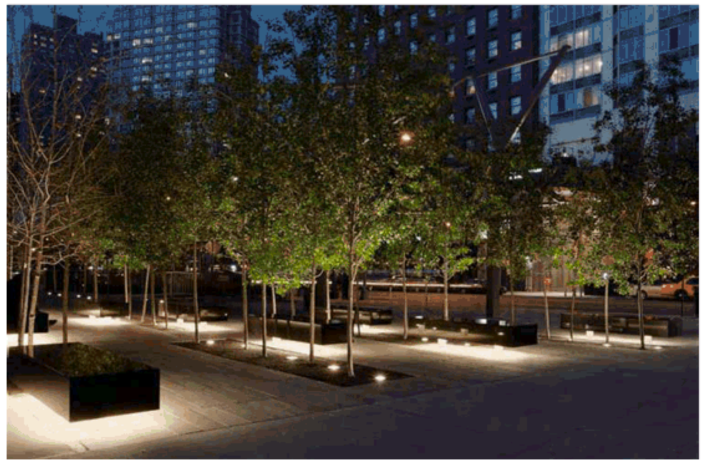
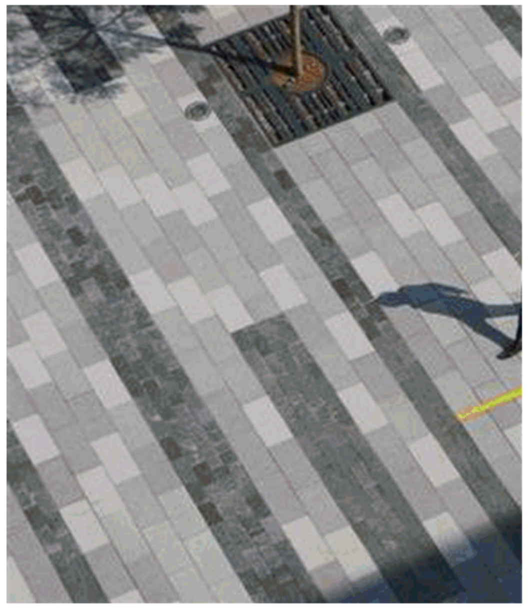
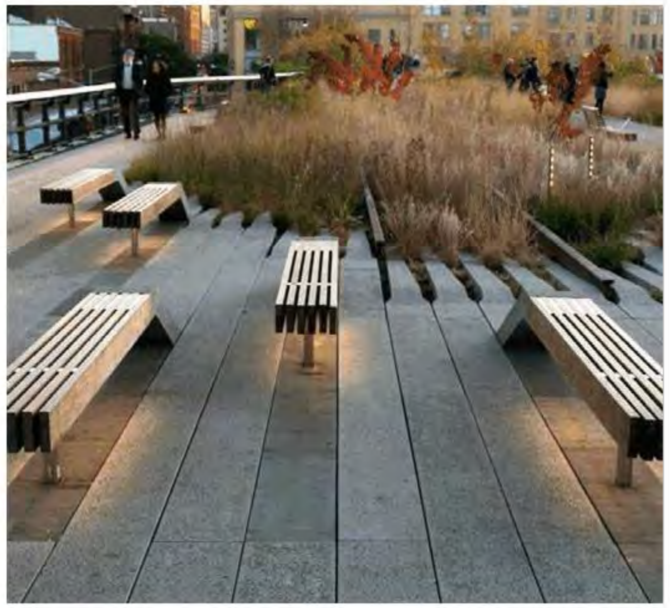
2.6 PRECEDENT IMAGERY

CIVIC SQUARE





COMMUNITY PARK

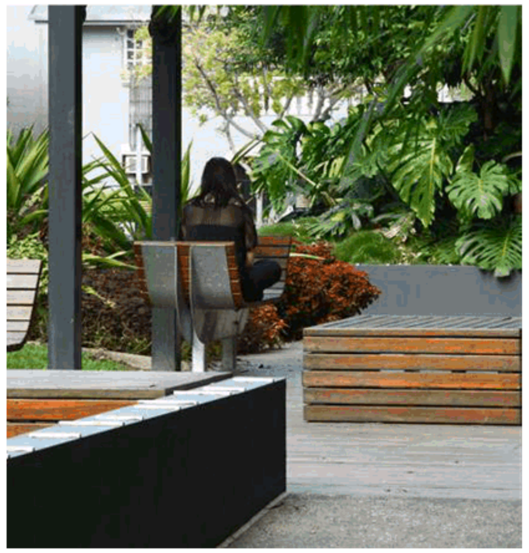


RECREATIONAL PARK





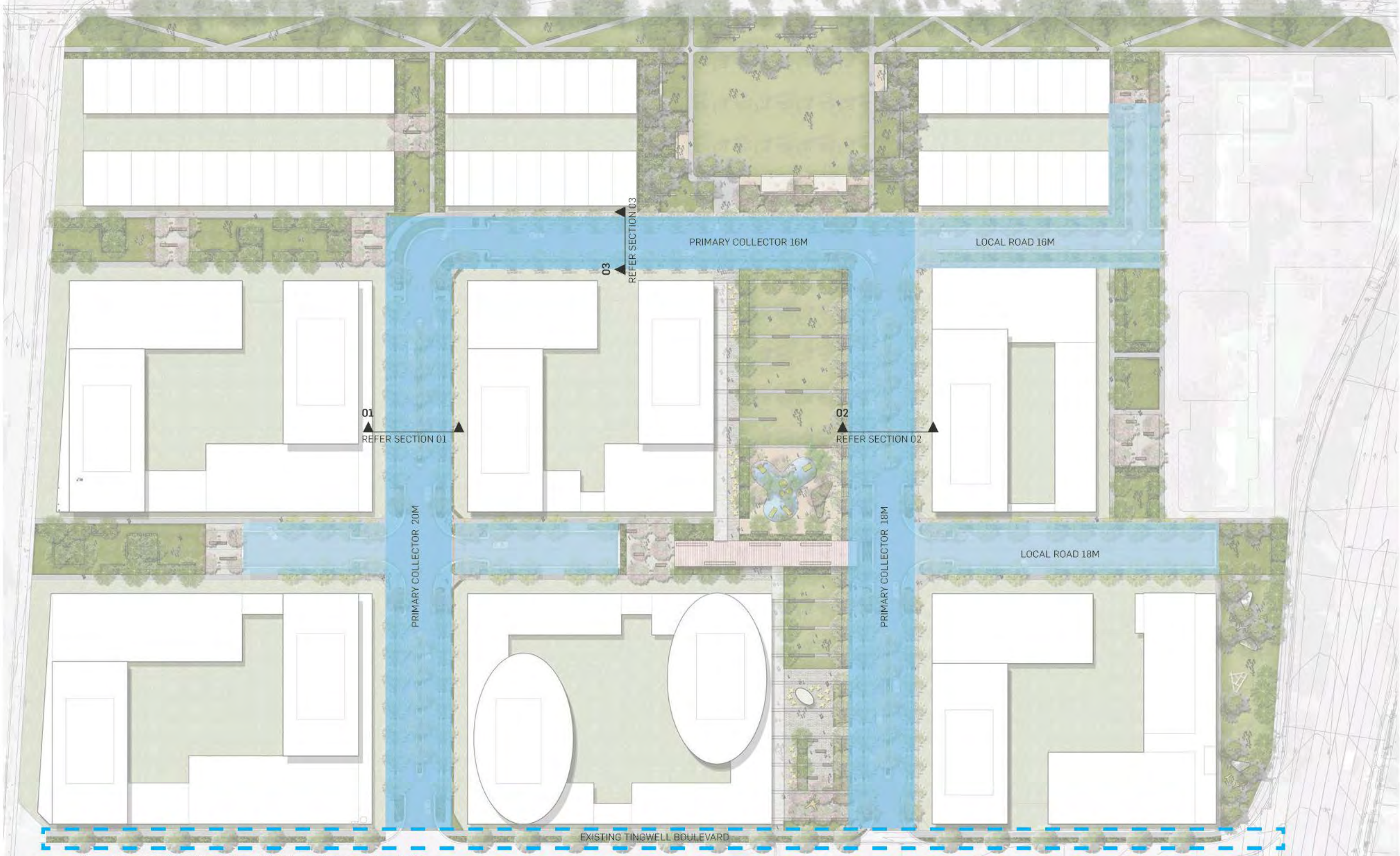

LINK PARKS





3.0 STREETSCAPE STRATEGY

3.1 STREET TYPOLOGY



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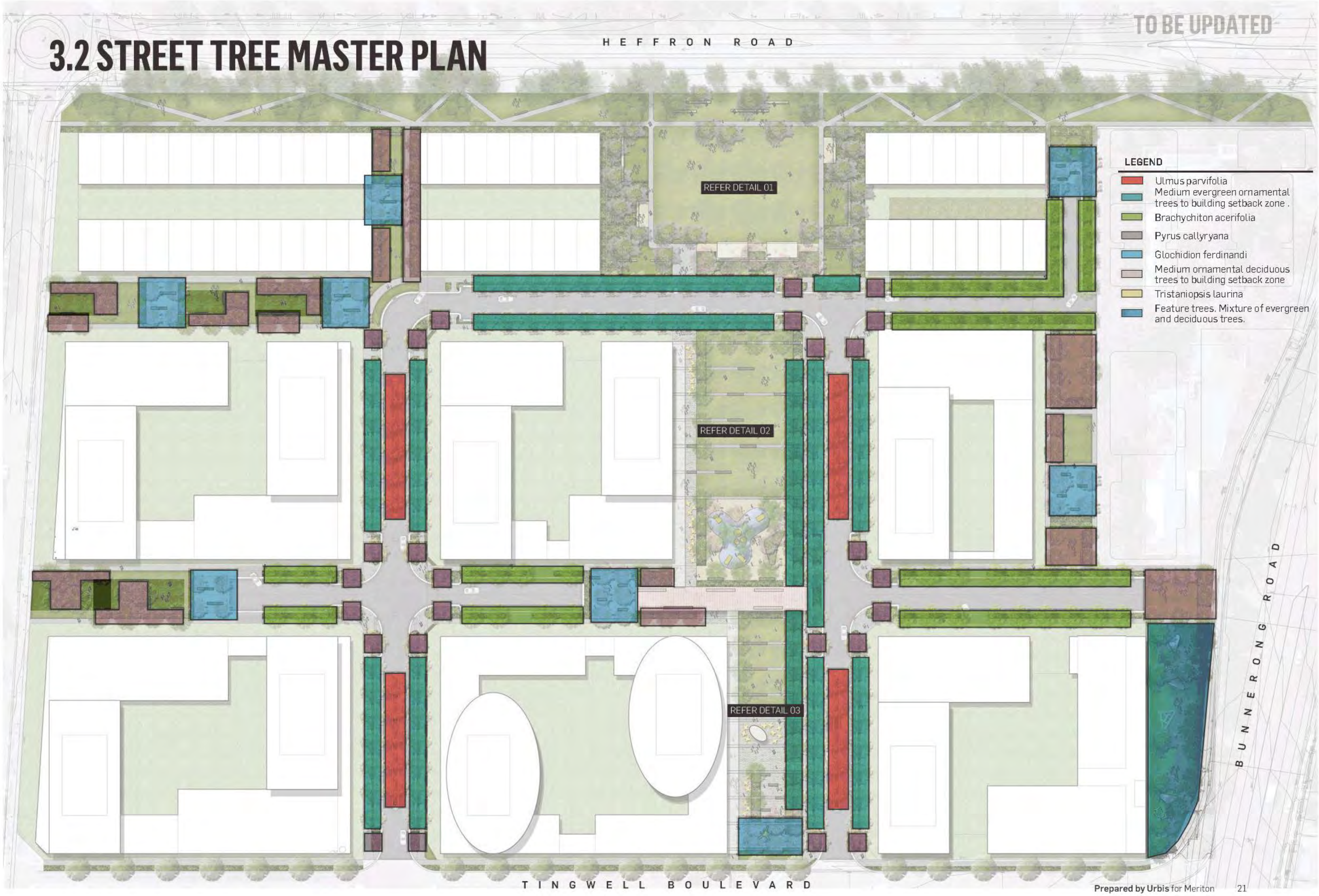
3.2 STREET TREE MASTER PLAN



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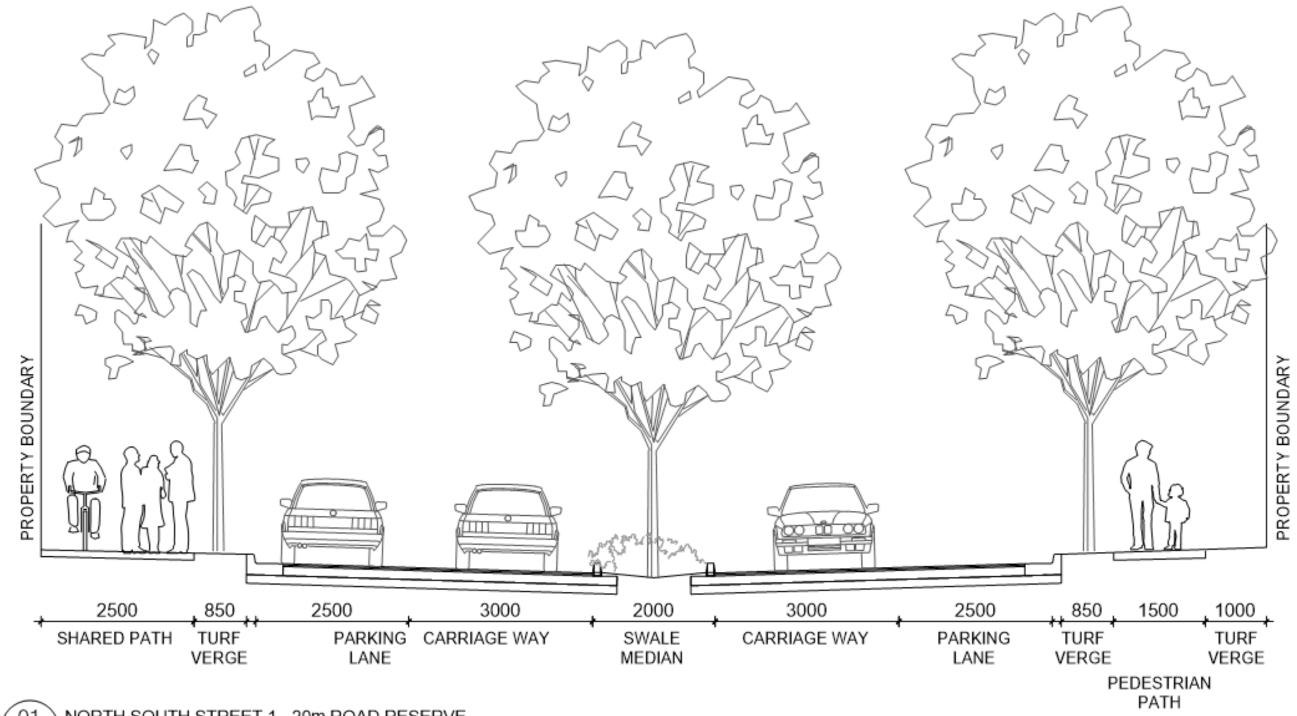
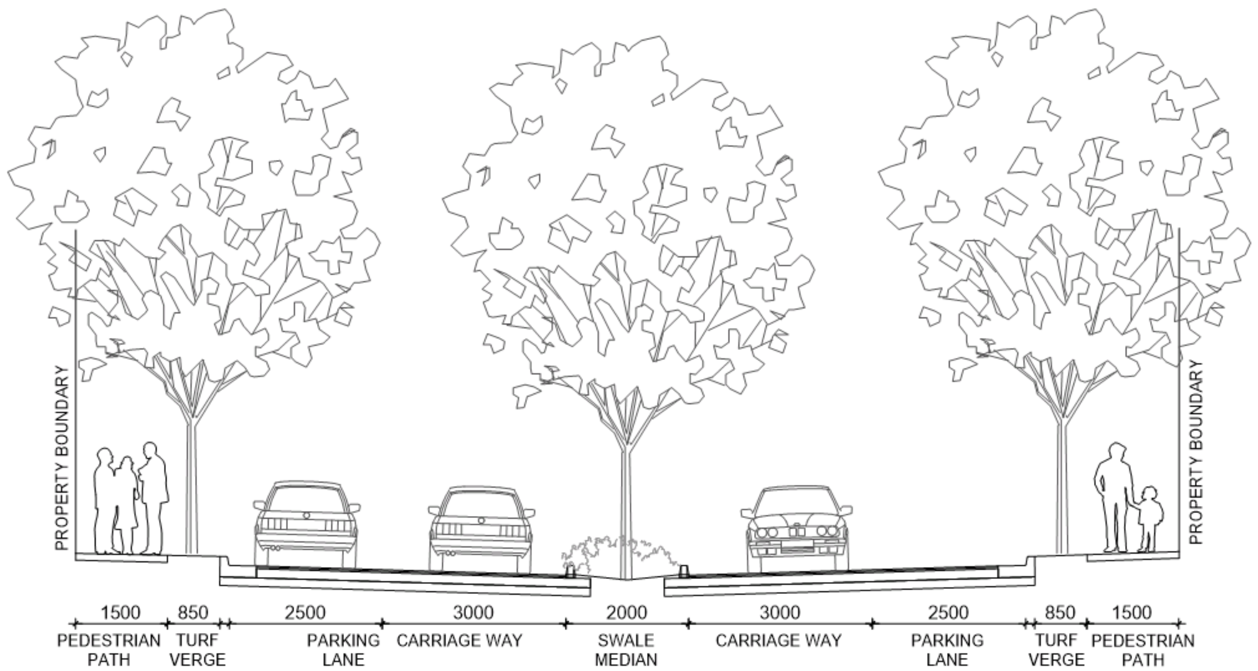
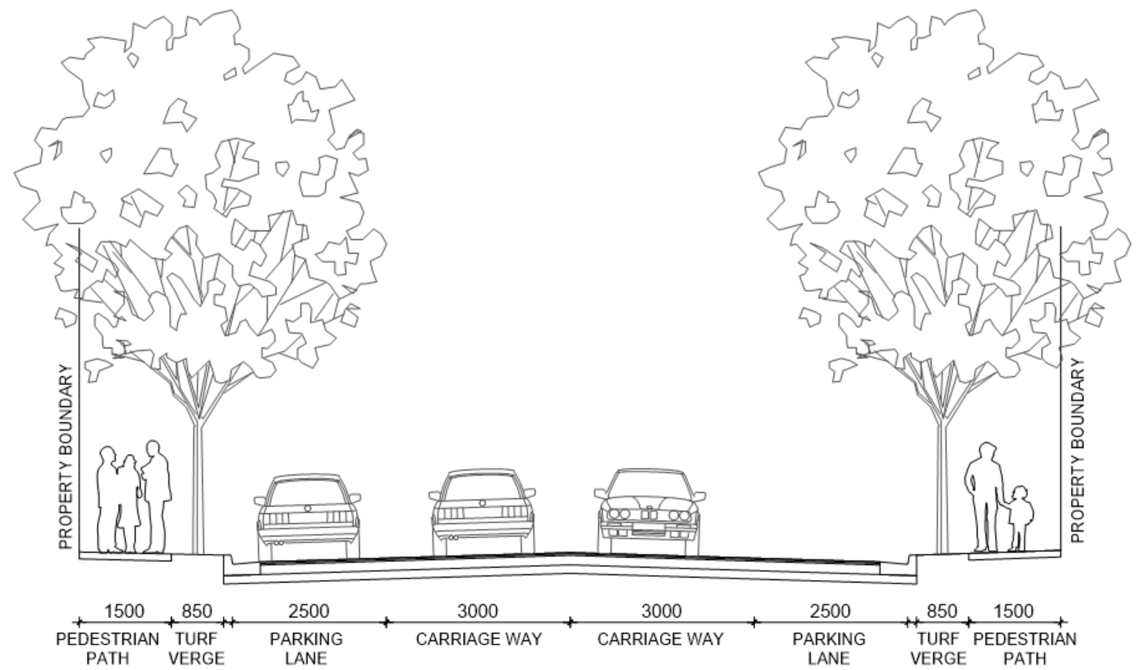
3.3 TYPICAL STREETSCAPE SECTIONS



01 NORTH SOUTH STREET 1 - 20m ROAD RESERVE
SCALE 1:50@ A1; 1:100 @ A3



02 NORTH SOUTH STREET 2 - 18m ROAD RESERVE
SCALE 1:50@ A1; 1:100 @ A3



03 LOCAL STREET - 16m ROAD RESERVE
SCALE 1:50@ A1; 1:100 @ A3

4.0 MATERIALS, FURNITYRE & FIXTURES STRATEGY

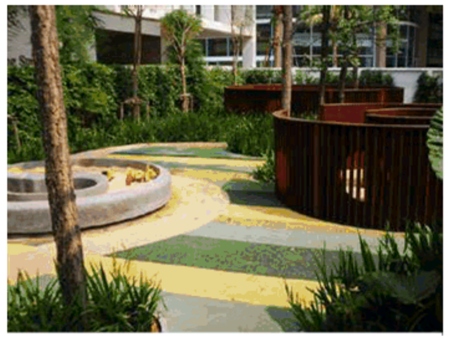
PAVING & FINISHES

P1: Pavement Type 1
- Large concrete unit pavers
- Colour finish: TBC

P2: Pavement Type 2
- Insitu exposed aggregate concrete
- Colour finish: TBC

P3: Pavement Type 3
- Small concrete unit pavers
- Colour finish: TBC

P4: Pavement Type 4
- Decomposed granite
- Colour: Gold



P5: Pavement Type 5
- Soft fall rubber
- Various colours

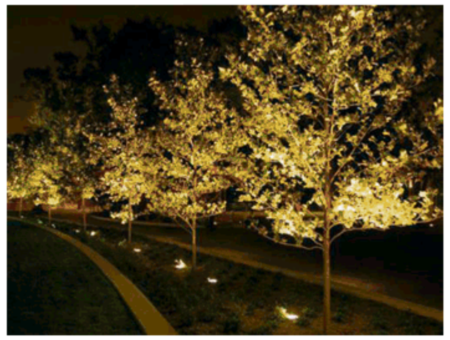
WALLS

W1: Wall Type 1
- Insitu concrete seating walls
- Variou sizes

W2: Wall Type 2
- Insitu concrete amphitheater walls

LIGHTING

L1: Light Type 1
- Pedestrian pole top lighting
- To match BATA Stage 1



L2: Light Type 2
- Feature uplighting

L3: Light Type 3
- feature seat lighting

FURNITURE

F1: Furniture Type 1
- Integrated timber seating
- Supplier: Street Furniture Australia

F2: Furniture Type 2
- Timber bench seating
- Supplier: Street Furniture Australia

F3: Furniture Type 3
- Bench seat (no back)
- To match Stage 1 furniture

F4: Furniture Type 4
- Bench seat (with back)
- To match Stage 1 furniture

F5: Furniture Type 5
- Rubish bin
- To match Stage 1 furniture

F6: Furniture Type 6
- Stainless steel bollard
- To match Stage 1 furniture

F7: Furniture Type 7
- Bike racks
- To match Stage 1 furniture

F8: Furniture Type 8
- Tree Grates
- To match Stage 1 furniture

PLAY EQUIPMENT

PE1: Play Type 1
-Sulptural play equipment
- Supplier: Kompan

PE2: Play Type 2
- Mounded soft fall with integrated tunnels
- Supplier: Kompan

PE3: Play Type 3
- Play dome
- Supplier: Lump Sculpture Studio

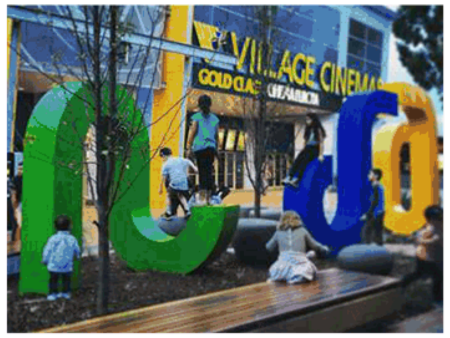
P4: Pavement Type 4
- Sculptural play
- Supplier: Lump Sculpture Studio

P5: Pavement Type 5
- Stepping logs
- Insitu/site won timber logs

FITNESS EQUIPMENT

FE1: Fitness Type 1
- Fitness Station 1
- Supplier: Park Fit

PUBLIC ART



A1: Public Art Type 1
- Main Civic Square Urban Art
- Supplier: Lump Sculpture Studio

A2: Public Art Type 2
- Dome Play Space
- Supplier: Lump Sculpture Studio

SHELTERS

SH1: Shelter Type 1
- Civil Square Arbour
- Supplier: Insitu

SH2: Shelter Type 2
- Play space shade structure
- Supplier: Insitu

SH3: Shelter Type 3
- Park shelter
- Supplier: Landmark

5.0 PLANTING STRATEGY

5.1 PLANTING STRATEGY

Trees				
Code	**Botanical Name**	**Common Name**	**Mature Height x Spread (m)**	**Supply height (Pot size)**
Cm	*Corymbia maculata*	Spotted Gum	30x10	200L
Lc	*Lophostemon confertus*	Brush Box	16x8	200L
Mq	*Melaleuca quinquenervia*	Paperbark	15x10	200L
Jm	*Jacaranda mimosifolia*	*Jacaranda*	10 x 8	200L
Ps	*Pyrus callyryana 'chanticleer'*	Ornamental Pear	15x7	200L
Ag	*Angophora floribunda*	Rough barked Apple	18 x 8	200L
Ba	*Brachychiton acerifolia*	Illiwarra Flame Tree	5-10 x 6	200L
Up	*Ulmus parvifolia*	Chinese Elm	10x4	200L
Li	*Lagerstroemia indica*	Crepe Myrtle	6x4	200L
Tl	*Tristaniopsis laurina*	Water Gum	15x7	200L

Shrubs & Groundcovers			
Botanical Name	**Common Name**	**Mature Height x Spread (m)**	**Supply height (Pot size)**
Shrubs			
Adenanthos seiceus	Wooly Bush	1.5 x 1	200mm
Callistemon 'little John'	Bottlebrush	1.5x1.5	200mm
Crinum penduculatum	Swamp Lily	2 x 2	200mm
Doryanthes excelsa	Gymea lily	2 x 1.5	200mm
Hymenocallis littoralis	Spider lily	0.7 x 0.7	200mm
Muraya paniculata	Mock Orange	3x 1	200mm
Metrosideros sp.	New Zealand Christmas Bush	1 x 1	200mm
Monstera deliciosa	Swiss Cheese Plant	3 x 3	200mm
Philodendron Xanadu	Xanadu	1 x 1	200mm
Phormium tenax	New Zealand Flax	1.5 x 1	200mm
Raphiolepis sp	Indian Hawthorn	1 x 1	200mm
Strelizia juncea	Bird of Paradise	6 x 3.5	200mm
Syzygium sp	Dwarf Lilly pilly	3 x 2	200mm
Westringia fruticosa	Coastal Rosemary	1 x 1	200mm
Grasses + Groundcovers			
Agapanthus africanus	African Lily	0.6 x 0.6	150mm
Agave attenuate	Agave	0.5 x 0.6	150mm
Aspidistra elatior	Cast Iron Plant	0.4 x 0.6	150mm
Dianella longifolia	Blueberry Lily	1 x 0.5	150mm
Dietes grandiflora	Pale Flax Lily	1.5 x 1	150mm
Gazania spp.	Pale Yellow	Ground Cover	150mm
WSUD			
Cyperus gracilis	Slender Flat-sedge	1 x 1	150mm
Dianella longifolia	Blueberry Lily	0.4 x 0.4	150mm
Einadia hastata	Berry Saltbush	1 x .5	150mm
Juncus usitatus	Common Rush	1.1 x 0.7	150mm
Plectranthus parviflorus	Cockspur flower	1 x 0.5	150mm

Street Trees

Structural Trees

Feature Trees


Metrosideros sp.


Raphiolepis sp


Agave attenuate


Strelizia juncea


Doryanthes excelsa


Muraya paniculata


Philodendron Xanadu


Westringia fruticosa


Hymenocallis littoralis


Callistemon 'little John'

Shrubs & Groundcovers


Cyperus gracilis


Dianella longifolia


Einadia hastata


Juncus usitatus


Plectranthus parviflorus

WSUD Planting

5.2 PLANT ESTABLISHMENT + MAINTENANCE

Landscape Maintenance Strategy

General

- Planting maintenance period: the planting maintenance period will be 52 weeks and will commence from the date of practical completion. Of each phase of planting works (hereby specified to be a separable part of the works). It is anticipated that planting works will be undertaken in one phase
- : 2 weeks prior to practical completion, furnish a proposed planting establishment program, and amend it as required. Such proposal should contain details of the types and frequency of maintenance activities involved with the establishment of plants and grassed areas. Comply with the approved program.
- : keep a log book recording when and what maintenance work has been done and what materials, including approved toxic materials, have been used. Log book must be signed off by the client's representative after each maintenance visit. Maintain log book in location nominated by superintendent. All entries are to be initialled by person nominated by superintendent. Log book to contain a copy of the approved planting establishment program.
- : submit the supplier's written statement certifying that plants are true to the required species and type, and are free from diseases, pests and weeds.
- : the contractor is to ensure suitable insurance cover and / or bank guarantee is in place for the theft and / or damage of all works executed under this contract for the plant maintenance period.

Planting Maintenance

: provide any fencing or barriers necessary to protect the planting from damage throughout the planting establishment period.

: throughout the planting maintenance period, continue to carry out recurrent works of a maintenance nature all to the extent required to ensure that the plants are in the best possible condition at the end of the planting maintenance period. These activities are including but not limited to:

- Weeding, Rubbish removal, Fertilizing, Pest and disease control, Adjust / replace stakes and ties, Topping up mulch, Cultivating, Pruning, Keeping the site neat and tidy

: the contractor is responsible for the replacement of failed, damaged or stolen trees, shrubs and groundcovers throughout the planting establishment period.

Weeding

: regularly remove, by hand, rubbish and weed growth that may occur or recur throughout turfed, planted and mulched areas. Continue eradication throughout the course of the works and during the planting establishment periods.

: the contractor must make allowance for a higher level of maintenance during establishment to ensure that weeds are controlled.

: re-application of herbicide such as Ronstar or equivalent if required.

Compliance

- : plant maintenance shall be deemed complete subject to the following compliance with the criteria:
- Repairs to planting media completed
- Ground surfaces are covered with the specified treatment to the specified depths
- Pests, disease, or nutrient deficiencies or toxicities are not evident.
- Organic and rock mulched surfaces have been maintained in a weed free and tidy condition and to the specified depth
- Vegetation is established and well formed
- Plants have healthy root systems that have penetrated into the surrounding, undisturbed ground and not able to be lifted out of its planting hole
- Vegetation is not restricting essential sight lines and signage
- Collection and removal of litter
- All non-conformance reports and defects notifications have been closed out.
- Plant maintenance compliance schedule:*as defined by the superintendent

Pruning

- : tree plantings shall be left to grow in a form consistent with the growth habit of the species.
- : cut back tree canopies and groundcovers to road verges, and light poles and signs as required achieving clear sight lines when viewed along roadway.
- : pruning to be undertaken by a qualified tree surgeon / arborist

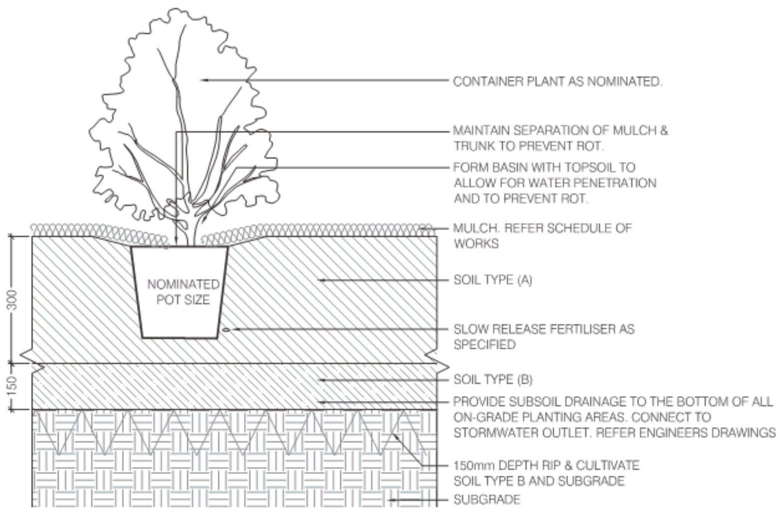
Fertilising

- Generally: the fertiliser regimes have been devised to provide sufficient long-term fertility for the vegetation type and it is anticipated that all except the very high status horticultural beds such as feature plantings (entry and courtyard planting) for colour and foliage will not need regular fertiliser regimes.
- Testing: additional nitrogen may be required due to drawdown effects from composts and mulches and localised waterlogging. To compensate for this, soil testing is to be carried out after 12 months to ascertain nutrient requirements.

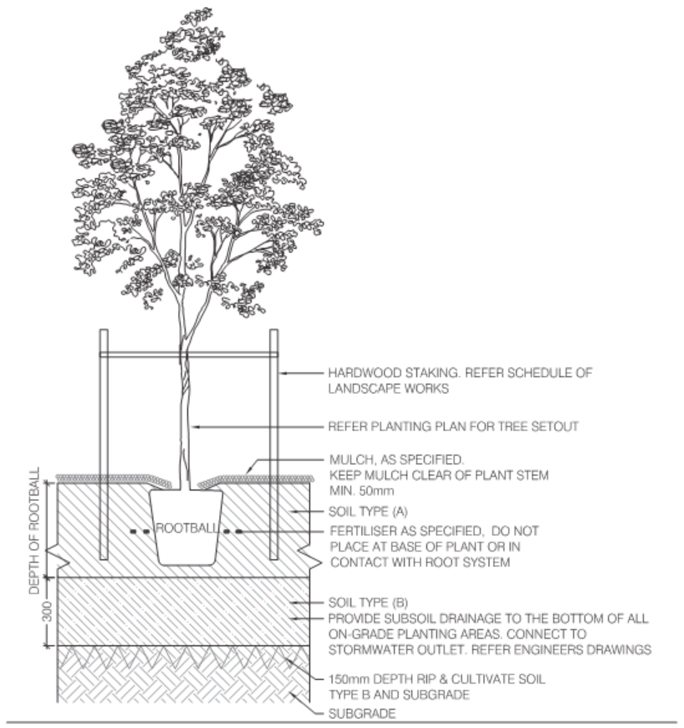
Completion

- Cleaning: remove temporary protective fences and tree stakes at the end of the planting maintenance period.

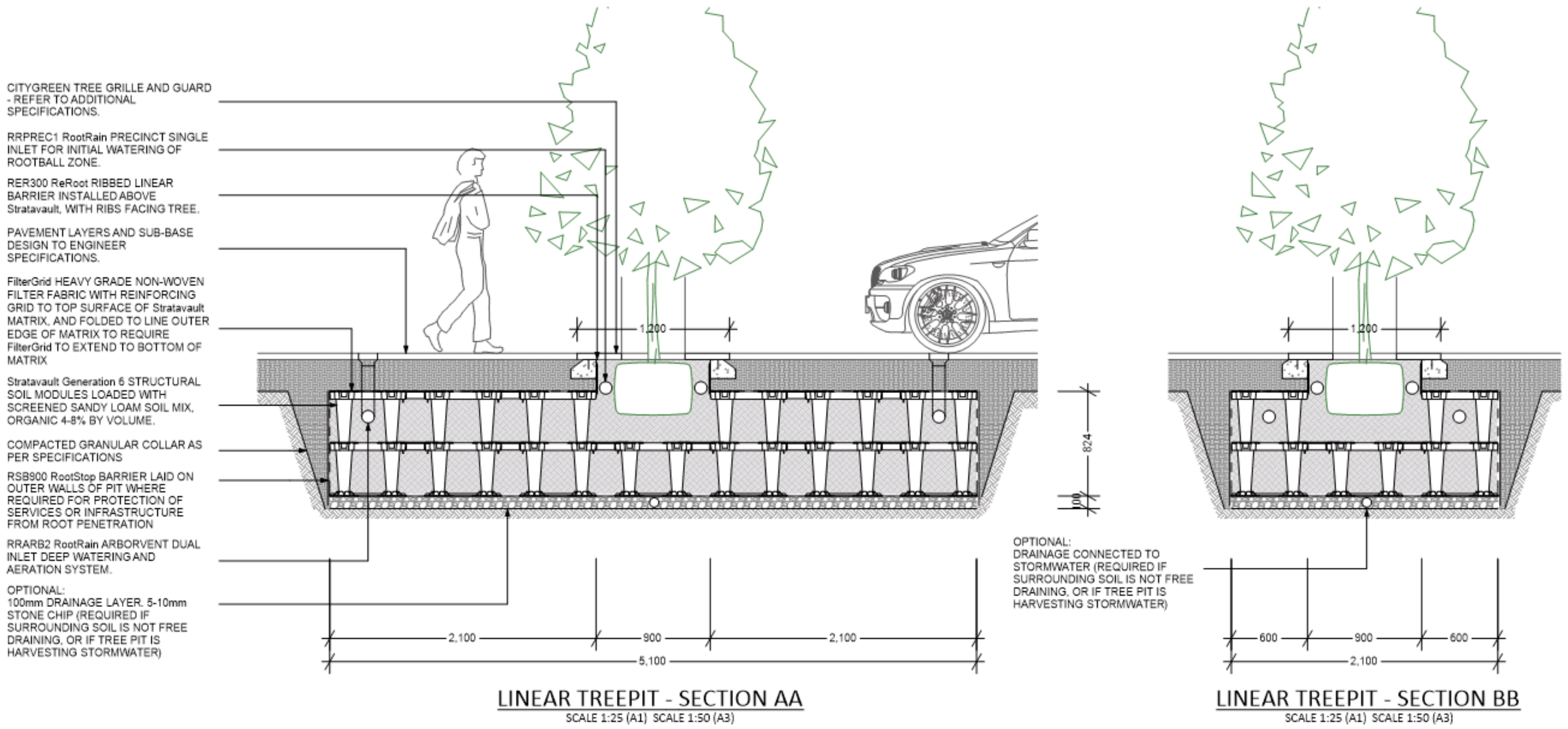
6.0 TYPICAL LANDSCAPE DETAILS



Typical Shrubs/grasses/groundcovers on grade 1:20@A3 - 1:10 @A1



Typical Tree on grade 1:40@A3 - 1:20 @A1



Typical Tree in Paving

URBIS.COM.AU

Council Reference: S11/47-12 & F18/740

Ms. Clare Harley
Manager Strategic Planning
Bayside Council
PO Box 21
ROCKDALE NSW 2216

Attention: Charlotte Lowe

Dear Ms. Harley

NOTIFICATION OF EXHIBITION – PLANNING PROPOSAL:
128 & 130-150 BUNNERONG ROAD, PAGEWOOD (BATA SITE)

Thank you for your letter dated 21 November 2018 requesting Transport for NSW (TfNSW) comment on the subject planning proposal to amend the *Botany Bay Local Environmental Plan 2013* (BBLEP).

The amendment relates to land at 128 and part 130-150 Bunnerong Road, Pagewood with the following key outcomes:

- Amend the zoning for the site from part IN1 General Industrial and part R3 Medium Density Residential to R4 High Density Residential;
- Maximum floor space ratio (FSR) development standard of 2.35:1;
- Introduce a new Additional Local Provision at Clause 6.12 of the BBLEP 2013 requiring the preparation of a development control plan for the subject site;
- Introduce a new clause at Schedule 1 Additional Permitted Uses of the BBLEP 2013 to permit 'commercial premises', 'recreation facility (indoor)' and 'serviced apartment' with development consent. Non-residential uses across the site must have a minimum total floor space of 5,000 sqm.

As part of the planning proposal, a draft Voluntary Planning Agreement has been prepared with the intention to deliver the following local infrastructure and public benefits:

- Dedication of Affordable Housing Units with a total of 100 bedrooms;
- A single monetary contribution of $23.9 million; and
- Dedication of approximately 20,000 sqm of public open space and all public roads.

Council is advised that consultation meetings and ongoing correspondence had taken place between the Proponent, Meriton Property Services Pty Ltd (the Applicant), TfNSW and Roads and Maritime Services (Roads and Maritime) during and following the exhibition period. Comments were provided by TfNSW and Roads and Maritime following these meetings. Correspondence between TfNSW and Roads and Maritime is provided in **Appendix A** to inform the assessment process.

Notwithstanding, Council should consider the following in addition to the comments provided to the Proponent. Detailed comments which expand upon the below has been provided in **Appendix B**.

Transport for NSW
Level 26 477 Pitt Street, Haymarket NSW 2000
T 02 8202 2200 | **W** transport.nsw.gov.au | ABN 18 804 239 602

a. Council should implement travel demand strategies, which could include initiatives such as reduced on-site car parking provisions, to mitigate the potential impact of traffic movements to/from future developments. A contribution toward local and regional active transport connections would also help in this regard. The following suggestions should be considered for funding:

   1. An upgrade of the on-road cycle lanes, along Banks Avenue between Heffron Road and General Bridge Crescent, to a separated cycleway.
   2. A new shared path along Heffron Road, Page Street and Cowper Avenue, which will link to a future Green Corridor.

   The commitment to deliver transport infrastructure would ensure that the planning objectives of the Eastern City District Plan are implemented in conjunction with the dwelling growth associated with the subject land use changes.

b. The Southeast Sydney bus service network will change once the CBD & Southeast Light Rail opens in mid-2020. The definition of the network has not yet been finalised.

c. It is recommended that Council includes LEP controls to limit the floor space of the additional permitted use of 'retail premises' to 5,000 sqm. This has been recommended as any exceedance of the retail floor space has not been accounted for in the traffic assessment and the associated traffic may exceed the capacity of the road infrastructure and recently delivered upgrades.

d. The preparation of the site-specific DCP or the assessment of any Masterplan application should consider the following:

   1. Any direct vehicular access points to Bunnerong Road from the site is unlikely to be supported by Roads and Maritime.
   2. Any future vehicular access points to the site on Heffron Road or Banks Avenue should be located as far as practical away from any signalised intersections.
   3. Any future child care centres should be positioned and oriented such that vehicular and pedestrian access is obtained from the local/internal road network only, on road safety grounds.

e. Roads and Maritime has reviewed revised modelling provided by the Applicant on 2 March 2019 and noted some matters that should be addressed either prior to the making of the Plan, or at a minimum in any transport study prepared in support of the future Masterplan DA (refer to Item f. in Appendix B).

I trust the above has been of assistance to Council. If you require clarification of any comments provided, please contact Ken Ho, Transport Planner, via email at ken.ho@transport.nsw.gov.au.

Yours sincerely

1/4/2019

Mark Ozinga
Principal Manager, Land Use Planning & Development
Freight, Strategy & Planning

CD19/00140

Appendix A: Consultation Background

Council is advised that consultation meetings and ongoing correspondence had taken place between the Proponent, Meriton Property Services Pty Ltd, TfNSW and Roads and Maritime Services (Roads and Maritime) during the exhibition period. The following meetings were held:

- 24 January 2019, held at TfNSW offices.
- 14 February 2019, held at Roads and Maritime offices.

The initial meeting provided the opportunity to discuss the planning proposal and for both agencies to provide comments to the Proponent, following this meeting. A subsequent meeting was held to discuss the agency comments and provided the Proponent opportunity to respond or seek advice as to how to address the agency comments accordingly.

A response was provided by the Applicant, which has been included overleaf. The Applicant's response includes the comments provided by TfNSW and Roads and Maritime following the meeting held on 24 January 2019 for Council's consideration.

Appendix B: Detailed Comments on Planning Proposal

a. Aligning Growth with Infrastructure

Reference is made to planning priorities, objectives and actions within the *"Our Greater Sydney 2056: Eastern City District Plan – connecting communities"*:

- Planning Priority E1 – planning for a city supported by infrastructure
- Planning Priority E10 – delivering integrated land use and transport planning and a 30-minute city
- Planning Priority E11 – growing investment, business opportunities and jobs in strategic centres

  Eastgardens-Maroubra Junction

  Actions

  48. e. promote place making initiatives to improve the quality and supply of public spaces, promote walking and cycling connections and integrate with the Green Grid

  f. improve public transport connections, and walking and cycling between Eastgardens-Maroubra Junction and Randwick

The proposed land use changes and subsequent growth should contribute to satisfying the abovementioned planning principles.

It is noted that the VPA exhibited in support of the planning proposal includes local infrastructure contributions and includes a clause which excludes any requirement for the developer to pay local infrastructure contributions under Section 7.11 & 7.12 of the *Environmental Planning and Assessment Act 1979*.

TfNSW and Roads and Maritime request that consideration is also given to contributions towards regional and State transport infrastructure to support the residential growth in Pagewood. TfNSW advises that there is the opportunity for monetary contributions to be directed to deliver improved cycling infrastructure that could service the development and the broader local community, encouraging mode shift to active transport modes. The commitment to deliver transport infrastructure would ensure that the planning objectives of the Eastern City District Plan are implemented in conjunction with the housing growth associated with the subject land use changes.

In this regard, VPA contributions could be directed towards the delivery of:

1. An upgrade of the on-road cycle lanes, along Banks Avenue between Heffron Road and General Bridge Crescent, to a separated cycleway.
2. A new shared path along Heffron Road, Page Street and Cowper Avenue, which will link to a future Green Corridor.

The delivery of (1) along Banks Avenue would contribute to the Greater Sydney Green Grid, as shown in **Figure 1**, and satisfy the abovementioned planning priorities. It would also form an extension of Council's planned cycling project along Houston Road and General Bridge Crescent (subject to funding under the Active Transport Program), which was exhibited for consultation[1]. The separated cycleway could also be utilised by existing residents and future residents associated with the future development of the site.

The provision of (2) would integrate the development and the surrounding shared path network with the Green Grid, particularly the future Green Corridor along Eastlakes, which has been identified as high priority within the Eastern City District Plan.

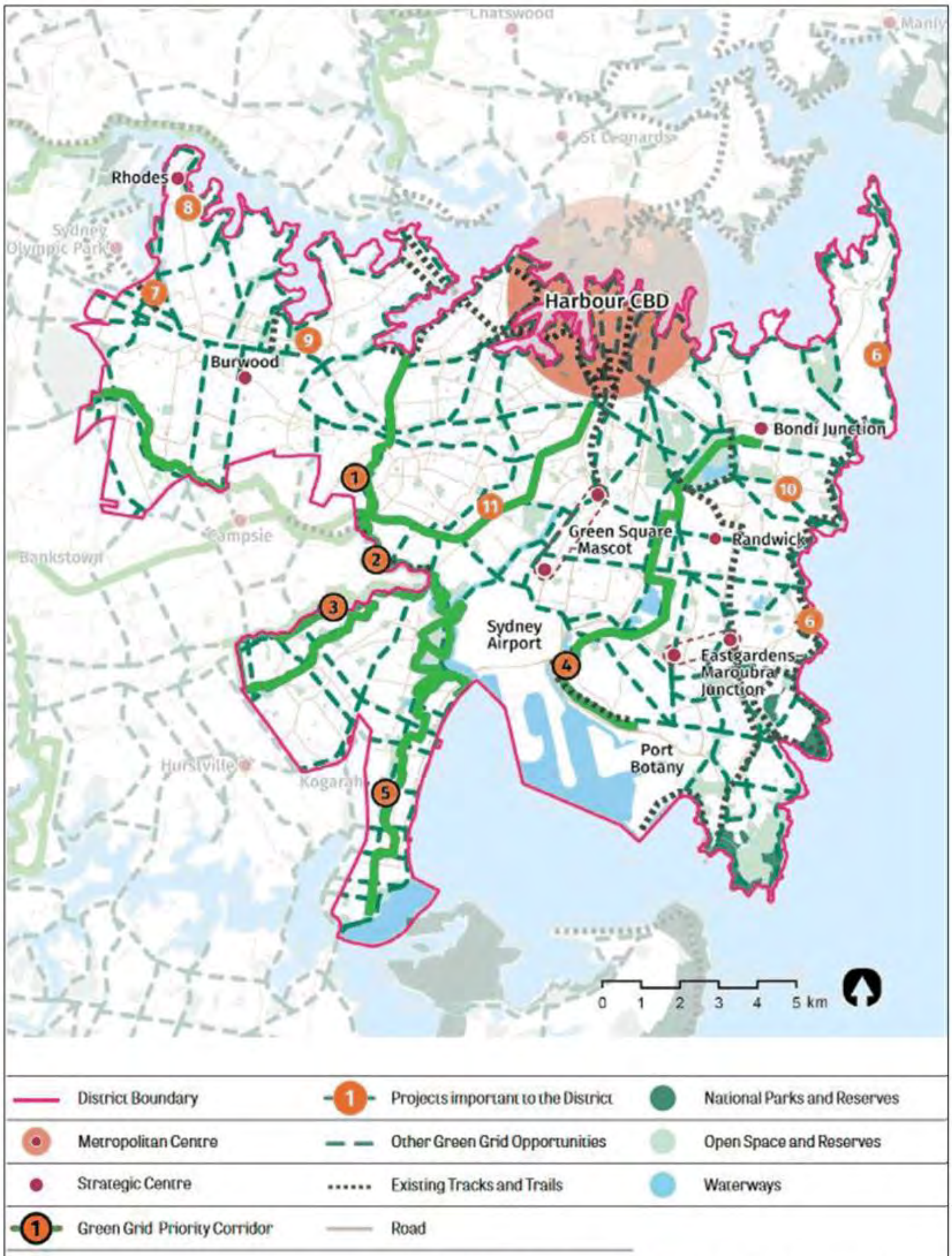
[1] Bayside Council, Jun 2018, accessed 1 March 2019, URL: https://haveyoursay.bayside.nsw.gov.au/cycling-improvements-at-bayside-more-transport-options

Should Council adopt the above recommendations, the process for delivery would be a decision for Council. Potential delivery processes could be Works-in-Kind linked with development of the site or a Council initiated project.

In addition to the above, the proposal to rezone the site from employment uses to predominantly residential uses will cumulatively increase traffic demands on regional road infrastructure and likely increase the flow of traffic from the site to key employment destinations. A select link strategic traffic analysis undertaken by Roads and Maritime of an established high density residential development to the south of the subject site (TZ424 in Hillsdale), determined that a high proportion of trips originating in the subject locality are likely to travel to/from the west along Wentworth Avenue to key destinations.

This is also reflected in the development traffic distributions documented in the Transport Modelling Report, dated 2 March 2019, which shows a high proportion of development traffic using Wentworth Avenue. Roads and Maritime also notes increased delays and deterioration of Level of Service at the intersection of Wentworth Avenue and Page Street resulting from the development in both 2021 and 2031, particularly in the AM peak period (through comparison of the 'Future Base with Development Traffic' compared to the 'Future Base' scenarios modelled).

It is understood that the proponent has made commitment to contribute towards road improvement initiatives on the surrounding network. TfNSW / RMS would like to continue to work with Council to explore ways in which any of these contributions can be directed towards the planned intersection upgrades on Wentworth Avenue (at Page Street and Baker Street).



Source: Greater Sydney Commission, 2017, adapted from Sydney Green Grid, unpublished report prepared by Tyrrell Studio and Office of the Government Architect for the Greater Sydney Commission

Figure 1: Greater Sydney Green Grid – Eastern City

b. Bus Services

With regards to bus services, it is anticipated that the Southeast Sydney bus service network will change once the CBD & Southeast Light Rail opens in mid-2020. The definition of the network has not yet been finalised.

Recent changes (December 2018) to the bus network, where some changes were made to services operating to/through Eastgardens. For instance, Routes 310 and X10 were withdrawn and several new routes were introduced; 307, 310X and 400N. Improvements to Route 391 were also made. The mentioned changes were outlined in the following media release found at https://transportnsw.info/news/2018/bus-changes-in-sydneys-south-east.

c. Car Parking Provision

It is recommended that Council implement parking controls that would reflect the locality of the site within a strategic centre. The Eastgardens-Maroubra Junction strategic centre would have a range of services, including retail, medical, restaurants, supported by public transport connections (primarily bus transit).

Additional delays on the road network will also impact travel times for buses as services share the same carriageway as general traffic. Therefore, Council should implement travel demand strategies, such as reduced on-site car parking provisions to mitigate the potential impact of traffic movements to/from future developments.

A recommended action would be for Council to implement site-specific clauses within the LEP or DCP with maximum provisions for residential car parking consistent with the Guide to Traffic Generating Developments (Roads and Maritime Services, October 2002):

Metropolitan Regional (CBD) Centres:

- 0.4 spaces per 1 bedroom unit
- 0.7 spaces per 2 bedroom unit
- 1.20 spaces per 3 bedroom unit
- 1 space per 7 units (visitor parking)

d. Potential Retail Traffic Impacts

The traffic assessment has assumed that retail uses will be limited to a total of 5,000 sqm (plus the 1,300 sqm approved on site Urban Block 5C in the Pagewood Green Masterplan site). In this regard, it is recommended that Council includes controls in the LEP to limit the floor space of the additional permitted use of 'retail premises' to 5,000 sqm. This should be set out within the site specific additional permitted use clause. A potential clause could be as follows:

> ***Schedule 1 Additional permitted uses***
> *X Use of certain land at 128 & 130-150 Bunnerong Road, Pagewood*
> *(1) This clause applies to certain land at 128 & 130-150 Bunnerong Road, Pagewood, being Lot X DP X, shown as "Item X" on the Additional Permitted Uses Map.*
> *(2) Development for the purposes of **commercial premises** is permitted with development consent.*
> *(3) Development consent under this clause may only be granted if the consent authority is satisfied that the maximum combined gross floor area of **retail** premises is no more than 5,000m^2.*

The above has been recommended as any exceedance of the retail floor space beyond 5,000 sqm has not been accounted for in the traffic assessment and the associated traffic may exceed the capacity of the road infrastructure and recently delivered upgrades on the surrounding road network.

e. Site-specific DCP and/or Masterplan

The following comments are provided to Council, which would affect the preparation of the site-specific DCP or the assessment of any Masterplan application:

1. Roads and Maritime is unlikely to support any direct vehicular access points to Bunnerong Road from the site as this is a key movement corridor on the state road network which carries high volumes of buses, freight and general traffic where the safety and efficiency of through traffic is of great importance. This requirement should be reflected in any access controls set out in a Development Control Plan (DCP) for the site.
2. Any future vehicular access points to the site on Heffron Road or Banks Avenue should be located as far as practical away from any signalised intersections. Configuration of any such direct access points to these roads should be in consultation with Council and RMS.
3. Any future child care centres should be positioned and oriented such that vehicular and pedestrian access is obtained from the local/internal road network only, on road safety grounds. The local/internal road network is anticipated to have lower traffic volumes and operating speeds than surrounding higher order roads and will be more conducive to improved safety outcomes. This should be reflected in any site specific DCP for the site.

f. Detailed Modelling Review

Roads and Maritime has reviewed the modelling files and Transport Modelling Report submitted on 2 March 2019 and provides the following comments:

1. Item 4.2 (P.17) – different costs were used in the base, 2021 and 2031 models. Justification should be included in the report.
2. Item 5 (P.23) – a minor discrepancy was noted between values charted in Fig 23 and 24 and Table 6. The AM and PM Peaks values are mismatched.
3. Item 6.1.1 (P.29) – the modelled travel times along Route 1 East to West are faster than observed data for both PM [74 sec (47%)] and Weekend model [61 sec (37%)]. This should be reviewed as more traffic could be attracted to this route in future models.

From: Ozinga, Mark
Sent: Monday, 11 February 2019 9:10 AM
To: Matthew Lennartz
Cc: Andrew Hulse (andrew.hulse@arup.com); James R Turner (james-r.turner@arup.com); McKibbin, Matthew; murray.cleaver@rms.nsw.gov.au; Ho, Ken; DAVIS Rachel A
Subject: RE: Follow-up - Pagewood Green (Part II)
Attachments: 20190201 Roads and Maritime Comments BATA.DOCX

Follow Up Flag: Follow up
Flag Status: Completed

Hi Matthew.

TfNSW and RMS have reviewed the PP and associated documents. Prior to us finalising our comments to Council, we would like to offer you an opportunity to review our comments and respond (either with clarifications and potentially further work to be resubmitted for review prior to us finalising).

RMS specific comments are attached (thanks Rachel) and our comments are outlined below. Once you have had a chance to review them, we would be pleased to sit down with you and go through the issues and provide you with an opportunity to respond.

TfNSW Specific Comments

-
Comments to be considered as part of the PP

- To improve transport infrastructure, provide greater, safer and more desirable travel choices, VPA contributions should include provision for separated cycleway along Banks Ave to General Bridge Cres. This would connect with the separated cycleway being planned along Doncaster Ave and Houston Rd. This link is identified as a "Green Grid" opportunity within the Eastern City District Plan.
- Similar to above, the GSC plan identifies a priority green corridor for public open space along Mill Stream to Botany Dams/Eastlakes. It would be beneficial for existing and future residents to be able to safely access the future green corridor by cycling and walking. As such, consideration should be given for the contributions to include the provision for a shared path along Heffron Road, Page Street and through Cowper Avenue.
- The Southeast bus network will change when the Light Rail opens in mid-2020. Definition of the network is not yet finalised.
- The documentation does not consider the recent changes (December 2018) to the bus network in the SE where some changes were made to services operating to/through Eastgardens. E.g. Routes 310 and X10 were withdrawn and several new routes were introduced – 307, 310X and 400N. Improvements to route 391 were also made.
- Bunnerong Road/Wentworth Avenue: The right turn bay on Bunnerong Road is short at about 45 metres in length. There does not appear to be sufficient median width to extend the right turn bay, but improvements could be investigated in consultation with RMS.

Comments on parking and access (likely to impact DCP / masterplan stage):

- Roads and Maritime is unlikely to support any direct vehicular access points to Bunnerong Road from the site as this is a key movement corridor on the state road network which carries high volumes of buses, freight and general traffic where the safety and efficiency of through traffic is of great importance. This requirement should be reflected in any access controls set out in a Development Control Plan (DCP) for the site.
- Any future vehicular access points to the site on Heffron Road or Banks Avenue should be located as

far as practical away from any signalised intersections. Configuration of any such direct access points to these roads should be in consultation with Council and RMS.

- Any future child care centres should be positioned and oriented such that vehicular and pedestrian access is obtained from the local/internal road network only, on road safety grounds. The local/internal road network is anticipated to have lower traffic volumes and operating speeds than surrounding higher order roads and will be more conducive to improved safety outcomes.
- Any proposal to reduce parking rates to reduce reliance on private vehicle trips and encourage the use of public and active transport would be supported. Some councils such as Parramatta and Sydney have set maximum parking controls, which are good examples.

Mark Ozinga
Principal Manager Land Use Planning & Development
Freight, Strategy & Planning Division
Transport for NSW

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Level 26, 477 Pitt Street, Haymarket, NSW, 2008

From: Matthew Lennartz [mailto:matthewl@meriton.com.au]
Sent: Wednesday, 30 January 2019 11:59 AM
To: McKibbin, Matthew; DAVIS Rachel A; murray.cleaver@rms.nsw.gov.au; Ozinga, Mark; Ho, Ken
Cc: Andrew Hulse (andrew.hulse@arup.com); James R Turner (james-r.turner@arup.com)
Subject: RE: Follow-up - Pagewood Green (Part II)
Importance: High

Hi Matt and Rachel,

Further to my voicemails, when can we expect a response from TfNSW/RMS.

Please call if you would lie to discuss.

Regards

Matthew Lennartz
Executive Manager – Planning and Government

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From: Matthew Lennartz

Sent: Thursday, 24 January 2019 3:47 PM
To: McKibbin, Matthew <Matthew.McKibbin@transport.nsw.gov.au>; 'DAVIS Rachel A' <Rachel.Davis@rms.nsw.gov.au>; 'murray.cleaver@rms.nsw.gov.au' <murray.cleaver@rms.nsw.gov.au>; Ozinga, Mark <Mark.Ozinga@transport.nsw.gov.au>; 'Ho, Ken' <Ken.Ho@transport.nsw.gov.au>
Cc: Andrew Hulse (andrew.hulse@arup.com) <andrew.hulse@arup.com>; James R Turner (james-r.turner@arup.com) <james-r.turner@arup.com>
Subject: Follow-up - Pagewood Green (Part II)
Importance: High

Hi All,

Thanks for your time today and thankyou for appreciating the timeframes involved and committing to get the assessment completed ASAP.

If we could get the initial points raised by Murray that would be a great start. We will review and respond immediately.

Further to the meeting, I can confirm the updated modelling has been issued earlier this afternoon.

Please contact myself or James Turner (0449 703 401) directly with any queries.

Regards

Matthew Lennartz
Executive Manager – Planning and Government

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Attachment A: Detailed Comments Transport Impact Assessment

Roads and Maritime notes that the subject proposal seeks to:

- Rezone the land from part IN1 General Industrial zone and part R3 Medium Density Residential zone to R4 High Density Residential zone across the site;
- Allow 'commercial premises' including retail as an additional permitted use on the land
- Amend the Floor Space Ratio control from 1:1 to 2.35:1
- It is understood that this is intended to facilitate a total of: 5,000m^2 retail on the site, two child childcare centres and a total of approximately 2,100 residential units.

It is noted that the planning proposal site partially overlaps with the previous 'Pagewood Green' Masterplan site as it encompasses the area which was to contain Urban Blocks 1 & 2 of the Masterplan. Roads and Maritime notes that the Pagewood Green Masterplan for the adjoining site had initially been approved for 2,200 apartments, 5,000sqm retail and four child care centres. It is understood this was later modified to reduce the retail uses to 1,300sqm and remove two child care centres under DA2014/96/02.

Roads and Maritime has reviewed the Transport Impact Assessment (TIA) dated 21 November 2018 and provides the following comments which should be addressed in an addendum TIA:

<u>Data and Assumptions</u>

1. Crash investigation (2013) data included in the report is considered to be outdated and it is recommended that updated data is obtained.
2. Journey to Work data based on 2011 data is also considered outdated, however may not have changed significantly compared to 2016 Journey to Work data. This should be updated.
3. The TIA suggests a considerable mode shift to public transport in future years, however it is noted that there is no committed mass-transit public transport infrastructure improvements proposed within a typical walking distance from the site. The subject site is 1.7km from the light rail terminus.
4. The PM peak volumes for the residential component is considered to be too low. Recent surveys undertaken by Roads and Maritime for high density residential sites that are more than 1km from mass transit indicate the average for PM trips is likely to be up to 0.3 vtph. Given that light rail would not provide the speed and capacity that heavy rail provides, residents may not be as willing to walk 1.7km to use this for their daily commute. Roads and Maritime would suggest the PM peak trip rate is reconsidered. A comparable site could be surveyed to establish an appropriate rate. It is acknowledged that the likely slight increase in the rate is unlikely to have a significant impact on the overall traffic generation potential that has been suggested for the residential component of the site.
5. The explanation of the traffic generation of existing uses compared to proposed uses should be more clearly explained. The assessment provided seems to imply retail is permitted in the existing zoning of IN1 General Industrial and R3 Medium Density Residential. The assessment of traffic generation potential of the site under existing planning controls should be based on existing permissible uses only.

   It is understood however that the adjoining Pagewood Green Masterplan had initially been approved for a total of 5,000sqm of retail and four child care centres being developed (in addition to residential), which was later reduced to 1,300sqm retail and two child care centres. It is noted the 5,000sqm retail and four child care centres had been accounted for in the previous Masterplan traffic assessment and road upgrades delivered/being constructed.

It is noted that Pagewood Green I and II combined indicative yield would be a total of approximately 6,300sqm retail and four child care centres (in addition to residential uses). It is understood that to avoid 'double-counting' the future retail/commercial development traffic on the network, just the additional 1,300sqm retail not previously accounted for, plus 2,100 apartments, would be factored into the assessment in 'with development' scenarios.

As the traffic assessment has assumed that retail uses will be limited to a total of 5,000sqm (plus the 1,300sqm approved on site Urban Block 5C in the Pagewood Green Masterplan site), Roads and Maritime strongly recommends that Council includes controls in the LEP to limit the floor space of the additional permitted use of 'Commercial premises' if pursued for retail use, to 5,000sqm. This should be set out within the site specific additional permitted use clause. Any exceedance of this has not been accounted for in the traffic assessment and the associated traffic may significantly exceed the capacity of the road infrastructure.

6. It is noted that the previous internal road network layout for the Pagewood Green Masterplan (I) intended access from Westfield Drive for emergency vehicle only. Roads and Maritime seeks confirmation if this is still the case (ie that there are no connections for general traffic to Westfield Drive from the internal road network), as any change to this would impact distributions on the external road network.

Modelling:

7. Roads and Maritime has reviewed the modelling prepared in support of the Transport Impact Assessment (provided 10 January 2019 and 24 January 2019) and provides detailed comments at **Attachment B** which should be addressed in an addendum Transport Impact Assessment. Roads and Maritime cannot validate the modelling as 'fit for purpose' in its current form.

Upgrades mentioned/potential improvements

8. Roads and Maritime would encourage investigation and provision of improvements to pedestrian and cyclist connections from the site to key destinations and bus services, such as regional cycleway links and pedestrian crossing facilities.
9. There is an opportunity to enhance connections for active transport and supporting facilities such as bicycle parking and improved paths on Heffron Road and Banks Avenue to adjacent destinations such as Hensley Athletics Field.
10. Roads and Maritime suggests investigation of pedestrian crossing facilities, for example at the intersections of Wentworth Avenue/Dennison Street and Wentworth Avenue/Banks Avenue to provide improved links to the sporting fields.
11. It is noted that the report refers to double-diamond configuration at the intersection of Wentworth Avenue and Page Street however Roads and Maritime understands that Council's plans for the intersection do not include double-diamond.
12. Bunnerong Road/Wentworth Avenue: The right turn bay on Bunnerong Road is short at about 45 metres in length. There does not appear to be sufficient median width to extend the right turn bay, but improvements could be investigated. Replacement of the right turn filter with designated phasing could be investigated.

Parking and access

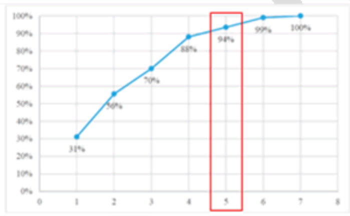
13. Roads and Maritime would not support any direct vehicular access points to Bunnerong Road from the site as this is a key movement corridor on the state road network which carries high volumes of buses, freight and general traffic where the safety and efficiency of through traffic is of great importance. Roads and Maritime

requests that this is reflected in any access controls set out in a Development Control Plan (DCP) for the site.

14. Any future vehicular access points to the site on Heffron Road or Banks Avenue should be located as far as practical away from any signalised intersections. Consideration should be given to restricting any such direct access points to these roads to left-in/left-out only.
15. Any future child care centres should be positioned and oriented such that vehicular and pedestrian access is obtained from the local/internal road network only, on road safety grounds. The local/internal road network is anticipated to have lower traffic volumes and operating speeds than surrounding higher order roads and will be more conducive to improved safety outcomes.
16. Roads and Maritime supports proposed reduced parking rates to discourage reliance on private vehicle trips and encourage the use of public and active transport. Council may wish to consider including these maximum parking rates in the LEP, or site specific DCP, so that future DAs and modifications do not exceed these rates. Parramatta Council has maximum parking controls for certain development in the CBD within its LEP as an example.

Attachment B: Modelling Review Comments

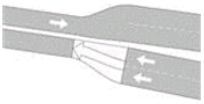
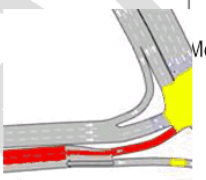
Topic / Report Section	Comment	Likely impact
Section 1.5	Section 6.2, page 29 states that "The modelling extent is shown in Figure 21 as previously agreed with Roads and Maritime Services." In previous correspondence on 21 June 2016, prior to the planning proposal receiving a Gateway determination, Roads and Maritime had advised that "While there are no major issues with the brief in-principle, Roads and Maritime cannot give any further detailed comment or final endorsement to the extent of the model/study area until the details of the planning proposal, trip generation of the maximum yield, and traffic distributions are known". The modelling extent had not been endorsed by Roads and Maritime at that time as the full planning proposal details were unknown. The section of Bunnerong Road between Wentworth Avenue and Fitzgerald Avenue is congested during peak periods due to the volume of traffic turning right from Wentworth Avenue to Bunnerong Road and then turning left into Fitzgerald Avenue as well as the bus stop just south of Fitzgerald Avenue. It is therefore recommended that the model area is extended to cover this section in order to investigate the impacts of the proposed development. Explanation/justification should be provided if this intersection is not included.	Medium
Section 3.4	Signal coding criteria refers to Table 11.3, page 105 of the RMS Traffic Modelling Guidelines (RMS, 2013), however the criteria are not provided within the report. All criteria that the model is being assessed against should be explicitly outlined within the report.	Minor
Section 4.1	Table 4 should include values, as well as percentages, so comparison can be made directly to the information provided in section 1.6.	Minor
Section 4.2	The report states that stochastic traffic assignment has been adopted that uses a combination of static and stochastic; 50% is assigned as static (which is referred to as vehicles that are familiar with the network) and 50% is assigned as stochastic (which is referred to as vehicles that are unfamiliar with the network. This approach is often referred to as one-shot simulation and is generally applicable to models with limited route choices. This description of traffic assignment in the report is somewhat confusing. With the adopted setting, 50% of generated vehicles will follow a path read from a path assignment file (static assignment) and 50% will follow a path built by the adopted route choice model (Logit).	Major

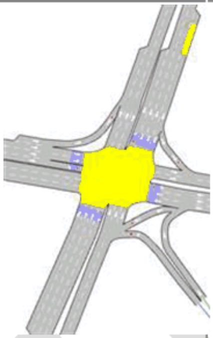
Topic / Report Section	Comment	Likely impact
	Given that majority of drivers in the area would be accustomed to the conditions and congestion (well aware of possible routes), 50% assignment to represent unfamiliar drivers appears questionable. Also, the introduction of additional demands (development) and changes to road network infrastructure is likely to alter existing travel patterns as well as create the need for development traffic to establish the best routes to and from the development. To replicate this behaviour, an application of DUE (dynamic user equilibrium) assignment would be more appropriate. Also, no value for attractiveness weight has been defined which can result in through traffic being assigned to lower order roads.	
Section 4.3	The model stability section only outlines a median seed, with no specific comments on the stability of the model. No model stability checks have been conducted to ensure the model is fit for purpose. This process should be undertaken as per section 11.7 of the RMS Traffic Modelling Guidelines.	Medium
Section 5	There is a minor discrepancy between the values charted in Figure 20 and the corresponding values in Table 6 which should be updated:  	Minor
Section 5	Figures 16-18 are direct outputs from Aimsun. Aimsun modelling software default regression plot y-intercept does not pass through 0, which is required as per RMS Modelling Guidelines section 9.18. Although this will have minimal impact on the regression plot statistics, it is recommended that these charts are created as per the RMS guidelines.	Medium
Section 6.1.1	RMS Traffic Modelling Guidelines section 11.5 state that model travel times must be within 15% or 1 minute of the observed travel times. The Guidelines also state the above criteria should hold true for both the full length of travel time routes and for individual travel time route segments (disaggregated level). The validation results in Section 6.1 did not comment on segments which do not meet the criteria. Analysis of route segments should be included with justification provided, or justification for exclusion should be outlined.	Medium

Topic / Report Section	Comment	Likely impact
	The model appears to underestimate travel times and congestion observed in the network and further details may be required.	
Section 7	No commentary regarding external transport infrastructure that may affect trip patterns within the study area. For example, the construction (and completion) of the Sydney CBD and South East Light Rail (CSELR), that starts/terminates 2km to the north of the development, may potentially have an effect on route choice.	Minor
Section 7.3.1	It is unclear how data provided in Tables 19 and 20 has been used for modelling purposes. A more detailed discussion should be included in this section.	Minor
Section 7.3.2	The future growth estimates process outlined in Table 21 and Figure 35 seem appropriate, however it should be outlined how these percentages are then translated to origins and destinations in the Aimsun matrices.	Minor
Section 7.3.3	With limited traffic data available for external-to-external trips, a growth of 1% pa has been assumed. This value generally seems low; however, taking in to consideration the east-west movements average at -0.74% growth p.a. it may be appropriate. The growth values in Table 22 should be included as growth p.a. rather than the change over the 4-year timeframe (2011 – 2015), so that the reader has a better understanding of the yearly growth rate applied. Further to this however, commentary regarding the potential impact of the CSELR due to be opened in 2021 and located approximately 2 km north of the site has not been provided. This significant infrastructure may alter travel patterns near the proposed development either through mode choice behaviour or capacity reductions along Anzac Parade and should be considered when developing future demands. While growth of 1% pa may be acceptable for 2021 due to the impact of CSELR, longer term (2031) growth rate is likely to be higher (Note: Roads and Maritime can currently assist by providing growth rate plots from its strategic model for comparison, subject to a data access agreement).	Medium
Section 7.4	More information is required to outline how the Population and Employment % increase in Table 24 have been applied to the growth factor matrices.	Minor
Section 8.2.1	Section 8.2.1 of the report states that Figure 42 is the configuration modelled for the future base model, however Banks Ave, located west of the site is shown to be connected to the development as shown in the figure below. This however was not the case in the Future Base 2021 or 2031 models received. Either the models or report should be updated for consistency.	Major

Topic / Report Section	Comment	Likely impact
	 Further to this, the Development models provide a connection to the west resulting in additional route choice for vehicles accessing the sites. This connection provides additional route choice options which are not available in the Future Base scenario as well as the opportunity for rat-running through the development, as seen in the example from the 2031 Development model. What is the reason of including this connection in the development model and not in the base models? Is it related to the proposed development?	
Section 9.2	It appears that subpaths have been used in the model to calculate LOS for intersections. It is important when using this process that the subpaths are defined for an appropriate length of the approach and do not pass through other signalised intersections, where delay may not be attributed to the correct intersection. One such issue can be observed with subpath **Int1_S** where the subpath extends > 600m and passes through another signalised intersection:	Medium

Topic / Report Section	Comment	Likely impact
		
Section 9.2 & 9.3	It is understood that any general network changes outlined that are not associated with the development are included in both the Future Base and Development models. Similarly, any signal operation updates or changes should be applied to both models so that the models provide relative comparisons, with the only differences in network performance coming from demands. The comparative analysis between Future Base models and Development models indicates several intersections that perform better with the development in place which does not appear logical without additional explanation. Additionally, the network statistics included in Table 29 highlight significant improvements to both average delay and travel time for Development models, especially in the PM peak. However, the PM peak Intersection Delays (and LOS) are relatively similar across all the included intersections. As such, further details should be provided regarding how the inclusion of the development corresponds to large improvements to the network performance statistics without corresponding improvements to intersection performance in the PM peak period.	Medium
Section 10	Within the summary of the calibration and validation criteria and results, it is stated that "through the operational modelling process it was found that the development yields have little impact on the network with some increases in delays at intersection." This is not consistent with Section 9.2 and 9.3 where there are several large differences in network performance statistics and intersection results.	Medium
Model Operation	The following examples for coding of merge sections are not best practice, as it may cause issues with vehicles overlapping (improper give-way functions):	Medium

Topic / Report Section	Comment	Likely impact
	 Aimsun best-practice modelling is that merge sections should never operate from more 'from' lanes than 'to' lanes and that they always have a merge section (sections does not simply end). The examples above should ideally be coded as follows:	
Model Operation	Bunnerong Road right turn traffic in the southbound direction turn into one continuous lane of Wentworth Avenue, while left turn traffic in the northbound direction turn into two continuous lanes of Wentworth Avenue as shown in the aerial photo below. However, target lanes are not set in the model to reflect current network configuration.  	Medium
Model Operation	In 2016, the left lane of Bunnerong Road south of Heffron Road in the northbound direction was for left turn traffic only as shown in the aerial photo below. This lane was set in the model as shared lane allowing through traffic besides left turn traffic. As the base model was built, calibrated and validated for 2016, the model network should be consistent with 2016 road network.	Medium

Topic / Report Section	Comment	Likely impact
	 	
Model Operation	Buses departing Eastgardens bus interchange turn into one of the two left lanes of Wentworth Avenue depending on their destination; however the model directs the buses to the most left lane as shown below which is not consistent with the traffic operation. 	Minor
Signal Coding	The traffic signal of Bunnerong Road, Maroubra Road and Heffron Road was coded in the model as actuated signal however it was set without rings or barriers. Rings and barriers have to be included to properly model overlap phases and reflects SCATS operations.	Medium

ARUP

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1 Introduction

Meriton engaged Arup to undertake the transport assessment for the proposed Planning Proposal being submitted for the Stage 2 masterplan site located at 128 Bunnerong Road and 130-150 Bunnerong Road, Pagewood.

Transport for NSW (TfNSW) and Roads and Maritime Services (Roads and Maritime) reviewed the Planning Proposal and associated documents including Arup's Transport Impact Assessment (TIA) dated 21 November 2018.

TfNSW and Roads and Maritime provided a series of comments prior to the finalisation of a response to Council. Arup and Meriton met with TfNSW/Roads and Maritime on two occasions (24 January and 14 February 2019) to discuss and agree actions for this response.

This report has been prepared to provide clarifications and further works in support of the Planning Proposal for TfNSW and Roads and Maritime as per the meetings and commentary received to date.

An updated Traffic Modelling Report has also been prepared and attached with this statement.

2 Transport for NSW comments

2.1 Comments to be considered as part of Planning Proposal

To improve transport infrastructure, provide greater, safer and more desirable travel choices, VPA contributions should include provision for separated cycleway along Banks Ave to General Bridge Cres. This would connect with the separated cycleway being planned along Doncaster Ave and Houston Rd. This link is identified as a "Green Grid" opportunity within the Eastern City District Plan.

Noted. The transport assessment noted missing linkages to the west of the site and acknowledges benefits in connecting to the proposed future Green Grid priority networks. Meriton acknowledged it would consider these connections and seek their inclusion in the Voluntary Planning Agreement (VPA), subject to the provision of information relating to the location, design and linear metre costing being provided by TfNSW which remains outstanding.

Similar to above, the GSC plan identifies a priority green corridor for public open space along Mill Stream to Botany Dams/Eastlakes. It would be beneficial for existing and future residents to be able to safely access the future green corridor by cycling and walking. As such, consideration should be given for the contributions to include the provision for a shared path along Heffron Road, Page Street and through Cowper Avenue.

Meriton acknowledged it would consider these connections and seek their inclusion in the VPA, subject to the provision of information relating to the location, design and linear metre costing being provided by TfNSW which remains outstanding.

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The Southeast bus network will change when the Light Rail opens in mid-2020. Definition of the network is not yet finalised.

Meriton and State Transit Authority (STA) have been in discussions and there is an understanding that buses will be provided directly to the development within the next few months and extra bus services will be freed up because of the CBD South East Light Rail, when operational. Meriton has already funded and completed the installation of a bus bay and shelter within the new Central Park under the existing development on the site.

The documentation does not consider the recent changes (December 2018) to the bus network in the SE where some changes were made to services operating to/through Eastgardens. E.g. Routes 310 and X10 were withdrawn and several new routes were introduced – 307, 310X and 400N. Improvements to route 391 were also made.

This is acknowledged and will improve the bus mode share for future bus customers residing at and visiting the site. No changes have been noted to the surrounding existing bus stop facilities and bus customers. Both current and future bus customers will adjust to the new services as required.

Bunnerong Road/Wentworth Avenue: The right turn bay on Bunnerong Road is short at about 45 metres in length. There does not appear to be sufficient median width to extend the right turn bay, but improvements could be investigated in consultation with RMS.

The JTW dataset suggests that the development traffic travels north and west towards the key centres, rather than south and east. There is also no vehicle access that permits traffic to travel south directly from the site, which would therefore encourage more trips via Banks Avenue and Denison Street.

Route choice is undertaken at the Maroubra Road / Heffron Road and Bunnerong Road intersection depending on the right turn capacity available. It is unlikely that additional capacity will be realised in real terms given the route choices available via Page Street /Heffron Road vs Wentworth Avenue. There is also ability to turn right at Westfield Drive prior to Wentworth Avenue to support network capacity. Accordingly, it is unreasonable to expect this development to undertake further upgrades at this intersection.

2.2 Comments on parking and access (likely to impact Development Control Plan / Masterplan stage)

Roads and Maritime is unlikely to support any direct vehicular access points to Bunnerong Road from the site as this is a key movement corridor on the state road network which carries high volumes of buses, freight and general traffic where the safety and efficiency of through traffic is of great importance. This requirement should be reflected in any access controls set out in a Development Control Plan (DCP) for the site.

Noted. No further access points are proposed on Bunnerong Road.

Any future vehicular access points to the site on Heffron Road or Banks Avenue should be located as far as practical away from any signalised intersections. Configuration of any such direct access points to these roads should be in consultation with Council and RMS.

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Noted. No further access points are proposed from the site, other than those already constructed at Banks Avenue and Bunnerong Road.

Any future child care centres should be positioned and oriented such that vehicular and pedestrian access is obtained from the local/internal road network only, on road safety grounds. The local/internal road network is anticipated to have lower traffic volumes and operating speeds than surrounding higher order roads and will be more conducive to improved safety outcomes.

Noted. Meriton has indicated a preference for child care centres to be orientated on the corners of the master planned site, accessing only within the site's car parking facilities. Childcare facilities have been designed and built this way at UB5W and UB4 as examples.

Any proposal to reduce parking rates to reduce reliance on private vehicle trips and encourage the use of public and active transport would be supported. Some councils such as Parramatta and Sydney have set maximum parking controls, which are good examples.

Noted. The proposal seeks a reduction to car parking rates from the Botany Bay Development Control Plan 2013 (BBDCP), specifically Part 4D 130-150 Bunnerong Road as follows:

Residential units	Planning Proposal	BBDCP
1 bedroom	0.5 spaces per unit	1.0 spaces per unit
2 bedrooms	1.0 spaces per unit	2.0 spaces per unit
3+ bedrooms	1.5 spaces per unit	2.0 spaces per unit

The Planning Proposal rates are below the BBDCP rates which are considered excessive for the specific circumstances of this site and the integrated mixed-use nature of the development as well as expanding transport services in the local area. This has been previously justified in the TIA report and further evidence will be provided as part of the future Masterplan DA for the site.

3 Roads and Maritime comments

3.1 Data and Assumptions

1. Crash investigation (2013) data included in the report is considered to be outdated and it is recommended that updated data is obtained.

Crash data requests via Roads and Maritime are delayed for detailed crash assessment. As such, The Centre for Road Safety portal data available was investigated in the interim to determine any road safety deficiencies near the site.

There was a total of 127 crashes recorded in the five-year period (between 2013 and 2017). Key statistics found from the crash data suggests:

- There were no fatalities, 30 serious injury, 32 moderate injury, 17 minor injury and 48 non-casualty crashes recorded
- Most crashes occurred at intersections, likely because of traffic volumes on surrounding roads.

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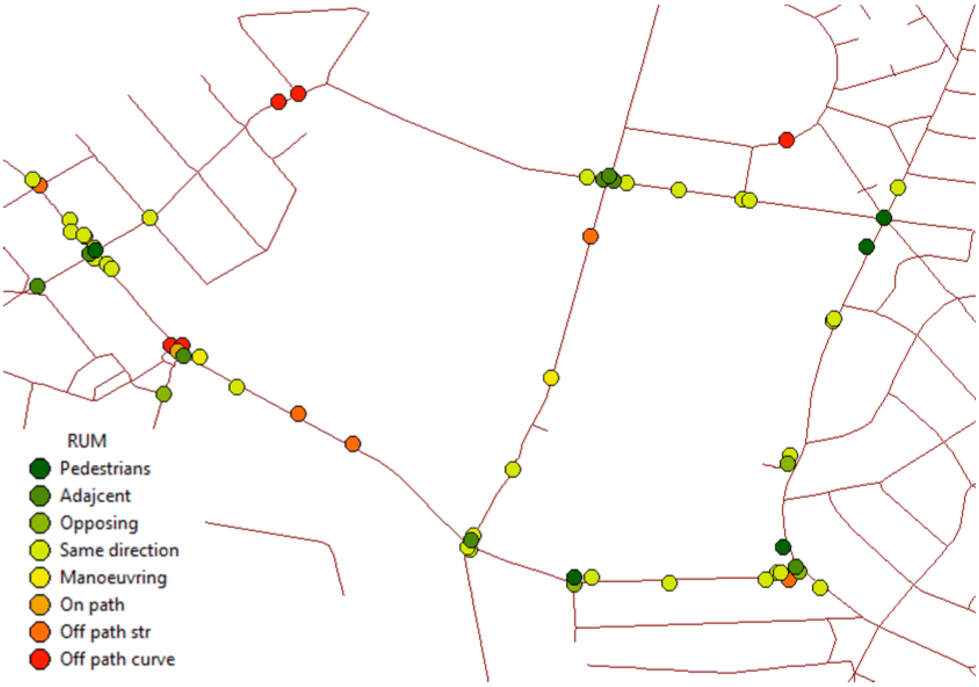
- There were five crashes involving pedestrians, recorded at:
  - Heffron Road/Maroubra Road and Bunnerong Road (two instances)
  - Page Street and Wentworth Avenue
  - Denison Road and Wentworth Avenue
  - Bunnerong Road and Wentworth Avenue
- Most crashes were right through crash types (32%), which is typical of filter right turn treatments
- Majority of crashes recorded were the same direction (29%) throughout the road network, mainly including rear ends,
- There were 16 off-path crash types, with hotspots recorded along Wentworth Avenue at Page Street and Baker Street intersections

The crashes mapped by their Road User Movement categories is displayed in the following figure. From the data available, there was minimal change from previous crash data statistics presented in the original TIA, of which were similar in nature. All crashes recorded were noted to occur before upgrades were completed on surrounding intersections as part of the Stage 1 development.



2. Journey to Work data based on 2011 data is also considered outdated, however may not have changed significantly compared to 2016 Journey to Work data. This should be updated.

The 2011 dataset was not directly translatable to 2016 as travel zones have changed and match the census Statistical Areas and District Zones. The Pagewood – Hillsdale – Daceyville SA2 was selected for both the Census' 2011 and 2016 years.

As such the comparison is shown in the table below and indicates little difference between these years with slightly higher car mode share inbound and slightly lower car mode share outbound. Regardless, both samples show a higher mode shift to public transport.

Mode	Inbound			Outbound		
	Report	Census comparison		*Report*	Census comparison	
	2011	2011	2016	*2011*	2011	2016
Train	*4%*	1%	2%	*3%*	1%	3%
Bus	*11%*	10%	13%	*19%*	17%	19%
Car	*62%*	67%	66%	*57%*	63%	65%
Walk	*5%*	5%	4%	*6%*	6%	4%
Other	*3%*	3%	4%	*4%*	4%	1%
Didn't travel	*15%*	14%	11%	*12%*	9%	8%
%	*100%*	100%	100%	*100%*	100%	100%
Trips	*4,466*	3,952	3464	*3,622*	4,280	3159

The key origins and destinations for the same 2016 dataset are tabulated below. These note areas that are north and west of the site as previously described.

SA3 name	Inbound	Outbound
Botany	37%	34%
Sydney Inner City	5%	33%
Eastern Suburbs North	1%	21%
Eastern Suburbs South	39%	6%
Kogarah - Rockdale	12%	
Canterbury / Hurstville	4%	

3. The TIA suggests a considerable mode shift to public transport in future years, however it is noted that there is no committed mass-transit public transport infrastructure improvements proposed within a typical walking distance from the site. The subject site is 1.7km from the light rail terminus.

See above comment regarding the mode shift already occurring. While it is acknowledged that light rail is not directly accessible from the site, additional bus services are proposed. Meriton and STA have discussed bus services that will be provided directly to the site within the short term, including bus stops built within the site.

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4. The PM peak volumes for the residential component is considered to be too low. Recent surveys undertaken by Roads and Maritime for high density residential sites that are more than 1km from mass transit indicate the average for PM trips is likely to be up to 0.3 vtph. Given that light rail would not provide the speed and capacity that heavy rail provides, residents may not be as willing to walk 1.7km to use this for their daily commute. Roads and Maritime would suggest the PM peak trip rate is reconsidered. A comparable site could be surveyed to establish an appropriate rate. It is acknowledged that the likely slight increase in the rate is unlikely to have a significant impact on the overall traffic generation potential that has been suggested for the residential component of the site.

A site survey was undertaken on 14 February 2019 at the Urban Block 5 West site, located in the southwest of the Stage 1 masterplan site. Meriton confirmed that there are 485 units in total and approximately 456 units sold or leased. This results in a potential 94% occupancy rate. The counts yielded the following:

- 60 residents in and 12 child-care in
- 31 residents/staff out and 12 child-care out

Assuming 456 apartments are occupied as noted below, and at least 11 childcare staff left during this time, the site yield's trip rates of **0.175 trips per unit**. Acknowledging the site's location relative to public transport, the higher car mode share, and the relatively newer occupation, other sources of data were also consulted.

In consultation with Transport for NSW, Arup undertook peak hour traffic surveys of comparable residential developments to derive a suitable traffic generation rate for the Cook Cove site in 2017. The sites selected were all newer, high density residential developments which were generally located between 400m and 1200m from a railway station. Therefore, the average of PM peak hour rate of **0.26 trips per unit** was adopted for the revised modelling.

5. The explanation of the traffic generation of existing uses compared to proposed uses should be more clearly explained. The assessment provided seems to imply retail is permitted in the existing zoning of IN1 General Industrial and R3 Medium Density Residential. The assessment of traffic generation potential of the site under existing planning controls should be based on existing permissible uses only.

It is understood however that the adjoining Pagewood Green Masterplan had initially been approved for a total of 5,000sqm of retail and four child care centres being developed (in addition to residential), which was later reduced to 1,300sqm retail and two child care centres. It is noted the 5,000sqm retail and four child care centres had been accounted for in the previous Masterplan traffic assessment and road upgrades delivered/being constructed.

It is noted that Pagewood Green I and II combined indicative yield would be a total of approximately 6,300sqm retail and four child care centres (in addition to residential uses). It is understood that to avoid 'double-counting' the future retail/commercial development traffic on the network, just the additional 1,300sqm retail not previously accounted for, plus 2,100 apartments, would be factored into the assessment in 'with development' scenarios.

As the traffic assessment has assumed that retail uses will be limited to a total of 5,000sqm (plus the 1,300sqm approved on site Urban Block 5C in the Pagewood Green Masterplan site), Roads and Maritime strongly recommends that Council includes controls in the LEP to limit the floor space of *the additional permitted use of 'Commercial premises' if pursued for retail use, to 5,000sqm. This should be set out within the site specific additional permitted use clause. Any exceedance of this has not been accounted for in the traffic assessment and the associated traffic may significantly exceed the capacity of the road infrastructure.*

The transport assessment noted the following:

- Stage 1 had 1,300sqm retail, 2,223 residential units and a 300sqm warehouse remaining
- Stage 2 absorbs two urban blocks from Stage 1, which included 376 residential units and two child-care centres and the remaining warehouse
- Stage 2 proposes 5,000sqm retail, 2,015 residential units and two child-care centres

This results in an extra 1,639 residential units and an extra 1,3000sqm retail because of the Planning Proposal.

Regarding the suggested capping of "commercial premises" to 5,000 sqm. We understand the intent, but the Department of Planning and Environment requires a minimum of 5,000 sqm of non-residential uses to drive support services for the future population and employment opportunities. A cap would mean, the "commercial premises" must be exactly 5,000 sqm. On a site of this scale, this is impractical.

In any event, the degree of non-residential uses would need to be outlined in subsequent DA's with supporting traffic studies and would be subject to a Roads and Maritime referral and/or concurrence.

Accordingly, it is not necessary to limit the commercial premises to 5,000 sqm in the planning instrument and this can be dealt with at the DA process.

6. It is noted that the previous internal road network layout for the Pagewood Green Masterplan (I) intended access from Westfield Drive for emergency vehicle only. Roads and Maritime seeks confirmation if this is still the case (ie that there are no connections for general traffic to Westfield Drive from the internal road network), as any change to this would impact distributions on the external road network.

Noted. There is and will not be vehicle access proposed on Westfield Drive.

3.2 Modelling

7. Roads and Maritime has reviewed the modelling prepared in support of the Transport Impact Assessment (provided 10 January 2019 and 24 January 2019) and provides detailed comments at Attachment B which should be addressed in an addendum Transport Impact Assessment. Roads and Maritime cannot validate the modelling as 'fit for purpose' in its current form.

Arup's Response to the tables are provided in Chapter 4. The Traffic Modelling Report originally prepared by Arup has been updated to incorporate these comments and is attached to this response.

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3.3 Upgrades mentioned / potential improvements

8. Roads and Maritime would encourage investigation and provision of improvements to pedestrian and cyclist connections from the site to key destinations and bus services, such as regional cycleway links and pedestrian crossing facilities.

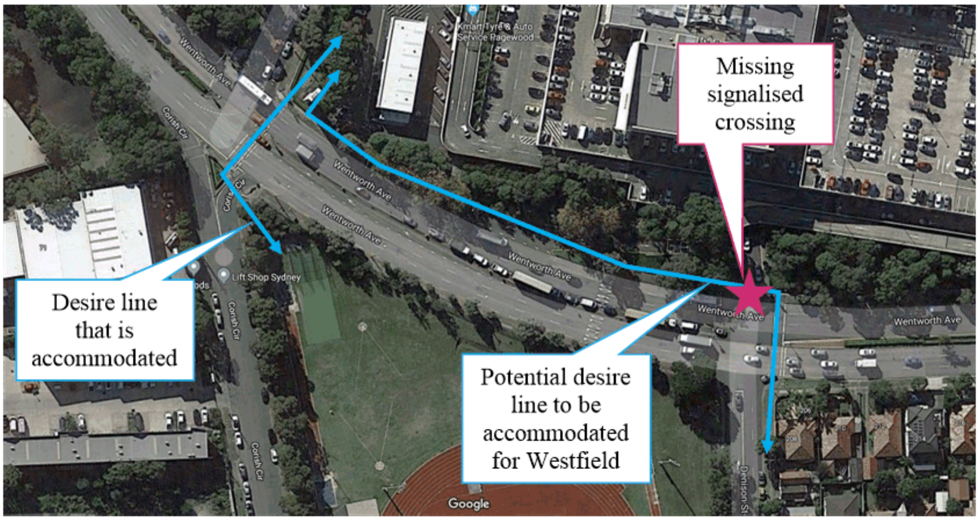
Noted. This is addressed in the TfNSW commentary above.

9. There is an opportunity to enhance connections for active transport and supporting facilities such as bicycle parking and improved paths on Heffron Road and Banks Avenue to adjacent destinations such as Hensley Athletics Field.

Noted. This is addressed in the TfNSW commentary above.

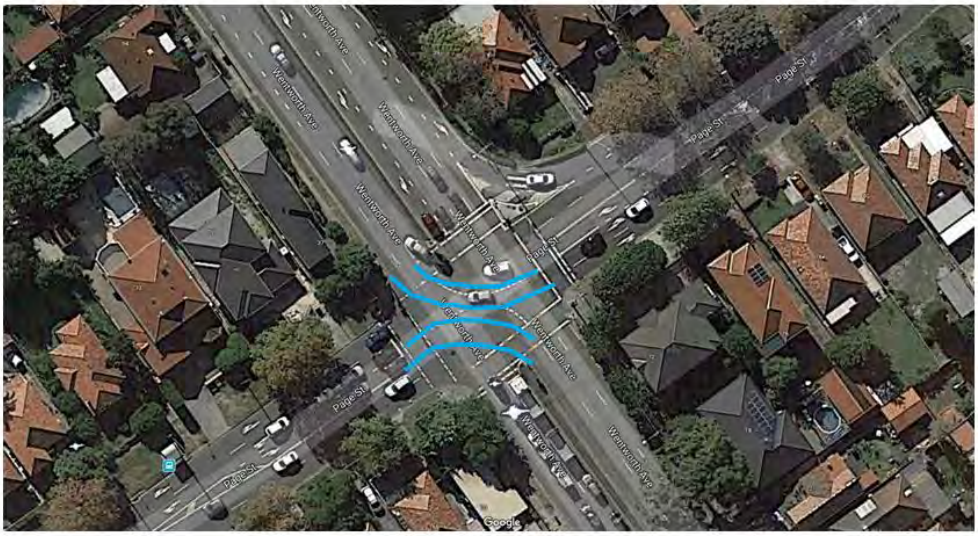
10. Roads and Maritime suggests investigation of pedestrian crossing facilities, for example at the intersections of Wentworth Avenue/Dennison Street and Wentworth Avenue/Banks Avenue to provide improved links to the sporting fields.

Wentworth Avenue and Denison Street could utilise a signalised pedestrian crossing on the Westfield exit as there are currently no safe crossing points, however this is not a pedestrian desire line for the development. Any upgrades should be considered by potential Westfield developments in the future.



11. It is noted that the report refers to double-diamond configuration at the intersection of Wentworth Avenue and Page Street however Roads and Maritime understands that Council's plans for the intersection do not include double-diamond.

The report was meant to refer to a diamond - right turn as it is acknowledged that there is a northbound right turn ban into Page Street from Wentworth Street.



Wentworth Ave
Page St
Google

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12. Bunnerong Road/Wentworth Avenue: The right turn bay on Bunnerong Road is short at about 45 metres in length. There does not appear to be sufficient median width to extend the right turn bay, but improvements could be investigated. Replacement of the right turn filter with designated phasing could be investigated.

Noted. See previous response to TfNSW comment.

3.4 Parking and access

13. Roads and Maritime would not support any direct vehicular access points to Bunnerong Road from the site as this is a key movement corridor on the state road network which carries high volumes of buses, freight and general traffic where the safety and efficiency of through traffic is of great importance. Roads and Maritime requests that this is reflected in any access controls set out in a Development Control Plan (DCP) for the site.

Noted. See previous response to TfNSW comment

14. Any future vehicular access points to the site on Heffron Road or Banks Avenue should be located as far as practical away from any signalised intersections. Consideration should be given to restricting any such direct access points to these roads to left-in/left-out only.

Noted. See previous response to TfNSW comment

15. Any future child care centres should be positioned and oriented such that vehicular and pedestrian access is obtained from the local/internal road network only, on road safety grounds. The local/internal road network is anticipated to have lower traffic volumes and operating speeds than surrounding higher order roads and will be more conducive to improved safety outcomes.

Noted. See previous response to TfNSW comment

16. Roads and Maritime supports proposed reduced parking rates to discourage reliance on private vehicle trips and encourage the use of public and active transport. Council may wish to consider including these maximum parking rates in the LEP, or site specific DCP, so that future DAs and modifications do not exceed these rates. Parramatta Council has maximum parking controls for certain development in the CBD within its LEP as an example.

Noted. See previous response to TfNSW comment

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4 Modelling comments

The modelling comments have been addressed as per the following table. This has resulted in a requirement to re-calibrate and re-validate base models.

Item	Roads and Maritime comment	Arup response
1.5	Section 6.2, page 29 states that "The modelling extent is shown in Figure 21 as previously agreed with Roads and Maritime Services." In previous correspondence on 21 June 2016, prior to the planning proposal receiving a Gateway determination, Roads and Maritime had advised that "While there are no major issues with the brief in-principle, Roads and Maritime cannot give any further detailed comment or final endorsement to the extent of the model/study area until the details of the planning proposal, trip generation of the maximum yield, and traffic distributions are known". The modelling extent had not been endorsed by Roads and Maritime at that time as the full planning proposal details were unknown. The section of Bunnerong Road between Wentworth Avenue and Fitzgerald Avenue is congested during peak periods due to the volume of traffic turning right from Wentworth Avenue to Bunnerong Road and then turning left into Fitzgerald Avenue as well as the bus stop just south of Fitzgerald Avenue. It is therefore recommended that the model area is extended to cover this section in order to investigate the impacts of the proposed development. Explanation/justification should be provided if this intersection is not included.	The study area was previously agreed upon between Council and discussed with Roads and Maritime prior to collecting count data in 2017. The JTW dataset suggests that the development traffic travels north and west towards the key centres, rather than south. There is also no vehicle access that permits traffic to travel south directly from the site, which would therefore encourage more trips via Banks Avenue and Denison Street.
3.4	Signal coding criteria refers to Table 11.3, page 105 of the RMS Traffic Modelling Guidelines (RMS, 2013), however the criteria are not provided within the report. All criteria that the model is being assessed against should be explicitly outlined within the report.	Arup has added this information into the amended Traffic Modelling Report.
4.1	Table 4 should include values, as well as percentages, so comparison can be made directly to the information provided in section 1.6.	Arup has extracted these numbers and provided in the amended Traffic Modelling Report.
4.2	The report states that stochastic traffic assignment has been adopted that uses a combination of static and stochastic; 50% is assigned as static (which is referred to as vehicles that are familiar with the network)	DUE is now used instead. Models have been re-run and updated.

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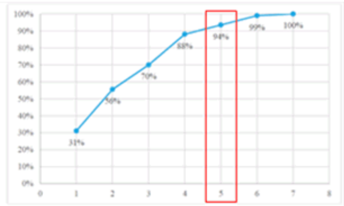
<table>
<tr>
<td></td>
<td>and 50% is assigned as stochastic (which is referred to as vehicles that are unfamiliar with the network. This approach is often referred to as one-shot simulation and is generally applicable to models with limited route choices.

This description of traffic assignment in the report is somewhat confusing. With the adopted setting, 50% of generated vehicles will follow a path read from a path assignment file (static assignment) and 50% will follow a path built by the adopted route choice model (Logit).

Given that majority of drivers in the area would be accustomed to the conditions and congestion (well aware of possible routes), 50% assignment to represent unfamiliar drivers appears questionable.

Also, the introduction of additional demands (development) and changes to road network infrastructure is likely to alter existing travel patterns as well as create the need for development traffic to establish the best routes to and from the development. To replicate this behaviour, an application of DUE (dynamic user equilibrium) assignment would be more appropriate.

Also, no value for attractiveness weight has been defined which can result in through traffic being assigned to lower order roads.</td>
<td>Rather than use attractiveness, cost will be used instead.</td>
</tr>
<tr>
<td>4.3</td>
<td>The model stability section only outlines a median seed, with no specific comments on the stability of the model. No model stability checks have been conducted to ensure the model is fit for purpose. This process should be undertaken as per section 11.7 of the RMS Traffic Modelling Guidelines.</td>
<td>Additional commentary and calculations have been provided along with a plot showing model stability into the amended Traffic Modelling Report.</td>
</tr>
<tr>
<td>5</td>
<td>There is a minor discrepancy between the values charted in Figure 20 and the corresponding values in Table 6 which should be updated:


<table>
<tr><th>Model</th><th>GEH < 5</th><th>GEH < 10</th></tr>
<tr><td>AM Peak</td><td>98%</td><td>100%</td></tr>
<tr><td>PM Peak</td><td>93%</td><td>100%</td></tr>
<tr><td>WE Peak</td><td>100%</td><td>100%</td></tr>
</table></td>
<td>Arup has fixed this discrepancy in the amended Traffic Modelling Report.</td>
</tr>
</table>

5	Figures 16-18 are direct outputs from Aimsun. Aimsun modelling software default regression plot y-intercept does not pass through 0, which is required as per RMS Modelling Guidelines section 9.18. Although this will have minimal impact on the regression plot statistics, it is recommended that these charts are created as per the RMS guidelines.	Arup has replotted graphs in Excel so that they pass through 0,0 in the amended Traffic Modelling Report.
6.1.1	RMS Traffic Modelling Guidelines section 11.5 state that model travel times must be within 15% or 1 minute of the observed travel times. The Guidelines also state the above criteria should hold true for both the full length of travel time routes and for individual travel time route segments (disaggregated level). The validation results in Section 6.1 did not comment on segments which do not meet the criteria. Analysis of route segments should be included with justification provided, or justification for exclusion should be outlined. The model appears to underestimate travel times and congestion observed in the network and further details may be required.	Results have been reassessed and comments regarding travel time (total and disaggregated) that fall outside the 1 minute/15% are provided in the amended Traffic Modelling Report.
7	No commentary regarding external transport infrastructure that may affect trip patterns within the study area. For example, the construction (and completion) of the Sydney CBD and South East Light Rail (CSELR), that starts/terminates 2km to the north of the development, may potentially have an effect on route choice.	Arup is not aware of any further changes to the immediate surrounding transport network that will materially impact route choice. Traffic growths outputted by the Aimsun model have been compared to the STFM plots and are not considerably different. Comment has been provided on CSELR and how it will likely not affect the route choice within our model. Route choice will not be hugely impacted given that there is a lack of alternate routes from the CSELR to/from the study area.

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7.3.1	It is unclear how data provided in Tables 19 and 20 has been used for modelling purposes. A more detailed discussion should be included in this section.	Arup has provided trip rates as well as more commentary in the amended Traffic Modelling Report.
7.3.2	The future growth estimates process outlined in Table 21 and Figure 35 seem appropriate, however it should be outlined how these percentages are then translated to origins and destinations in the Aimsun matrices.	Arup has provided commentary of how it's used for origin/destination and development demand in the amended Traffic Modelling Report.
7.3.3	With limited traffic data available for external-to-external trips, a growth of 1% pa has been assumed. This value generally seems low; however, taking in to consideration the east-west movements average at -0.74% growth p.a. it may be appropriate. The growth values in Table 22 should be included as growth p.a. rather than the change over the 4-year timeframe (2011 – 2015), so that the reader has a better understanding of the yearly growth rate applied. Further to this however, commentary regarding the potential impact of the CSELR due to be opened in 2021 and located approximately 2 km north of the site has not been provided. This significant infrastructure may alter travel patterns near the proposed development either through mode choice behaviour or capacity reductions along Anzac Parade and should be considered when developing future demands. While growth of 1% pa may be acceptable for 2021 due to the impact of CSELR, longer term (2031) growth rate is likely to be higher (Note: Roads and Maritime can currently assist by providing growth rate plots from its strategic model for comparison, subject to a data access agreement).	Arup has included total base growth p.a. across the models. We have reviewed the STFM outputs and compared our plots to review background growth as necessary. These plots are appended and indicate that growth rates adopted in the future base modelling are adequate.

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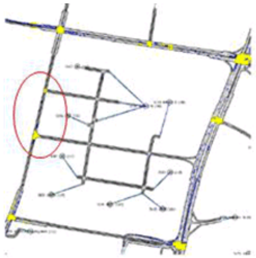
7.4	More information is required to outline how the Population and Employment % increase in Table 24 have been applied to the growth factor matrices.	Arup has provided commentary within the amended Traffic Modelling Report.
8.2.1	Section 8.2.1 of the report states that Figure 42 is the configuration modelled for the future base model, however Banks Ave, located west of the site is shown to be connected to the development as shown in the figure below. This however was not the case in the Future Base 2021 or 2031 models received. Either the models or report should be updated for consistency.  Further to this, the Development models provide a connection to the west resulting in additional route choice for vehicles accessing the sites. This connection provides additional route choice options which are not available in the Future Base scenario as well as the opportunity for rat-running through the development, as seen in the example from the 2031 Development model. What is the reason of including this connection in the development model and not in the base models? Is it related to the proposed development?	Arup has modelled an additional future scenario, including one future model with all development flows based on the future approved road network. Results are discussed in the amended Traffic Modelling Report.

		
9.2	It appears that subpaths have been used in the model to calculate LOS for intersections. It is important when using this process that the subpaths are defined for an appropriate length of the approach and do not pass through other signalised intersections, where delay may not be attributed to the correct intersection. One such issue can be observed with subpath **Int1_S** where the subpath extends > 600m and passes through another signalised intersection:	Arup has amended the sub-paths for all scenarios: Int1_S

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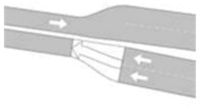
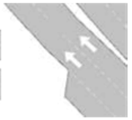
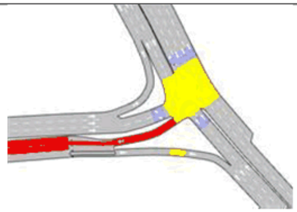
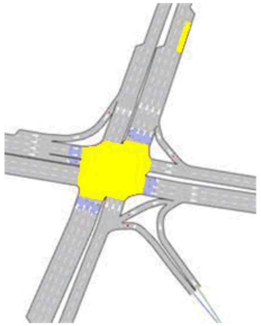
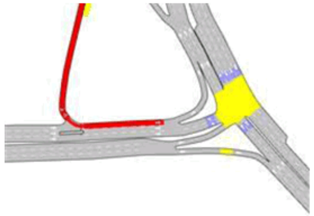
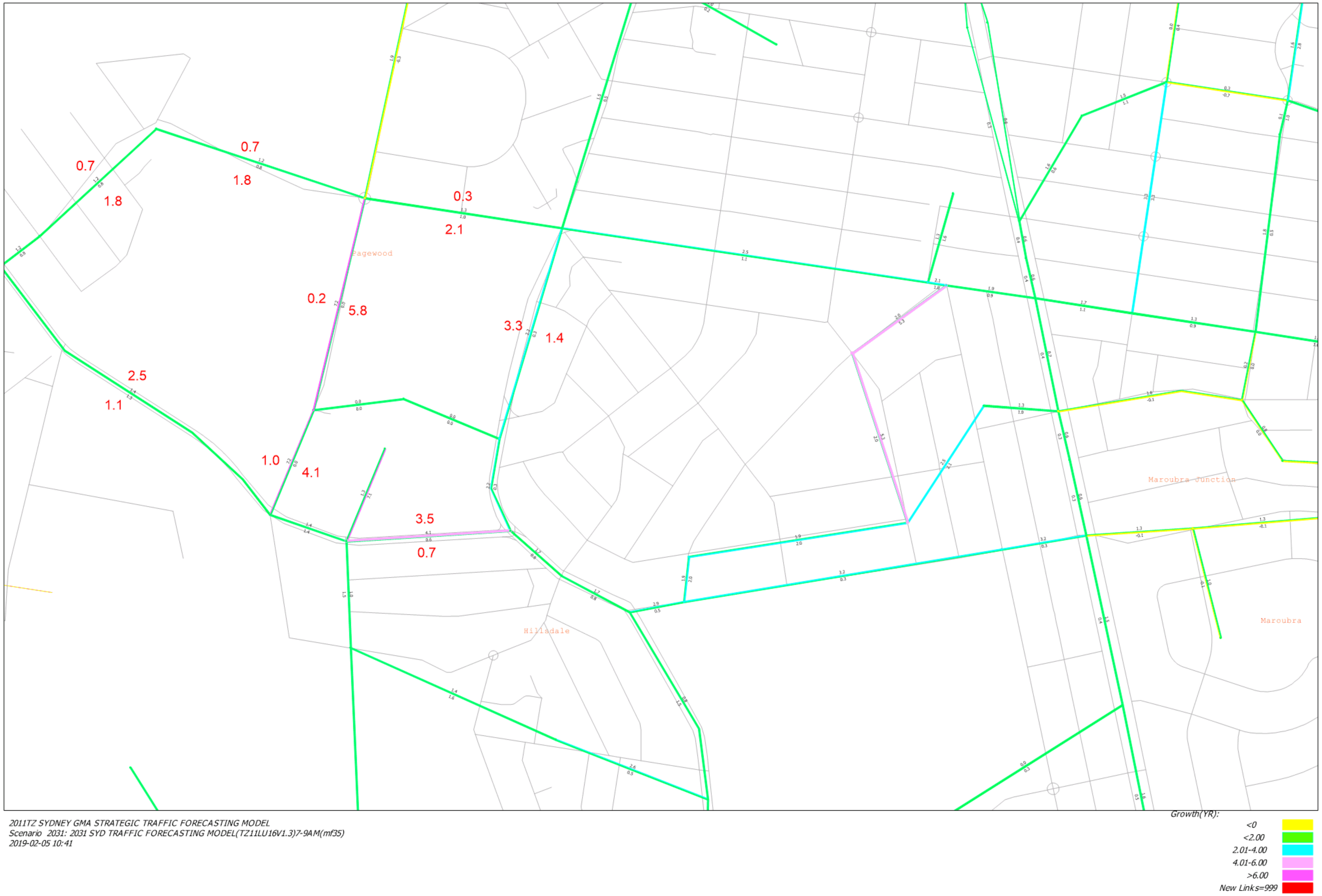
9.2 & 9.3	It is understood that any general network changes outlined that are not associated with the development are included in both the Future Base and Development models. Similarly, any signal operation updates or changes should be applied to both models so that the models provide relative comparisons, with the only differences in network performance coming from demands. The comparative analysis between Future Base models and Development models indicates several intersections that perform better with the development in place which does not appear logical without additional explanation. Additionally, the network statistics included in Table 29 highlight significant improvements to both average delay and travel time for Development models, especially in the PM peak. However, the PM peak Intersection Delays (and LOS) are relatively similar across all the included intersections. As such, further details should be provided regarding how the inclusion of the development corresponds to large improvements to the network performance statistics without corresponding improvements to intersection performance in the PM peak period.	Arup has reviewed signal operations and updated models as necessary.

10	Within the summary of the calibration and validation criteria and results, it is stated that "through the operational modelling process it was found that the development yields have little impact on the network with some increases in delays at intersection." This is not consistent with Section 9.2 and 9.3 where there are several large differences in network performance statistics and intersection results.	Arup has revised this section and re-worded commentary to ensure consistency in the amended Traffic Modelling Report.
Model Operation	The following examples for coding of merge sections are not best practice, as it may cause issues with vehicles overlapping (improper give-way functions):   Aimsun best-practice modelling is that merge sections should never operate from more 'from' lanes than 'to' lanes and that they always have a merge section (sections does not simply end). The examples above should ideally be coded as follows:  	Arup has fixed short lanes and re-run models.
Model Operation	Bunnerong Road right turn traffic in the southbound direction turn into one continuous lane of Wentworth Avenue, while left turn traffic in the northbound direction turn into two continuous lanes of Wentworth Avenue as shown in the aerial photo below. However, target lanes are not set in the model to reflect current network configuration.	Arup has fixed and re-run the models. - Bunnerong / Wentworth SBRT and NBLT

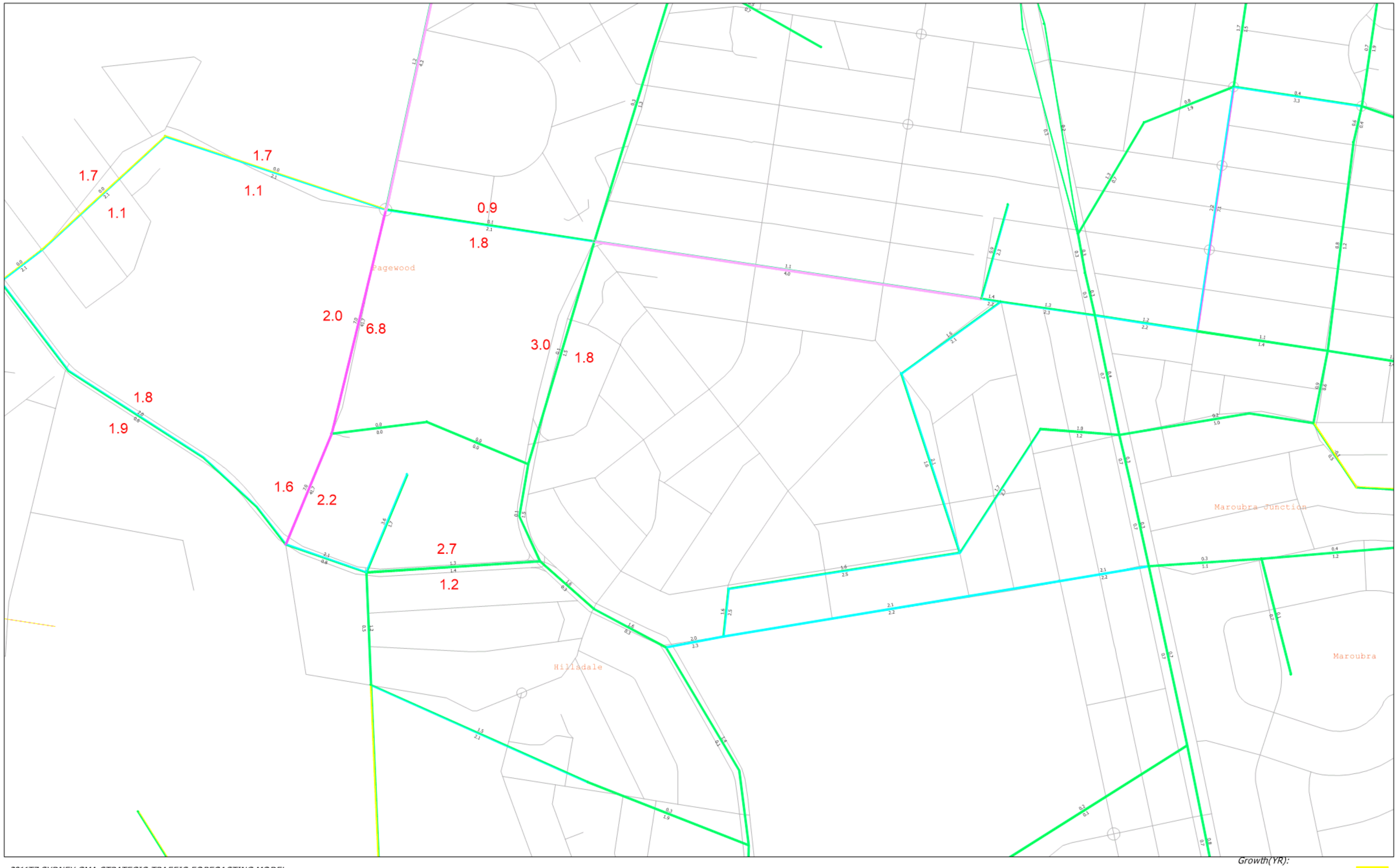
	 	
Model Operation	In 2016, the left lane of Bunnerong Road south of Heffron Road in the northbound direction was for left turn traffic only as shown in the aerial photo below. This lane was set in the model as shared lane allowing through traffic besides left turn traffic. As the base model was built, calibrated and validated for 2016, the model network should be consistent with 2016 road network.  	Arup has fixed and re-run the models. - NBLT shared lane at Bunnerong/Heffron

Model Operation	Buses departing Eastgardens bus interchange turn into one of the two left lanes of Wentworth Avenue depending on their destination; however the model directs the buses to the most left lane as shown below which is not consistent with the traffic operation. 	Arup has fixed and re-run the models. - SBLT from Eastgardens Bus interchange
Signal coding	The traffic signal of Bunnerong Road, Maroubra Road and Heffron Road was coded in the model as actuated signal however it was set without rings or barriers. Rings and barriers have to be included to properly model overlap phases and reflects SCATS operations.	As discussed in the signalling section, the differences between the model and the observed phase times were already within acceptable levels and as such, this was not modified.

ROAD TRAFFIC GROWTH (%YR, 2HRSPK) LINKS & INTERSECTIONS



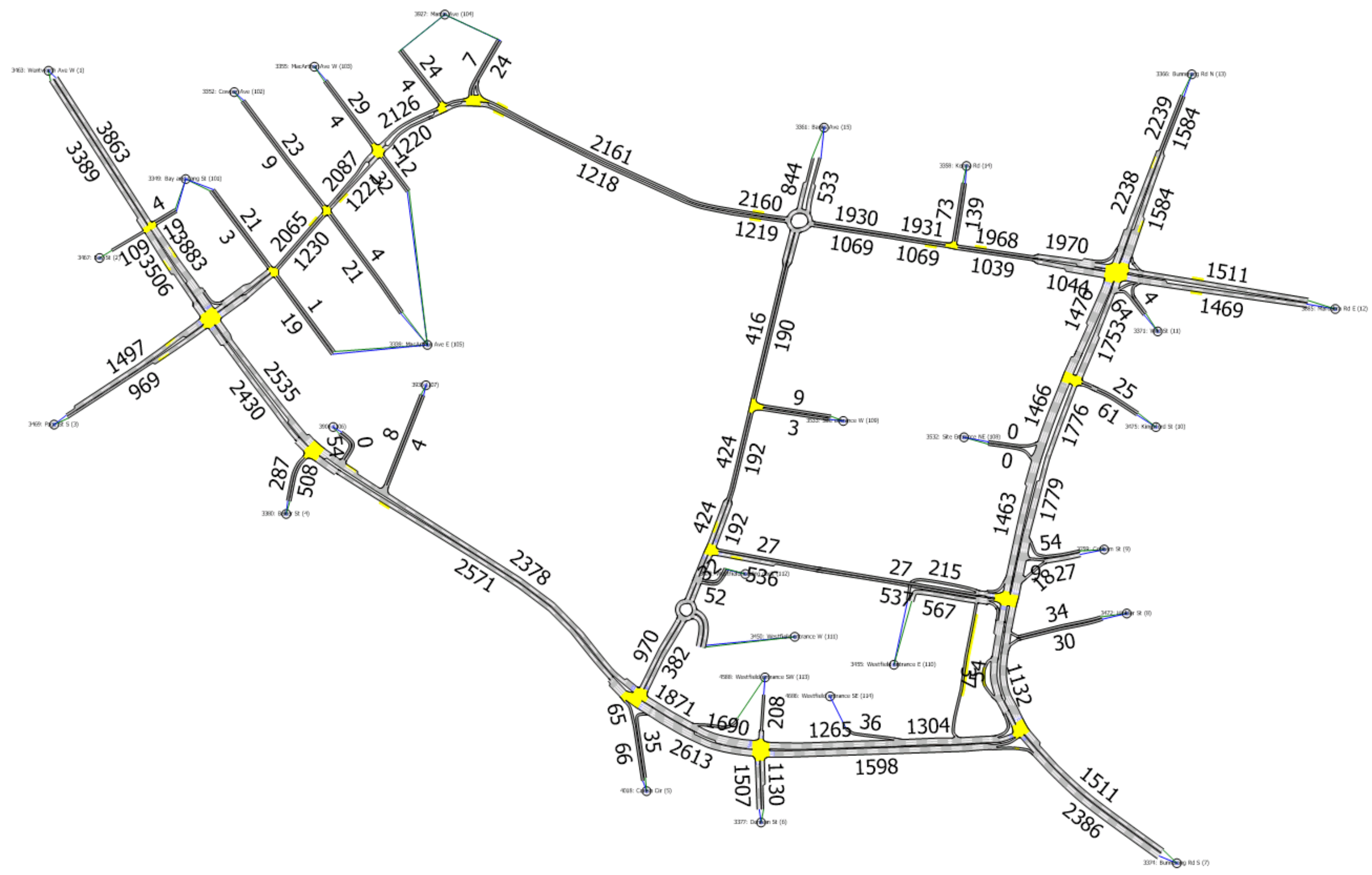
ROAD TRAFFIC GROWTH (%YR, 2HRSPK) LINKS & INTERSECTIONS

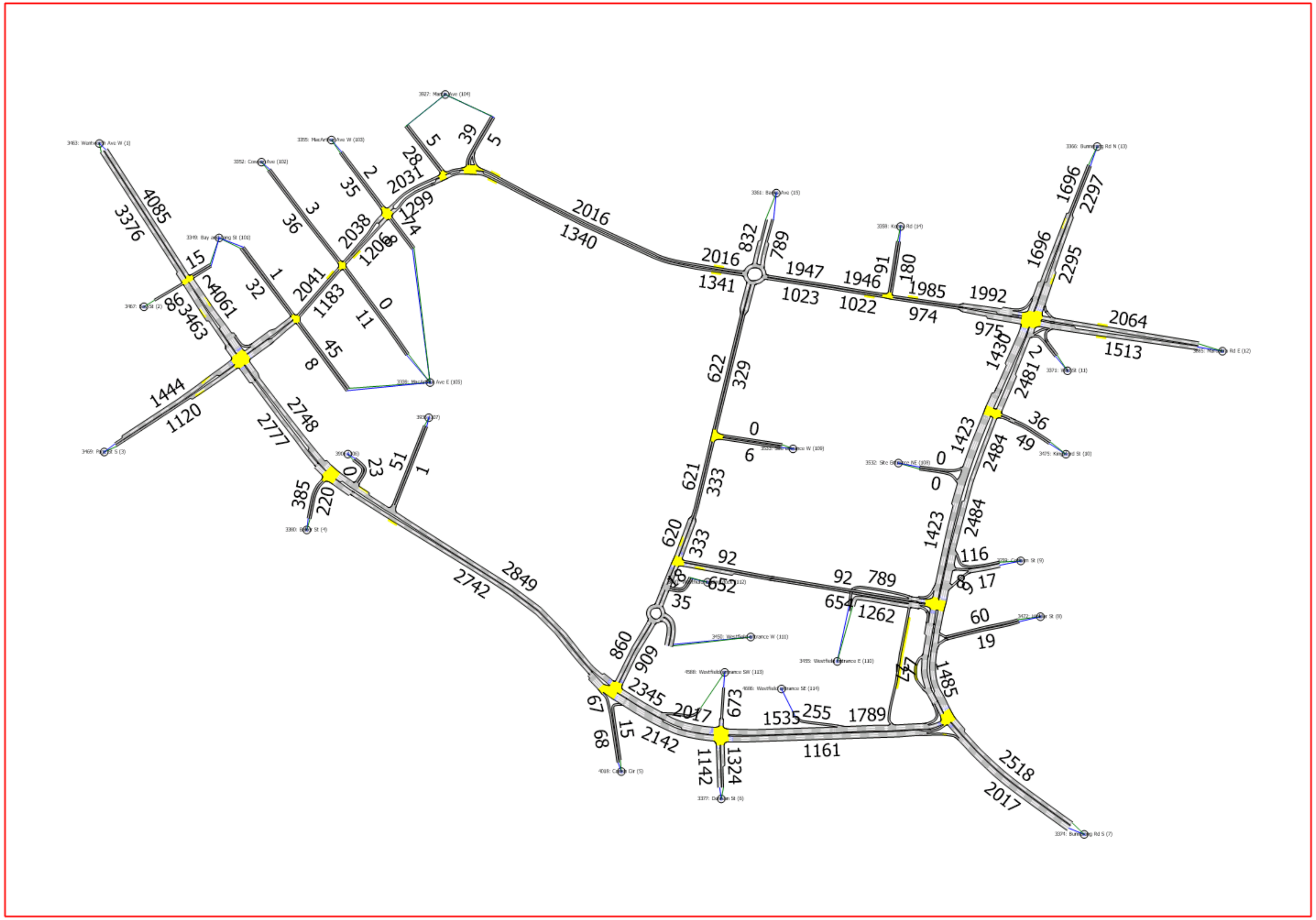


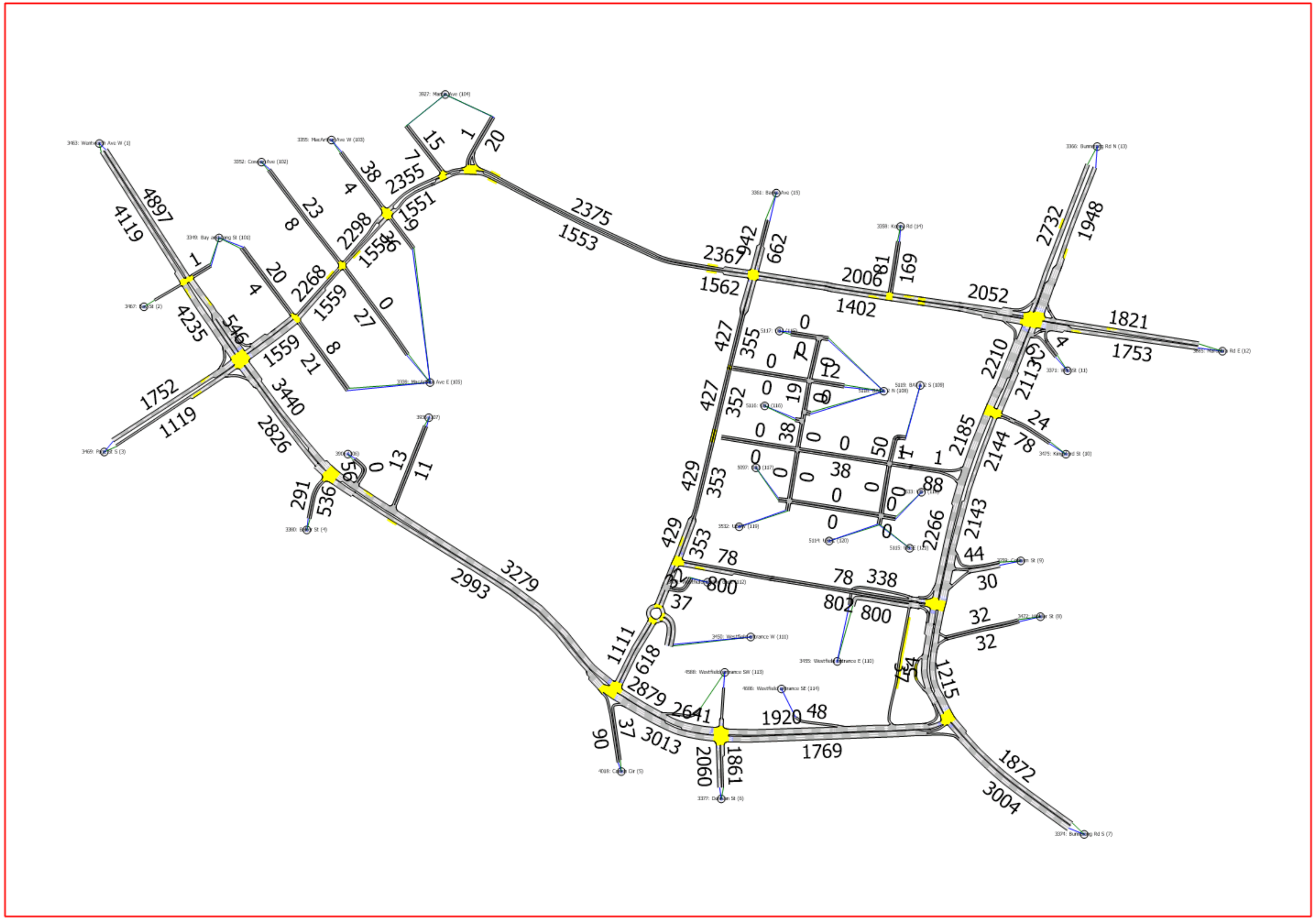
2011TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 20310: 2031 SYD TRAFFIC FORECASTING MODEL(TZ11LU16V1.3)4-6PM(mf55)
2019-02-05 10:42

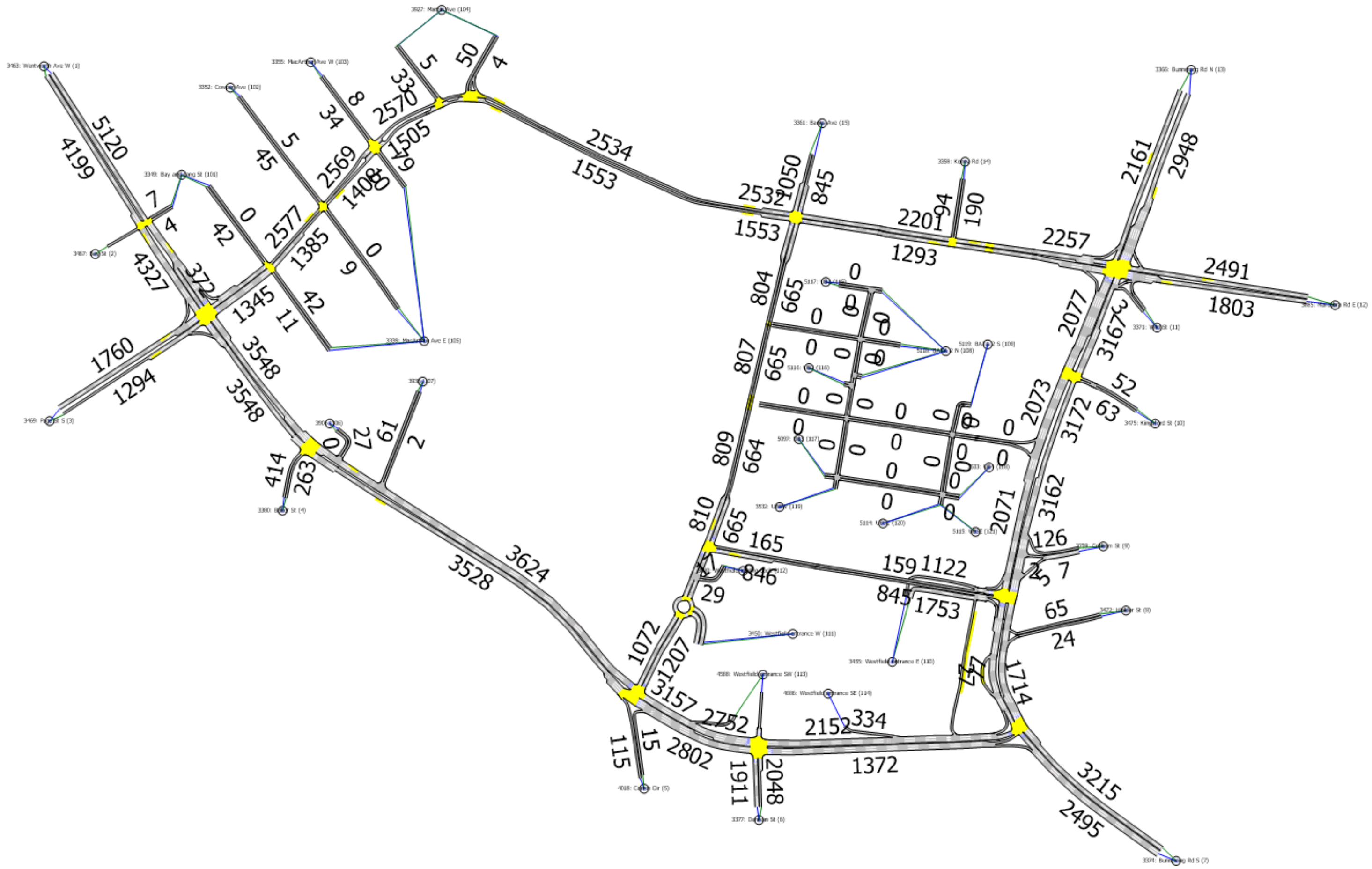
Growth(YR):

- <0
- <2.00
- 2.01-4.00
- 4.01-6.00
- >6.00
- New Links=999









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1122
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Meriton Properties

128 Bunnerong Road, Pagewood

Traffic Modelling Report

Rev B | 2 March 2019

Job number 237575

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Contents

Tables

Figures

1 Introduction

1.1 Background

The objective of this study was to develop a traffic model suitable for analysing the proposed extension of the Meriton Properties Pagewood development to include the British American Tobacco Australia (BATA) site. The modelling is used to test development yields, assess network impacts and understand access arrangements.

This report also details the option testing that was undertaken to support the expanded Meriton Properties development on the British American Tobacco Australia site. In order to test the traffic and transport implications of potential development options and network changes the base models are to be modified to reflect potential future conditions. The types of changes to the base models that are required include:

- Additional demands due to existing site development approvals, which are expected to be taken up in the near-term
- Possible minor adjustments to road network arraignments
- Potential increases in external traffic passing through the study area

Once the future base model was established then the incremental demands and network changes associated with the development options were added to the future base model creating the options models.

This latest report revision has been updated to incorporate commentary received by Transport for NSW (TfNSW) and Roads and Maritime Services (Roads and Maritime) on 11 February 2019.

1.2 Purpose of this report

This report aims to provide background information relevant to the development of the micro-simulation model and demonstrate that the model has been developed in accordance with the relevant guidelines. The goal is to establish confidence that the model is fit-for-purpose for use as part of the subject study only. This is achieved through the presentation of information relevant to the development, calibration and validation of the model including:

- Identification of the network area to be modelled
- Identification of the data used as inputs to the model
- Traffic demand matrix development
- Model validation and calibration

1.3 Software package

The software used for the analysis presented in this report was Aimsun Next 8.2.3 (R54491x64). Aimsun is an integrated transport modelling software package approved by the Roads and Maritime that is commonly used for micro and mesoscopic traffic models.

1.4 Site location

Pagewood is located directly to the east of Sydney Airport and 8km south of the Sydney CBD. The University of New South Wales is located to the north with Port Botany located immediately to the south. There are four wider network connections within the site: Bunnerong Road, Wentworth Avenue, Denison Street and Page Street/Heffron Road.

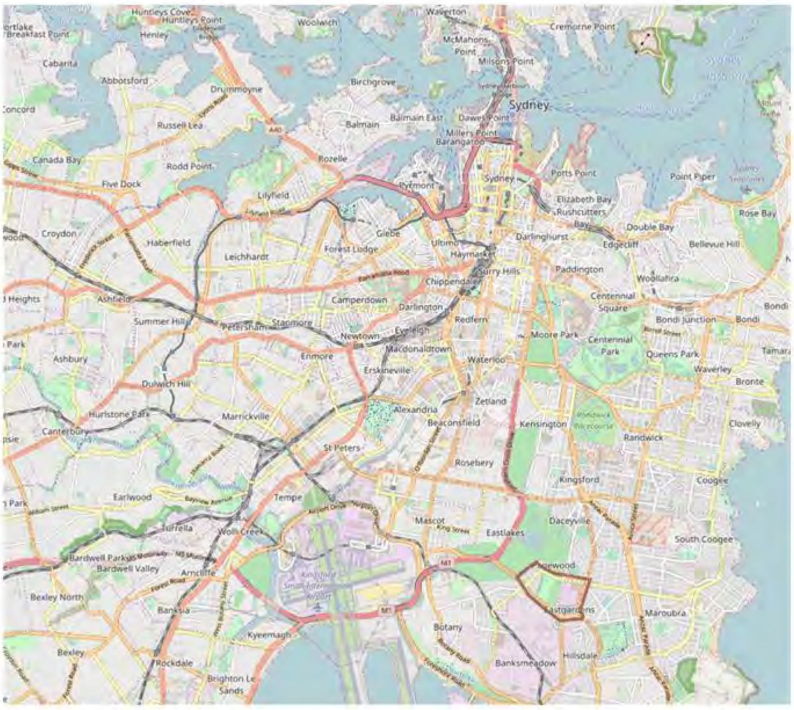

Figure 1 Pagewood location within Sydney (*source: Open Street Maps)*

1.5 Study area

The study area was defined by the major roads surrounding the BATA extension site and is illustrated in Figure 2 below.

Figure 2 Study area definition (*source: google maps*)

The study area includes residential and retail areas, notably the Eastgardens Westfield in the south east corner of the study area. To understand how the road network functions, it is crucial to consider the strong freight corridor formed by Wentworth Road running along the southern edge of the study network and Denison Street extending to the south.

1.6 Time periods

In order to select the appropriate time periods to assess, data from the traffic counts were collated across the network with the 15-minute overall demand graphed, see Figure 3. The-15-minute flows were also calculated by summarising the hourly volumes beginning every 15 minutes (see Figure 4, Figure 5 and Figure 6).

This process clearly highlighted the busiest period for the morning, afternoon and weekend peak. As the demand profile was flat for a sustained period of time in the PM and weekend time period, a two-hour peak was chosen to be modelled. The AM peak for consistency was also modelled as 2-hours.

- AM weekday peak: 7:30 – 9:30am
- PM weekday peak: 4:30 – 6:30pm
- Weekend peak: 11:15am – 1:15pm

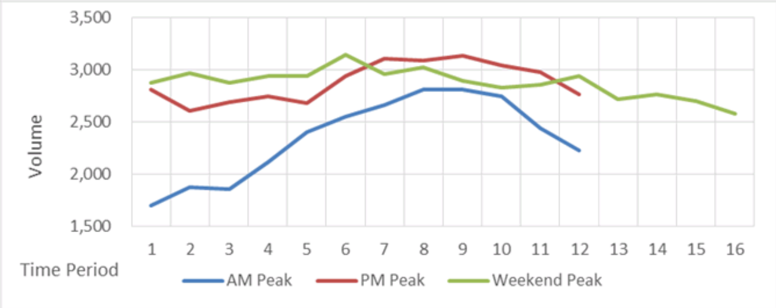

Figure 3 Demand profiling, volume per 15min period

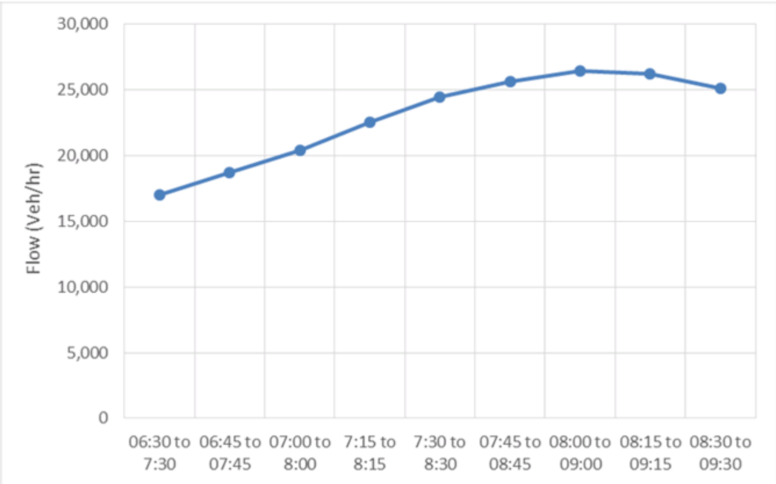

Figure 4 AM Peak identification, 15 min flows

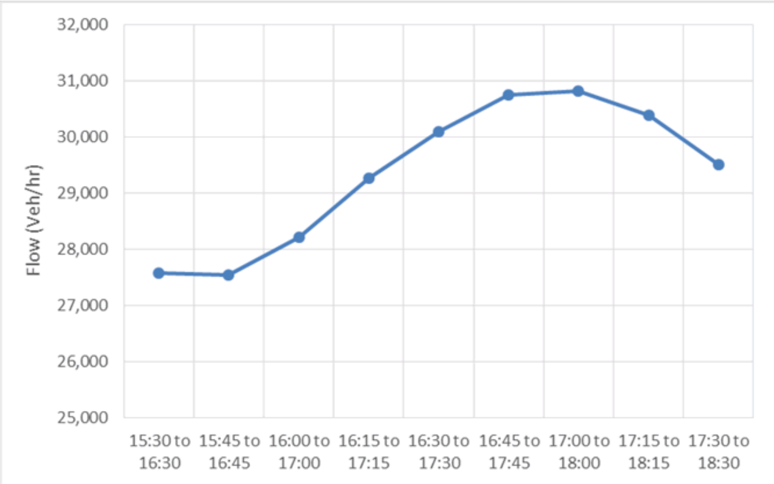

Figure 5 PM Peak identification, 15 min flows

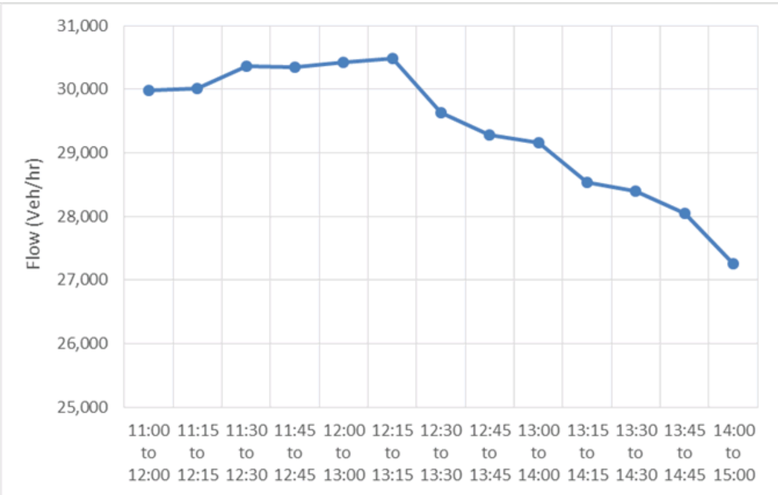

Figure 6 Weekend Peak identification, 15 min flows

2 Data Collection

Developing the model of the study network required the collection of several different data types. This data was used for coding the base model and subsequently during the calibration and validation process. Table 1 below details the types of data collected and their respective uses.

Table 1 Summary of data used in base model

Data type	Description	Location	Date and time	Used for
Intersection counts	Turn counts were undertaken by subconsultants Matrix. This data was recorded in 15-minute intervals and categorised into car, truck, bus and pedestrians.	11 intersections across the study area (See Figure 7)	Thursday 18 August, 6:30-9:30am and 3:30-6:30pm Saturday 20 August, 11am – 3pm	Prior matrix and Calibration
Videos of intersections	Videos were used to collect data about average phasing data to use as a starting point for the base model signals.	11 intersections across the study area (See Figure 7	Thursday 18 August, 6:30-9:30am and 3:30-6:30pm Saturday 20 August, 11am – 3pm	Signal operations
Travel time	Travel time through the model along two routes 1. Page Street – Heffron Road – Maroubra Road 2. Wentworth Road – Bunnerong Road	2 routes through the study area (See Figure 8)	Thursday 18 August and Saturday 20 August	Model Validation
Site observation	Site visit to study area	Whole study area	Wednesday 16 November	Assessing model operation
TCS plans	Plans from the RTA (now Roads and Maritime) showing layout and possible phases for signalised intersections	6 signalised intersections in network	NA	Signal operations
Bus network data	Timetabling and routing data for buses operating in study area (See Section 3.3)	Whole study area	Timetables for Nov 2016 used	Creating base model Public Transport demand
Journey to Work data	Data from 2011 census about travel patterns in the area	Wider Pagewood area	2011 Census	Developing trip distribution for prior matrix
Roads and Maritime guide to traffic generating developments	Information on land use trip generation	Internal network zones	2013 release	Estimating demand in prior matrix

Figure 7 Intersection Count Locations *(source: Matrix traffic and transport data)*

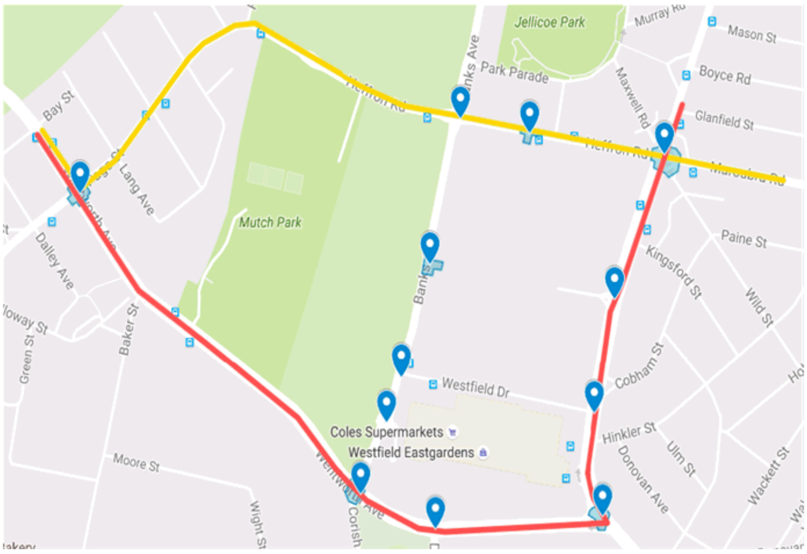

Figure 8 Travel time routes assessed *(source: Matrix traffic and transport data)*

3 Network Development

The network was initially created through the importation of an open street map data file of the study area. The network was then subsequently refined using aerial images from SIXmaps until the required level of detail was obtained.

3.1 Road hierarchy

Three primary road types have been used in the model, sub-arterial (orange), collector (yellow) and local roads (white) as shown in Figure 9. Although not specifically built as sub arterial roads, Page Street and Heffron Road perform a sub-arterial function with regards to network connections. The coding of road types was undertaken primarily for static model adjustments and static assignment.

Figure 9 Road Hierarchy

3.2 Travel speeds

Travel speeds within the network have been applied in accordance with posted speeds. These are generally as follows:

- 70km/h along Wentworth Road
- 60km/h along Bunnerong Road
- 50km/h along all residential roads

The default speed distributions within each of these speed categories have been adopted.

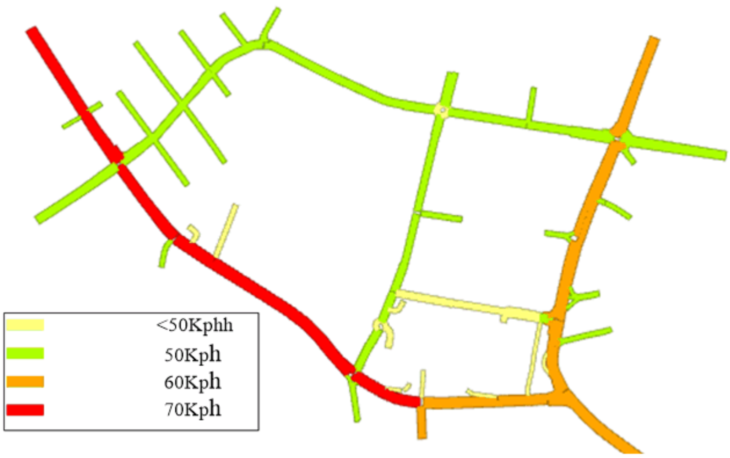

Figure 10 Speed ranges within model

3.3 Public transport

Buses are the only form of public transport (excluding taxis) within the study area. Table 2 highlights the bus routes that have been coded within the model. Dead running buses and school buses have not been explicitly coded as it is expected that these services will be captured within the heavy vehicle counts.

The bus interchange at Eastgardens has been coded as a bus only area with a few buses starting and terminating in this area. Site observations indicated that there was no congestion associated with bus layovers and as such there was no need to explicitly model bus layovers.

Table 2 Bus routes included within the model (2017)

Route
301
302
310, X10
316, 317
353
391, 392, X92
400, 410

3.4 Signal operations

Actuated signals have been coded into the model to capture the variability of signal times within Pagewood. A maximum and minimum green time was specified for all phases with some having the ability to be skipped if no demand was present. A gap out parameter of 5 seconds was used with some of the mainline movements having a reducing gap parameter to account for potentially long green times.

The reducing gap parameter reduces the gap required for gapping out over a specified time-period so that phases have the ability to substantially extend the maximum green time only when necessary.

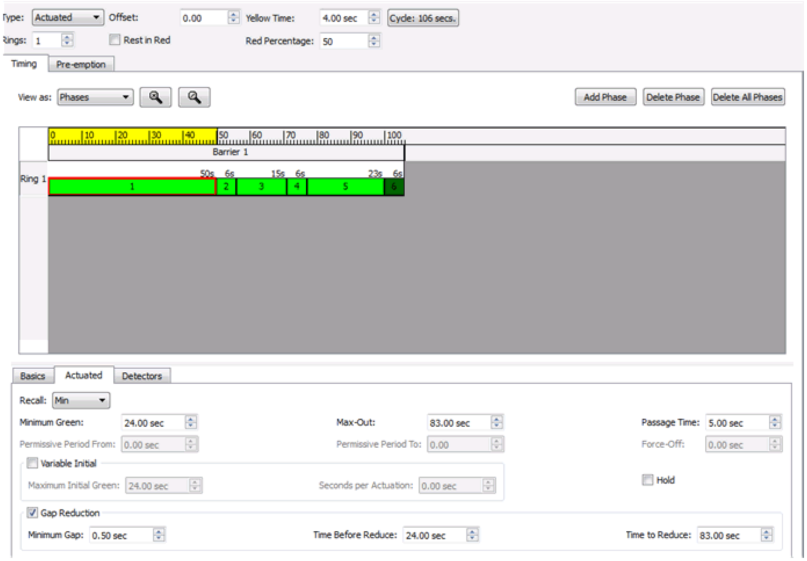

Figure 11 Example of Actuated Signal Coding

Table 3 compares the phase green time proportion for the signalised intersections in the model with observed values. This highlights that most of the modelled actuated signals are acceptable as per Table 11.3 page 105 of the *Roads and Maritime Modelling guidelines (Roads and Maritime, 2013)*. The table that modelled cycle time and green time for each phase should be within 10 percent of the observed. The modelled cycle times all fall within 10 percent of the observed and as such, it was not shown in this document.

The phase times at the intersections of Bunnerong Road / Westfield Drive, Wentworth Avenue / Corish Circle, Bunnerong Road / Wentworth Avenue, and Westfield Drive / Banks Avenue all sit within the criteria recommended by the Roads and Maritime guidelines save for two phases. These two phases were the second phase for both the PM and weekend peak period for the Bunnerong Road / Westfield Drive intersection and is due to the balance between green times given to the right hand turn and the through movement. The right turn starts as a filter before transitioning to a trailing right turn arrangement. In the weekend peak the through movement is running for a larger proportion of the green time than observed with the right-hand turn running for less. In the model, vehicles are finding gaps in traffic during the filter turns while it is more likely that less confident drivers will instead wait for the priority phase as they know this phase is coming. The difference of 13% and 15% is not considered to be significant enough to apply a different signal logic from the other signals.

The three-phase operation at the Wentworth Avenue / Denison Road intersection lies just 4% above the required criteria in the PM peak. The modelled phase time of phase A is noticeably shorter than the observed phase times. This is due to the actuated phase, phase B, being called more often in the model. The actuation of phase B relies on the eastbound right turn movement. However, as the number of right turning movements from the model match the observed counts, the difference in the phase times is not related to higher volumes but could be instead due to the lack of platooning from the upstream intersection. Additionally, since the slight change in phase times produces only a very localised effect and does not directly affect the development site to the north, the focus of this study, it is not considered to cause any significant issues.

The intersection at Wentworth Avenue / Page Street shows phase times for the second phase slightly over than the criteria at 2% during the PM peak. The issue is caused by the actuation in phase B occurring more often in the model than observed. The actuation of phase B is caused by the southbound right turn movement from Wentworth Avenue to Page Street. As the phase is happening less in the model than the observed it shows that more vehicles in the model are finding gaps during the filtered right turn in the previous phase than observed on site, because more conservative drivers are aware of the trailing right hand turn and thus only accept larger than normal gaps. This movement is only 4% above the criteria and again is not considered significant enough to warrant applying different signal logic.

The phase times at the Bunnerong Road / Heffron Road intersection show the A phase running 1% over the criteria in the PM peak period and 3% in the weekend peak periods. While this may seem large, the overall phase time itself is relatively short (34s), and so 3% of that only reflects a 1 second difference for both peak periods.

Table 3 Phase Green time proportions, Modelled vs Observed

Intersection	Run	Phase	Modelled	Observed	abs diff
Bunnerong_Westfield	AM	1	78%	76%	2%
		2	7%	10%	3%
		3	15%	14%	1%
	PM	1	62%	52%	9%
		2	10%	25%	15%
		3	28%	22%	6%
	WE	1	54%	44%	10%
		2	18%	31%	13%
		3	28%	24%	4%
Wentworth_Corish	AM	1	60%	54%	6%
		2	9%	11%	3%
		3	23%	24%	1%
		4	8%	10%	2%
	PM	1	53%	49%	5%
		2	14%	17%	3%
		3	25%	30%	5%
		4	8%	5%	3%
	WE	1	49%	51%	1%
		2	16%	17%	1%
		3	26%	29%	2%
		4	8%	4%	4%
Bunnerong_Wentworth	AM	1	49%	50%	1%
		2	13%	18%	4%
		3	38%	33%	5%
	PM	1	51%	48%	4%
		2	8%	17%	9%
		3	41%	36%	5%
	WE	1	45%	44%	1%
		2	19%	19%	0%
		3	35%	36%	1%
Banks_Westfield	AM	1	76%	86%	10%
		2	24%	14%	10%
	PM	1	78%	78%	0%
		2	22%	22%	0%
	WE	1	77%	80%	3%
		2	23%	20%	3%

Intersection	Run	Phase	Modelled	Observed	abs diff
Wentworth_dension	AM	1	44%	53%	9%
		2	19%	20%	1%
		3	37%	27%	9%
	PM	1	44%	58%	14%
		2	18%	12%	6%
		3	38%	30%	8%
	WE	1	48%	54%	6%
		2	14%	13%	0%
		3	39%	33%	6%
Wentworth_Page	AM	1	39%	38%	1%
		2	12%	22%	10%
		3	24%	19%	5%
		4	25%	21%	4%
	PM	1	47%	45%	2%
		2	5%	17%	12%
		3	20%	19%	0%
		4	28%	19%	10%
	WE	1	54%	46%	7%
		2	1%	8%	7%
		3	23%	27%	4%
		4	23%	19%	4%
Bunnerong_Heffron	AM	1	38%	30%	8%
		2	10%	14%	4%
		3	9%	17%	8%
		4	21%	24%	3%
		5	22%	15%	7%
	PM	1	42%	31%	11%
		2	10%	14%	4%
		3	23%	27%	4%
		4	19%	17%	2%
		5	7%	10%	3%
	WE	1	44%	31%	13%
		2	9%	15%	6%
		3	20%	27%	7%
		4	17%	17%	0%
		5	11%	10%	1%

3.5 Priority controlled movements

Priority control movements at intersections as well as right turn filter movements at signalised intersections have had priority rules applied. These priority rules (known as warnings in Aimsun) are consistent with observed signposted and functional priorities in the Pagewood area. Figure 12 details the gap acceptance parameters used in the model.

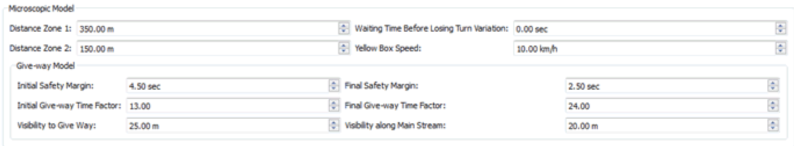

Figure 12 Gap acceptance parameters

The initial safety margin is the initial gap that vehicles will look for. After 58.5 seconds (4.5 x 13.0), vehicles will decrease their gap acceptance linearly to a gap of 2.5 seconds over a 60 second (2.5 x 24.0) period. The visibility to give way (25m) is when vehicles start to look for a gap and visibility along main stream (20m) is the distance into the opposing stream of traffic that vehicles can see.

3.6 Traffic management

Traffic management functions have been used in Aimsun to model lane closures, school zones and traffic calming devices (e.g. chicanes and speed humps). Lane closures have been modelled for Wentworth Avenue westbound in the PM and weekend models to account for parking that is restricted for only park of the simulation period. A speed change has been used to model the school zone on Bunnerong Road that is similarly only active for part of the AM simulation period. A permanent speed change is used for sections along Page Street / Heffron Road corridor to capture the effects of the traffic calming devices along this corridor. The speed change is representative of the suggested speed of 25km/hr.

3.7 Pedestrian conflicts

Pedestrian right of way conflicts within the model have been coded using the traffic management functionality "Periodic Section Incident". A periodic section incident will close off a section of road for a specified period of time based on an occurrence rate and an occurrence length. The average arrival interval of a pedestrian at a crossing based of the pedestrian volumes was used for the occurrence rate and the occurrence length was based of calculated crossing times. A standard deviation was applied to both the occurrence rate and length to randomise the closures.

Figure 13 Periodic section incident at the location of a zebra crossing

The effect of pedestrian crossings on signal times was not explicitly modelled due to signals being coded as actuated. However, as the green time proportions in the model matched the green time observed it can be deduced that pedestrian effects at signals are being captured.

4 Base Model Development

4.1 Demand development

To model demand in the network, the study area was broken into 29 zones shown in Figure 14. Zones 101 to 114 are internal zones with the Meriton Properties site being covered by zone 108 and the BATA site by 109. Zones 1 through 15 are external zones.

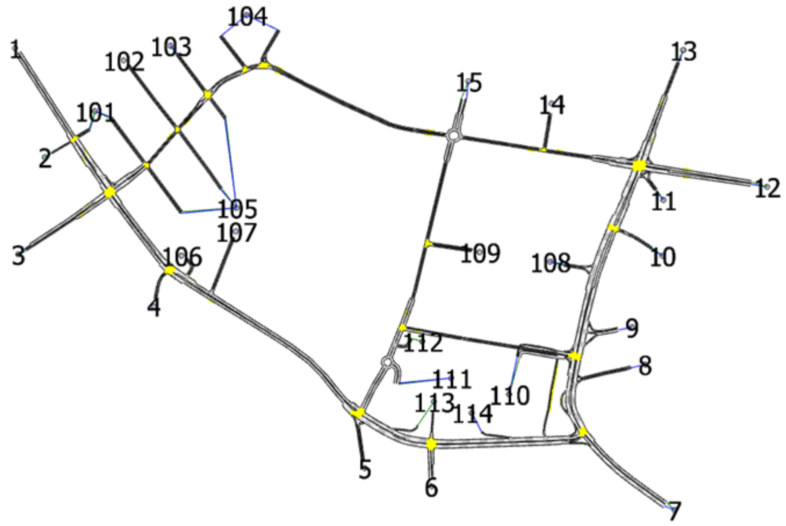

Figure 14 Zones used for demand development

To generate the correct matrix pattern, traffic from the internal zones was estimated using traffic generation rates based on land use and journey to work information. Estimations were then confirmed and/or corrected using site observations.

External zones were calculated using turn count survey data, by calculation the entering and exiting traffic volumes with major trunk movements deduced using wider network linkages and site observations. Once the total demand for each zone was estimated, a prior origin-destination matrix was constructed.

A static origin-destination (OD) adjustment scenario was run on the prior matrix in which the prior OD pairs were automatically adjusted by the modelling software to better match the turning count survey data. A deviation matrix was created also created and applied to restrict the amount of traffic that could be added or removed from model zones. This prevents unrealistic zone pair volumes such as unrealistically large weaving trips, which may match the survey data but are extremely unlikely to occur.

After the static OD adjustment was complete the matrices were manually checked for unrealistic zone pairs with some final manual edits being made to increase model calibrations.

The last step in the process was to split the matrices into 8, 15-minute periods to profile the volumes. Table 4 highlights the demand profile used in each peak period. These demand profiles were based on total volumes at the following intersections:

- Bunnerong Road & Heffron Road & Maroubra Road and Wild Street
- Bunnerong Road / Wentworth Avenue
- Wentworth Avenue / Page Street

Table 4 Demand Profile (based on three key intersections)

Time Period	AM total	AM percentage	PM total	PM percentage	WE total	WE percentage
1	2401	12%	2674	11%	2963	12%
2	2551	12%	2938	12%	2871	12%
3	2659	13%	3101	13%	2937	12%
4	2806	14%	3082	13%	2934	13%
5	2807	14%	3135	13%	3143	13%
6	2742	13%	3040	13%	2959	13%
7	2440	12%	2976	13%	3020	13%
8	2227	11%	2760	12%	2892	12%

4.2 Traffic assignment

Traffic was assigned to the network using a combination of dynamic user equilibrium assignment (DUE) and stochastic assignment. The DUE assignment involves running a series of iterations to calculate the optimum solution in which all route choices within each OD pair experiences the same travel time/cost.

The paths from this DUE were then input into five stochastic assignment runs, each with a different seed number (560, 28, 7771, 2849, 86524, as per the Roads and Maritime modelling guidelines).

The DUE convergence plots for the AM, PM and weekend are shown below. All models reached the 0.5% relative gap threshold and converged in less than 20 iterations.

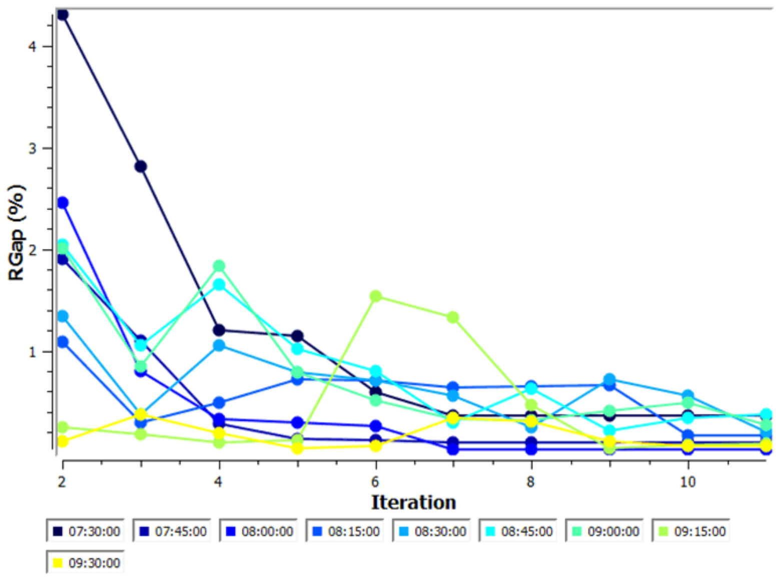

Figure 15 AM DUE Convergence

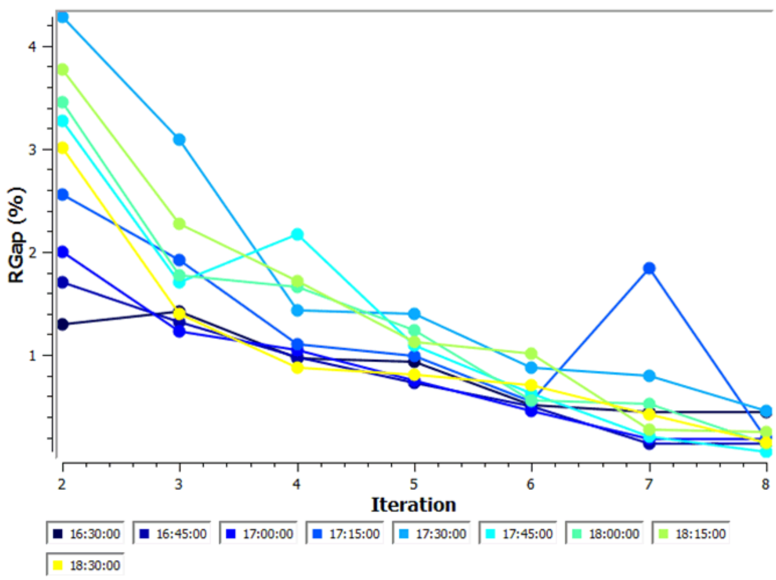

Figure 16 PM DUE Convergence

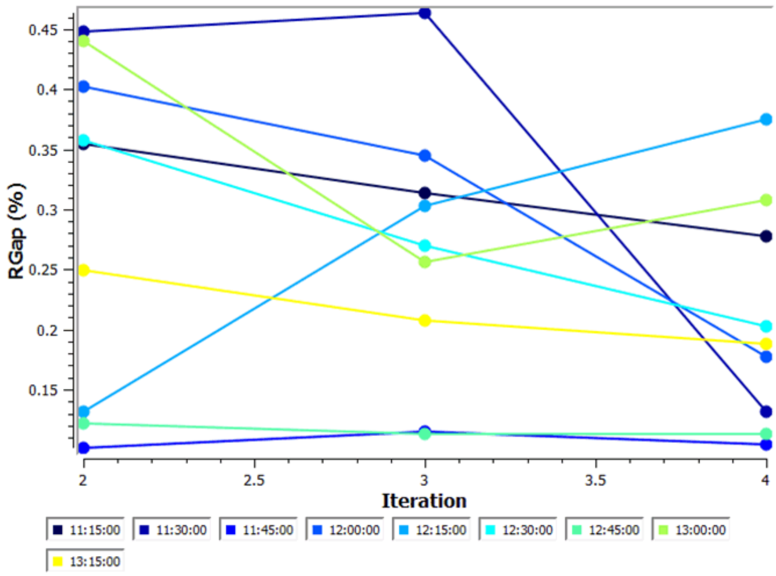

Figure 17 Weekend DUE Convergence

4.3 Model stability

Section 11 of the *Roads and Maritime Modelling guidelines* provide guidance on calibrating and validating microsimulation traffic models. For the purposes of presenting calibration results, the guidelines suggest comparing vehicle hours travelled for each simulated seed run and identifying the median value. As shown in Table 5, the comparison shows that the median seed for the AM peak is 7,771, PM peak is 2,849, and weekend peak is 28.

Table 5 Total travelled time (in hours) for each peak period and seed number (medians highlighted)

Seed No.	AM	AM difference from mean	PM	PM difference from mean	Weekend	Weekend difference from mean
28	644.48	1%	719.97	3%	752.83	0%
560	662.60	1%	751.02	1%	762.52	1%
2849	637.20	3%	740.83	0%	741.70	1%
7771	654.09	0%	742.30	0%	737.88	2%
86524	660.03	1%	733.66	1%	763.23	1%

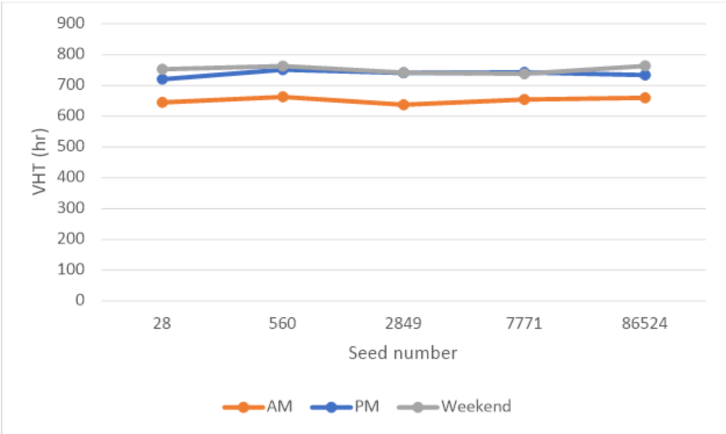

Figure 18 VHT for AM, PM and weekend models

As shown, there is not much variance in the vehicle hours travelled (VHT) in AM, PM or weekend models with the largest difference from the mean being 3%.

The highlighted median seeds were used for the volume and travel time validation for the corresponding peak periods.

5 Base Model Calibration

Table 11.2 of the *Roads and Maritime Modelling guidelines* state that the proportion of links within a microsimulation model with a GEH of 5 or lower to be greater than 85% across the whole network. Plots showing the observed volumes compared to modelled volumes using the corresponding median seed simulations are shown in Figure 19, Figure 20 and Figure 21 for AM, PM and weekend traffic respectively.

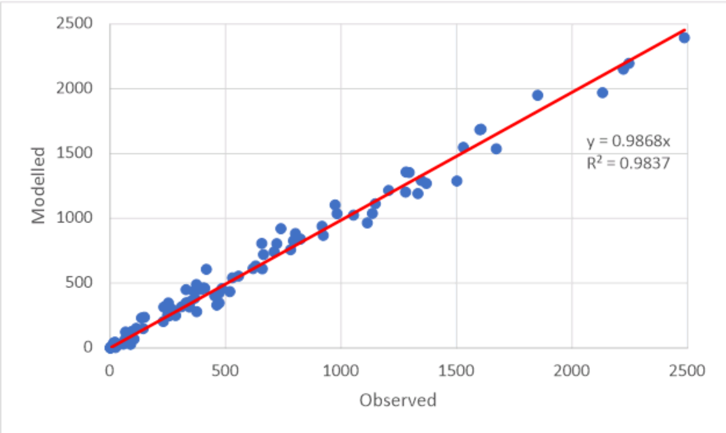

Figure 19 Observed vs modelled plot for AM peak traffic

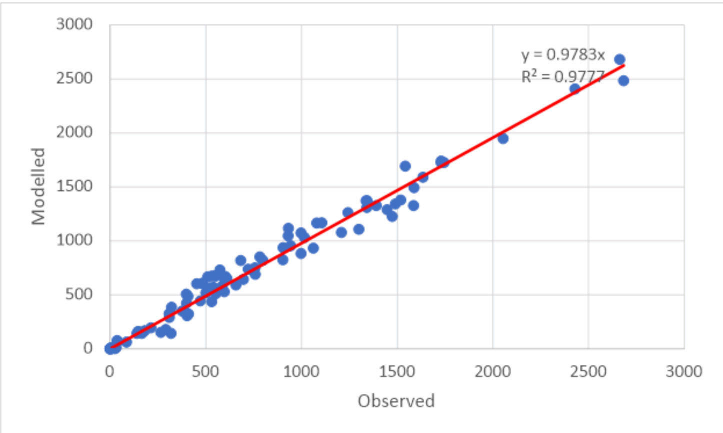

Figure 20 Observed vs modelled plot for PM peak traffic

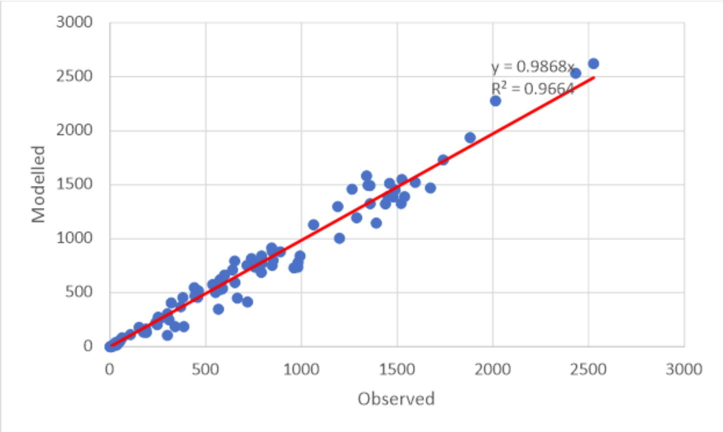

Figure 21 Observed vs modelled plot for weekend traffic

The R squared values are above 96% in all scenarios indicating very good fits between the observed and modelled volumes. The cumulative percent distribution GEH plots are shown in Figure 22, Figure 23 and Figure 24 for AM, PM and weekend traffic respectively.

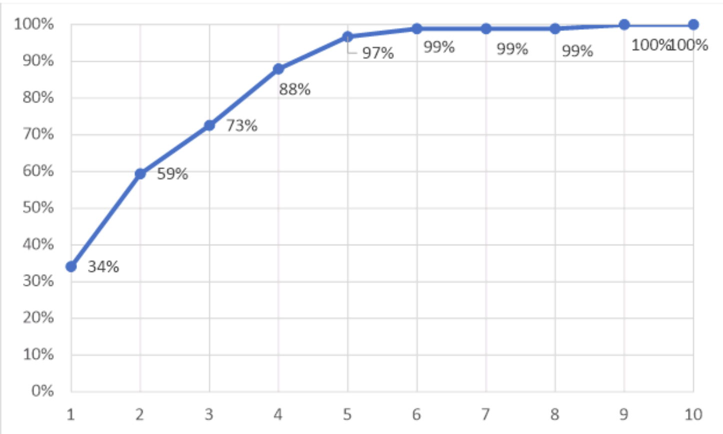

Figure 22 GEH distribution plot for AM traffic

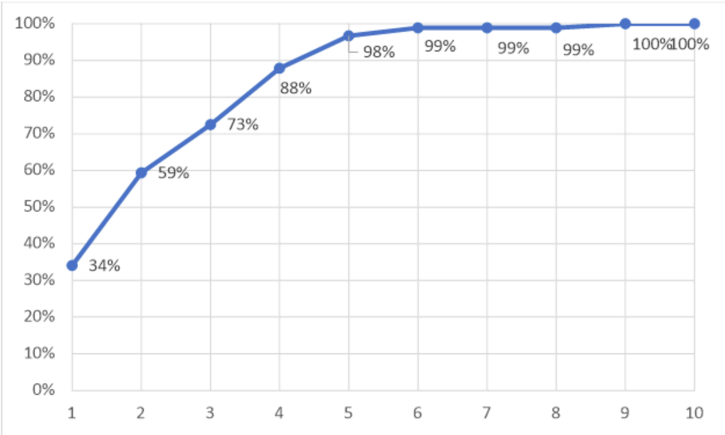

Figure 23 GEH distribution plot for PM traffic

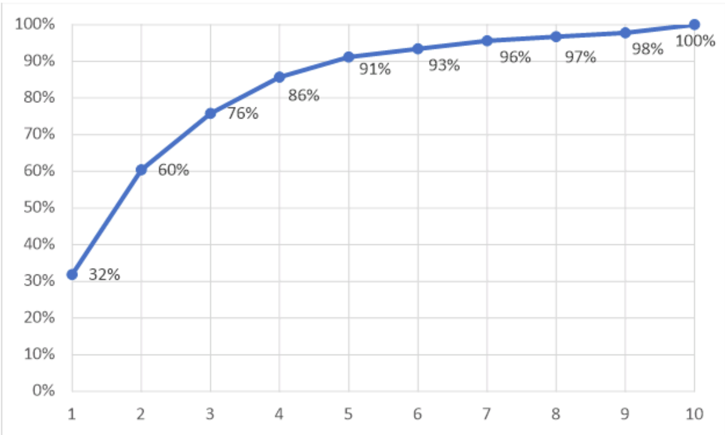

Figure 24 GEH distribution plot for weekend traffic

As shown, the proportion of links with GEH lower than or equal to 5 exceed 85% as suggested by the *Roads and Maritime Modelling guidelines*. The weekend peak exhibits lower GEH overall compared to the weekday AM and PM peaks but is still well within the 85% threshold.

Table 6 GEH Summary Statistics

Model	GEH < 5	GEH < 10
AM Peak	98%	100%
PM Peak	97%	100%
WE Peak	91%	100%

6 Base Model Validation

As described in Section 2, travel time data was also collected for two routes. Both routes have the same start and end points: from the Wentworth Avenue / Page Street intersection to Maroubra Road / Bunnerong Road intersection.

Route 1 travels via Page Street and Heffron Road while Route 2 travels via Wentworth Avenue and Bunnerong Road as shown in Figure 25.

Figure 25 Location of travel time routes

6.1.1 Travel time results

Table 11.3 from the *Roads and Maritime Modelling guidelines* suggest that the modelled travel times should be within 15% of the observed travel times. The modelled travel times compared to the observed travel times are shown below for the AM, PM and weekend peaks.

6.1.1.1 AM peak

Modelled and observed travel times along Route 1 and Route 2 in both directions during the AM peak are shown in Figure 26, Figure 27, Figure 28 and Figure 29. Route 1 in the eastbound direction and Route 2 in the westbound direction lies marginally outside the specified criteria at certain sections. However, as shown in light blue, the minimum/maximum observed travel time depicts large variability in the data and so this issue is not considered significant.

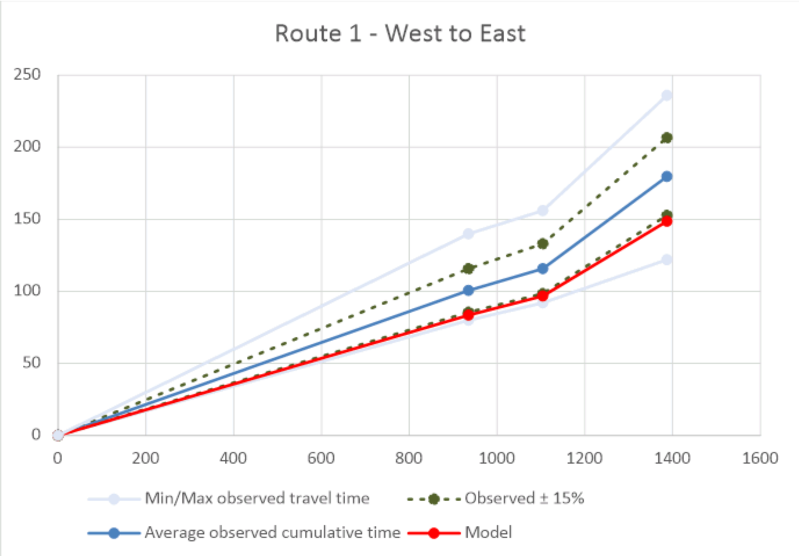

Figure 26 Route 1 - West to East (AM)

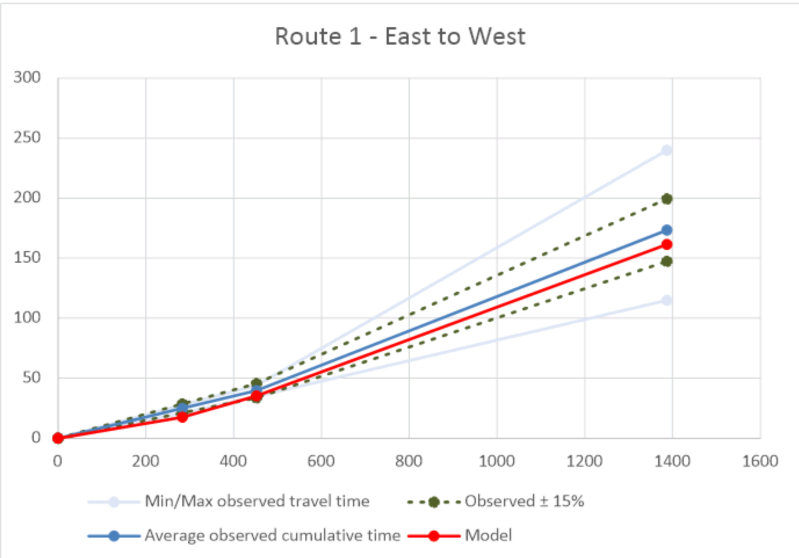

Figure 27 Route 1 - East to West (AM)

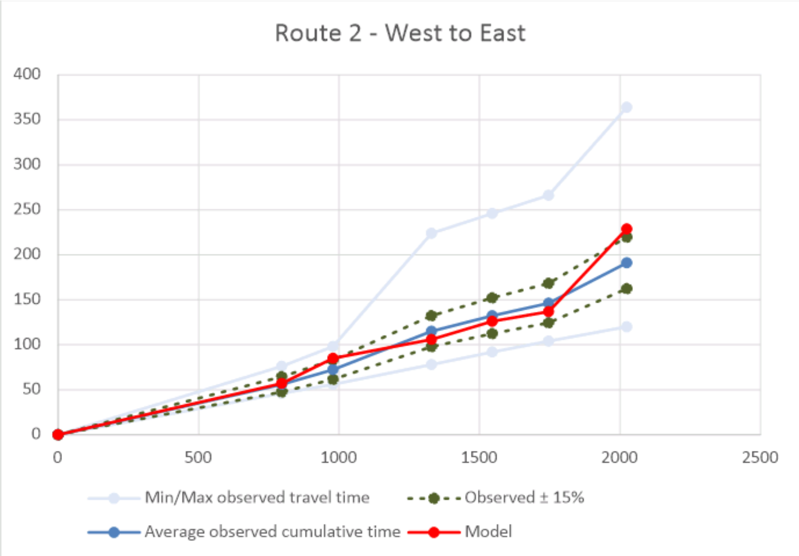

Figure 28 Route 2 - West to East (AM)

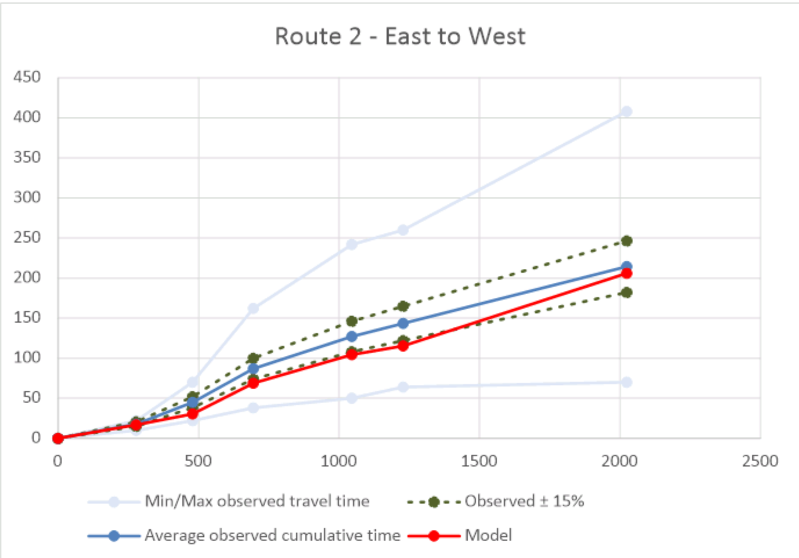

Figure 29 Route 2 - East to West (AM)

Table 7 Route 1 West to East (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	935	935	101	101	116	85	83	83
2	3	169	1104	15	116	133	98	13	97
3	4	283	1387	64	180	207	153	52	149

Table 8 Route 1 East to West (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
4	4	0	0	0	0	0	0	0	0
4	3	283	283	25	25	29	21	18	18
3	2	169	452	15	40	46	34	18	35
2	1	935	1387	134	173	199	147	126	161

Table 9 Route 2 West to East (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	796	796	56	56	64	48	57	57
2	3	182	978	16	72	83	61	28	85
3	4	351	1329	43	115	132	98	21	106
4	5	216	1545	17	132	152	112	20	126
5	6	201	1746	14	146	168	124	11	137
6	7	278	2024	45	191	220	162	92	229

Table 10 Route 2 East to West (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
7	7	0	0	0	0	0	0	0	0
7	6	278	278	18	18	21	15	17	17
6	5	201	479	27	45	52	38	14	30
5	4	216	695	42	87	100	74	38	69
4	3	351	1046	40	127	146	108	36	104
3	2	182	1228	16	143	165	122	11	115
2	1	796	2024	71	214	246	182	91	206

6.1.1.2 PM peak

Modelled and observed travel times along Route 1 and Route 2 in both directions during the PM peak are shown in Figure 30, Figure 31, Figure 32 and Figure 33. Modelled time for Route 1 east to west is slightly lower than the criteria however this is only in the first section and the remaining modelled section travel times match the observed. Along Route 2 in the eastbound direction, the travel time for one section was overestimated in the model. However, the difference between the modelled and observed cumulative travel time reduced with distance. Additionally, the modelled travel time lie within the range of travel times observed for the same time period. As such, this was not considered to be a significant issue. Although the overall modelled travel time along Route 2 west to east matches the observed data quite well, the modelled travel time is slightly higher than the observed for a short section. This could be attributed to the small sample size (11 over 2 hours) and the variance being located in between two closely spaced actuated intersections.

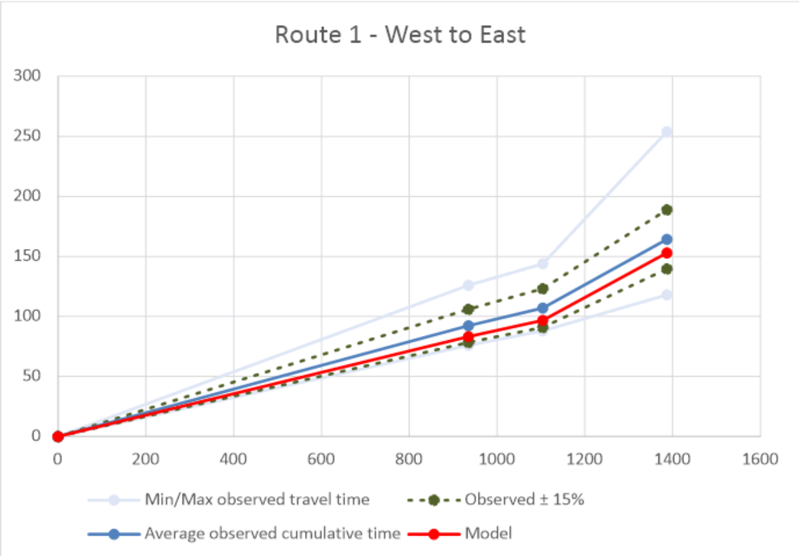

Figure 30 Route 1 - West to East (PM)

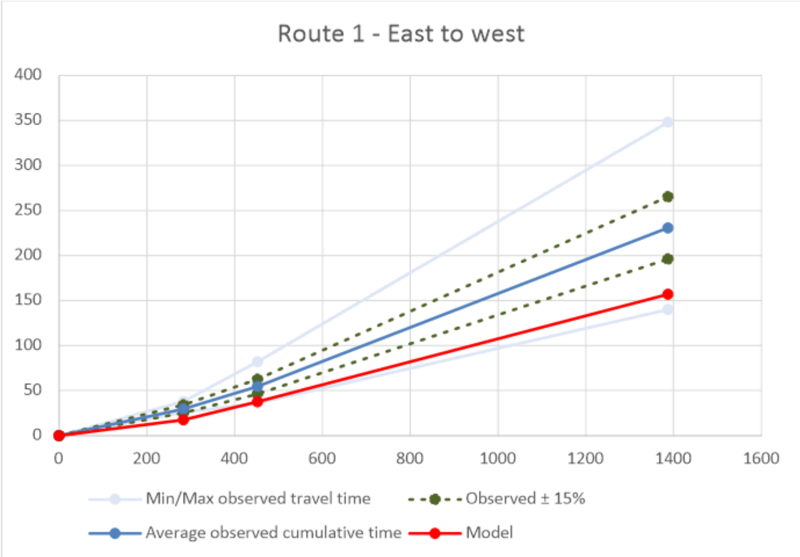

Figure 31 Route 1 - East to West (PM)

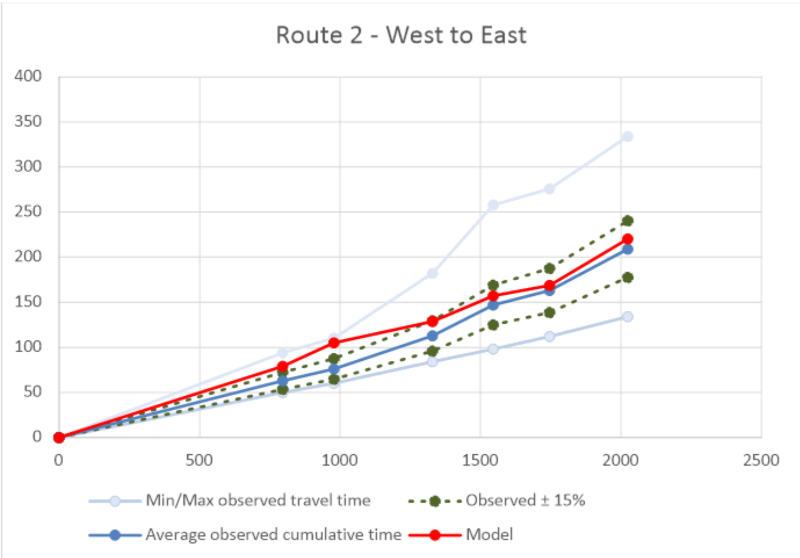

Figure 32 Route 2 - West to East (PM)

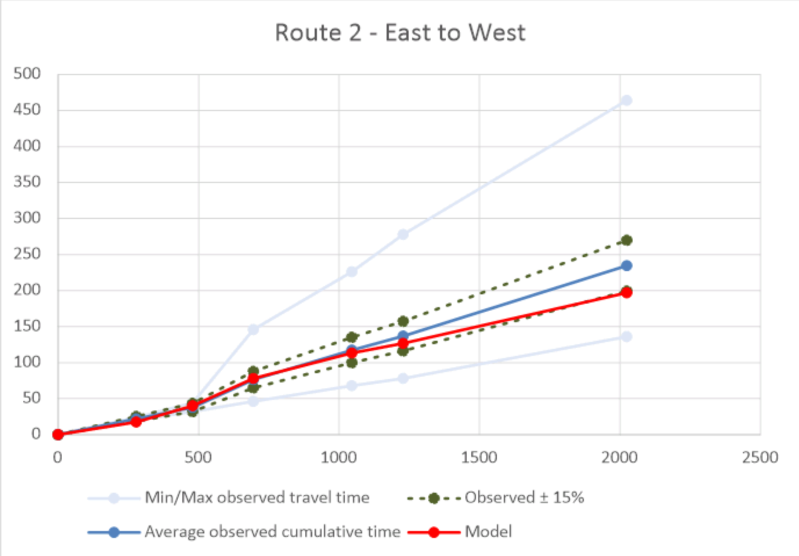

Figure 33 Route 2 - East to West (PM)

Table 11 Route 1 West to East (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	935	935	92	92	106	78	83	83
2	3	169	1104	15	107	123	91	13	97
3	4	283	1387	57	164	189	140	56	153

Table 12 Route 1 East to West (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
4	4	0	0	0	0	0	0	0	0
4	3	283	283	30	30	34	25	18	18
3	2	169	452	25	54	63	46	20	38
2	1	935	1387	176	231	265	196	119	157

Table 13 Route 2 West to East (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	796	796	63	63	72	53	79	79
2	3	182	978	13	76	87	65	26	105
3	4	351	1329	37	113	130	96	23	129
4	5	216	1545	34	147	169	125	29	157
5	6	201	1746	16	163	187	139	11	169
6	7	278	2024	46	209	240	178	52	220

Table 14 Route 2 East to West (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
7	7	0	0	0	0	0	0	0	0
7	6	278	278	22	22	25	19	17	17
6	5	201	479	16	38	43	32	22	40
5	4	216	695	39	76	88	65	38	78
4	3	351	1046	41	117	135	100	35	113
3	2	182	1228	19	137	157	116	13	127
2	1	796	2024	98	235	270	199	70	197

6.1.1.3 Weekend peak

Modelled and observed travel times along Route 1 and Route 2 in both directions during the weekend peak are shown in Figure 34, Figure 35, Figure 36 and Figure 37. Like the PM peak, Route 1 east to west performs slightly faster in the model compared to the observed but still lies within the large range of observed data and is therefore not considered a significant issue especially since how well the other calibration/validation measures such as volumes and signal timings match.

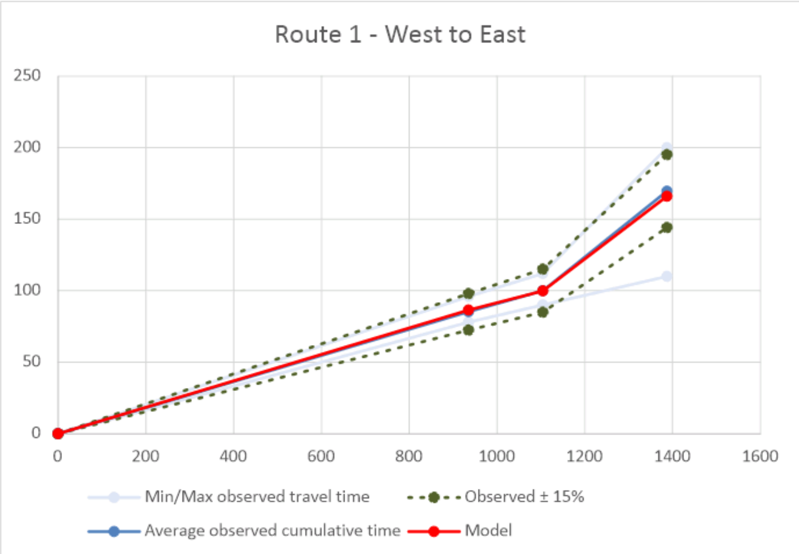

Figure 34 Route 1 - West to East (Weekend)

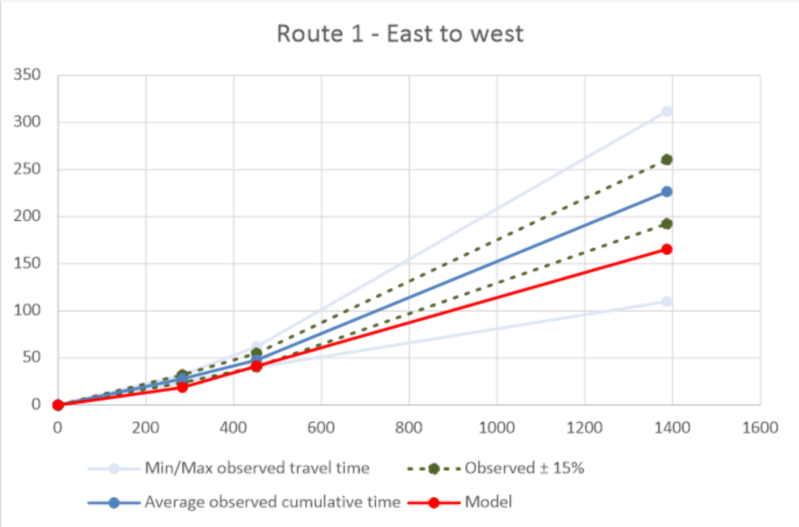

Figure 35 Route 1 – East to West (Weekend)

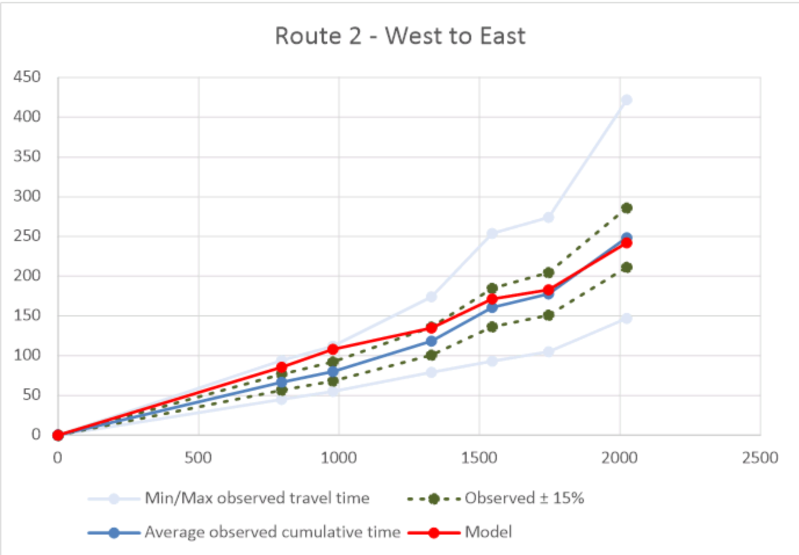

Figure 36 Route 2 - West to East (Weekend)

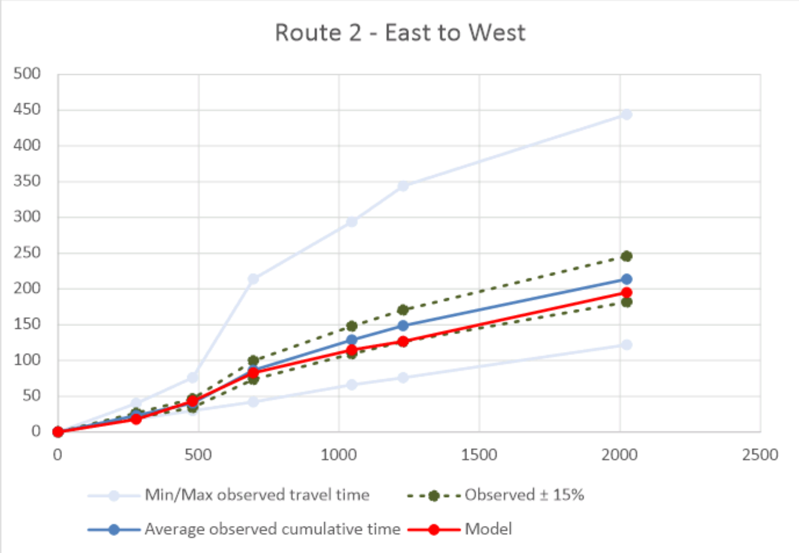

Figure 37 Route 2 - East to West (Weekend)

Table 15 Route 1 West to East (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	935	935	85	85	98	72	86	86
2	3	169	1104	15	100	115	85	13	100
3	4	283	1387	70	170	195	144	66	166

Table 16 Route 1 East to West (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
4	4	0	0	0	0	0	0	0	0
4	3	283	283	28	28	32	24	19	19
3	2	169	452	20	48	55	41	23	41
2	1	935	1387	179	227	261	193	124	166

Table 17 Route 2 West to East (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	796	796	67	67	77	57	85	85
2	3	182	978	13	80	92	68	23	108
3	4	351	1329	38	118	136	101	27	135
4	5	216	1545	42	161	185	137	37	172
5	6	201	1746	17	178	204	151	12	183
6	7	278	2024	71	249	286	211	59	242

Table 18 Route 2 East to West (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	Section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
7	7	0	0	0	0	0	0	0	0
7	6	278	278	23	23	27	20	18	18
6	5	201	479	17	40	46	34	25	43
5	4	216	695	46	87	100	74	40	83
4	3	351	1046	42	129	148	109	32	115
3	2	182	1228	20	149	171	126	12	127
2	1	796	2024	65	214	246	182	68	195

7 Future Demand Development

7.1 Methodology

The future traffic demands that are to be analysed using the traffic micro-simulation model have been developed based on projections of future land uses, increases in population and employment as well as historical growth along traffic corridors. A few residential and mixed-use sites are expected to be developed around the site in the near to medium term, including the currently approved developments on the British American Tobacco Australia (BATA) site. The additional traffic generated by these developments form a baseline future for assessment.

As the main purpose of this study is to analyse the impacts of the changes to development on the BATA site. The additional traffic will be calculated as a change to the original proposed development.

To cross check the demands, the proposed floor space and dwelling yields with associated employment and population forecasts are calculated and compared against government forecasts prepared by the Bureau of Transport Statistics for 2021. These checks indicate that the proposed scenarios being used in this study are broadly in line with this separate set of projections.

As the 2031 design year model is also required, a scenario was created for 10 years after completion of the development. The demand for year 2031 are calculated using similar growth factors. To increase accuracy the growth factors for different regions in the model were determined using a combination of population and employment forecasts. Through traffic movements and shopping centre traffic volumes were increased separately to maintain the separate distribution for these trips.

As shown in Figure 38, it is noted that the CBD and South East Light Rail (CSELR) Project is located to the north of the study site. However, the CSELR is expected to have insignificant impacts on the model due to the lack of alternate north-south routes running between the study area and the CSELR. There are no foreseeable changes elsewhere within the South East region that are likely to affect travel patterns throughout the study area.

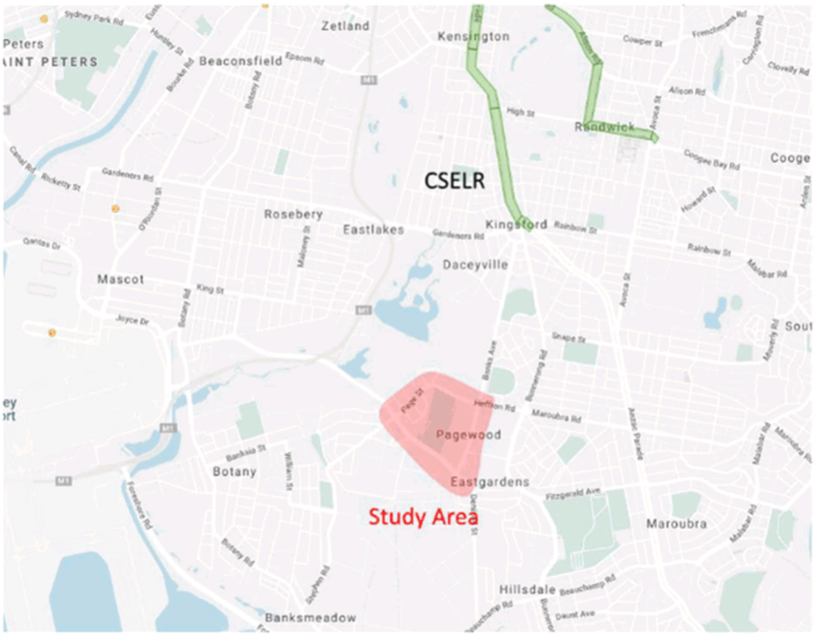

Figure 38 CSELR in relation to the study area

7.2 Design horizons

Two design year horizons were considered for the future year modelling, Year 2021 and 2031. Future baseline models as well as development models were developed for both horizon years. 2021 represents the year of completion and 2031 is the ten-year horizon past opening.

7.3 Development of Year 2021 demands

The future base traffic generation involves estimating both the increase in background traffic generation from approved developments, the increase in through trips and the increase in shopping trips to Eastgardens Westfield's. Subsequent options will be tested against this future base case.

Development traffic was then calculated as a change to the future base demands. Through this process, public transport and pedestrian demands remained as per the base model as it is unlikely public transport frequencies will increase in the immediate future and not ascertainable for the modelling to predict. Pedestrian demand was modelled using section incidents and an increase in pedestrians will not necessarily lead to a direct increase in conflicts with cars as pedestrians are likely to bunch.

7.3.1 Background traffic growth

At the micro-simulation level of granularity background growth is the traffic generated by the number of residential and mixed-use sites in and around the study area that are expected to be developed in the near future.

There are two developments within proximity to the site, Bunnings and the Orica development site, that along with the currently approved Meriton Properties development, will form the network background growth. It is also assumed that the BATA site under investigation will continue to operate as a warehouse. The background traffic generation is detailed below in Table 19 and Table 20.

Table 19 Meriton Properties Site traffic generation

Land Use	Size	Trip rates (2hr)			Traffic Generation (2hr)		
		AM	PM	WE	AM	PM	WE
Residential	2,222 units	0.44	0.41	0.39	977	924	868
Specialty Retail	5,000 m2	0	0.05	0.06	0	238	317
Childcare	4 centres (100-children each)	0.56	0.56	0	222	222	0
Warehouse	50,000 m2	0.01	0.01	0	397	397	0
Total					1,596	1,781	1,185

To calculate the traffic generation within the Meriton Properties development, trip rates were obtained from the Roads and Maritime Guide to Traffic Generating Developments and multiplied by a factor of 1.6 to convert them to 2-hour trip rates based on the peak profile. The land use units were then multiplied by these 2-hour trip rates to obtain 2-hour traffic generation as shown in Table 19 and Table 20.

Table 20 Adjacent land use changes traffic generation

Land Use	Size	Traffic generation (1hr)			Traffic Generation (2hr)		
		AM	PM	WE	AM	PM	WE
Bunnings	14,900m2	250	350	760	400	560	1216
Office	6,000m2	180	180	0	288	288	0
Industrial	60,000m2						
Masters	9,803m2	105	148	320	168	236	512
Total		535	678	1080	856	1084	1728

The peak hour trips for the adjacent land uses were obtained from the Botany/Banksmeadow Traffic Modelling Review (by SMEC dated March 2015). These values were for 1-hour, so they were multiplied by a factor of 1.6 to acquire 2-hour traffic generation.

This generated traffic was then considered in all the future scenarios.

7.3.2 Eastgardens traffic

Changes in population in the Eastgardens Catchment is expected to change access and egress traffic levels and distributions. The Eastgardens trade area extends around 5km to 7km radius from the centre. A 6.5km boundary was drawn around Eastgardens with the catchment being broken up into 4 quadrants whose size depends on network access, see Figure 39. The predicted population increases for the travel zones within each of these quadrants was then assessed to calculate the increase in traffic and any potential change in traffic profile. The largest increase in traffic was experienced to the north and south.

Table 21 Eastgardens growth rates

Quadrant	Population Increase to 2021	Population Increase to 2031 from 2021
North	23%	15%
East	11%	13%
South	20%	14%
West	14%	15%

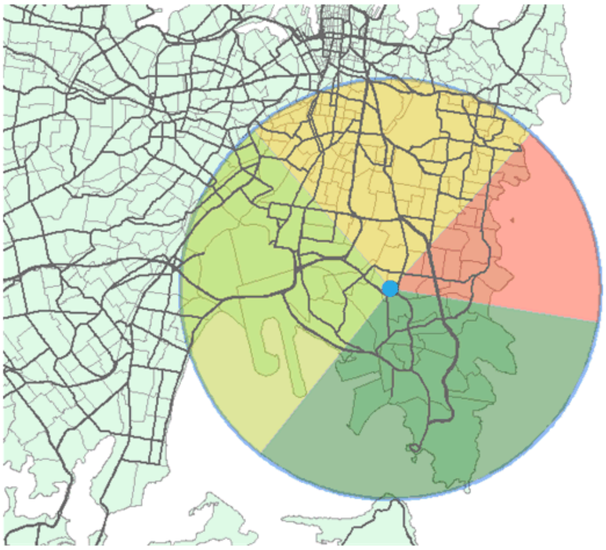

Figure 39 Eastgardens retail catchment

These growth rates then formed a growth matrix for only zones affected by the Eastgardens catchment. This growth matrix was then applied to the calibrated base matrix to form the future base matrix. The development of the future base matrices considers the background growth, through traffic growth and the Eastgardens growth.

7.3.3 Through traffic growth

The Roads and Maritime traffic volume viewer was used to assess increase in volumes on through movements, trips that start and end in external zones. Data for Wentworth Avenue was only available for two years, see Table 22, where a decrease was observed in the eastbound direction and an increase in the westbound. No data was available for Bunnerong Road with the closest count being located on Anzac Parade north of Lang Road. Given the lack of available information a 1% per annum growth rate was assumed for the through movements. This was later compared to the Strategic Forecast Traffic Model Forecasts supplied by Roads and Maritime and deemed sufficient.

Table 22 Wentworth Avenue traffic volumes *source: Roads and Maritime traffic volume viewer*

	2011	2015	Growth	Growth p.a.
Wentworth Ave (eastbound)	23,673	21,679	-8%	-2%
Wentworth Ave (westbound)	21,550	22,227	+3%	+1%

7.3.4 Development traffic

The changes to the development include the removal of the warehouse, the construction of an additional 1,639 residential apartments as well as the increase of 1,300 sqm Gross Floor Area (GFA) of retail on top of the total development up to 5,000 sqm GFA of specialty retail (original retail provision approved in 2014). Table 23 below highlights the original traffic generation numbers with the associated changes because of the above development traffic.

Table 23 Change to development traffic

Development Type	Original Development Proposal			Proposed Changes		
	AM	PM	WE	AM	PM	WE
Residential	977	765	868	+723	+725	+642
Retail	0	238	317	0	+48	+63
Childcare	222	222	0	+28	+28	0
Warehouse	397	397	0	-397	-397	0
Total	**1,596**	**1,781**	**1,185**	**+354**	**+404**	**+705**

The traffic generated by both Stage 1 and Stage 2 development is assumed to follow the same distribution as current Journey to Work trips for the surrounding area as documented in the *Arup BATA 2014 Traffic Report*. The zones in the previous model correlate well with zones in the new model being developed and so it is simple to allocate the trips generated by the development to origin-destination pairs.

Zone	Origin/Destination	PM Peak		SAT Peak	
		In	Out	In	Out
1	Wentworth Ave (W)	37%	16%	26%	26%
2	Heffron Road (W)	4%	2%	3%	3%
3	Banks Avenue (N)	4%	2%	3%	3%
4	Bunnerong Road (N)	5%	2%	4%	4%
5	Maroubra Road (E)	4%	2%	3%	3%
6	Bunnerong Road (S)	14%	6%	10%	10%
7	Denison Road (S)	4%	2%	3%	3%
		70%	30%	50%	50%

Figure 40 Development traffic distribution

7.4 Development of 2031 demands

As the 2031 design year horizon is an additional 10 years out (a total of 15 years from the survey data) it is not appropriate to try and account for all potential land use changes. As such, to develop demands for the 2031 design year horizon the Bureau of Transport Statistics population and employment forecasts were used to determine growth factors for all the internal zones between the years of 2021 and 2031.

The growth factors were determined for all travel zones within or immediately adjacent to the site except for the development travel zone. A growth factor matrix was created as opposed to applying a blanket growth factor to all demands. Traffic in the development zone would remain as per the proposed development planes. In the AM and PM peaks, a combination of population and employment was used to determine the growth factors with the combination depending on direction of travel. For the weekend peak, only population was used.

To account for through trips the 1% per annum growth rate was carried through to 2031 from 2021. Eastgardens traffic was estimated by again looking at the catchment growth, see Table 21. And a heavy vehicle growth factor was calculated based on the increase in employment only. Through this process, public transport and pedestrian demands remained as per the base model as the future of bus frequencies is uncertain due to the possibility of light rail being extended within the vicinity of Pagewood. Pedestrian demand was modelled using section incidents and an increase in pedestrians will not necessarily lead to a direct increase in conflicts with cars as pedestrians are likely to bunch.

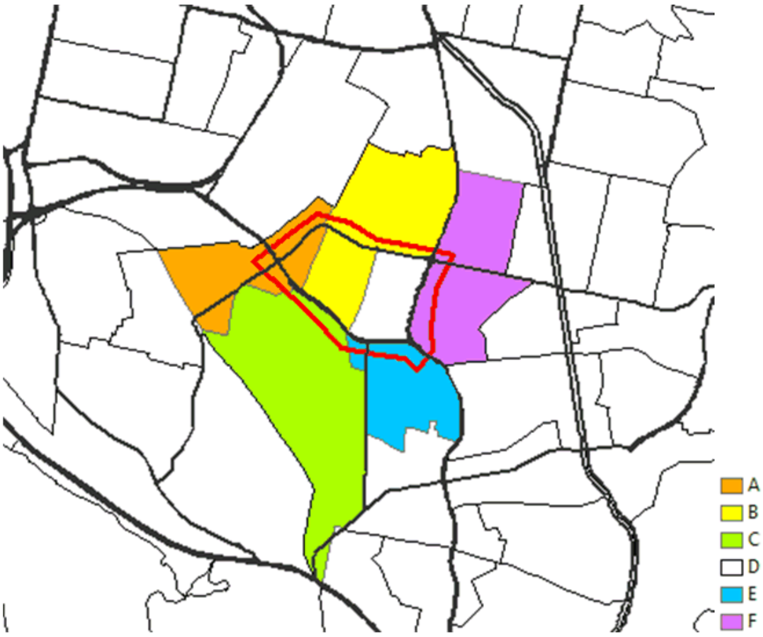

Figure 41 Study area travel zones

Table 24 Travel zones population and employment increases

Travel Zone	Population Increase	Employment Increase
A	6%	8%
B	5%	13%
C	0%	5%
E	46%	10%
F	9%	12%

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	101	102	103	104	105
1	-	7%	-	6%	7%	7%	-	9%	9%	9%	9%	-	-	10%	-	7%	7%	7%	7%	7%
2	7%	-	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	7%	7%	7%
3	-	7%	-	6%	7%	7%	-	9%	9%	9%	9%	-	-	10%	-	7%	7%	7%	7%	7%
4	4%	4%	4%	-	4%	4%	4%	6%	6%	6%	6%	6%	6%	7%	7%	4%	4%	4%	4%	4%
5	16%	16%	16%	14%	-	15%	15%	18%	18%	18%	18%	18%	18%	18%	18%	16%	16%	16%	16%	16%
6	16%	16%	16%	14%	15%	-	15%	18%	18%	18%	18%	18%	18%	18%	18%	16%	16%	16%	16%	16%
7	-	18%	-	16%	18%	18%	-	20%	20%	20%	20%	-	-	20%	-	18%	18%	18%	18%	18%
8	9%	9%	9%	7%	8%	8%	8%	-	11%	11%	11%	11%	11%	11%	11%	9%	9%	9%	9%	9%
9	9%	9%	9%	7%	8%	8%	8%	11%	-	11%	11%	11%	11%	11%	11%	9%	9%	9%	9%	9%
10	9%	9%	9%	7%	8%	8%	8%	11%	11%	-	11%	11%	11%	11%	11%	9%	9%	9%	9%	9%
11	9%	9%	9%	7%	8%	8%	8%	11%	11%	11%	-	11%	11%	11%	11%	9%	9%	9%	9%	9%
12	-	9%	-	7%	8%	8%	-	11%	11%	11%	11%	-	-	11%	-	9%	9%	9%	9%	9%
13	-	8%	-	6%	7%	7%	-	10%	10%	10%	10%	-	-	10%	-	8%	8%	8%	8%	8%
14	7%	7%	7%	5%	6%	6%	6%	9%	9%	9%	9%	9%	9%	-	9%	7%	7%	7%	7%	7%
15	-	7%	-	5%	6%	6%	-	9%	9%	9%	9%	-	-	9%	-	7%	7%	7%	7%	7%
101	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	-	7%	7%	7%	7%
102	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	-	7%	7%	7%
103	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	-	7%	7%
104	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	7%	-	7%
105	7%	7%	7%	6%	7%	18%	18%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	7%	7%	-

Figure 42 AM peak growth factor matrix

The process undertaken to calculate growth factor matrices for the model network is simplified as follows:

1. The travel zone increases shown in Table 24 were extrapolated to the corresponding zones in the traffic model
2. These increases may be averaged in the event of overlapping zones
3. Steps 1 and 2 are repeated for population increase as well as employment increase
4. A third matrix is created by averaging the travel zone difference, population difference as well as employment difference
5. The steps above are performed for the AM, PM and Weekend peak periods (as shown in Figure 42)

8 Future Network Changes

8.1 Wider network changes

There are three intersections in the network that being upgraded in the immediate future; Bunnerong Road and Heffron Road/Maroubra Road, Heffron Road and Banks Avenue, and Wentworth Avenue and Page Street. The changes are detailed below in Figure 43, Figure 44 and Figure 45.

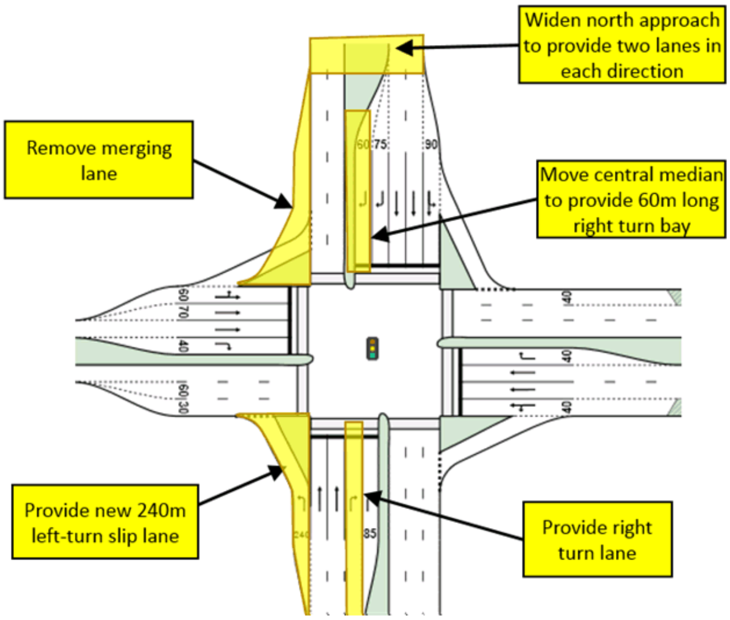

Figure 43 Bunnerong Road / Heffron Road changes, *source: Arup, 130-150 Bunnerong Road, Pagewood Section 34 Conference Report*

There has also been further signal optimisation of all the remaining signalised intersections except for Bunnerong Road / Wentworth Avenue to cater for the increased demand to and from Eastgardens Shopping Centre.

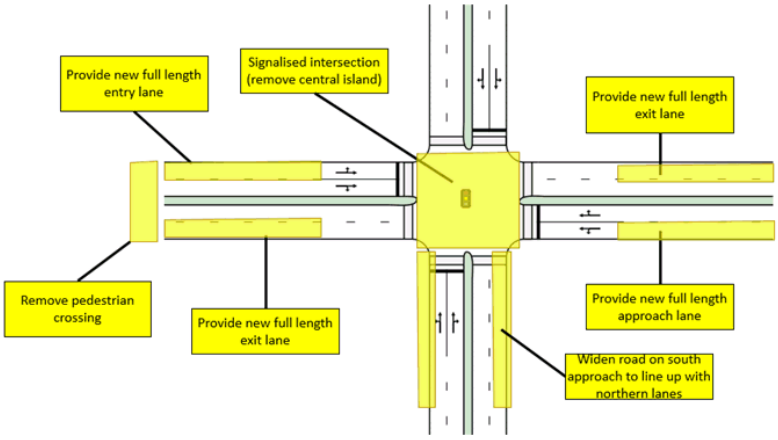

Figure 44 Heffron Road / Banks Avenue changes, *source: Arup, 130-150 Bunnerong Road, Pagewood Section 34 Conference Report*

Additional changes required because of background traffic included the expansion of Wentworth Avenue eastbound (with the removal of unused parking) to three lanes between Page Street and Banks Avenue allowed for the required additional capacity needed to reduce effective green time to the mainline movements. It is understood that this intersection is currently being tendered as a different layout, but no further information has been provided to update future traffic models. There are no further details available other than those obtained from the Botany/ Banksmeadow Traffic Modelling Review (by SMEC dated March 2015.

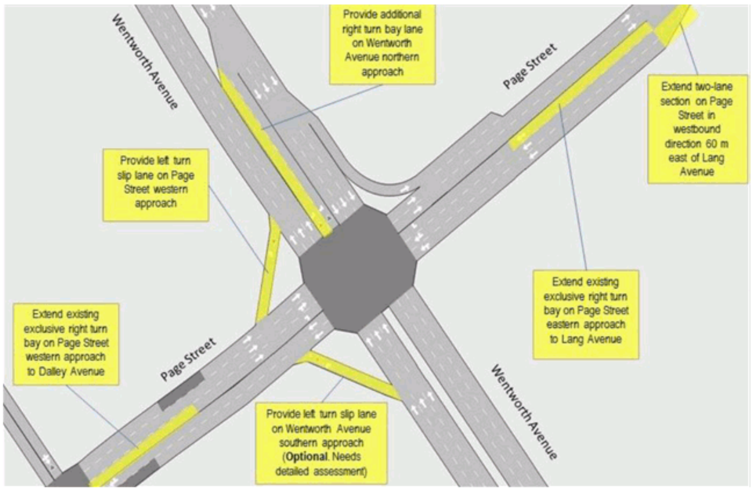

Figure 45 Wentworth Avenue and Page Street *source: SMEC*

8.2 Development network changes

8.2.1 Original masterplan

As per the original masterplan outlined in, *130-150 Bunnerong Road, Pagewood Section 34 Conference Report* the following network in the development site was coded as the future base model, see Figure 46.

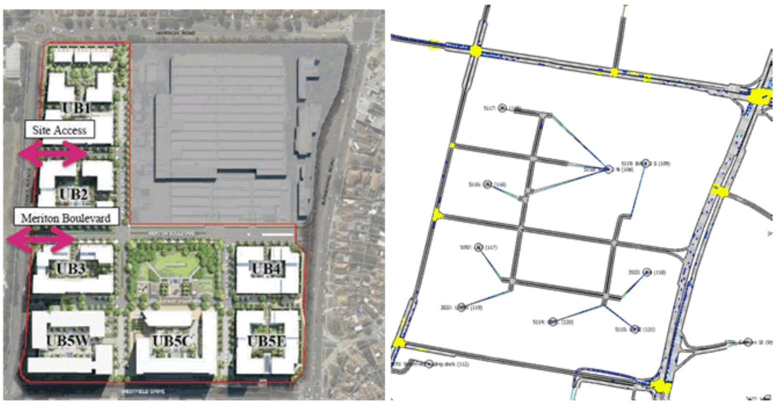

Figure 46 Original Pagewood masterplan

8.2.2 Future network testing

The proposed site intends to utilise the existing Meriton Boulevard accesses as external access arrangements (shown in Figure 47) which includes an all movements access to Banks Avenue to the west of the site (Meriton Boulevard only) and a left in and left out access to Bunnerong Road.

These accesses were the adopted access points for the traffic modelling, which create a balanced distribution across the external road network. Other access options were assessed, but this minimum layout forms the best-balanced approach

Figure 47 Future proposed masterplan

9 Results

9.1 Scenarios

In total 21 models were run including base year models, future base year models and future year development models. Table 25 below details each model scenario that was run for an AM, PM and Weekend peak period. For each scenario the intersection Level of Service (LoS), Travel time analysis and network performance will be explored.

Table 25 Model Scenarios

Model	Abbreviation	Design Year	Description
Base Model	Base	2016	Calibrated base model exploring existing conditions.
Future Base	FB	2021, 2031	Future base model that includes all likely and currently approved developments. This includes the original Meriton Properties Pagewood proposal. This model forms the benchmark for all future year models.
Future Development with Base	FBD	2021, 2031	Future year models that include the same future year base road network from the approved Stage 2 Masterplan (i.e. two access to Banks Avenue) with future development flows
Future Development	FD	2021, 2031	Future year models that includes all the changes to the previously proposed Meriton Properties development and improvements in the road network.

9.2 Year 2021 Intersection Level of Service (LoS)

The network statistics for the Year 2021 models are outlined in the following tables. These statistics compare the future base and development models. The results from the Year 2021 models are outlined further below. Further commentary for each peak period is provided.

Table 26 2021 Network Statistics for Average Speeds

Peak Period	Average Speeds (Km/hr)		
	Future Base	Future Base with Development Traffic	Future Development improvement
AM	33	31	33
PM	31	29	32
WE	29	28	30

Table 27 2021 Network Statistics for Average Delay

Peak Period	Average Delay (Seconds)		
	Future Base	Future Base with Development Traffic	Future Development improvement
AM	65	78	67
PM	74	86	73
WE	87	93	84

Table 28 2021 Network Statistics for Travel Time

Peak Period	Travel Time (seconds)		
	Future Base	Future Base with Development Traffic	Future Development improvement
AM	122	135	125
PM	132	144	131
WE	145	151	142

The results noted in the AM peak are also reflected in the PM peak period with some delay around the Wentworth Avenue / Banks Avenue / Corish Circle intersection as retail traffic to Westfield Eastgardens is intensified. Otherwise, overall the network operates well with LoS no greater than C.

In the overall network, the Wentworth / Page intersection performs worse than all other intersections in the PM peak period. Performance at this intersection is slightly better in the Future Development due to the proposed introduction of diamond phasing to better allocate phasing for the turning volumes.

Table 29 AM peak LoS results

Intersection	Future Base		Future Base with Development Traffic		Future Development improvement	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Heffron/ Maroubra/ Bunnerong	37	C	36	C	37	C
Bunnerong/ Westfield	11	A	14	A	14	A
Bunnerong/ Wentworth	20	B	22	B	19	B
Wentworth/ Dennison	27	B	30	C	29	C
Wentworth/ Banks/ Corish	29	C	27	B	31	C
Banks/ Westfield entrance	4	A	4	A	2	A
Banks/ Heffron	22	B	25	B	21	B
Wentworth/ Page	52	D	90	F	46	D

Results indicate that the intersections surrounding the Westfield Shopping Centre have greater impact. Specifically, this includes the intersection at Wentworth / Banks / Corish as well as the Wentworth / Denison intersection as they act as the primary access points to the area from the south. Otherwise, the results are overall very similar to the AM peak with minimal change as a result of the development.

Table 30 PM peak LoS results

Intersection	Future Base		Future Base with Development Traffic		Future Development improvement	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Heffron/ Maroubra/ Bunnerong	37	C	37	C	38	C
Bunnerong/ Westfield	16	B	23	B	19	B
Bunnerong/ Wentworth	20	B	21	B	17	B
Wentworth/ Dennison	32	C	33	C	37	C
Wentworth/ Banks/Corish	39	C	50	D	45	D
Banks/ Westfield entrance	4	A	5	A	3	A
Banks/ Heffron	31	C	36	C	21	B
Wentworth/ Page	56	D	66	E	42	C

The weekend scenarios display a similar pattern of delay as the PM but with increased overall delays due to increased retail demand from Westfield.

In the AM and PM peaks, all the intersections along Bunnerong Road remain largely unaffected. However, in the Weekend peak these intersections have higher demand especially at Heffron / Maroubra / Bunnerong.

At the Heffron/ Banks intersection, there is some evidence of "rat-running" observed, where people take unintended routes through the site to avoid signals on the main road network.

Table 31 Weekend peak LoS results

Intersection	Future Base		Future Base with Development Traffic		Future Development improvement	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Heffron/ Maroubra/ Bunnerong	47	D	45	D	45	D
Bunnerong/ Westfield	30	C	28	B	39	C
Bunnerong/ Wentworth	27	B	28	B	24	B
Wentworth/ Dennison	41	C	33	C	31	C
Wentworth/ Banks/ Corish	44	D	63	E	38	C
Banks/ Westfield entrance	5	A	5	A	4	A
Banks/ Heffron	24	B	26	B	24	B
Wentworth/ Page	47	D	51	D	50	D

9.3 Year 2031 Intersection Level of Service (LoS)

Despite the development traffic, the network capacity in 2031 was able to be improved over and above the existing future base scenario. This indicates that there is currently spare capacity on the network that is only restricted by the operation of a few key intersections.

The network statistics for Year 2031 are displayed below.

Table 32 2031 Network Statistics for average speeds

Peak Period	Average Speeds (Km/hr)		
	Future Base	Future Base with Development Traffic	Future Development improvement
AM	30	27	31
PM	26	25	28
WE	27	25	27

Table 33 2031 Network Statistics for average delay

Peak Period	Average Delay (Seconds)		
	Future Base	Future Base with Development Traffic	Future Development improvement
AM	80	106	73
PM	116	132	100
WE	110	131	102

Table 34 2031 Network Statistics for travel time

Peak Period	Travel Time (seconds)		
	Future Base	Future Base with Development Traffic	Future Development improvement
AM	138	164	130
PM	174	189	158
WE	168	188	160

As the AM peak period model has relatively lower demands, there is little change in the intersection level of service (LoS) as indicated in Table 35 except for Wentworth / Page which reports a LoS F with the Base networks. Where the development makes the most difference is in the PM peak period (see Table 36).

The diamond phasing at Wentworth Avenue and Page Street allows the intersections to effectively deal with the tidal peak demands competing with retail trips around the Westfield Eastgardens site. In the Weekend peak period (see Table 37), two of the intersections have increased demand, however overall there is still a network improvement.

As shown below, the intersection of Wentworth / Banks / Corish is unable to cope with the growth in PM and weekend demand and performs poorly in the Future Base and Future Base with Development Traffic. Wentworth / Banks / Corish performs poorly in the future base due to the retail within the area, resulting in a more pronounced peak. A similar but less pronounced effect can be seen at the Banks / Heffron intersection which is the primary northern access point.

Table 35 AM Peak Period Intersection Level of Service

Intersection	Future Base		Future Base with Development Traffic		Future Development improvement	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Heffron/ Maroubra/ Bunnerong	38	C	40	C	38	C
Bunnerong/ Westfield	12	A	17	B	16	B
Bunnerong/ Wentworth	22	B	23	B	23	B
Wentworth/ Dennison	31	C	32	C	31	C
Wentworth/ Banks/ Corish	35	C	50	D	36	C
Banks/ Westfield entrance	5	A	5	A	3	A
Banks/ Heffron	24	B	26	B	21	B
Wentworth/ Page	77	F	133	F	52	D

Table 36 PM Peak Period Intersection Level of Service

Intersection	Future Base		Future Base with Development Traffic		Future Development improvement	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Heffron/ Maroubra/ Bunnerong	41	C	38	C	42	C
Bunnerong/ Westfield	20	B	25	B	21	B
Bunnerong/ Wentworth	23	B	24	B	19	B
Wentworth/ Dennison	41	C	38	C	44	D
Wentworth/ Banks/ Corish	143	F	157	F	68	E
Banks/ Westfield entrance	5	A	5	A	13	A
Banks/ Heffron	33	C	43	D	35	C
Wentworth/ Page	76	F	90	F	47	D

Table 37 Weekend Peak Period Intersection Level of Service

Intersection	Future Base		Future Base with Development Traffic		Future Development improvement	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Heffron/ Maroubra/ Bunnerong	50	D	57	E	49	D
Bunnerong/ Westfield	42	C	69	E	65	E
Bunnerong/ Wentworth	29	C	30	C	25	B
Wentworth/ Dennison	46	D	51	D	40	C
Wentworth/ Banks/ Corish	79	F	117	F	50	D
Banks/ Westfield entrance	4	A	5	A	6	A
Banks/ Heffron	28	B	28	B	26	B
Wentworth/ Page	49	D	50	D	49	D

10 Summary

To assess the impacts of proposed developments, and works identified as part of the study, a micro-simulation model has been developed using software package Aimsun. The model has been calibrated and validated carried out using criteria defined by Roads and Maritime Traffic Modelling Guidelines. The key results of the models' calibration and validation against Roads and Maritime criteria are as follows.

- Intersection turning movements satisfied GEH criteria for each of the three peak periods assessed with 85% of GEH below 5 and 100% below 10.
- The R^2 was greater than 0.9 for each peak period, when plotting modelled and observed traffic flows.
- The travel time routes were generally within approximately 15% or 1 minute with only one route in each peak period being slightly quicker than observed.
- Observations made onsite at areas of congestion were generally comparable to behaviours observed within the model

The input data, model development, calibration and validation are considered to have produced a model that is considered 'fit for purpose' for the type of study being undertaken.

Through the operational modelling process, it was found that the development yields have little impact on the network with some increases in delays at certain intersections. In the weekend peak however, the development traffic is delayed accessing the wider network due to the intensification of retail traffic around Eastgardens with the associated congestion.

It was also found that as the road network is expanded, and additional connections are added to the wider network, delays increase. This is in part due to the intensification of traffic around Eastgardens from the growth in the retail catchment. This new traffic is using the expanded network for alternative routes increasing turning movements and the associated merging and weaving behaviour reducing road capacity.

In summary, the network is considered operates satisfactorily with the expanded development and upgrades already committed to, however it is advisable that the road layout is refined as to minimise new connections onto Banks Avenue and Heffron Road. It is also advisable to assess possible changes to the network to account for the increased demand to Eastgardens shopping centre as retail traffic has the largest effect on the network.

Appendix ATurning Movement Summary

Note that all volumes given are for the two-hour peak periods identified in Section 1.6.

Table 34 AM turn count calibration results

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Heffron//Bunnerong	1_NE_NW	268	299	1.3
Heffron//Bunnerong	1_NE_S	472	348	4.3
Heffron//Bunnerong	1_NE_SE	24	4	3.8
Heffron//Bunnerong	1_NE_SW	722	805	2.1
Heffron//Bunnerong	1_NW_NE	249	255	0.3
Heffron//Bunnerong	1_NW_S	983	1036	1.2
Heffron//Bunnerong	1_NW_SW	362	437	2.7
Heffron//Bunnerong	1_S_NE	329	451	4.4
Heffron//Bunnerong	1_S_NW	1333	1192	2.8
Heffron//Bunnerong	1_S_SW	104	70	2.6
Heffron//Bunnerong	1_SE_S	21	45	3.0
Heffron//Bunnerong	1_SW_NE	803	883	1.9
Heffron//Bunnerong	1_SW_NW	657	807	3.9
Heffron//Bunnerong	1_SW_S	79	47	2.9
Heffron/Site access	10_E_W	1281	1359	1.5
Heffron/Site access	10_W_E	1601	1686	1.5
Heffron/Banks	11_E_in	1295	1355	1.2
Heffron/Banks	11_E_out	1606	1689	1.4
Heffron/Banks	11_E_thr	454	402	1.8
Heffron/Banks	11_N_in	530	541	0.3
Heffron/Banks	11_N_out	794	827	0.8
Heffron/Banks	11_N_thr	1530	1549	0.3
Heffron/Banks	11_S_in	332	347	0.6
Heffron/Banks	11_S_out	402	463	2.1
Heffron/Banks	11_S_thr	1347	1293	1.1
Heffron/Banks	11_W_in	1851	1951	1.6
Heffron/Banks	11_W_out	1206	1216	0.2
Heffron/Banks	11_W_thr	473	424	1.6
Wentworth/Page	12_E_S	136	231	5.0
Wentworth/Page	12_E_W	2247	2197	0.8

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Wentworth/Page	12_N_E	44	32	1.4
Wentworth/Page	12_N_S	375	281	3.7
Wentworth/Page	12_N_W	740	921	4.4
Wentworth/Page	12_S_E	344	316	1.1
Wentworth/Page	12_S_N	782	759	0.6
Wentworth/Page	12_S_W	367	384	0.6
Wentworth/Page	12_W_E	2487	2394	1.3
Wentworth/Page	12_W_N	974	1104	2.9
Wentworth/Page	12_W_S	484	458	0.8
Bunnerong/Westfield	3_E_S	20	22	0.3
Bunnerong/Westfield	3_N_S	1054	1025	0.6
Bunnerong/Westfield	3_N_W	519	436	2.7
Bunnerong/Westfield	3_S_N	1672	1537	2.4
Bunnerong/Westfield	3_S_W	394	453	2.0
Bunnerong/Westfield	3_W_N	113	152	2.4
Bunnerong/Westfield	3_W_S	67	124	4.1
Bunnerong/Wentworth	4_N_S	619	613	0.2
Bunnerong/Wentworth	4_N_W	556	554	0.1
Bunnerong/Wentworth	4_S_N	1370	1270	1.9
Bunnerong/Wentworth	4_S_W	1114	966	3.2
Bunnerong/Wentworth	4_W_N	664	722	1.6
Bunnerong/Wentworth	4_W_S	923	868	1.3
Bunnerong/Denison	5_E_S	149	237	4.5
Bunnerong/Denison	5_E_W	1502	1289	4.0
Bunnerong/Denison	5_N_E	93	128	2.4
Bunnerong/Denison	5_N_S	66	69	0.3
Bunnerong/Denison	5_N_W	58	30	3.0
Bunnerong/Denison	5_S_E	257	249	0.4
Bunnerong/Denison	5_S_W	1279	1204	1.5
Bunnerong/Denison	5_W_E	1148	1113	0.7
Bunnerong/Denison	5_W_S	825	841	0.4
Wentworth/Corish	6_E_N	462	330	4.7
Wentworth/Corish	6_E_S	15	38	3.2
Wentworth/Corish	6_E_W	2222	2153	1.0
Wentworth/Corish	6_N_E	143	149	0.4

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Wentworth/Corish	6_N_W	252	347	3.9
Wentworth/Corish	6_S_W	80	67	1.1
Wentworth/Corish	6_W_E	2132	1971	2.5
Wentworth/Corish	6_W_N	417	607	5.9
Banks/Westfield entrance	7_E_in	230	203	1.3
Banks/Westfield entrance	7_E_out	1136	1038	2.1
Banks/Westfield entrance	7_E_thr	233	315	3.5
Banks/Westfield entrance	7_N_in	710	742	0.8
Banks/Westfield entrance	7_N_out	348	358	0.4
Banks/Westfield entrance	7_N_thr	659	611	1.3
Banks/Westfield entrance	7_S_in	918	939	0.5
Banks/Westfield entrance	7_S_out	374	489	3.9
Banks/Westfield entrance	7_S_thr	89	29	5.5
Banks/Westfield Dr	8_E_N	22	40	2.3
Banks/Westfield Dr	8_E_S	284	250	1.5
Banks/Westfield Dr	8_N_E	3	4	0.4
Banks/Westfield Dr	8_N_S	406	460	1.8
Banks/Westfield Dr	8_S_E	17	27	1.5
Banks/Westfield Dr	8_S_N	309	317	0.3
Banks/Site access	9_E_N	1	0	1.0
Banks/Site access	9_E_S	2	2	0.0
Banks/Site access	9_N_E	2	0	1.4
Banks/Site access	9_N_S	410	461	1.7
Banks/Site access	9_S_E	3	8	1.5
Banks/Site access	9_S_N	329	347	0.7

Table 35 PM turn count calibration results

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Heffron//Bunnerong	1_NE_NW	165	143	1.3
Heffron//Bunnerong	1_NE_S	602	671	1.9
Heffron//Bunnerong	1_NE_SE	31	10	3.3
Heffron//Bunnerong	1_NE_SW	759	690	1.8
Heffron//Bunnerong	1_NW_NE	500	521	0.7
Heffron//Bunnerong	1_NW_S	1634	1589	0.8
Heffron//Bunnerong	1_NW_SW	407	487	2.7
Heffron//Bunnerong	1_S_NE	599	622	0.7
Heffron//Bunnerong	1_S_NW	1209	1078	2.7
Heffron//Bunnerong	1_S_SW	181	169	0.6
Heffron//Bunnerong	1_SE_S	25	6	3.4
Heffron//Bunnerong	1_SW_NE	997	1073	1.7
Heffron//Bunnerong	1_SW_NW	522	565	1.3
Heffron//Bunnerong	1_SW_S	147	162	0.9
Heffron/Site access	10_E_W	1337	1372	0.7
Heffron/Site access	10_W_E	1744	1725	0.3
Heffron/Banks	11_E_in	1343	1372	0.6
Heffron/Banks	11_E_out	1729	1723	0.1
Heffron/Banks	11_E_thr	657	591	1.9
Heffron/Banks	11_N_in	798	821	0.6
Heffron/Banks	11_N_out	682	817	3.5
Heffron/Banks	11_N_thr	1588	1492	1.7
Heffron/Banks	11_S_in	483	607	3.8
Heffron/Banks	11_S_out	553	677	3.5
Heffron/Banks	11_S_thr	1447	1288	3.0
Heffron/Banks	11_W_in	1730	1740	0.2
Heffron/Banks	11_W_out	1390	1327	1.2
Heffron/Banks	11_W_thr	540	569	0.9
Wentworth/Page	12_E_S	321	386	2.4
Wentworth/Page	12_E_W	2429	2408	0.3
Wentworth/Page	12_N_E	37	75	3.6
Wentworth/Page	12_N_S	472	444	0.9
Wentworth/Page	12_N_W	696	643	1.4
Wentworth/Page	12_S_E	399	424	0.9

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Wentworth/Page	12_S_N	611	650	1.1
Wentworth/Page	12_S_W	409	322	3.2
Wentworth/Page	12_W_E	2663	2680	0.2
Wentworth/Page	12_W_N	1079	1165	1.8
Wentworth/Page	12_W_S	402	308	3.5
Bunnerong/Westfield	3_E_S	12	5	1.7
Bunnerong/Westfield	3_N_S	1474	1227	4.8
Bunnerong/Westfield	3_N_W	932	1117	4.1
Bunnerong/Westfield	3_S_N	1490	1342	2.8
Bunnerong/Westfield	3_S_W	585	579	0.2
Bunnerong/Westfield	3_W_N	552	511	1.3
Bunnerong/Westfield	3_W_S	398	506	3.6
Bunnerong/Wentworth	4_N_S	1243	1261	0.4
Bunnerong/Wentworth	4_N_W	596	529	2.0
Bunnerong/Wentworth	4_S_N	1299	1107	3.9
Bunnerong/Wentworth	4_S_W	904	938	0.8
Bunnerong/Wentworth	4_W_N	783	852	1.7
Bunnerong/Wentworth	4_W_S	1585	1327	4.8
Bunnerong/Denison	5_E_S	140	143	0.2
Bunnerong/Denison	5_E_W	1341	1309	0.6
Bunnerong/Denison	5_N_E	310	292	0.7
Bunnerong/Denison	5_N_S	213	194	0.9
Bunnerong/Denison	5_N_W	265	152	5.5
Bunnerong/Denison	5_S_E	152	157	0.3
Bunnerong/Denison	5_S_W	1062	932	2.9
Bunnerong/Denison	5_W_E	1518	1379	2.6
Bunnerong/Denison	5_W_S	943	955	0.3
Wentworth/Corish	6_E_N	531	437	3.0
Wentworth/Corish	6_E_S	6	12	1.4
Wentworth/Corish	6_E_W	2053	1949	1.6
Wentworth/Corish	6_N_E	319	144	8.1
Wentworth/Corish	6_N_W	722	738	0.4
Wentworth/Corish	6_S_W	86	62	2.0
Wentworth/Corish	6_W_E	2683	2484	2.8
Wentworth/Corish	6_W_N	574	731	4.3

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Banks/Westfield entrance	7_E_in	1015	1030	0.3
Banks/Westfield entrance	7_E_out	1542	1692	2.6
Banks/Westfield entrance	7_E_thr	291	179	5.2
Banks/Westfield entrance	7_N_in	930	1047	2.6
Banks/Westfield entrance	7_N_out	511	668	4.6
Banks/Westfield entrance	7_N_thr	903	824	1.9
Banks/Westfield entrance	7_S_in	1106	1168	1.3
Banks/Westfield entrance	7_S_out	998	883	2.7
Banks/Westfield entrance	7_S_thr	308	326	0.7
Banks/Westfield Dr	8_E_N	25	3	4.2
Banks/Westfield Dr	8_E_S	377	350	1.0
Banks/Westfield Dr	8_N_E	7	5	0.6
Banks/Westfield Dr	8_N_S	532	675	4.1
Banks/Westfield Dr	8_S_E	39	69	2.9
Banks/Westfield Dr	8_S_N	453	602	4.6
Banks/Site access	9_E_N	0	0	0.0
Banks/Site access	9_E_S	0	2	1.4
Banks/Site access	9_N_E	0	0	0.0
Banks/Site access	9_N_S	548	674	3.6
Banks/Site access	9_S_E	1	0	1.0
Banks/Site access	9_S_N	482	605	3.7

Table 36 Weekend turn count calibration results

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Heffron//Bunnerong	1_NE_NW	320	406	3.2
Heffron//Bunnerong	1_NE_S	845	913	1.6
Heffron//Bunnerong	1_NE_SE	35	43	0.9
Heffron//Bunnerong	1_NE_SW	794	771	0.6
Heffron//Bunnerong	1_NW_NE	443	470	0.9
Heffron//Bunnerong	1_NW_S	1594	1522	1.3
Heffron//Bunnerong	1_NW_SW	369	369	0.0
Heffron//Bunnerong	1_S_NE	651	792	3.7
Heffron//Bunnerong	1_S_NW	1538	1390	2.7
Heffron//Bunnerong	1_S_SW	259	260	0.0
Heffron//Bunnerong	1_SE_S	106	111	0.3
Heffron//Bunnerong	1_SW_NE	847	753	2.4
Heffron//Bunnerong	1_SW_NW	461	517	1.8
Heffron//Bunnerong	1_SW_S	174	134	2.3
Heffron/Site access	10_E_W	1358	1493	2.5
Heffron/Site access	10_W_E	1479	1388	1.7
Heffron/Banks	11_E_in	1347	1494	2.8
Heffron/Banks	11_E_out	1451	1390	1.1
Heffron/Banks	11_E_thr	575	621	1.3
Heffron/Banks	11_N_in	738	816	2.0
Heffron/Banks	11_N_out	791	839	1.2
Heffron/Banks	11_N_thr	1288	1195	1.9
Heffron/Banks	11_S_in	564	589	0.7
Heffron/Banks	11_S_out	582	534	1.4
Heffron/Banks	11_S_thr	1340	1582	4.5
Heffron/Banks	11_W_in	1439	1321	2.2
Heffron/Banks	11_W_out	1264	1459	3.7
Heffron/Banks	11_W_thr	640	711	1.9
Wentworth/Page	12_E_S	300	305	0.2
Wentworth/Page	12_E_W	2014	2277	4.0
Wentworth/Page	12_N_E	53	59	0.6
Wentworth/Page	12_N_S	440	546	3.4
Wentworth/Page	12_N_W	716	753	1.0
Wentworth/Page	12_S_E	457	456	0.0

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Wentworth/Page	12_S_N	551	501	1.5
Wentworth/Page	12_S_W	239	221	0.8
Wentworth/Page	12_W_E	2526	2622	1.3
Wentworth/Page	12_W_N	852	800	1.3
Wentworth/Page	12_W_S	246	203	2.0
Bunnerong/Westfield	3_E_S	27	34	0.9
Bunnerong/Westfield	3_N_S	1521	1326	3.7
Bunnerong/Westfield	3_N_W	1189	1297	2.2
Bunnerong/Westfield	3_S_N	1741	1731	0.2
Bunnerong/Westfield	3_S_W	718	415	9.0
Bunnerong/Westfield	3_W_N	790	687	2.7
Bunnerong/Westfield	3_W_S	452	480	0.9
Bunnerong/Wentworth	4_N_S	1359	1325	0.7
Bunnerong/Wentworth	4_N_W	665	451	6.4
Bunnerong/Wentworth	4_S_N	1489	1452	0.7
Bunnerong/Wentworth	4_S_W	890	878	0.3
Bunnerong/Wentworth	4_W_N	961	730	5.6
Bunnerong/Wentworth	4_W_S	1525	1548	0.4
Bunnerong/Denison	5_E_S	151	178	1.5
Bunnerong/Denison	5_E_W	1390	1144	4.9
Bunnerong/Denison	5_N_E	308	248	2.5
Bunnerong/Denison	5_N_S	187	163	1.3
Bunnerong/Denison	5_N_W	252	272	0.9
Bunnerong/Denison	5_S_E	190	132	3.2
Bunnerong/Denison	5_S_W	847	883	0.9
Bunnerong/Denison	5_W_E	1460	1512	1.0
Bunnerong/Denison	5_W_S	760	766	0.2
Wentworth/Corish	6_E_N	566	346	7.3
Wentworth/Corish	6_E_S	18	16	0.3
Wentworth/Corish	6_E_W	1881	1937	0.9
Wentworth/Corish	6_N_E	340	186	6.7
Wentworth/Corish	6_N_W	652	593	1.7
Wentworth/Corish	6_S_W	63	82	1.6
Wentworth/Corish	6_W_E	2432	2533	1.4
Wentworth/Corish	6_W_N	598	662	1.8

Intersection	Turning movement	Observed volume (all veh types)	Modelled volume (all veh types)	GEH
Banks/Westfield entrance	7_E_in	1063	1129	1.4
Banks/Westfield entrance	7_E_out	1674	1471	3.6
Banks/Westfield entrance	7_E_thr	299	105	9.7
Banks/Westfield entrance	7_N_in	981	736	5.9
Banks/Westfield entrance	7_N_out	586	618	0.9
Banks/Westfield entrance	7_N_thr	992	841	3.5
Banks/Westfield entrance	7_S_in	1198	1004	4.1
Banks/Westfield entrance	7_S_out	982	780	4.8
Banks/Westfield entrance	7_S_thr	380	454	2.6
Banks/Westfield Dr	8_E_N	35	14	3.0
Banks/Westfield Dr	8_E_S	386	185	8.4
Banks/Westfield Dr	8_N_E	7	0	2.6
Banks/Westfield Dr	8_N_S	588	540	1.4
Banks/Westfield Dr	8_S_E	49	45	0.4
Banks/Westfield Dr	8_S_N	536	575	1.2
Banks/Site access	9_E_N	3	0	1.7
Banks/Site access	9_E_S	14	3	2.7
Banks/Site access	9_N_E	0	0	0.0
Banks/Site access	9_N_S	583	536	1.4
Banks/Site access	9_S_E	3	0	1.7
Banks/Site access	9_S_N	564	588	0.7

Meriton Properties

128 and 130-150 Bunnerong Road, Pagewood

Transport Impact Assessment

Rev E | 21 November 2018

Job number 237575

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1 Introduction

1.1 Background

Meriton Properties (Meriton) commissioned Arup to undertake traffic and transport analysis for the proposed 128 and 130-150 Bunnerong Road, Pagewood site. An L-shaped parcel (10.35ha) known as 130-150 Bunnerong Road, Pagewood was approved as a concept masterplan in 2014. A Development Control Plan (DCP) including a site specific chapter has been prepared (refer to Chapter 9D – British American Tobacco Australasia, of the Botany Bay DCP 2013).

The intended outcome of the Planning Proposal is to amend the *Botany Bay Local Environmental Plan 2013* (BBLEP 2013) as follows:

- Rezone the subject site from part IN1 General Industrial and part R3 Medium Density Residential to R4 High Density Residential.
- Increase the maximum floor space ratio (FSR) development standard from 1:1 to 2.35:1.
- Increase the maximum height of buildings development standard to part RL 37.0 (15m), part RL 60.0 (39m) and park RL 91.0 (70m).
- Introduce a new clause at Schedule 1 Additional Permitted Uses of the BBLEP 2013 to permit 'commercial premises', 'recreational facility (indoor)' and 'hotel and motel accommodation'. Non-residential uses across the site must have a minimum total floor space of 5,000sqm.

A concept plan illustrating the type of development facilitated by the Planning Proposal has been prepared by SJB. The concept plan contemplates a high-density residential development with buildings of 2-20 storeys oriented around a network of internal roads and public open space. The development will accommodate approximately 2,015 dwellings and allowance has been made for 5,000m^2 retail floor space and 2×75-place childcare centres.

The subject site is located within a broader site known as 128 and 130-150 Bunnerong Road, Pagewood. The site is within the Bayside Local Government Area (LGA) and is legally described as Lot 1 DP 1187426 and Lot 24 DP 1242288 or 128 and 130-150 Bunnerong Road, Pagewood (see **Figure 1**).

The broader site was previously occupied by industrial uses associated with the manufacturing operations of British American Tobacco Australasia (BATA). Lot 1 was excised from the larger site, remaining for reduced industrial uses while the remaining portion of the site was rezoned in June 2013 to support mixed use development, including high density residential uses.

The Planning Proposal request relates to Lot 1 DP 1187426 and Lot 24 DP 1242288 or 128 and 130-150 Bunnerong Road, Pagewood and covers an area of approximately 8.95ha. The site has frontages to an internal road (Meriton Boulevard) to the south, Bunnerong Road to the east, Banks Avenue to the west and Heffron Road to the north.

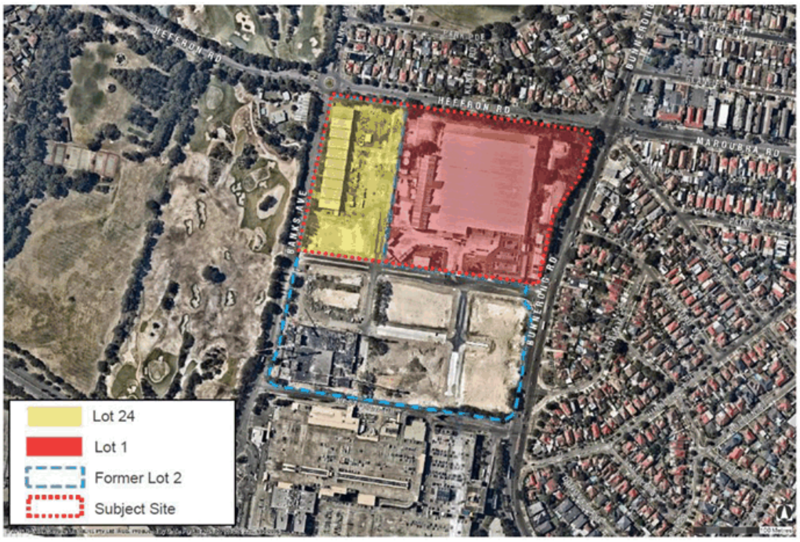


Figure 1: Location plan

This report has been prepared for review by Roads and Maritime in response to previous correspondence to determine the necessity for road upgrades on surrounding roads. The traffic models used and described within this report and supporting reports are submitted together with this report.

This report references the previously prepared documentation for the remainder of the BATA site including:

- Colston Budd Hunt and Kafes and supplementary PB report dated March 2012
- Arup Traffic Impact Assessment dated 24 July 2014
- Arup S34 Conference Report dated 5 May 2015

1.2 Report scope

This transport report supports the rezoning application related to 128 Bunnerong Road, Pagewood and the northern portion of 130-150 Bunnerong Road, Pagewood and will outline the following:

- Existing transport conditions
- Forecast traffic generation
- Road network impacts
- Parking provision
- Access arrangements
- Public transport availability
- Pedestrian and cycle linkages

2 Existing site context

2.1 Site description

The proposed development site relates to 128 Bunnerong Road, Pagewood and the northern portion of 130-150 Bunnerong Road, Pagewood which is shown in Figure 2. The site is located within the Bayside Council local government area. The overall site is bound by Heffron Road to the north, Meriton Boulevard to the south, Bunnerong Road to the east and the north-south street No.1 to the west. The site is located some 8kms south of the Sydney CBD and 1km west of Maroubra Junction and located within the Bayside Council Local Government Area. Adjacent land uses include:

- Approved concept masterplan for 2,223 residential units, four child care centres and 5,000m^2 retail at 130-150 Bunnerong Road, Pagewood;
- Westfield Eastgardens shopping centre to the south of the site;
- Existing low-density residential development to the north and east of the site; and
- Bonnie Doon Golf Club to the west of the site across Banks Avenue.

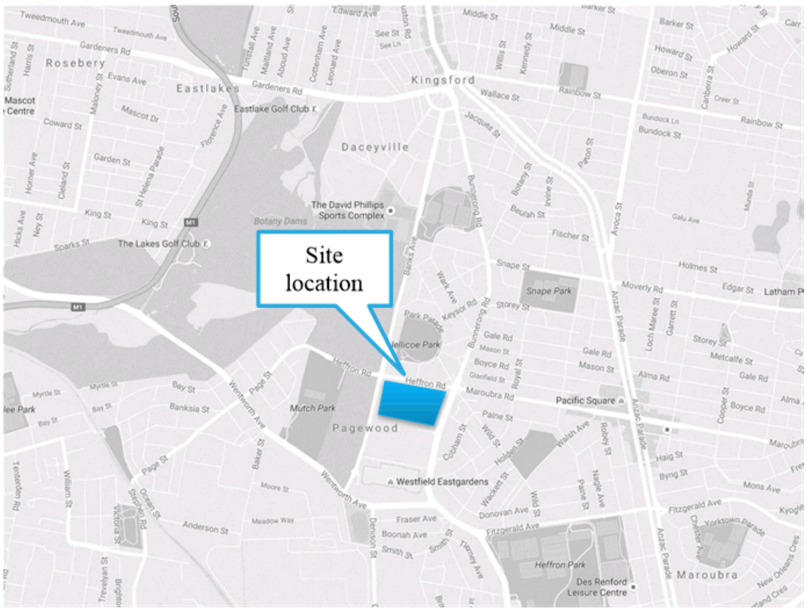


Figure 2: Site location plan

The site was previously used by the British American Tobacco Australia (BATA) as a production facility and contains a large warehouse. There are also some heritage buildings on the northeast corner of the site. The site has staff car parking and loading areas suitable for B-double vehicles. Existing vehicular access to the BATA site is provided from Meriton Boulevard, which is accessed from Bunnerong Road as a left-in / left-out priority intersection.

In 2008, BATA lodged a proposal to rezone part of the site to allow medium density residential development plus other non-residential uses which was approved in June 2013. The site has been subdivided into two lots under DA 11/272. Lot 1 which is located in the north-east corner of the site was retained by BATA for its reduced operation. The approved rezoning of the site is as follows:

- Zone IN1 for industrial use within the BATA retained site at 128 Bunnerong Road;
- Zone B4 mixed use and Zone R3 medium density residential for 130-150 Bunnerong Road.

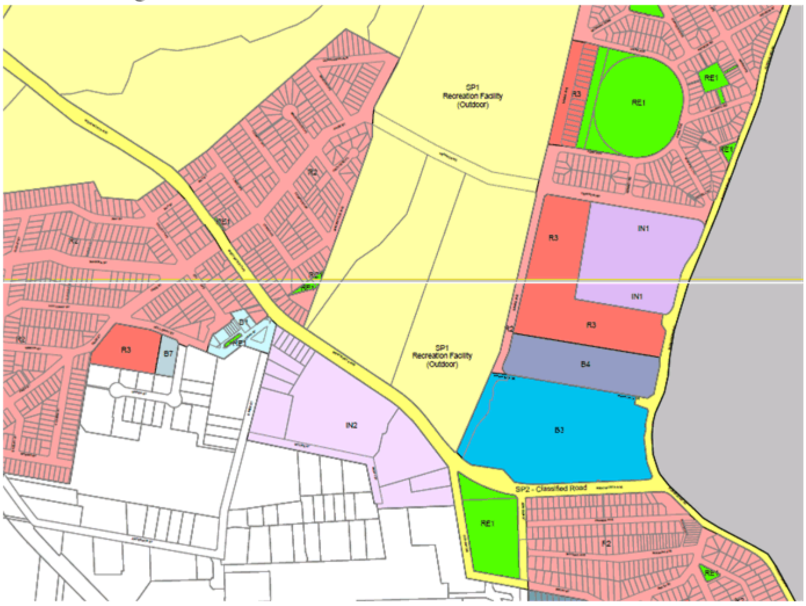


Figure 3: Current Botany Bay LEP zoning

2.2 Road network

The main roads surrounding the site are Bunnerong Road to the east, Wentworth Avenue to the south, Banks Avenue to the west and Heffron Road/Maroubra Road to the north.

Bunnerong Road is a north-south state road connecting La Perouse to Kingsford Nine Ways. It generally has three traffic lanes in each direction and a speed limit of 60km/h. Bunnerong Road is a major bus corridor with buses connecting to the Sydney CBD, La Perouse and Matraville.

Wentworth Avenue, (located further south to the site) is a state road with three traffic lanes in each direction. It serves as a major connection between Mascot and Eastgardens. Wentworth Avenue has a speed limit of 70km/h.

Westfield Drive is a private road located between Banks Avenue and Bunnerong Road and provides access to both the Westfield Eastgardens and the approved 130-150 Bunnerong Road, Pagewood masterplan site.

Banks Avenue is a local road connecting Eastgardens to Kingsford. It has generally has two traffic lanes in each direction and has a speed limit of 50km/h.

Heffron Road and Maroubra Road are regional roads that connect Banksmeadow to Maroubra. Heffron Road generally has one traffic lane and one parking lane in each direction and Maroubra Road is a multi-lane divided road. In the immediate vicinity of the site Heffron Road has a speed limit of 50km/h. Bus services also operate on Heffron Road and Maroubra Road.

There are also internal roads being constructed as part of the approved masterplan site, which include a series of public and private roads. The public roads include Meriton Boulevard which runs east-west through the site between Bunnerong Road and Banks Avenue, a local street east-west street north of Meriton Boulevard and two north-south streets.

2.3 Public transport

The site has good access to public transport. The main public transport servicing the site are buses. A number of major bus routes operate on nearby roads as shown in Table 1. Bus stops are located on Heffron Road between Banks Avenue and Bunnerong Road, Bunnerong Road near Heffron Road (northeast of the site) and at the Westfield Eastgardens bus terminal (southeast of the site).

Table 1: Bus services

Bus route	Frequency
Route 301, Eastgardens to City – Circular Quay via Mascot, Eastlakes, Roseberry, Zetland, Waterloo and Surry Hills	Every 30 minutes throughout the day in both directions of travel
Route 302, Eastgardens to City – Circular Quay via Kingsford, Kensington, Waterloo and Surry Hills	Every hour throughout the day in both directions of travel
Route 310 Port Botany and Eastgardens to city	Every 20 minutes throughout the day in both directions of travel
Route 316, Eastgardens to Bondi Junction via South Maroubra, Maroubra Beach, South Coogee, Randwick Junction and Waverley	Every 20 minutes throughout the day in both directions of travel
Route 317, Eastgardens to Bondi Junction via South Maroubra, Maroubra Beach, South Coogee, Randwick Junction and Waverley	Every 30 minutes throughout the day in both directions of travel
Route 353, Eastgardens to Bondi Junction via Maroubra, Maroubra Beach, South Coogee, Coogee, Clovelly and Waverley	Every 30 minutes throughout the day in both directions of travel
Route 391, La Perouse and Little Bay to City via Bunnerong Road	Every 30 minutes throughout the day in both directions of travel
Route 392, La Perouse and Little Bay to City via Bunnerong Road	Every 30 minutes throughout the day in both directions of travel
Route 400 Burwood to Bondi Junction	Every 30 minutes throughout the day in both directions of travel
Route 410 Rockdale to Bondi Junction	Every 15 minutes throughout the day in both directions of travel. Only operates during the AM and PM peak periods

2.4 Active transport

2.4.1 Cycling

There are a number of cycle facilities surrounding the development site, consisting mainly of on-road facilities or shoulders. These include an off-road facility along Wentworth Avenue and on-road marked cycle lanes on Heffron Road / Page Street and Banks Avenue. A map of surrounding cycleways is shown in Figure 4.

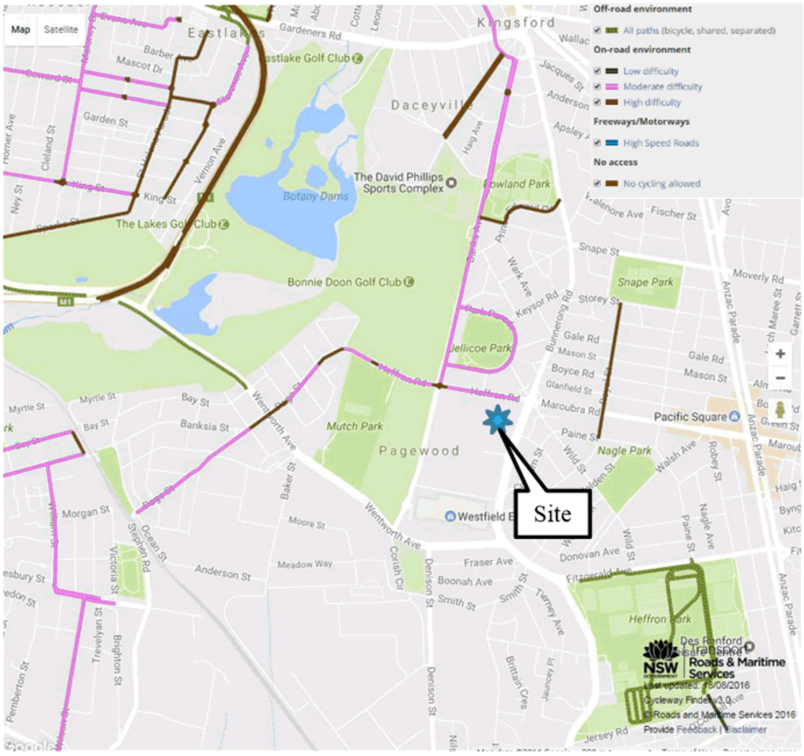


Figure 4: Cycling routes (Source: Roads and Maritime Cycleway Finder)

2.4.2 Walking

Due to the site's close proximity to public transport and local amenities, there is a good network of local footpaths. Footpaths and kerb ramps are provided on both sides of the road on Bunnerong Road, Heffron Road and Westfield Drive. A pedestrian footpath is provided on the eastern side of Banks Avenue.

There are also ample pedestrian crossing opportunities in the area, with multiple signalized pedestrian crossing opportunities on Westfield Drive, Bunnerong Road and Maroubra Road. The local area has wide roads which are shared between cyclists and motorists. An on-road separated cycleway is marked along Heffron Road, north of the site.

Pedestrian connections to surrounding amenities such as shops, transport, parks, sports fields and schools were plotted and then audited. The diagram below shows the most direct and safest connections to these amenities. Main attractors include:

- Pacific Square
- Maroubra Road shops
- Westfield Eastgardens (including bus interchange)
- Nagle Park
- Jellicoe Park
- Heffron Park
- Hensley Athletic Field
- Mutch Park
- Our Lady of the Annunciation Catholic School and Church
- South Sydney High School
- Pagewood Public School
- Future light rail stop at Kingsford

Figure 5: Walking routes from development

2.5 Travel patterns

Mode share patterns at the site were analysed using 2011 Journey to Work (JTW) Census data from the Bureau of Transport Statistics. The JTW data for travel zone 421, 423, 424 and 640 were used to assess the likely mode of peak hour trips approaching/departing the site (as the travel zone containing the site is purely employment). The results of the analysis are presented in Table 2.

Table 2: 2011 Journey to Work (JTW) travel patterns (for travel zones 421, 423, 424 and 640)

Mode	Inbound trips to work	Outbound trips to work
Train	4%	3%
Bus	11%	19%
Car	62%	57%
Walk	5%	6%
Other	3%	4%
Did Not Travel	15%	12%
Total %	100%	100%
Total Trips	4,466	3,622

Source: BTS, 2011

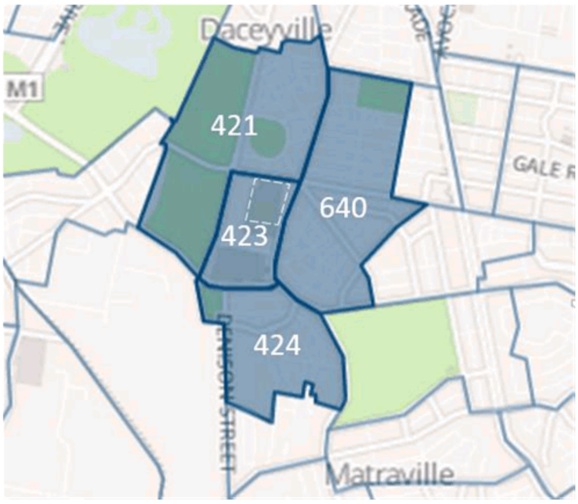


Figure 6: Journey to Work travel zone coverage

The data revealed that outbound trips by local residents rely more heavily on car trip modes (57%), followed by bus (19%). Other modes noted walking (6%) and train (3%).

2.6 Road safety

Crashes were analysed on the surrounding streets of the site over the most recent five-year period (from January 2009 – December 2013 inclusive). Overall, there were 123 crashes recorded, of which there were no fatalities, 51 injuries and 72 non-casualty (tow away) crashes. The data also indicates a fairly even distribution of crashes per year as shown in Figure 7.

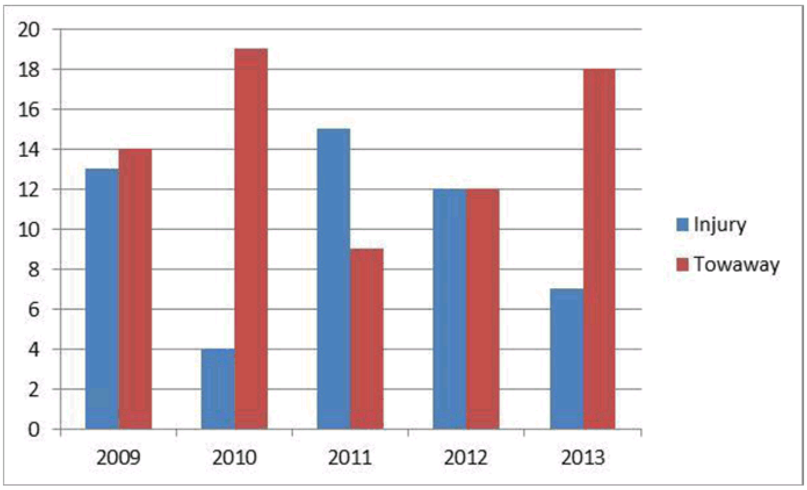


Figure 7: Degree of crashes per year (2008-2013) on surrounding streets

The crash data was sorted into hourly time periods (Figure 8). Crashes were more concentrated in the commuter peak periods. Interestingly, the highest recorded hourly time period was in the PM peak hours (4pm-6pm), likely indicating higher traffic volumes.

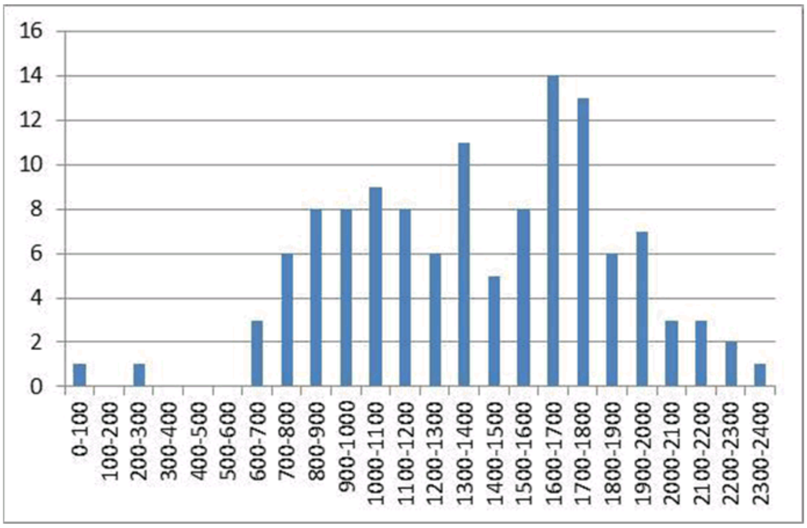


Figure 8: Crashes by time period

The crash data was sorted into days of the week (Figure 9). Crashes were more concentrated in the earlier days of the week, indicating that they were not directly related to shopper peaks (which are Thursdays and weekends).

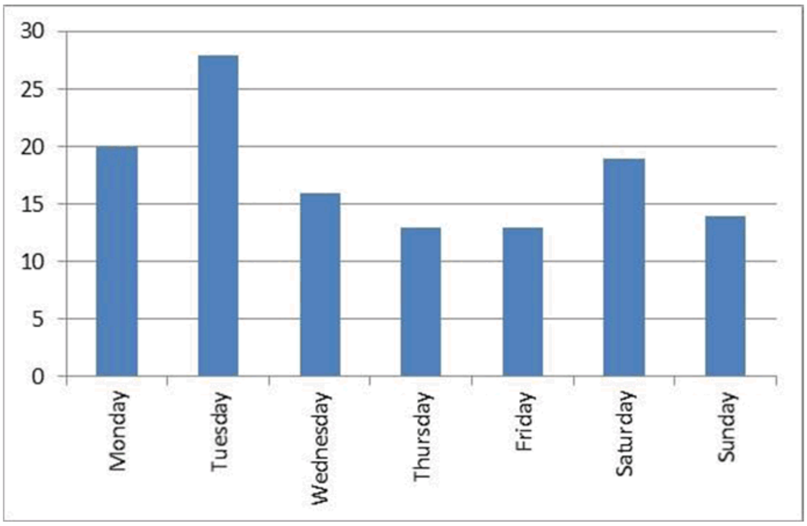


Figure 9: Crashes by day of the week

The crash data was classified into the various road user movement (RUM) codes to analyse crash clustering. The majority of crash types were recorded as vehicles from opposing directions, followed by vehicles in same direction which are common along arterial roads and at intersections (Figure 10).

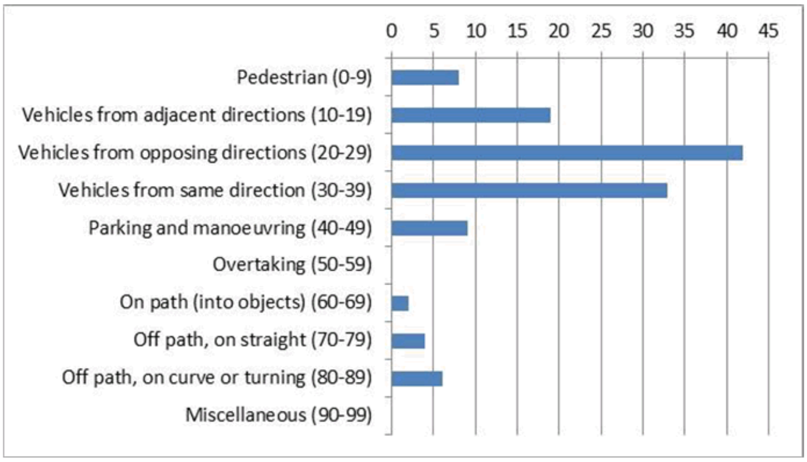
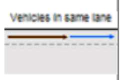


Figure 10: Crash types by road user movement categories

2.7 Crash clusters

Crash clusters for the purposes of this study were defined as three or more crashes with the same RUM code, within 50m of each other. Crash clusters were focused around key intersections and are detailed in Table 3 and Figure 11. There were no recognisable clusters for pedestrians, but crash types were similarly 'emerging pedestrians' crash types surrounding the site.

Table 3: Investigation of crash clusters at intersections by road user movements

Primary street	Cross street	Adjacent cross traffic	Adjacent right-thru from right	Same rear end	Opposite right through
					
Bunnerong Road	Heffron Road	3		7	
Heffron Road	Banks Avenue	6		4	
Bunnerong Road	Westfield Drive			3	13
Bunnerong Road	Wentworth Avenue			3	12
Wentworth Avenue	Banks Avenue		4		6
Wentworth Avenue	Denison Street				11

Bunnerong Road / Heffron Road had a number of rear ends and cross traffic crashes recorded. These were recorded in all approaches, indicating no common contributing factors. These are inherently common at a signalised intersection, considering the current traffic volumes and are not easily treatable without major upgrades. There were a number of rear ends that appeared to occur on the southbound lanes leaving the intersection, perhaps due to driveways and merging from upstream parking along the carriageway.

Heffron Road / Banks Avenue had a large number of cross traffic crashes and rear ends. Similarly, these are inherently common at intersections such as a roundabout (or signalised) intersection and are not treatable without major upgrades. It is likely that a signalised intersection will continue to have these types of crashes, with a reduced rate, but more severity (given increase of traffic speeds). Crashes were more common along Heffron Road, but were spread either side of the intersection at no specific area.

Bunnerong Road / Westfield Drive and **Bunnerong Road / Wentworth Avenue** had a large number of opposite right through crashes, which are treatable given the filter right turn occurring from Bunnerong Road. It is suggested to remove the filer if non-detrimental to traffic flows or amend the sightlines for this approach.

Wentworth Avenue / Banks Avenue had a number of opposing right through and adjacent right through crashes. This is likely resulting due to filter right turns and vehicles running red due to saturation of the turn bay on Wentworth Avenue. More right turn capacity (extra lane) is suggested for Wentworth Avenue to help alleviate traffic volumes and safety at this intersection.

Wentworth Avenue / Denison Street had a large number of right through crashes. This is likely a result of the phase that allows Westfield to exit and filter right turns from Dension Street. No upgrades are suggested without major detriments to the traffic flows.

The crash types identified as clusters are considered common at intersections (where the majority of crashes were recorded). Therefore, as a consequence of the level of traffic on surrounding roads, crashes are fairly typical and there are no further safety upgrades recommended as a result of the assessment.

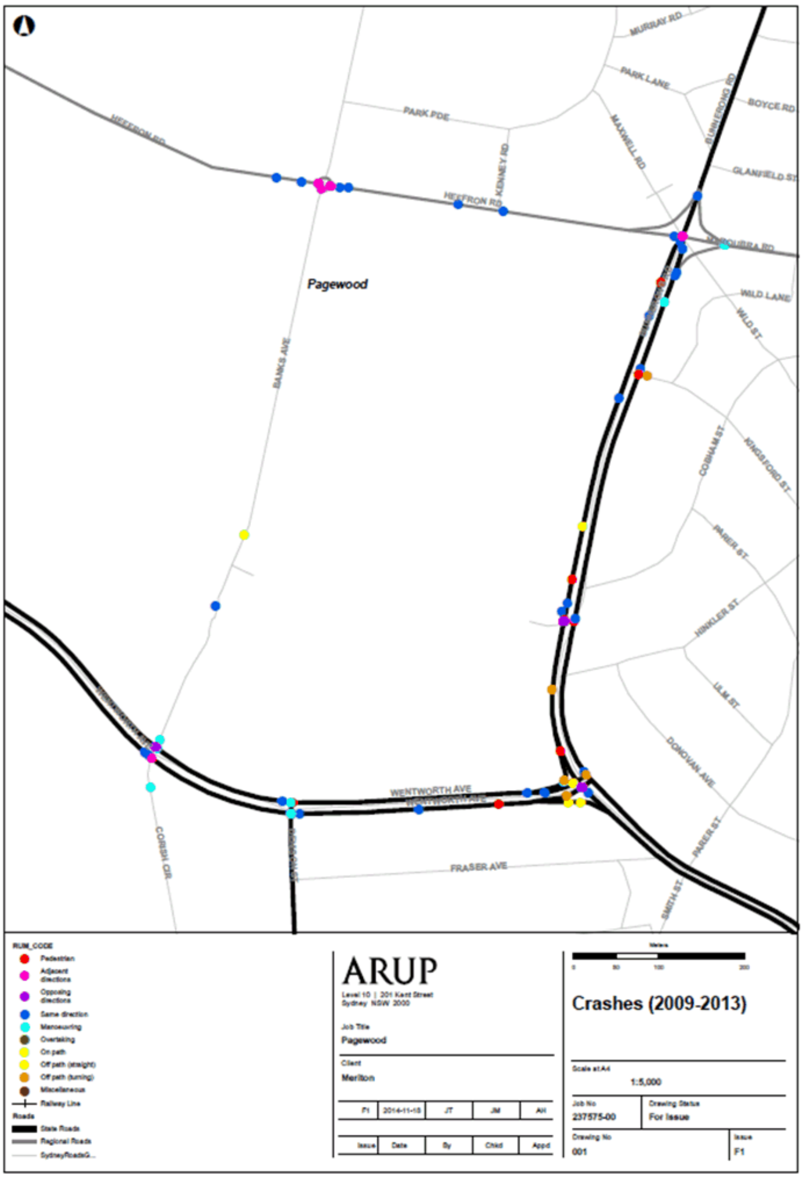


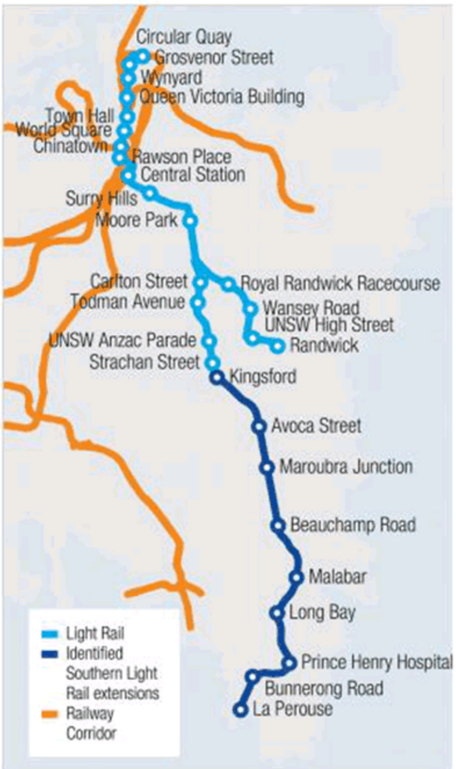
Figure 11: Crash investigation 2008 - 2013

3 Planning context

3.1 Sydney Light Rail

The current Sydney Light Rail is proposed to terminate at Kingsford, which is a 25-minute walk from the site. However, Infrastructure NSW noted that the light rail may be extended to La Perouse via Maroubra Junction in the State Infrastructure Strategy Update. This would place a light rail stop within a 15-minute walk of the proposed site.

Figure 2.9 Potential Anzac Parade Light Rail extensions



Source: Transport for NSW

Figure 12: Potential Light Rail extension

Meriton, in liaison with the former Botany Bay Council and Randwick Council, had also approached the NSW State Government to consider extending the current CBD and South East Light Rail to Maroubra Junction and on to the site. This would service the suburbs of Maroubra, Pagewood, Matraville, Eastgardens and the broader South-East Sydney area. There would also be further opportunities to expand this service beyond the site to the south and west, expanding the potential for cross district transport connections.

3.2 Sydney Metro West

The NSW Government has announced a new underground metro railway line linking the Parramatta and Sydney CBDs, and communities along the way. The Sydney Metro West project addresses Sydney's rapid growth, with the city's population to increase above 6 million in the next 20 years. The new railway is expected to be built largely underground and operational in the second half of the 2020s. The final number of potential stations will be identified following community and industry consultation. Four key precincts to be serviced have initially been identified at:

- Parramatta, where the number of jobs is expected to double over the next 20 years to 100,000.
- Sydney Olympic Park, where 34,000 jobs and more than 23,000 residents will be located by 2030.
- The Bays Precinct, Sydney's new innovation hub where 95 hectares of land is being regenerated.
- The Sydney CBD, allowing easy access to the existing public transport network and Stages 1 and 2 of Sydney Metro, which is currently under construction.

Following the announcement, a consortium proposed value-capture for the project, including connections further west to Badgerys Creek via Westmead and further east to La Perouse via Maroubra. The potential alignments proposed by the consortium are noted in Figure 13 and could have a connection as close as Maroubra to the proposed site.

Figure 13: Potential Metro West alignments (Source Conybeare Morrison, BG&E)

3.3 Previous studies

BATA resolved that a large proportion of their large industrial landholding at Pagewood was superfluous to their future production needs. A draft Master Plan was prepared and submitted to Council in early 2011. Council prepared a site specific DCP to include the rezoning of the surplus part of the site.

A Traffic and Transport Study (CBH&K) was prepared in March 2012 to accompany the draft LEP and this was supported by a Traffic Modelling Assessment (Parsons Brinkerhoff). Scenarios tested for the rezoned site included:

- 35,000m^2 retail with 1,200 residential apartments generating 1,650 to 1,850 peak hour trips during the PM and weekend peaks respectively
- 5,000m^2 retail with 1,500 residential apartments generating 550 to 700 peak hour trips during the PM and weekend peaks respectively

The LEP and DCP documents were subsequently enacted and development consent granted for subdivision of the total site along with alterations, additions and fit-out of production facility buildings on the retained lot. Roads and Maritime has agreed with the above processes subject to a number of conditions including:

- provision of traffic signals at the Bunnerong Road/Access Road intersection with separate right and left turn lanes
- widening of Bunnerong Road (south) to upgrade the Maroubra Road/Heffron Road intersection

3.4 Previously approved intersection upgrades

A number of intersection upgrades were required to permit the development of the approved concept masterplan at 130-150 Bunnerong Road. These includes funded upgrades (either fully or partially by developer) at the following locations:

- Marourbra Road / Heffron Road Bunnerong Road
- Heffron Road and Banks Avenue
- Wentworth Avenue and Page Street

3.4.1 Maroubra Road / Heffron Road and Bunnerong Road

Proposed upgrades to this intersection include additional right turn lanes for the south and north approach of Bunnerong Road (incorporating previous PB modelling advice and additional traffic modelling undertaken by SMEC and Arup). Upgrades would require civil works including relocation of the central median, repaving and widening of the road on the northern approach.

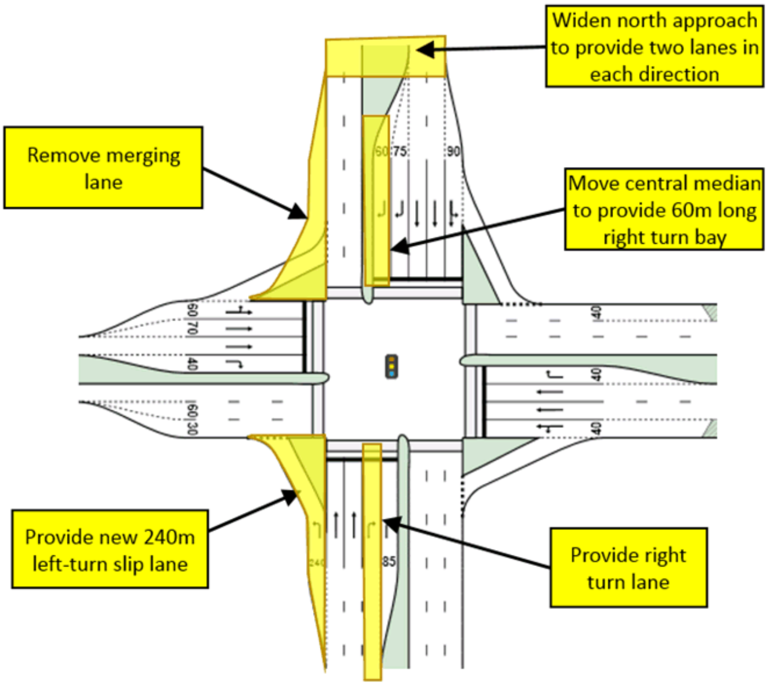


Figure 14: Approved upgrade for Maroubra Road / Heffron Road and Bunnerong Road

3.4.2 Heffron Road and Banks Avenue

The adopted option (by Council preference) was to upgrade the intersection to a two-phase signalised intersection. This would require a new set of signal infrastructure, major civil works to remove the roundabout and approach islands, and reinstatement of kerbs to tighten approaches. An indicative diagram of the upgrades is shown below.

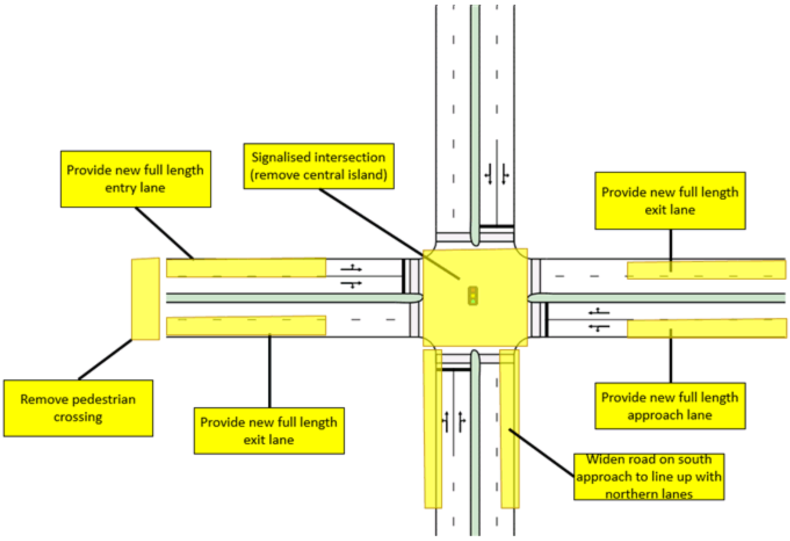


Figure 15: Approved upgrade for Heffron Road and Banks Avenue

3.4.3 Page Street and Wentworth Avenue

Upgrades to this intersection were previously outlined in the SMEC report (2015) to include:

- An additional right turn bay from Wentworth Avenue north approach
- Extension of right turn bays on Page Street west and east
- Extension of two lane section on Page Street east (up to 60m length)
- Left turn slip lane provisions on the west and south approaches.

It is anticipated that upgrades will require major civil works including relocation of the kerb and central median on Wentworth Avenue.

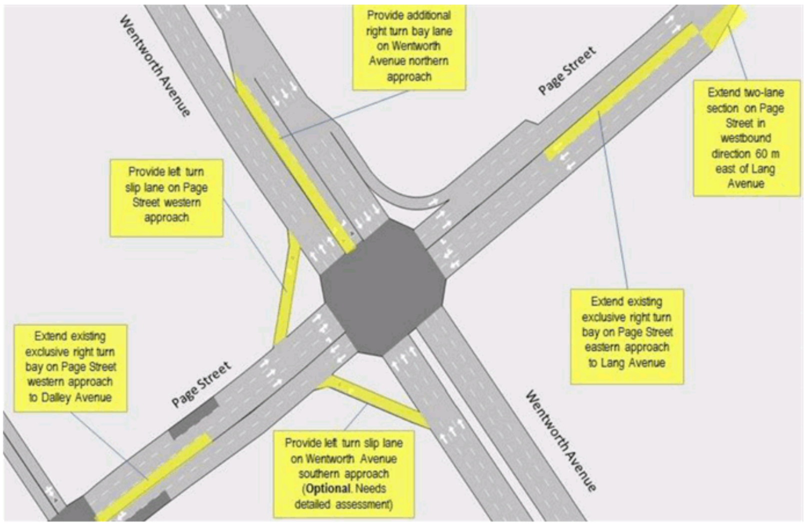


Figure 16: Upgrade to Page Street and Wentworth Avenue

3.4.4 Intersections of Banks Avenue and Wentworth Avenue; and Denison Street and Wentworth Avenue

Upgrade works were discussed with Council for these intersections and there is no scope to provide infrastructure upgrades without significant land acquisition. Previous upgrades were identified in previous reports, but were not addressed in the latest development application submitted by Westfield. Therefore, given that the intersection operates within acceptable level of service parameters with the approved development traffic, there were proposed no proposed upgrades of these intersections.

4 Development proposal

The proposed site incorporates some of the area of the previously approved concept masterplan at 130-150 Bunnerong Road. It is proposed to absorb urban blocks 1 and 2 of the Stage 1 Pagewood Green concept masterplan and incorporate these blocks into a new northern precinct.

Meriton proposes to provide 5,000m^2 retail on the site, two 75-child childcare centres and provide a total of 2,015 residential units with potential for aged care in the northeast block. Some of the 2,015 residential units may also be considered as serviced apartments in future development applications.

As a result, it is proposed that the approved concept masterplan site reduces the residential apartments by approx. 376 dwellings, and reduces the retail provision on the site from originally approved 5,000m^2 GFA. This equates to an additional 1,639 residential apartments, an additional child care centre (approx. 50 children) and a net increase of approx. 1,300m^2 retail against the approved concept masterplan (for 130-150 Bunnerong Road, Pagewood). This scenario was adopted for the traffic and transport analysis.

4.1 Internal site access

The proposed development will utilise the approved concept masterplan internal road network, with some adjustments to the undeveloped portion of the site to accommodate the additional urban blocks. The internal road network will provide separation and access to up to the urban blocks and parklands within the site. The proposed internal road networks are shown in Figure 17.

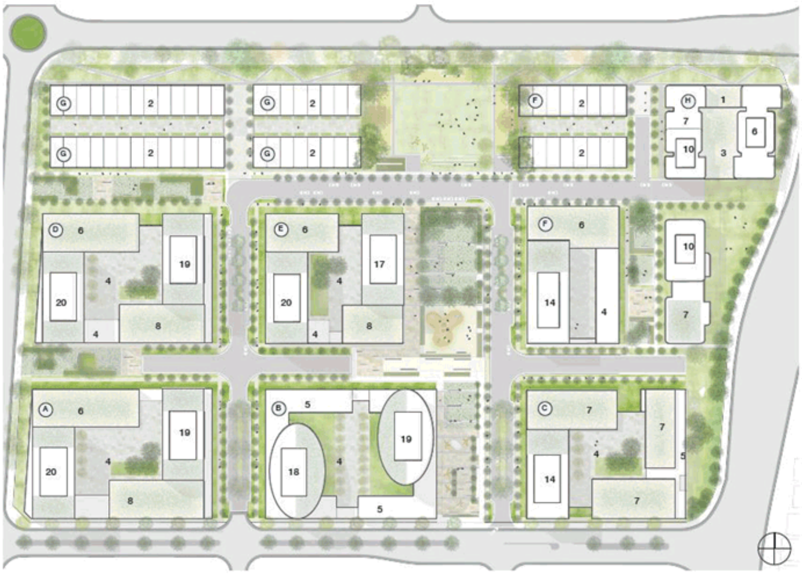


Figure 17: Proposed development masterplan

4.2 External site access

The proposed site intends to utilise the existing Meriton Boulevard accesses as external access arrangements (shown in Figure 18) which includes:

- An all movements access to Banks Avenue to the west of the site (Meriton Boulevard only); and
- A left in and left out access to Bunnerong Road.

These accesses were the adopted access points for the traffic modelling, which create a balanced distribution across the external road network. Other access options were assessed, but this minimum layout forms the best-balanced approach as later described in Section 6.6.

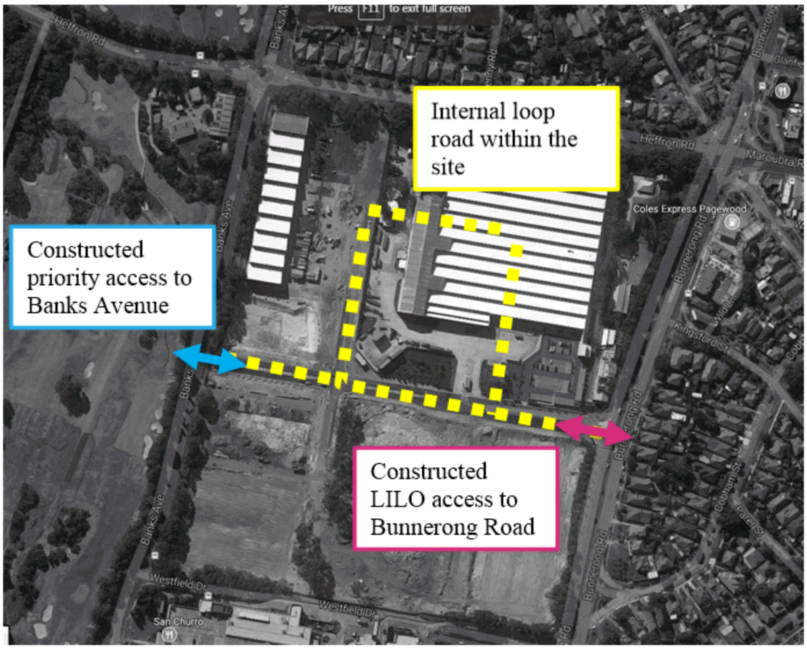


Figure 18: Proposed access arrangements

5 Transport Assessment

5.1 Future mode split

5.1.1 Traffic generation

The traffic generation rates used for the previous Concept Masterplan were adopted, which utilised an adjusted rate from the Roads and Maritime Technical Direction (TDT 2013/04a) and Journey to Work data based on the following:

$$\frac{Journey\ to\ Work\ car\ mode}{'surveyed\ sites'car\ mode\ \times 'surveyed\ sites'\ trip\ rates\ per\ unit}$$

The rate for high density residential was determined as a function of the mode share for the development by calculating the peak hour ratios between the sites from the Technical Direction. Given the non-car mode share was 58% for the surveyed sites (in Metropolitan Sydney) and 38% from the JTW data (in Table 2), this resulted in the following peak hour generation rates for the proposed development:

- Weekday AM 0.277
- Weekday PM 0.217
- Weekend Noon 0.246

Serviced apartments are considered to have a similar trip rate to the expected residential uses of the site due to the close proximity to transport and the similar demographics expected in the accommodation.

5.1.2 Forecast mode split

The Roads and Maritime Technical Direction (TDT 2013/04a) and Journey to Work data was utilised to determine the person trips and forecast mode split for the development. It should be acknowledged that demographics will likely be different to the current journey to work dataset, which is focused on a low density established residential area context. The person peak hour trip generation rates that have been adopted for the proposed development are as follows, which are based on the average rates for high density residential developments as outlined in TDT 2013/04a:

- Weekday AM 0.725
- Weekday PM 0.592
- Weekend Noon 0.660

As a result of the traffic generation and person trip generation, the forecast mode splits have been analysed and illustrated in Table 4.

Table 4: Forecast mode split

Mode	AM Peak Hour		PM Peak Hour		Weekend Peak Hour	
	%	Number	%	Number	%	Number
Car	38%	454	30%	356	34%	403
Train	6%	69	5%	58	5%	64
Bus	37%	436	31%	365	34%	403

Mode	AM Peak Hour		PM Peak Hour		Weekend Peak Hour	
	%	Number	%	Number	%	Number
Walk	12%	138	10%	115	11%	127
Other	8%	92	6%	77	7%	85
Total	100%	1,188	100%	971	100%	1,081

The number represents a significant shift to bus modes, which is further discussed in Section 5.4.

5.2 Parking and loading provisions

5.2.1 Car parking

The number of off-street parking spaces are specified by Bayside Council in the Development Control Plan (DCP) 2013. Meriton have proposed parking rates which have been compared to the relevant DCP Part 3A and 9D rates, and the approved Stage 1 concept masterplan rates (summarised below in Table 5.)

Table 5: Minimum car parking rates

Development type	Part 3A/9D BBDCP	Approved Stage 1 masterplan	Proposed rates
Residential flat buildings			
Studio / 1 bedroom apartments	1 space per apartment	1 space per apartment	0.5 space per apartment
2 bedroom apartments	2 spaces per apartment	1.5 space per apartment	1 spaces per apartment
3 bedroom apartments	2 spaces per apartment	2 space per apartment	1.5 spaces per apartment
Visitor parking	1 space per 5 apartments	1 space per 10 apartments	1 space per 10 apartments
Commercial / Retail / Infrastructure			
Shops	1 space per 25m^2	1 space per 40m^2	1 space per 40m^2
Childcare	1 space per 2 employees	1 space per 2 employees	1 space per 2 employees
	1 space per 5 children	1 space per 5 children	1 space per 5 children
	1 pick-up and set-down space per 20 children.	1 pick-up and set-down space per 20 children.	1 pick-up and set-down space per 20 children.

It is considered appropriate to reduce car parking for residential uses to reduce car mode share from the development. Car parking is a major contributor to car usage and the reduced rates are expected to result in reduced traffic generation. The rates proposed are more aligned to the recommended RTA Guide to Traffic Generating Developments rates which indicate:

- 0.6 spaces for 1-bedroom apartments
- 0.9 spaces for 2-bedroom apartments
- 1.4 spaces for 3+ bedrooms apartments

As a point of comparison, the 2011 Census car ownership in the surrounding suburbs (Botany, Pagewood, Hillsdale, Banksmeadow, Maroubra, Kingsford) for multi-unit dwellings was considered. The car ownership rates (Table 6) are also comparable with the RTA parking rates and subsequently the proposed rates.

Table 6: Car ownership in surrounding suburbs

Units (in area)	No. Units	No. Cars	Required Rate
One bedroom/studio	1245	895	**0.7189**
Two bedroom	5301	5376	**1.0141**
Three bedroom +	1940	2403	**1.2387**
Total	**8493**	**8685**	**1.0226**

The total car parking rates are comparable with the proposed unit mix, given the approximate 1:1 ratio overall as shown in Table 7.

Table 7: Meriton unit mix

Meriton proposed	Indicative unit mix	Cars	Rate
One bedroom/studio	392	196	0.5
Two bedroom	1,371	1,371	1
Three bedroom +	196	294	1.5
Total	**2,015**	**1,861**	**0.95**

The reduced parking rates are also supported by the good public transport network both planned and under constructions. The potential Light Rail extensions (identified in the NSW Transport Masterplan) and potential Sydney Metro connection may be within walking distance of the site and will further encourage mode shift away from cars and hence the reduced parking rates.

The site is within the Eastgardens and Maroubra district centre and it is expected that there will more services/facilities and transport options in the future to support the surrounding growth and proposed development.

5.2.2 Bicycle parking

The City of Botany Bay DCP states the following in relation to bicycle parking:

*C7 In every new building, where the floor space exceeds 600m² GFA (**except for houses and multi unit housing**) bicycle parking equivalent to 10% of the required car spaces or part therefore as required in Table 1 shall be provided.*

C8 Residential flat buildings where the floor space exceeds 600m² GFA shall provide secure bicycle storage as per AS 2890.3.

In the absence of specific rates for the provision of bicycle parking in the residential component, the 10% of car parking figure has been adopted consistent with the remainder of the Pagewood concept masterplan site.

5.3 Walk and cycle access

There are changes proposed to the walking and cycling network interface to the site. The extensive provision of walking/cycling facilities provided within the development will be integrated with the number of cycleways surrounding the site, which are shown in the figure below.

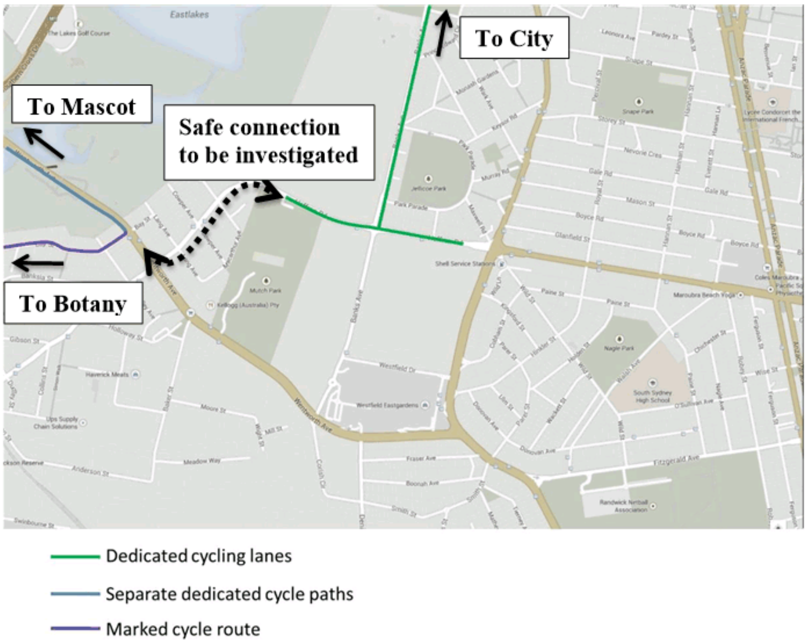


Figure 19: Cycleways surrounding site

The site has some good cycleway connections to the north. The northern route connects directly to the city via Kensington and the western route (from Bay Street) connects to General Holmes Drive and Botany. There are good regional connections to the west as well; however there is a gap along Page Street and limited safe opportunities to cross Wentworth Avenue to the shared path. It is recommended for Bayside Council to investigate this link or prepare a Bike Plan for the area for better regional cycle connections.

Secure bicycle parking is to be provided as a component of the proposed development. Provision of these facilities (along with the site being adjacent to regional shopping facilities) will encourage active travel, such as cycling as a viable mode of transport to the site. This will further contribute to a reduced car mode share of trips.

5.4 Public transport

The following sections outline the current, proposed and potential public transport servicing the site. These are also summarised in Figure 20.

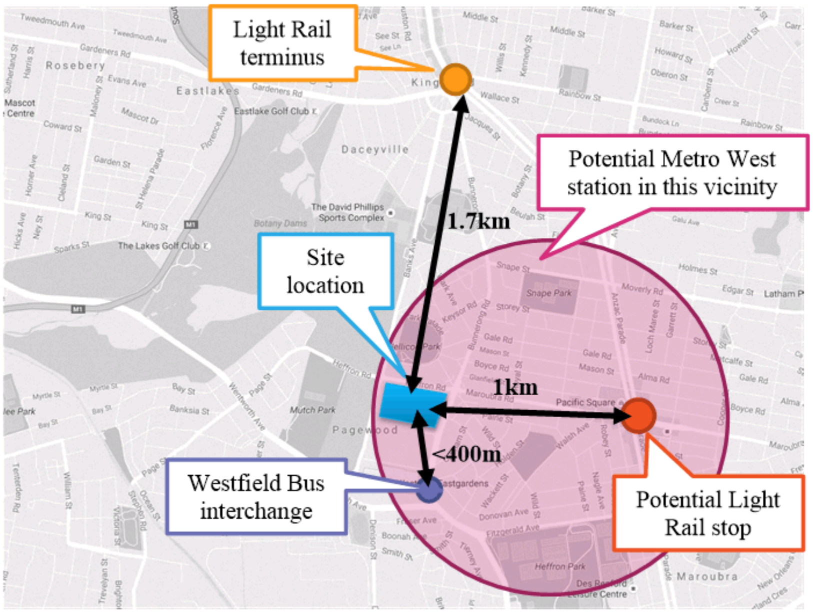


Figure 20: Public transport servicing the development

5.4.1 Bus infrastructure

Using the mode splits for buses established in Section 5.1, this equates to between 365 to 436 additional people using the bus during peak hours. From site observations, buses were generally 50% full leaving the Westfield interchange, however there may be impacts further towards the destinations such as the City. Therefore, using a bus occupancy of 50 people, this equates to an additional eight bus services during each of the peak hours to service the development. While a number of buses are being rerouted in this area to the Light Rail, it is likely these will need to be supplied towards the City as express services, which will supplement the local feeder services being directed to the Light Rail.

Meriton have discussed increased bus services and current capacities with Sydney Buses. It is understood that Sydney Buses will implement more than the required eight buses noted in the Transport Impact Assessment.

5.4.2 Sydney Light Rail

The current Sydney Light Rail stop under construction at Kingsford terminus is located 1.7km to the north, which may be considered just outside walking distance for most people. However, there will likely be some people who may consider walking within 25 minutes to the stop or cycling for 5 minutes. It is likely that future residents of the site will drive and park at the stop.

5.4.3 Potential Light Rail extension

The government has indicated that Light Rail may be extended to Maroubra Junction in the future, which is within 15 minutes' walk of the site. However, given the distance from the site, there is still expected to be a lower proportion of walk-up of this mode compared to bus, and people will likely try and drive to a commuter car park if available.

If Light Rail is extended to the site as discussed, patronage of bus is likely to be less and the need for additional services could potentially be mitigated given there will be a mode shift in the surrounding area to Light Rail.

5.4.4 West Metro

As stated in Section 3.2, there are also plans being considered for a West Metro rail line linking the second proposed Sydney Airport at Badgerys Creek to Central and possible extension to the south eastern suburbs. The potential extension may continue near the site and have the potential to attract patronage from the proposed development. This will further encourage less car trips from the development if the station is located within 800m of the site. However, given the uncertainty of the project, no mode split to this mode have been assumed.

5.5 Transport measures

5.5.1 Travel Plans

One of the objectives to reduce the level of private car usage is to favour more sustainable modes of travel such as walking, cycling and public transport. A method of achieving this is personalised marketing strategies to assist in modifying travel behaviour through communicating relevant travel choice information to the community. Marketing would begin through information to be produced by the developer, including:

- Travel information kits for residents (including Travel Access Guides)
- Travel Plans for employees and residents.

5.5.2 Wayfinding

Wayfinding signage would be installed at entry points to allow people to navigate their way around the precinct. Maps would also be installed to allow people to know about the nearby pedestrian and cycle connections.

5.5.3 Car share schemes

Car share schemes are designed to provide a flexible option for people who only require occasional car use and choose not to own a vehicle. They provide access to a vehicle when it is the most suitable mode choice, while avoiding the need and expense of owning a vehicle. They would potentially require lower parking rates than proposed in Section 5.2 to provide sufficient incentive for residents and businesses to reconsider purchasing a first or second vehicle in favour of using the car share vehicle. Without a vehicle sitting in a garage, private car is not the first mode considered, increasing the likelihood that other mode sustainable modes will be chosen.

Successful car share operations are based in metropolitan areas with high-density and mixed-use development, good levels of pedestrian access and constrained parking (fewer car parks or parking that is more expensive). When used in conjunction with public transport, walking, and cycling, car sharing has the ability to be an integral part of the sustainable transport network for urban areas.

Car sharing also has the ability to reduce the total fleet vehicles for an employer and reduce the use of private vehicles for commuting. This trend is supported by current research, such as the Transportation Research Board report that estimated that 'at least five private vehicles are replaced by each shared car' in 2005. Sydney's Go-Get club advertises that its research shows that each car in the scheme gets seven others off the roads.

6 Traffic impact assessment

6.1 Traffic generation

Using the mode splits for cars established in Section 5.1, this equates to the following peak one hour generation rates for the proposed development:

- 0.277 trips per apartment for Weekday AM peak hour
- 0.217 trips per apartment for Weekday PM peak hour
- 0.246 trips per apartment for Weekend Noon peak hour

In addition, child care and retail uses are proposed, which utilise different rates from Roads and Maritime as follows:

- 0.7 trips per child for childcare uses; and
- The following peak hour rates for retail uses:
  - 0.08 / m^2 GFA for AM peak hour trips
  - 0.12 / m^2 GFA for PM peak hour trips
  - 0.16 / m^2 GFA for weekend peak hour trips

A two-hour conversion of the traffic generation rates outlined in Section 5.1 were adopted for the modelling based on the development yield outlined in Chapter 4. This is outlined further in the appendices.

Table 8 outlines the net change of traffic generation relating to 128 Bunnerong Road, Pagewood and the northern portion of 130-150 Bunnerong Road, Pagewood. The net changes are approximately 1,639 additional residential units, an additional child care centre and an additional 1,000m^2 retail uses.

Table 8 Change to development traffic (over two-hour peak periods)

Development Type	Original Development Proposal			Proposed Changes		
	AM	PM	WE	AM	PM	WE
Residential	977	765	868	+723	+566	+642
Retail	0	238	317	0	+48	+63
Childcare	222	222	0	+28	+28	0
Warehouse	397	397	0	-397	-397	0
Total	**1,596**	**1,622**	**1,185**	**+354**	**+245**	**+705**

6.2 Traffic modelling methodology

A series of AIMSUM micro simulation traffic models have been created to assess traffic impacts from the proposed development. Further details of the modelling process and results are provided in Appendix A of this report. A series of existing conditions (Year 2016) traffic models were established for the AM, PM and weekend two-hour peak periods for the immediate surrounding road network. Travel time and turning count data was used to calibrate and validate the existing conditions models.

Future year models were created for each of the peak periods for Year 2021 (which is the intended completion year of development) and the 10-year horizon to Year 2031, which were the discussed years to be modelled with Roads and

Maritime during a meeting in December 2015. Future year models included background growth and surrounding key approved developments proposed such as Bunnings, Orica Industrial and Masters, with the following intersection upgrades:

- Page Street / Wentworth Avenue modifications
- Maroubra Road / Bunnerong Road / Heffron Road modification
- Heffron Road signalisation

In total 15 different scenario models were run, three base models, six future year base case models and six development models. Table 9 below details each model scenario that was run for an AM, PM and Weekend peak period. For each scenario the intersection Level of Service (LoS), travel time analysis and network performance will be explored.

Table 9 Model Scenarios

Model	Abbreviation	Design Year	Description
Base Model	Base	2016	Calibrated base model exploring existing conditions.
Future Base	FB	2021, 2031	Future base model that includes all likely and currently approved developments. This includes the original Meriton Pagewood proposal. This model will form the benchmark for all future year models.
Proposed Development	PD	2021, 2031	Future options model that includes the changes to the previously proposed Meriton development.

The model extent included an area from Page Street and Wentworth Avenue to Bunnerong Road between Wentworth Avenue and Maroubra Road. The modelling extent is shown in Figure 21 as previously agreed with Roads and Maritime Services.

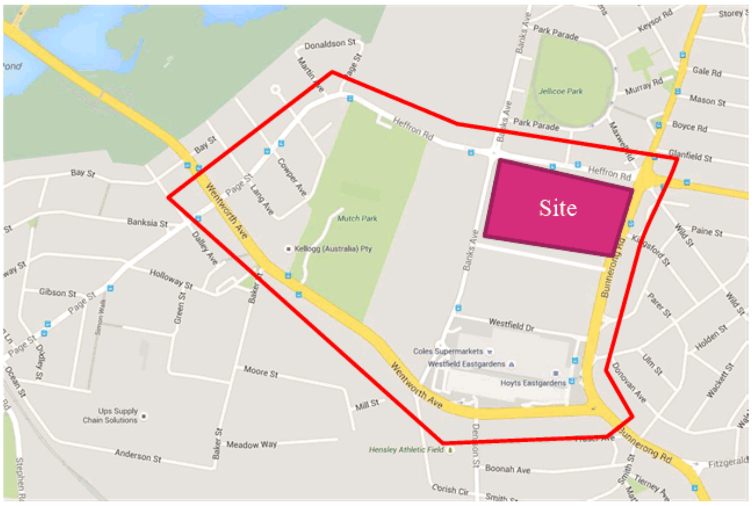


Figure 21: Modelling extents

6.3 Modelling results

In urban areas, the traffic capacity of the major road network is generally a function of the performance of key intersections. This performance is quantified in terms of Level of Service (LOS), which is based on the average delay per vehicle. The results of the surrounding intersections and network are summarised in the Traffic Modelling report in the Appendix. The following sections summarise the future models developed with the development traffic.

6.4 Year 2021

In the AM peak period, Wentworth Avenue / Banks Avenue / Corish Circle, Wentworth Avenue / Denison Street and Wentworth Avenue / Page Street intersections have the largest increase in delays as traffic accesses the wider network from the development site increasing the pressure on the side roads. This issue is further exacerbated with the introduction of the right hand turn as it creates an alternative route to Heffron Road. The introduced right turn does however remove the pressure off Wentworth Avenue / Page Street and to a lesser extent, the Banks Avenue / Heffron Road intersection via the alternative route.

Table 10 AM peak Level of Service results

Intersection	Future Base		Future Dev	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	41	C
Bunnerong/Meriton	1	A	2	A
Bunnerong/Westfield	10	A	13	A
Bunnerong/Wentworth	23	B	23	B
Wentworth/Dennison	35	C	31	C
Wentworth/Banks/Corish	32	C	24	B
Banks/Westfield entrance	4	A	3	A
Banks/Westfield	6	A	5	A
Banks/Meriton	1	A	2	A
Banks/Heffron	24	B	35	C
Wentworth/Page	63	E	59	E

The issues noted in the AM peak are also experienced in the PM peak period with an intensification of delays around Wentworth Avenue / Banks Avenue / Corish Circle intersection as retail traffic to Westfield Eastgardens intensifies.

Table 11 PM peak Level of Service results

Intersection	Future Base		Future Dev	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	39	C
Bunnerong/Meriton	1	A	2	A
Bunnerong/Westfield	10	A	16	B
Bunnerong/Wentworth	21	B	22	B
Wentworth/Dennison	32	C	32	C
Wentworth/Banks/Corish	21	B	37	C
Banks/Westfield entrance	2	A	3	A
Banks/Westfield	7	A	7	A
Banks/Meriton	1	A	3	A
Banks/Heffron	28	B	26	B
Wentworth/Page	68	E	46	D

In the weekend peak period, the worst delays are experienced as the intensification of Westfield Eastgardens traffic causes the saturation of the Wentworth Avenue / Banks Avenue / Corish Circle intersection shifting traffic to the Heffron Road corridor, resulting in an increase of delay at the Banks Avenue / Heffron Road intersection. With the introduction of the right-hand turn resulting in the further intensification of traffic on Banks Avenue, additional traffic is forced onto Heffron Road / Banks Avenue and the intersection begins to reach saturation point as well.

Table 12 Weekend peak Level of Service results

Intersection	Future Base		Future Dev	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	56	D	49	D
Bunnerong/Meriton	2	A	3	A
Bunnerong/Westfield	28	B	26	B
Bunnerong/Wentworth	32	C	30	C
Wentworth/Dennison	46	D	34	C
Wentworth/Banks/Corish	115	F	41	C
Banks/Westfield entrance	11	A	5	A
Banks/Westfield	7	A	7	A
Banks/Meriton	1	A	3	A
Banks/Heffron	54	D	26	B
Wentworth/Page	54	D	53	D

In the AM and PM peaks all the intersections along Bunnerong Road remain largely unaffected. However, in the Weekend peak these intersections come under increased pressure.

6.5 Year 2031

Despite the development traffic, the network capacity in 2031 was able to be improved over and above the existing future base scenario. Indicating that there is currently spare capacity on the network that is only restricted by the operation of a number of key intersections.

As the AM peak period model is relatively uncongested there is little change in the intersection level of service (LoS) as indicated in Table 13. Where the changes make the most difference is in the PM peak period (see

Table 14). The double diamond phasing at Wentworth Avenue and Page Street allows the intersections to effectively deal with the tidal peak demands competing with retail trips around the Westfield Eastgardens site. In the Weekend peak period (see Table 15), two of the intersections start to come under pressure again however overall there is still a network improvement even with the increased demand.

Table 13 AM Peak Period Intersection Level of Service

Intersection	Future Base		Development	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	45	D
Bunnerong/Westfield	10	A	15	B
Bunnerong/Wentworth	23	B	27	B
Wentworth/Denison	35	C	33	C
Wentworth/Banks/Corish	32	C	27	B
Banks/Westfield entrance	4	A	5	A
Banks/Heffron	24	B	33	C
Wentworth/Page	63	E	67	E

Table 14 PM Peak Period Intersection Level of Service

Intersection	Future Base		Development	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	43	D
Bunnerong/Westfield	10	A	22	B
Bunnerong/Wentworth	21	B	27	B
Wentworth/Denison	32	C	36	C
Wentworth/Banks/Corish	21	B	43	D
Banks/Westfield entrance	2	A	11	A
Banks/Heffron	28	B	36	C
Wentworth/Page	68	E	61	E

Table 15 Weekend Peak Period Intersection Level of Service

Intersection	Future Base		Development	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	56	D	54	D
Bunnerong/Westfield	28	B	33	C
Bunnerong/Wentworth	32	C	42	C
Wentworth/Denison	46	D	37	C
Wentworth/Banks/Corish	115	F	58	E
Banks/Westfield entrance	11	A	7	A
Banks/Heffron	54	D	32	C
Wentworth/Page	54	D	58	E

6.6 Road network impacts

During the operational modelling process, it was found that the development yields have little impact on the network. In the weekend peak period, development traffic has trouble accessing the wider network due to the intensification of retail traffic around Eastgardens. The deterioration in performance is established in the future based scenario, without the proposed development traffic and improves slightly across the peak periods with the proposed development.

It was also found that as the road network is expanded and additional connections are added to the wider network, delays increase. This is in part due to the intensification of traffic around Eastgardens from the growth in the retail catchment. This new traffic is using the expanded network for alternative routes increasing turning movements and the associated merging and weaving.

In summary, the network operates satisfactorily with the expanded development however it is advisable that the road layout is refined as to minimise new connections onto Banks Avenue and Heffron Road (consistent with the accesses nominated in Section 4.2). It is also recommended to assess possible changes to the network to account for the increased demand to Eastgardens shopping centre as it is retail traffic that has the largest effect on the network.

It is not advisable to include a right turn into Meriton Boulevard even though minimal additional delay is experienced along Bunnerong Road the right turn introduces an alternative route to Eastgardens. Increasing delays along Banks Avenue and Wentworth Avenue as a result.

7 Key recommendations

This transport impact assessment has been prepared for the rezoning of 128 Bunnerong Road, Pagewood and the northern portion of 130-150 Bunnerong Road, Pagewood based on the information available for this study. The rezoning will convert the Precinct to a mixed residential and community precinct. The assessment of the transport network required to support this rezoning has identified a number of influences from the wider Sydney road and light rail networks that could play a key role in determining the magnitude of development within the Eastern Suburbs subregion. The following recommendations are made to assess the impact of these wider regional impacts.

7.1 Arterial road network capacity

The region contains a number of arterial roads, including Wentworth Avenue, Bunnerong Road and Maroubra Road. All of these roads currently experience a level of congestion and are expected to face increased demand in the future. The Sydney Light Rail extension project is likely being considered by government, which may provide additional road capacity in the study area. Its impact on the amount of road capacity in the future and on flows is being investigated by state government.

The region has three main gateways that are mostly operating near capacity, with long delays and queues during peak periods. As a result, some intersections are already being upgraded to cater for development traffic of the 130-150 Bunnerong Road, Pagewood concept masterplan. Others have some spare capacity to accommodate future growth.

The future arterial road network conditions will have a large influence on the amount of traffic that can be generated by the subregion. Upgrades to the arterial road network may cause a re- distribution of trips in the area, changing the balance of traffic that uses each of the three gateway intersections.

Accordingly, there are no upgrades required to the surrounding local or arterial road network as a result of the Planning Proposal.

7.2 Public transport

Public transport surrounding the site is to be accommodated by buses. While a light rail extension has been planned to extend to Maroubra, this is still quite some distance from the site (approximately 1.0km from the site). In addition, the light rail extension adjacent to the site has not yet been approved by government. As such, with the additional residents expected, there may be capacity issues with the public transport system.

The buses servicing the surrounding roads are described in Section 2.3 of the traffic impact assessment. There are approximately 23 bus services during the AM peak hour (of which 7 provide services to the City).

Additional demand may be distributed amongst some of the buses within the area as there was observed capacity on the local routes. However, with the cumulative effects from the approved concept masterplan, Section 5.4 indicates that an extra eight bus services will likely need to be provided so that there is spare capacity retained for the routes further down the lines.

7.3 Development levels

An analysis of the road network capacity has been used to estimate that the road network could sustain development within the 128 Bunnerong Road, Pagewood and the northern portion of 130-150 Bunnerong Road, Pagewood site to the following levels:

- 1,639 additional dwellings across the entire project accommodating approximately 4,400 residents
- 1,000m^2 GFA additional retail

Other strategies to reduce vehicle trip generation without the need to construct more road upgrades include.

- a more extensive public transport upgrade
- higher public transport frequencies assisted by dedicated public transport priority
- reduced parking rates to encourage the use of alternative modes of transport.

7.4 Summary

This traffic and transport assessment has been undertaken for the proposed rezoning of the 128 Bunnerong Road, Pagewood and the northern portion of 130-150 Bunnerong Road, Pagewood site. The subject site has an area of 8.95ha. A Development Control Plan (DCP) including a site-specific chapter has been prepared (refer to Chapter 9D - British American Tobacco Australasia, of the Botany Bay DCP 2013).

The site will have good access to public transport, with buses and light rail (under construction) providing alternatives to car usage. The potential extended transport network and reduced parking rates on the site in comparison to the site specific DCP will also reduce car dependence and result in lesser road network impacts.

Through the operational modelling process it was found that the development yields have little impact on the network with the current approved and committed upgrades proposed. In the weekend peak however development traffic has trouble accessing the wider network due to the intensification of retail traffic around Eastgardens.

This is a broader network issue not generated by the proposed development as the project will have local retail or is within walking distance to the Westfield Centre. Accordingly, the development does not generate the need for any localised upgrades.

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Appendix A

Traffic modelling report

Meriton Properties

128 Bunnerong Road, Pagewood

Traffic Modelling Report

Rev A | 6 August 2018

Job number 237575

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Contents

1 Introduction

1.1 Background

The objective of this study was to develop a traffic model suitable for analysing the proposed extension of the Meriton Properties Pagewood development to include the British American Tobacco Australia (BATA) site. The modelling is used to test development yields, assess network impacts and understand access arrangements.

This report also details the option testing that was undertaken to support the expanded Meriton Properties development on the British American Tobacco Australia site. In order to test the traffic and transport implications of potential development options and network changes the base models are to be modified to reflect potential future conditions. The types of changes to the base models that are required include:

- Additional demands due to existing site development approvals, which are expected to be taken up in the near-term
- Possible minor adjustments to road network arraignments
- Potential increases in external traffic passing through the study area

Once the future base model has been established then the incremental demands and network changes associated with the development options will be added to the future base model creating the options models.

1.2 Purpose of this report

This report aims to provide background information relevant to the development of the micro-simulation model, and demonstrate that the model has been developed in accordance with the relevant guidelines. The ultimate goal is to establish confidence that the model is fit-for-purpose for use as part of the subject study only. This is achieved through the presentation of information relevant to the development, calibration and validation of the model including:

- Identification of the network area to be modelled
- Identification of the data used as inputs to the model
- Traffic demand matrix development
- Model validation and calibration

1.3 Software package

The software used for the analysis presented in this report was Aimsun Next 8.2.3 (R54491x64). Aimsun is an integrated transport modelling software package approved by the RMS that is commonly used for micro and mesoscopic traffic models.

1.4 Site location

Pagewood is located directly to the east of Sydney Airport and 8km south of the Sydney CBD. The University of New South Wales is located immediately to the north with port botany located immediately to the south. There are four wider network connections within the site: Bunnerong Road, Wentworth Avenue, Denison Street and Page Street/Heffron Road.

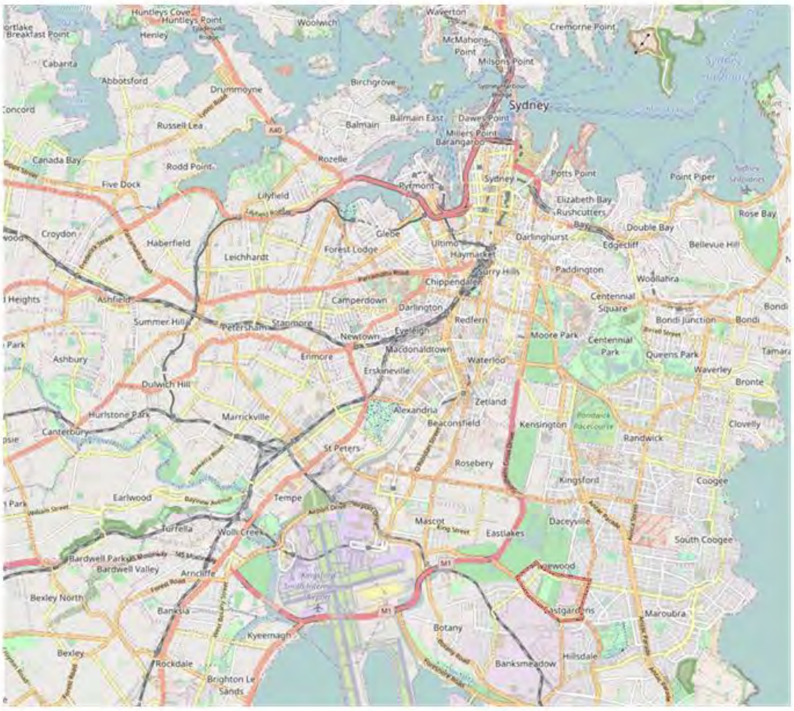


Figure 1 Pagewood location within Sydney (*source: Open Street Maps)*

1.5 Study area

The study area was defined by the major roads surrounding the BATA extension site and is illustrated in Figure 2 below.

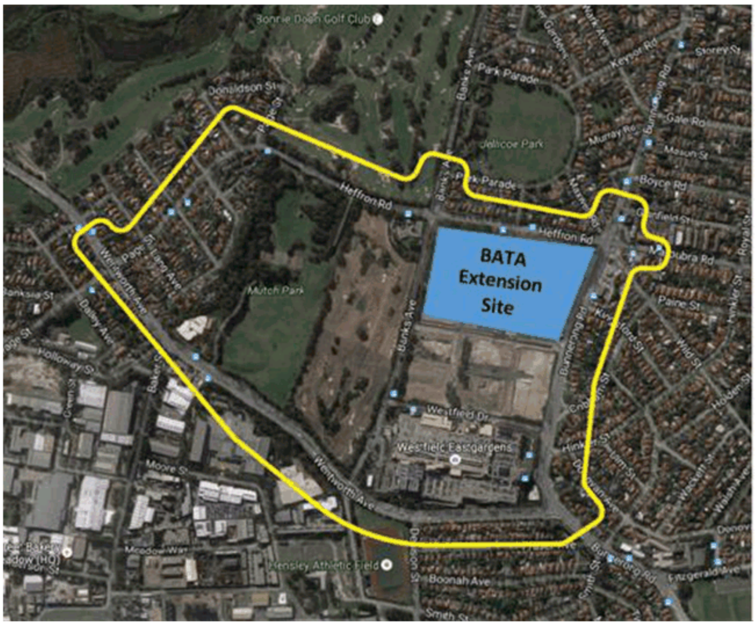


Figure 2 Study area definition (*source: google maps*)

The study area includes residential and retail areas, notably the Eastgardens Westfield in the south east corner of the study area. In order to understand how the road network functions, it is crucial to consider the strong freight corridor formed by Wentworth Road running along the southern edge of the study network and Denison Street extending to the south.

1.6 Time periods

In order to select the appropriate time periods to assess, data from the traffic counts were collated across the network with the 15 minute overall demand graphed, see Figure 3. The 15 minute flows were also calculated by surmising the hourly volumes beginning every 15 minutes, see Figure 4, Figure 5 and Figure 6.

This process clearly highlighted the busiest period for the morning, afternoon and weekend peak. As the demand profile was fairly flat for a sustained period of time in the PM and weekend time period a two hour peak was chosen to be modelled. The AM peak for consistency was also modelled as 2 hours.

- AM weekday peak: 7:30 – 9:30am
- PM weekday peak: 4:30 – 6:30pm
- Weekend peak: 11:15am – 1:15pm

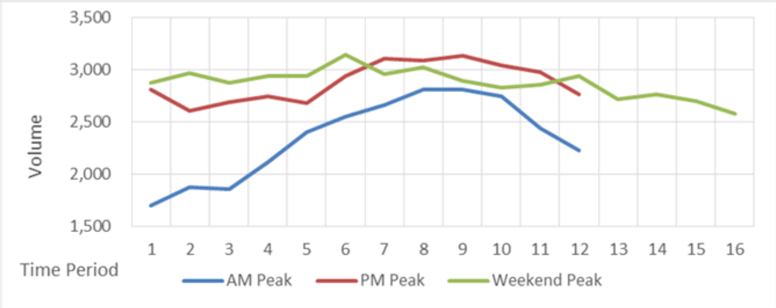


Figure 3 Demand profiling, volume per 15min period

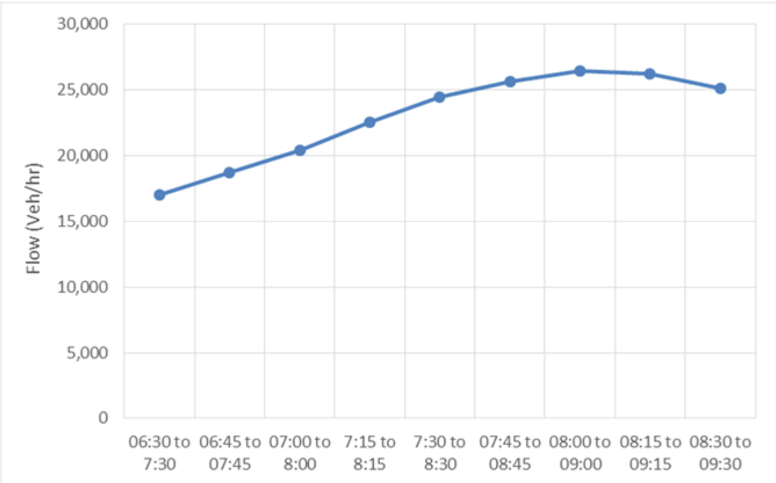


Figure 4 AM Peak identification, 15 min flows

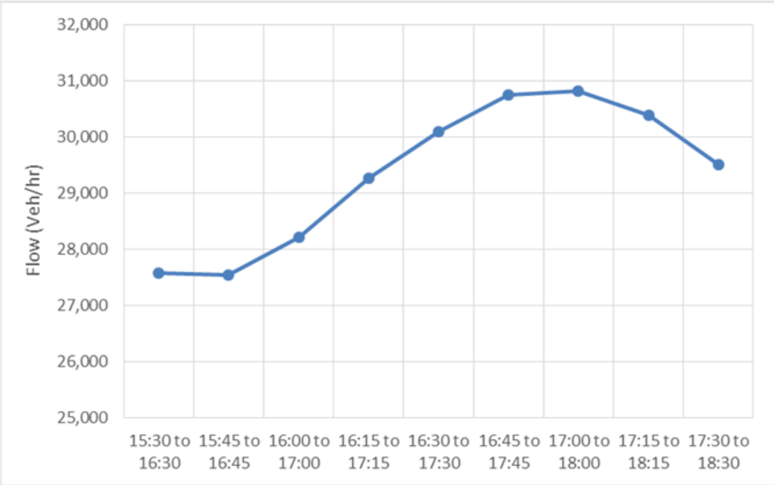


Figure 5 PM Peak identification, 15 min flows

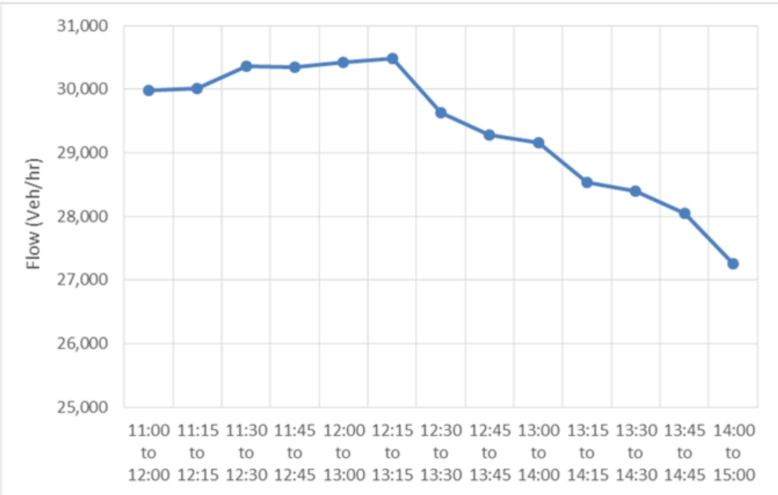


Figure 6 Weekend Peak identification, 15 min flows

2 Data Collection

Developing the model of the study network required the collection of several different data types. This data was used for coding the base model and subsequently during the calibration and validation process. Table 1 below details the types of data collected and their respective uses.

Table 1 Summary of data used in base model

Data type	Description	Location	Date and time	Used for
Intersection counts	Turn counts were undertaken by subconsultants Matrix. This data was recorded in 15minute intervals and categorised into car, truck, bus and pedestrians.	11 intersections across the study area (See Figure 7)	Thursday 18 August, 6:30-9:30am and 3:30-6:30pm Saturday 20 August, 11am – 3pm	Prior matrix and Calibration
Videos of intersections	Videos were used to collect data about average phasing data to use as a starting point for the base model signals.	11 intersections across the study area (See Figure 7)	Thursday 18 August, 6:30-9:30am and 3:30-6:30pm Saturday 20 August, 11am – 3pm	Signal operations
Travel time	Travel time through the model along two routes 1. Page Street – Heffron Rd – Maroubra Rd 2. Wentworth Rd – Bunnerong Rd	2 routes through the study area (See Figure 8)	Thursday 18 August and Saturday 20 August	Model Validation
Site observation	Site visit to study area	Whole study area	Wednesday 16 November	Assessing model operation
TCS plans	Plans from the RTA (now RMS) showing layout and possible phases for signalised intersections	6 signalised intersections in network	NA	Signal operations
Bus network data	Timetabling and routing data for buses operating in study area (See Section 3.3)	Whole study area	Timetables for Nov 2016 used	Creating base model Public Transport demand
Journey to Work data	Data from 2011 census about travel patterns in the area	Wider Pagewood area	2011 Census	Developing trip distribution for prior matrix
RMS guide to traffic generating developments	Information on land use trip generation	Internal network zones	2013 release	Estimating demand in prior matrix

Figure 7 Intersection Count Locations *(source: Matrix traffic and transport data)*

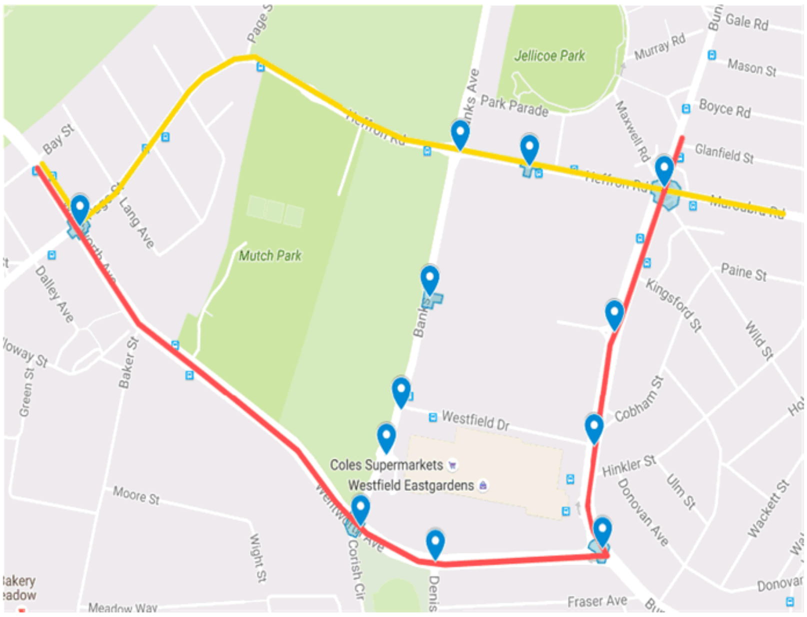


Figure 8 Travel time routes assessed *(source: Matrix traffic and transport data)*

3 Network Development

The network was initially created through the importation of an open street map data file of the study area. The network was then subsequently refined using aerial images from SIXmaps until the required level of detail was obtained.

3.1 Road hierarchy

Three primary road types have been used in the model, sub-arterial (orange), collector (yellow) and local roads (white) as shown in Figure 9. Although not specifically built as sub arterial roads, Page Street and Heffron Road perform a sub-arterial function with regards to network connections. The coding of road types was undertaken primarily for the purpose of static model adjustments and static assignment.

Figure 9 Road Hierarchy

3.2 Travel speeds

Travel speeds within the network have been applied in accordance with posted speeds. These are generally as follows:

- 70km/h along Wentworth Road
- 60km/h along Bunnerong Road
- 50km/h along all residential roads

The default speed distributions within each of these speed categories have been adopted.

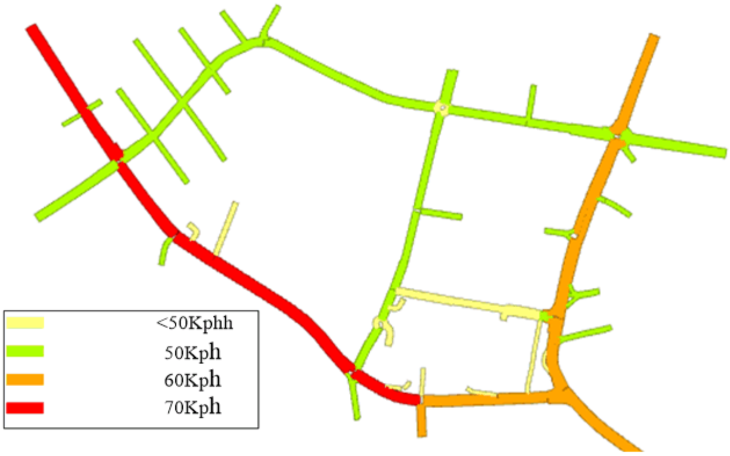


Figure 10 Speed ranges within model

3.3 Public transport

Buses are the only form of public transport (excluding taxis) within the study area. Table 2 highlights the bus routes that have been coded within the model. Dead running buses and school buses have not been explicitly coded as it is expected that these services will be captured within the heavy vehicle counts.

The bus interchange at Eastgardens has been coded as a bus only area with a number of buses starting and terminating in this area. Site observations indicated that there was no congestion associated with bus layovers and as such there was no need to explicitly model bus layovers.

Table 2 Bus routes included within the model

Route
301
302
310, X10
316, 317
353
391, 392, X92
400, 410

3.4 Signal operations

Actuated signals have been coded into the model to capture the variability of signal times within Pagewood. A maximum and minimum green time was specified for all phases with some having the ability to be skipped if no demand was present. A gap out parameter of 5 seconds was used with some of the mainline movements having a reducing gap parameter to account for potentially long green times.

The reducing gap parameter reduces the gap required for gapping out over a specified time period so that phases have the ability to substantially extend the maximum green time only when necessary.

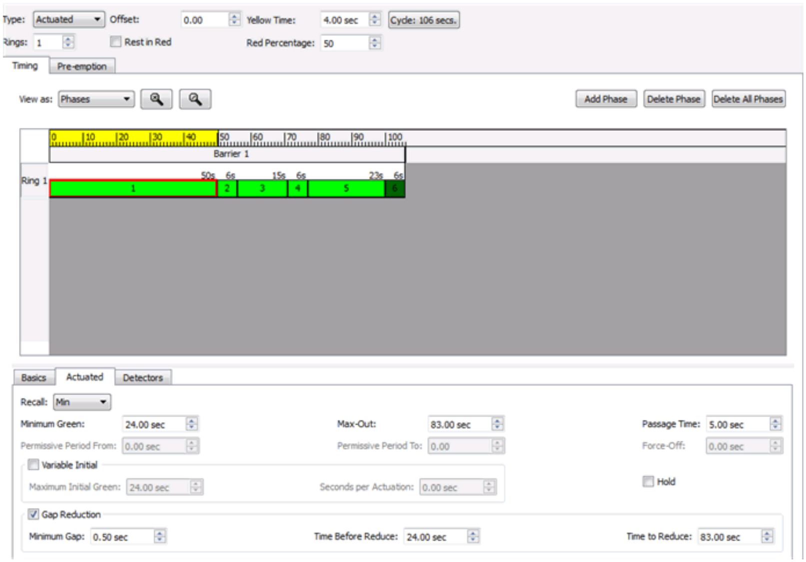


Figure 11 Example of Actuated Signal Coding

Table 3 compares the phase green time proportion for the signalised intersections in the model with observed values. This highlights that the actuated signals, with the exception of 53 phases, are acceptable as per table 11.3 page 105 of the *RMS Modelling guidelines (Roads and Maritime, 2013)*.

Three of the phases that lie just outside the criteria do so due to the balance between green times given to the right hand turn and the through movement. This occurs at the Bunnerong Road / Westfield Drive intersection where the right turn starts off as a filter before transitioning to a trailing right turn arrangement. In the weekend peak the through movement is running for a larger proportion of the green time than observed with the right hand turn running for less. In the model, vehicles are finding gaps in traffic during the filter turns while in reality it is more likely that less confident drivers will instead wait for the priority phase as they know this phase is coming. This intersection only shows a 21% difference in green time and as such, this issue is not considered to be significant enough to apply a different signal logic from the other signals. There is a less significant occurrence of this in the PM peak.

The three phase operation in the AM peak at the Wentworth Avenue / Denison Road intersection lies 1% above the required criteria. However as the intersection performs well within criteria for the other two peaks this was not considered significant enough to change the signal logic for all the peaks.

The final signal phase that exceeds criteria is the right hand turn from Wentworth Avenue into Page Street. Similar to the aforementioned issue at Bunnerong Road / Westfield Drive, more vehicles in the model are finding gaps during the filtered right turn than observed on site, again because more conservative drivers are aware of the trailing right hand turn and thus only accept larger than normal gaps. This movement is only 4% above the criteria and again is not considered significant enough to warrant applying different signal logic.

Table 3 Phase Green time proportions, Modelled vs Observed

Intersection	Run	Phase	Modelled	Observed	abs diff
Bunnerong_Westfield	AM	1	81%	82%	1%
		2	5%	11%	5%
		3	14%	15%	2%
	PM	1	62%	52%	10%
		2	12%	25%	13%
		3	26%	22%	3%
	WE	1	63%	45%	18%
		2	11%	32%	21%
		3	26%	25%	2%
Wentworth_Corish	AM	1	64%	54%	10%
		2	6%	11%	6%
		3	22%	24%	3%
		4	8%	10%	2%
	PM	1	59%	49%	10%
		2	13%	17%	3%
		3	21%	30%	9%
		4	7%	5%	2%
	WE	1	48%	51%	3%
		2	18%	17%	1%
		3	26%	29%	2%
		4	8%	4%	4%
Bunnerong_Wentworth	AM	1	48%	50%	1%
		2	14%	18%	3%
		3	37%	33%	5%
	PM	1	51%	48%	4%
		2	9%	17%	8%
		3	40%	36%	4%
	WE	1	49%	44%	4%
		2	17%	19%	2%
		3	34%	36%	3%
Banks_Westfield	AM	1	76%	86%	10%
		2	24%	14%	10%
	PM	1	76%	78%	2%
		2	14%	22%	7%
	WE	1	79%	80%	1%
		2	21%	20%	1%

..Table 3 continued

Intersection	Run	Phase	Modelled	Observed	abs diff
Wentworth_dension	AM	1	46%	53%	7%
		2	16%	20%	4%
		3	38%	27%	11%
	PM	1	48%	58%	9%
		2	15%	12%	3%
		3	36%	30%	6%
	WE	1	48%	54%	6%
		2	13%	13%	0%
		3	39%	33%	6%
Wentworth_Page	AM	1	38%	38%	0%
		2	13%	22%	9%
		3	25%	19%	6%
		4	25%	21%	4%
	PM	1	48%	45%	3%
		2	3%	17%	14%
		3	20%	19%	1%
		4	29%	19%	10%
	WE	1	53%	46%	7%
		2	0%	8%	8%
		3	24%	27%	3%
		4	23%	19%	4%
Bunnerong_Heffron	AM	1	38%	31%	7%
		2	11%	15%	4%
		3	10%	18%	8%
		4	21%	25%	4%
		5	21%	16%	5%
	PM	1	43%	34%	9%
		2	10%	15%	5%
		3	23%	29%	6%
		4	19%	18%	1%
		5	5%	11%	6%
	WE	1	44%	34%	10%
		2	8%	16%	8%
		3	20%	29%	9%
		4	16%	19%	3%
		5	12%	11%	1%

3.5 Priority controlled movements

Priority control movements at intersections as well as right turn filter movements at signalised intersections have had priority rules applied. These priority rules (known as warnings in Aimsun) are consistent with observed signposted and functional priorities in Pagewood. Figure 12 details the gap acceptance parameters used in the model.

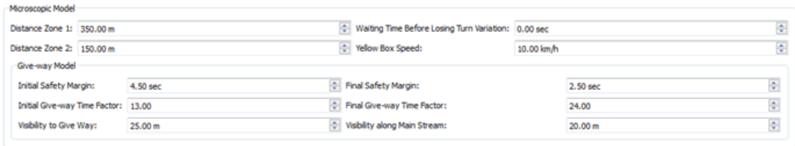


Figure 12 Gap acceptance parameters

The initial safety margin is the initial gap that vehicles will look for. After 58.5 seconds (4.5 * 13.0), vehicles will decrease their gap acceptance linearly to a gap of 2.5 seconds over a 60 second (2.5 * 24.0) period. The visibility to give way (25m) is when vehicles start to look for a gap and visibility along main stream (20m) is the distance into the opposing stream of traffic that vehicles can see.

3.6 Traffic management

Traffic management functions have been used in Aimsun to model lane closures, school zones and traffic calming devices (e.g. chicanes and speed humps). Lane closures have been modelled for Wentworth Avenue westbound in the PM and weekend models to account for parking that is restricted for only park of the simulation period. A speed change has been used to model the school zone on Bunnerong Road that is similarly only active for part of the AM simulation period. A permanent speed change is used for sections along Page/Heffron Road corridor to capture the effects of the traffic calming devices along this corridor. The speed change is representative of the suggested speed of 25km/hr.

3.7 Pedestrian conflicts

Pedestrian right of way conflicts within the model have been coded using the traffic management functionality “Periodic Section Incident”. A periodic section incident will close off a section of road for a specified period of time based on an occurrence rate and an occurrence length. The average arrival interval of a pedestrian at a crossing based of the pedestrian volumes was used for the occurrence rate and the occurrence length was based of calculated crossing times. A standard deviation was applied to both the occurrence rate and length to randomise the closures.

Figure 13 Periodic section incident at the location of a zebra crossing

The effect of pedestrian crossings on signal times was not explicitly modelled due to signals being coded as actuated. However as the green time proportions in the model matched the green time observed it can be deduced that pedestrian effects at signals are being captured.

4 Base Model Development

4.1 Demand development

To model demand in the network, the study area was broken into 29 zones shown in Figure 14. Zones 101 to 114 are internal zones with the Meriton Properties site being covered by zone 108 and the BATA site by 109. Zones 1 through 15 are external zones.

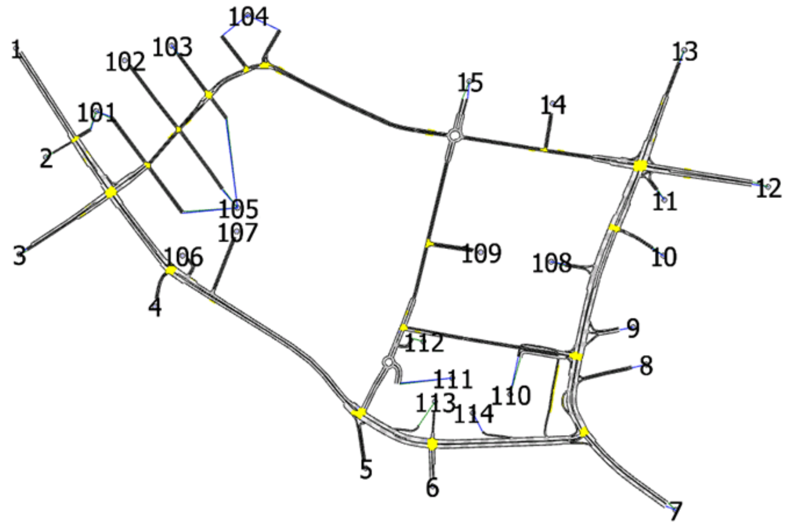


Figure 14 Zones used for demand development

In order to generate the correct matrix pattern traffic from the internal zones was estimated using traffic generation rates based on land use and journey to work information. Estimations were then confirmed and/or corrected using site observations.

External zones were calculated using turn count survey data, by calculation the entering and exiting traffic volumes with major trunk movements deduced using wider network linkages and site observations. Once the total demand for each zone was estimated, a prior origin-destination matrix was constructed.

A static origin destination (OD) adjustment scenario was run on the prior matrix in which the prior OD pairs were automatically adjusted by the modelling software to better match the turning count survey data. A deviation matrix was created also created and applied to restrict the amount of traffic that could be added or removed from particular model zones. This prevents unrealistic zone pair volumes such as unrealistically large weaving trips, which may match the survey data but are extremely unlikely to occur in reality.

After the static OD adjustment was complete the matrices were manually checked for unrealistic zone pairs with some final manual edits being made to increase model calibrations.

The last step in the process was to split the matrices into 8, 15 minute periods to profile the volumes. Table 4 highlights the demand profile used in each peak period.

Table 4 Demand Profile

Time Period	AM	PM	WE
1	12%	11%	12%
2	12%	12%	12%
3	13%	13%	12%
4	14%	13%	13%
5	14%	13%	13%
6	13%	13%	13%
7	12%	13%	13%
8	11%	12%	12%

4.2 Traffic assignment

Traffic was assigned to the network using a combination of static assignment and stochastic assignment. The static assignment method calculated paths and costs based of instantaneous flows using a Frank and Wolfe Assignment engine. The stochastic assignment was based on a c-logit model with the parameters shown in Figure 15.

The combination of 50% static and 50% stochastic allows for a representation of a mix of drivers on the network. 50% being drivers not entirely familiar with the network and less likely to react to changes in traffic with the other 50% being very familiar with the network and likely to change routes based of day to day conditions.

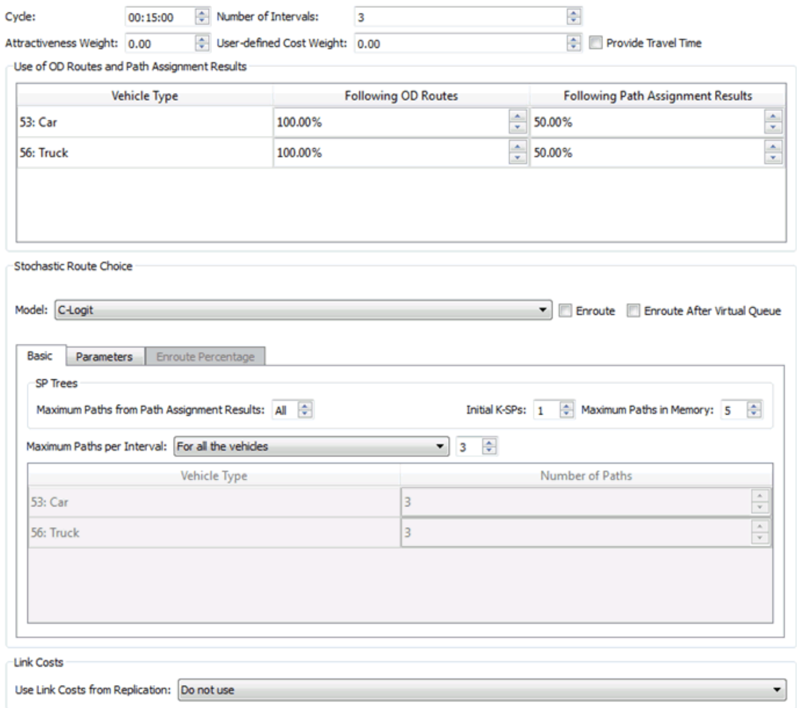


Figure 15 Assignment Parameters

4.3 Model stability

Section 11 of the *RMS Modelling guidelines* provide guidance on calibrating and validating microsimulation traffic models. For the purposes of presenting calibration results, the guidelines suggest comparing vehicle hours travelled for each simulated seed run and identifying the median value. As shown in Table 5, the comparison shows that the median seed for both AM and weekend peak periods is 28 while for the PM peak, the median seed is 560.

Table 5 Total travelled time for each peak period and seed number (medians highlighted)

Seed No.	AM	PM	Weekend
28	**680.91**	708.19	**788.49**
560	726.54	**710.32**	791.36
2849	663.91	715.09	897.73
7771	704.33	706.43	767.67
86524	677.88	738.77	781.10

The median seeds were used for the volume and travel time validation for the corresponding peak periods.

5 Base Model Calibration

Table 11.2 of the *RMS Modelling guidelines* state that the proportion of links within a microsimulation model with a GEH of 5 or lower to be greater than 85% across the whole network. Plots showing the observed volumes compared to modelled volumes using the corresponding median seed simulations are shown in Figure 16, Figure 17 and Figure 18 for AM, PM and weekend traffic respectively.

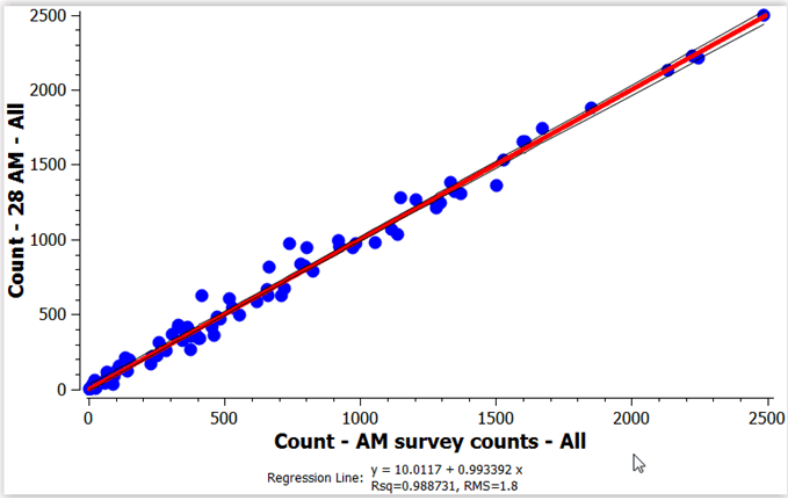


Figure 16 Observed vs modelled plot for AM peak traffic

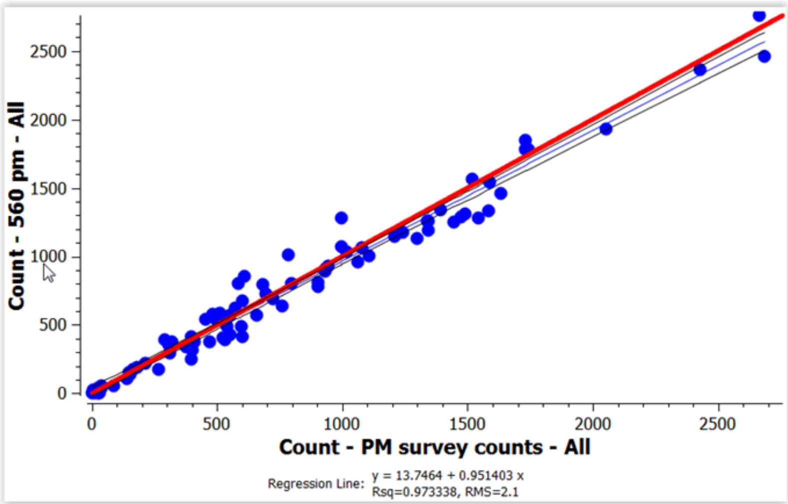


Figure 17 Observed vs modelled plot for PM peak traffic

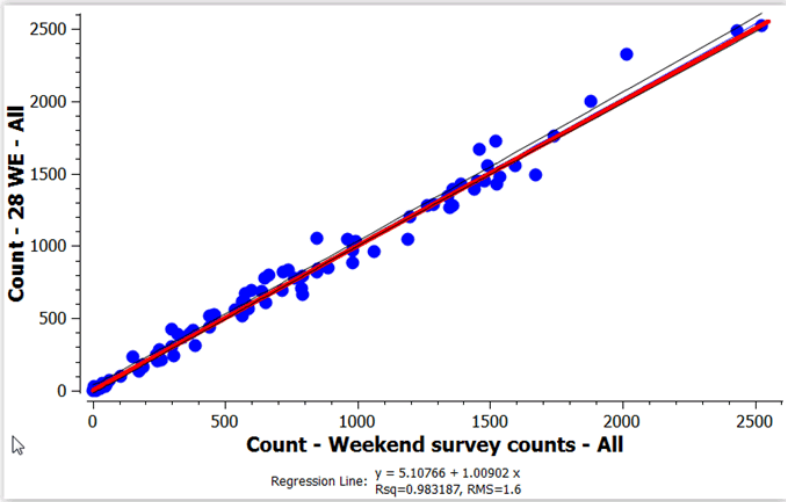


Figure 18 Observed vs modelled plot for weekend traffic

The R squared values are above 97% in all scenarios indicating very good fits between the observed and modelled volumes. The cumulative percent distribution GEH plots are shown in Figure 19, Figure 20 and Figure 21 for AM, PM and weekend traffic respectively.

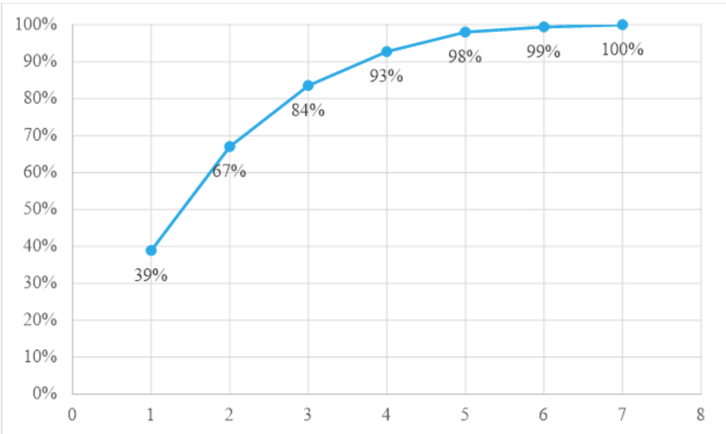


Figure 19 GEH distribution plot for AM traffic

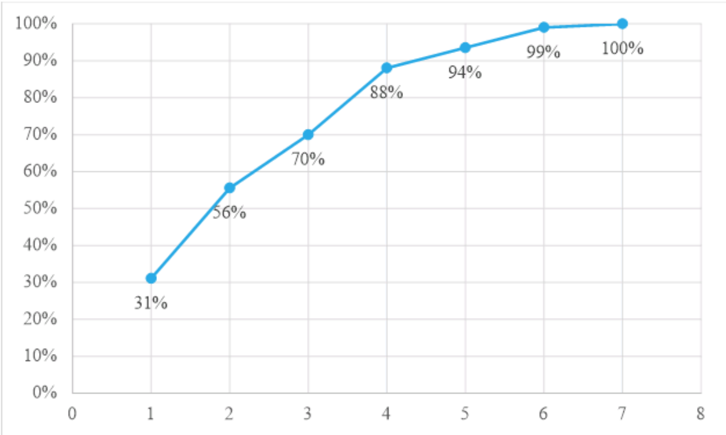


Figure 20 GEH distribution plot for PM traffic

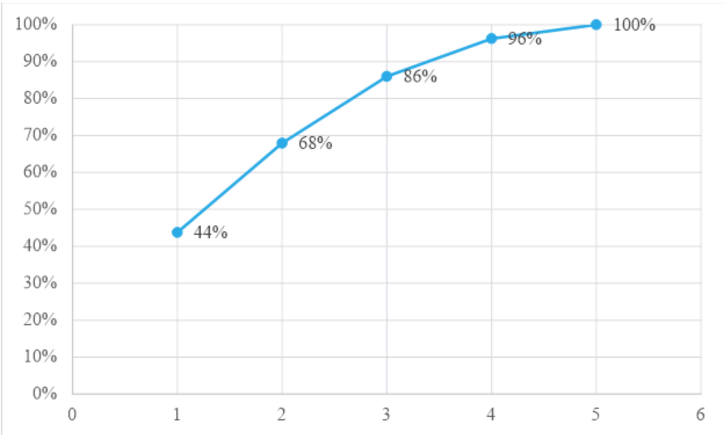


Figure 21 GEH distribution plot for weekend traffic

As shown, the proportion of links with GEH lower than or equal to 5 exceed 85% as suggested by the *RMS Modelling guidelines*. The weekend peak exhibits lower GEH overall compared to the weekday AM and PM peaks due to having lower rat-running movements.

Table 6 GEH Summary Statistics

Model	GEH < 5	GEH < 10
AM Peak	98%	100%
PM Peak	93%	100%
WE Peak	100%	100%

6 Base Model Validation

As described in Section 2, travel time data was also collected for two routes. Both routes have the same start and end points: from the Wentworth Avenue / Page Street intersection to Maroubra Road / Bunnerong Road intersection. Route 1 passes via Page Street and Heffron Road while Route 2 passes through Wentworth Avenue and Bunnerong Road as shown in Figure 22.

Figure 22 Location of travel time routes

6.1.1 Travel time results

Table 11.3 from the *RMS Modelling guidelines* suggest that the modelled travel times should be within 15% of the observed travel times. The modelled travel times compared to the observed travel times are shown below for the AM, PM and weekend peaks.

6.1.1.1 AM peak

Modelled and observed travel times along Route 1 and Route 2 in both directions during the AM peak are shown in Figure 23, Figure 24, Figure 25, and Figure 26. Only one route, Route 1 in the east to west direction lies marginally outside the specified criteria. There are a number of on-street parking and driveways along this route that could potentially lead to lower travel speeds than estimated in the model. However, as the model speeds are only marginally outside the criteria and as congestion increases drivers often behave more aggressively with regards to parking and turning into driveways this issue is not considered significant.

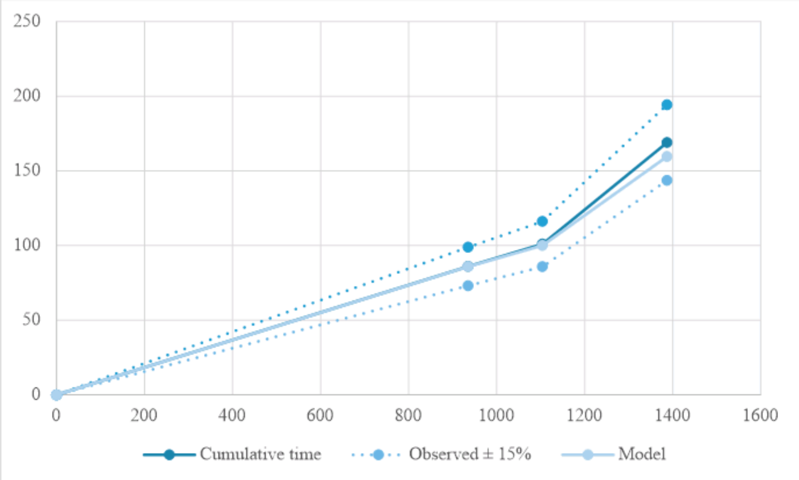


Figure 23 Route 1 - West to East (AM)

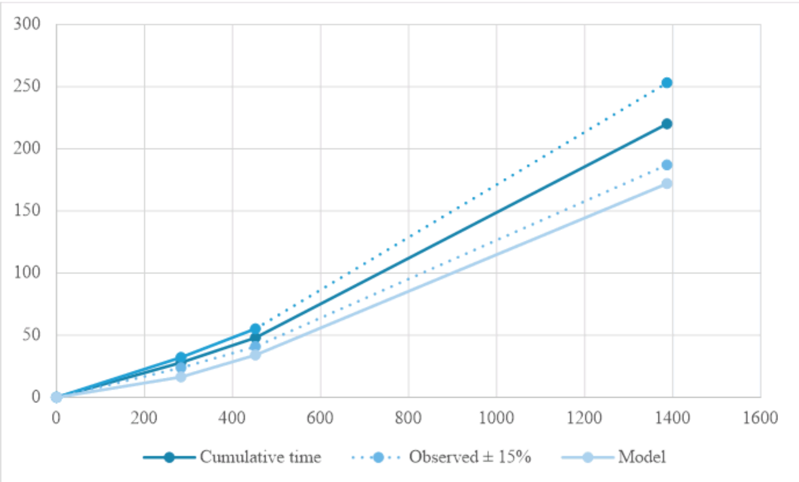


Figure 24 Route 1 - East to West (AM)

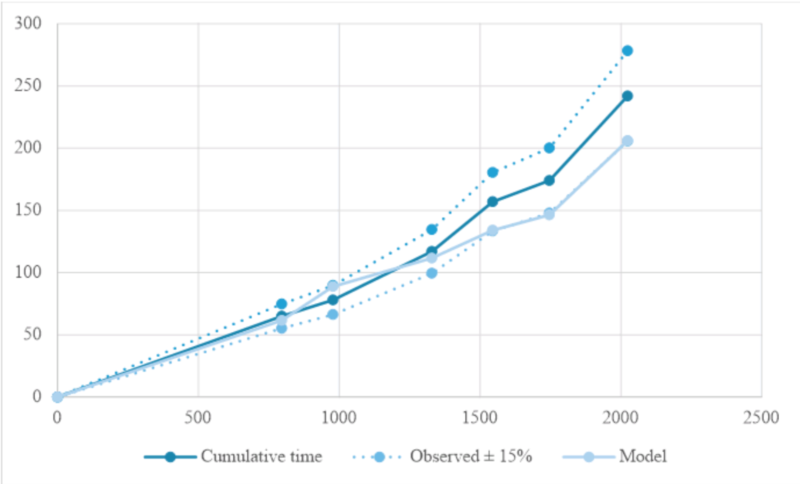


Figure 25 Route 2 - West to East (AM)

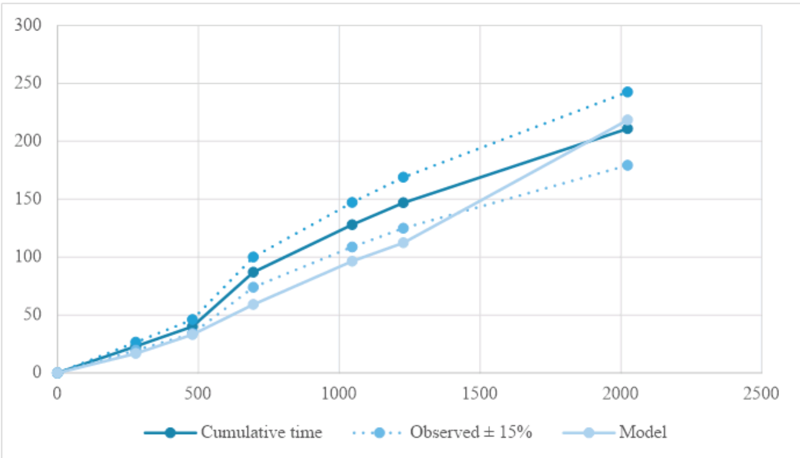


Figure 26 Route 2 - East to West (AM)

Table 7 Route 1 West to East (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	935	935	86	86	99	73	86	86
2	3	169	1104	15	101	116	86	14	100
3	4	283	1387	68	169	194	144	60	160

Table 8 Route 1 East to West (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
4	4	0	0	0	0	0	0	0	0
4	3	283	283	28	28	32	24	16	16
3	2	169	452	20	48	55	41	18	34
2	1	935	1387	172	220	253	187	138	172

Table 9 Route 2 West to East (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	796	796	65	65	75	55	62	62
2	3	182	978	13	78	90	66	27	89
3	4	351	1329	39	117	135	99	23	112
4	5	216	1545	40	157	181	133	22	134
5	6	201	1746	17	174	200	148	12	146
6	7	278	2024	68	242	278	206	60	206

Table 10 Route 2 East to West (AM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
7	7	0	0	0	0	0	0	0	0
7	6	278	278	23	23	26	20	17	17
6	5	201	479	17	40	46	34	16	33
5	4	216	695	47	87	100	74	26	59
4	3	351	1046	41	128	147	109	37	96
3	2	182	1228	19	147	169	125	16	112
2	1	796	2024	64	211	243	179	106	218

6.1.1.2 PM peak

Modelled and observed travel times along Route 1 and Route 2 in both directions during the PM peak are shown in Figure 27, Figure 28, Figure 29, and Figure 30. Similarly as the AM peak only one route lies marginally outside the criteria, Route 1 east to west.

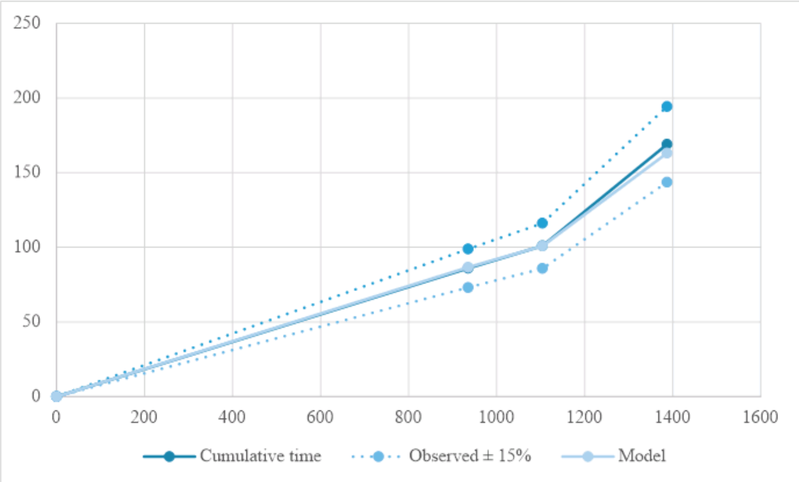


Figure 27 Route 1 - West to East (PM)

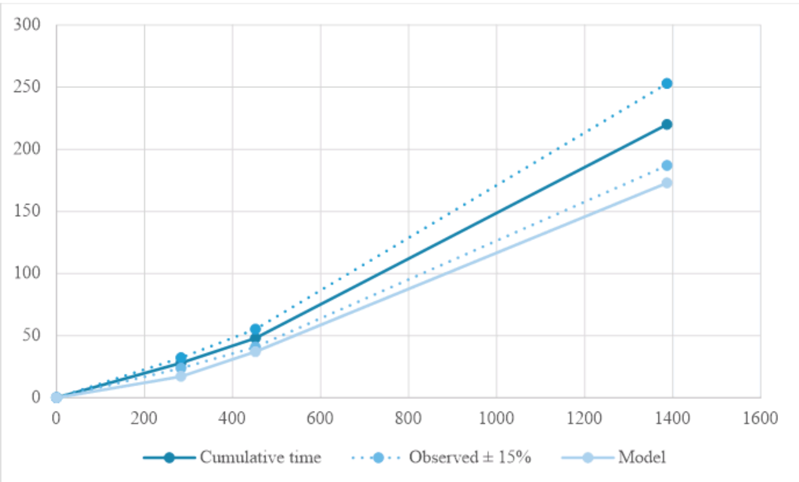


Figure 28 Route 1 - East to West (PM)

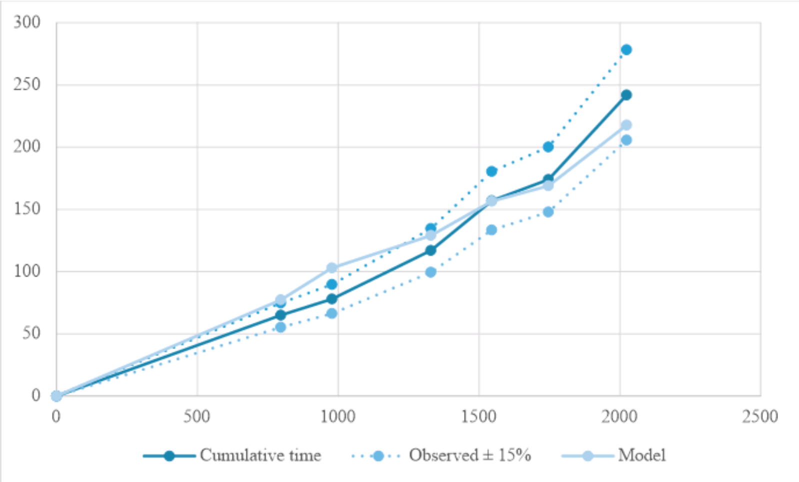


Figure 29 Route 1 - West to East (PM)

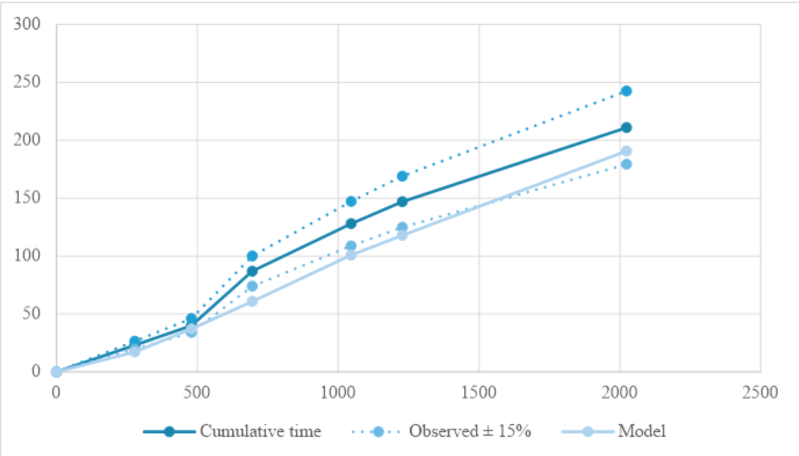


Figure 30 Route 1 - East to West (PM)

Table 11 Route 1 West to East (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	935	935	86	86	99	73	87	87
2	3	169	1104	15	101	116	86	14	101
3	4	283	1387	68	169	194	144	62	163

Table 12 Route 1 East to West (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
4	4	0	0	0	0	0	0	0	0
4	3	283	283	28	28	32	24	17	17
3	2	169	452	20	48	55	41	20	37
2	1	935	1387	172	220	253	187	136	173

Table 13 Route 2 West to East (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	796	796	65	65	75	55	77	77
2	3	182	978	13	78	90	66	26	103
3	4	351	1329	39	117	135	99	26	129
4	5	216	1545	40	157	181	133	28	157
5	6	201	1746	17	174	200	148	12	169
6	7	278	2024	68	242	278	206	49	218

Table 14 Route 2 East to West (PM)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
7	7	0	0	0	0	0	0	0	0
7	6	278	278	23	23	26	20	17	17
6	5	201	479	17	40	46	34	20	37
5	4	216	695	47	87	100	74	24	61
4	3	351	1046	41	128	147	109	40	101
3	2	182	1228	19	147	169	125	17	118
2	1	796	2024	64	211	243	179	73	191

6.1.1.3 Weekend peak

Modelled and observed travel times along Route 1 and Route 2 in both directions during the weekend peak are shown in Figure 31, Figure 32, Figure 33, and Figure 34. As with the AM and PM peak only one route lies marginally outside the criteria, route 1 east to west.

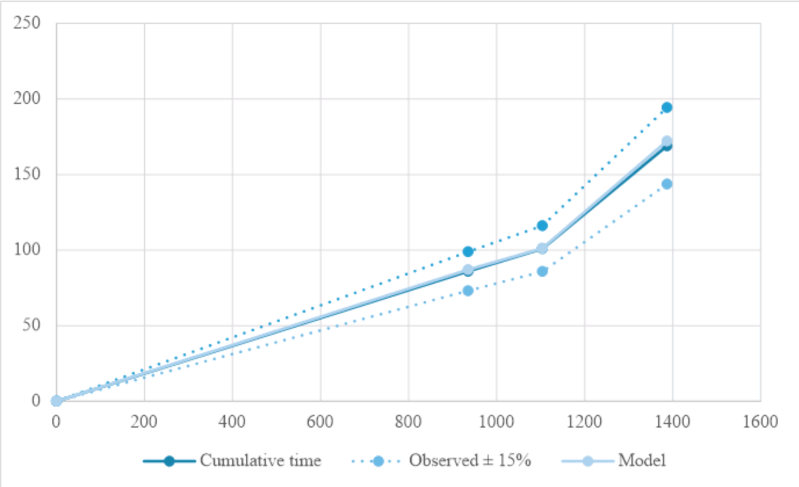


Figure 31 Route 1 - West to East (Weekend)

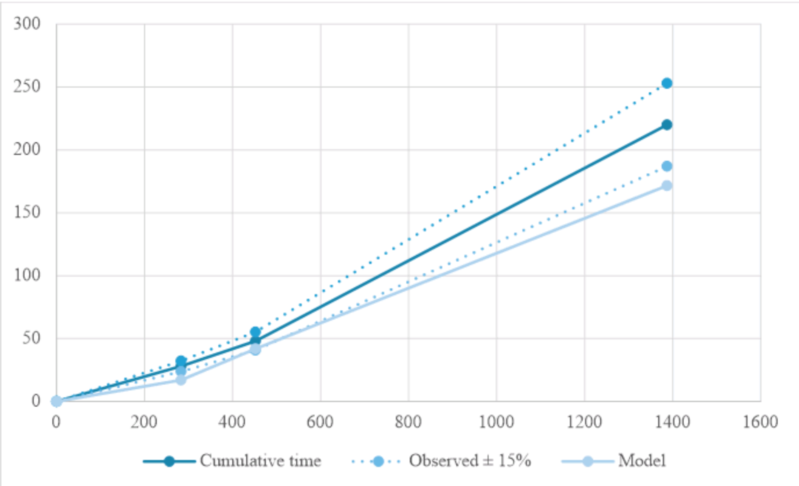


Figure 32 Route 1 – East to West (Weekend)

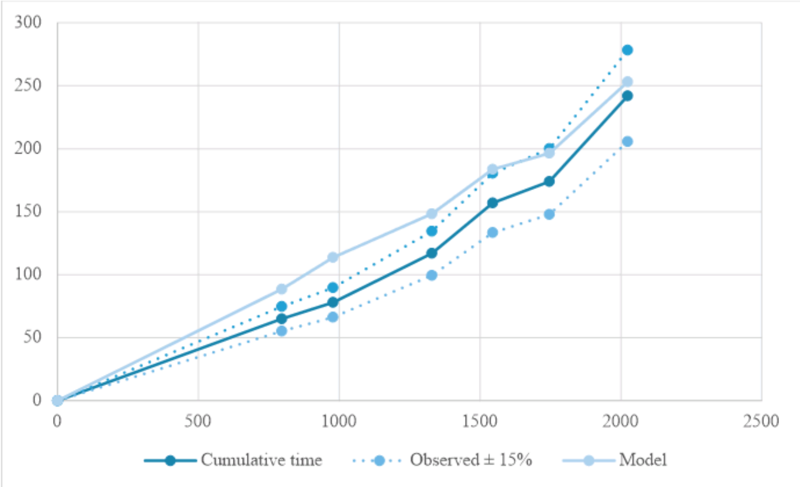


Figure 33 Route 2 - West to East (Weekend)

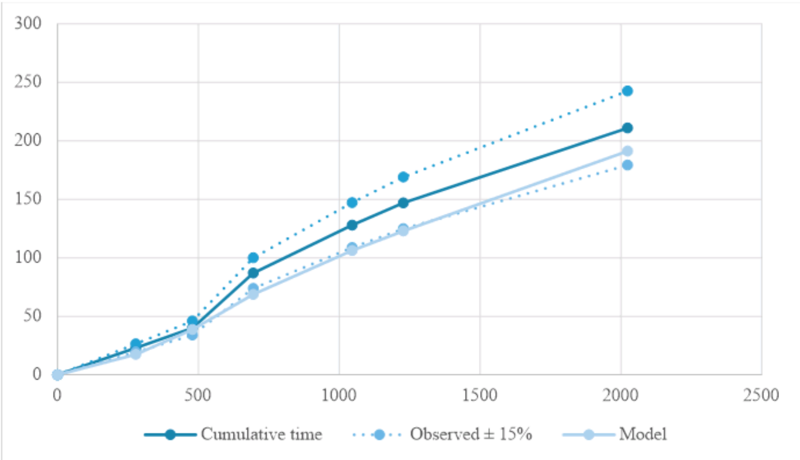


Figure 34 Route 2 - East to West (Weekend)

Table 15 Route 1 West to East (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	935	935	86	86	99	73	87	87
2	3	169	1104	15	101	116	86	14	101
3	4	283	1387	68	169	194	144	71	172

Table 16 Route 1 East to West (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
4	4	0	0	0	0	0	0	0	0
4	3	283	283	28	28	32	24	17	17
3	2	169	452	20	48	55	41	25	42
2	1	935	1387	172	220	253	187	130	172

Table 17 Route 2 West to East (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
1	1	0	0	0	0	0	0	0	0
1	2	796	796	65	65	75	55	89	89
2	3	182	978	13	78	90	66	25	114
3	4	351	1329	39	117	135	99	35	148
4	5	216	1545	40	157	181	133	35	184
5	6	201	1746	17	174	200	148	13	196
6	7	278	2024	68	242	278	206	57	253

Table 18 Route 2 East to West (Weekend)

				Observed (sec)				Modelled (sec)	
START	END	Section distance	Cumulative distance	section time	Cumulative time	Observed ± 15%	Observed ± 15%	Section time	Cumulative time
7	7	0	0	0	0	0	0	0	0
7	6	278	278	23	23	26	20	17	17
6	5	201	479	17	40	46	34	21	39
5	4	216	695	47	87	100	74	30	69
4	3	351	1046	41	128	147	109	38	106
3	2	182	1228	19	147	169	125	17	123
2	1	796	2024	64	211	243	179	68	191

7 Future Demand Development

7.1 Methodology

The future traffic demands that are to be analysed using the traffic micro-simulation model have been developed based on projections of future land uses, increases in population and employment as well as historical growth along traffic corridors. A number of residential and mixed use sites are expected to be developed around the site in the near to medium term, including the currently approved developments on the British American Tobacco Australia (BATA) site. The additional traffic generated by these developments form a baseline future for assessment.

As the main purpose of this study is to analyse the impacts of the changes to development on the BATA site. The additional traffic will be calculated as a change to the original proposed development.

To cross check the demands the proposed floor space and dwelling yields with associated employment and population forecasts are calculated and compared against government forecasts prepared by the Bureau of Transport Statistics for 2021. These checks indicate that the proposed scenarios being used in this study are broadly in line with this separate set of projections.

As the 2031 design year model is also required, a scenario 10 years after completion of the development, the demand for year 2031 are calculated using growth factors. To increase accuracy the growth factors for different regions in the model were determined using a combination of population and employment forecasts. Through traffic movements and shopping centre traffic volumes were increased separately to maintain the separate distribution for these trips.

7.2 Design horizons

Two design year horizons are to be considered for the future year modelling, Year 2021 and 2031. Future baseline models as well development models will be developed for both horizon years. 2021 represents the year of completion and 2031 is the ten year horizon past opening.

7.3 Development of Year 2021 demands

The future base traffic generation involves estimating both the increase in background traffic generation from approved developments, the increase in through trips and the increase in shopping trips to Eastgardens Westfield's. Subsequent options will be tested against this future base case.

Development traffic was then calculated as a change to the future base demands. Through this process public transport and pedestrian demands remained as per the base model as it is unlikely public transport frequencies will increases in the immediate future. Pedestrian demand was modelled using section incidents and an increase in pedestrians will not necessarily lead to a direct increase in conflicts with cars as pedestrians are likely to bunch.

7.3.1 Background traffic growth

At the micro-simulation level of granularity background growth is the traffic generated by the number of residential and mixed use sites in and around the study area that are expected to be developed in the near future.

There are two developments within close proximity to the site, Bunnings and the Orica development site, that along with the currently approved Meriton Properties development, will form the network background growth. It is also assumed that the BATA site under investigation will continue to operate as a warehouse. The background traffic generation is detailed below in Table 19 and Table 20.

Table 19 Meriton Properties Site traffic generation

Land Use	Size	Traffic Generation (2hr)		
		AM	PM	WE
Residential	2,222 units	977	765	868
Specialty Retail	5,000 m2	0	238	317
Childcare	4 centres (100- children each)	222	222	0
Warehouse	50,000 m2	397	397	
Total		1,596	1,622	1,185

Table 20 Adjacent land use changes traffic generation

Land Use	Size	Traffic Generation (2hr)		
		AM	PM	WE
Bunnings	14,900m2	400	560	1216
Office	6,000m2	288	288	0
Industrial	60,000m2			
Masters	9,803m2	168	236	512
Total		856	1084	1728

7.3.2 Eastgardens traffic

Changes in population in the Eastgardens Catchment is expected to change access and egress traffic levels and distributions. The Eastgardens trade area extends around 5km to 7km radius from the centre. A 6.5km boundary was drawn around Eastgardens with the catchment being broken up into 4 quadrants whose size depends on network access, see Figure 35. The predicted population increases for the travel zones within each of these quadrants was then assessed to calculate the increase in traffic and any potential change in traffic profile. The largest increase in traffic was experienced to the north and south.

Table 21 Eastgardens growth rates

Quadrant	Population Increase to 2021	Population Increase to 2032 from 2021
North	23%	15%
East	11%	13%
South	20%	14%
West	14%	15%

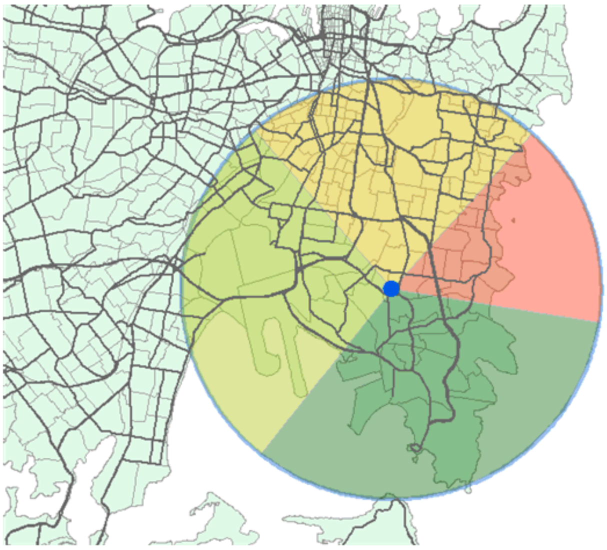


Figure 35 Eastgardens retail catchment

7.3.3 Through traffic growth

The Roads and Maritime traffic volume viewer was used to assess increase in volumes on through movements, trips that start and end in external zones. Data for Wentworth Avenue was only available for two years, see Table 22, where a decrease was observed in the eastbound direction and an increase in the westbound. No data was available for Bunnerong Road with the closest count being located on Anzac Parade north of Lang Road. Given the lack of available information a 1% per annum growth rate was assumed for the trough movements.

Table 22 Wentworth Avenue traffic volumes *source: RMS traffic volume viewer*

	2011	2015	Growth
Wentworth Ave (eastbound)	23,673	21,679	-8%
Wentworth Ave (westbound)	21,550	22,227	+3%

7.3.4 Development traffic

The changes to the development include the removal of the warehouse, the construction of an additional 1,639 residential apartments as well as the increase of 1,000 m2 Gross Floor Area (GFA) of retail bring the total development up to 5,000 m2 GFA of specialty retail. Table 23 below highlights the original traffic generation numbers with the associated changes as a result of the above development traffic.

Table 23 Change to development traffic

Development Type	Original Development Proposal			Proposed Changes		
	AM	PM	WE	AM	PM	WE
Residential	977	765	868	+723	+566	+642
Retail	0	238	317	0	+48	+63
Childcare	222	222	0	+28	+28	0
Warehouse	397	397	0	-397	-397	0
Total	**1,596**	**1,622**	**1,185**	**+354**	**+245**	**+705**

The traffic generated by both Stage 1 and Stage 2 development is assumed to follow the same distribution as current Journey to Work trips for the surrounding area as documented in the *Arup BATA 2014 Traffic Report*. The zones in the previous model correlate well with zones in the new model being developed and so it is simple to allocate the trips generated by the development to origin-destination pairs.

Zone	Origin/Destination	PM Peak		SAT Peak	
		In	Out	In	Out
1	Wentworth Ave (W)	37%	16%	26%	26%
2	Heffron Road (W)	4%	2%	3%	3%
3	Banks Avenue (N)	4%	2%	3%	3%
4	Bunnerong Road (N)	5%	2%	4%	4%
5	Maroubra Road (E)	4%	2%	3%	3%
6	Bunnerong Road (S)	14%	6%	10%	10%
7	Denison Road (S)	4%	2%	3%	3%
		70%	30%	50%	50%

Figure 36 Development traffic distribution

7.4 Development of 2031 demands

As the 2031 design year horizon is an additional 10 years out (a total of 15 years from the survey data) it is not appropriate to try and account for all potential land use changes. As such to develop demands for the 2031 design hear horizon the Bureau of Transport Statistics population and employment forecasts were used to determine growth factors for all the internal zones between the years of 2021 and 2031.

The growth factors were determined for all travel zones within or immediately adjacent to the site with the exception of the development travel zone, zone D and were used to create a growth factor matrix as opposed to applying a blanket growth factor to all demands. Traffic in the development zone would remain as per the proposed development planes. In the AM and PM peaks a combination of population and employment was used to determine the growth factors with the combination depending on direction of travel. For the weekend peak only population was used.

To account for through trips the 1% per annum growth rate was carried through to 2031 from 2021. Eastgardens traffic was estimated by again looking at the catchment growth, see Table 21. And a heavy vehicle growth factor was calculated based on increase in employment only. Through this process public transport and pedestrian demands remained as per the base model as the future of bus frequencies is uncertain due to the possibility of light rail being extended within the vicinity of Pagewood. Pedestrian demand was modelled using section incidents and an increase in pedestrians will not necessarily lead to a direct increase in conflicts with cars as pedestrians are likely to bunch.

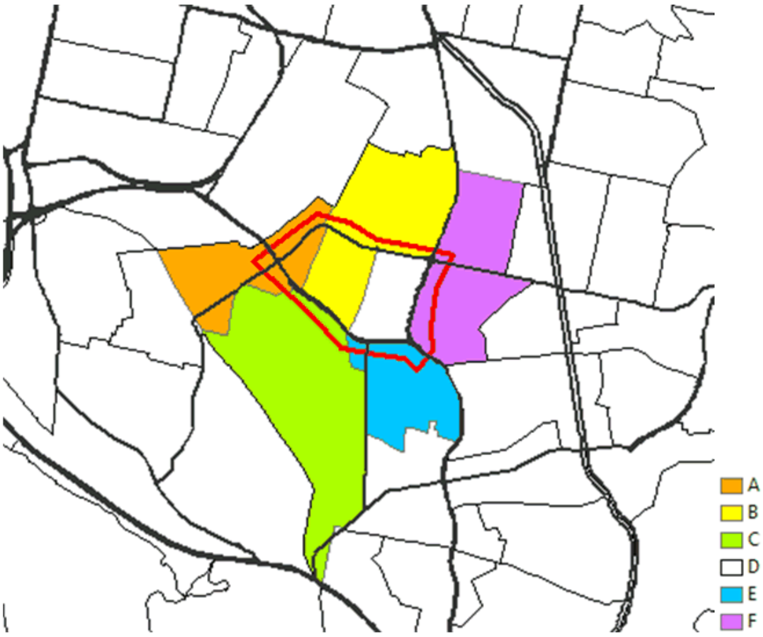


Figure 37 Study area travel zones

Table 24 Travel zones population and employment increases

Travel Zone	Population Increase	Employment Increase
A	6%	8%
B	5%	13%
C	0%	5%
E	46%	10%
F	9%	12%

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	101	102	103	104	105
1	-	7%	-	6%	7%	7%	-	9%	9%	9%	9%	-	-	10%	-	7%	7%	7%	7%	7%
2	7%	-	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	7%	7%	7%
3	-	7%	-	6%	7%	7%	-	9%	9%	9%	9%	-	-	10%	-	7%	7%	7%	7%	7%
4	4%	4%	4%	-	4%	4%	4%	6%	6%	6%	6%	6%	6%	7%	7%	4%	4%	4%	4%	4%
5	16%	16%	16%	14%	-	15%	15%	18%	18%	18%	18%	18%	18%	18%	18%	16%	16%	16%	16%	16%
6	16%	16%	16%	14%	15%	-	15%	18%	18%	18%	18%	18%	18%	18%	18%	16%	16%	16%	16%	16%
7	-	18%	-	16%	18%	18%	-	20%	20%	20%	20%	-	-	20%	-	18%	18%	18%	18%	18%
8	9%	9%	9%	7%	8%	8%	8%	-	11%	11%	11%	11%	11%	11%	11%	9%	9%	9%	9%	9%
9	9%	9%	9%	7%	8%	8%	8%	11%	-	11%	11%	11%	11%	11%	11%	9%	9%	9%	9%	9%
10	9%	9%	9%	7%	8%	8%	8%	11%	11%	-	11%	11%	11%	11%	11%	9%	9%	9%	9%	9%
11	9%	9%	9%	7%	8%	8%	8%	11%	11%	11%	-	11%	11%	11%	11%	9%	9%	9%	9%	9%
12	-	9%	-	7%	8%	8%	-	11%	11%	11%	11%	-	-	11%	-	9%	9%	9%	9%	9%
13	-	8%	-	6%	7%	7%	-	10%	10%	10%	10%	-	-	10%	-	8%	8%	8%	8%	8%
14	7%	7%	7%	5%	6%	6%	6%	9%	9%	9%	9%	9%	9%	-	9%	7%	7%	7%	7%	7%
15	-	7%	-	5%	6%	6%	-	9%	9%	9%	9%	-	-	9%	-	7%	7%	7%	7%	7%
101	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	-	7%	7%	7%	7%
102	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	-	7%	7%	7%
103	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	-	7%	7%
104	7%	7%	7%	6%	7%	7%	7%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	7%	-	7%
105	7%	7%	7%	6%	7%	18%	18%	9%	9%	9%	9%	9%	9%	10%	10%	7%	7%	7%	7%	-

Figure 38 AM peak growth factor matrix

8 Future Network Changes

8.1 Wider network changes

There are three intersections in the network that being upgraded in the immediate future; Bunnerong Road and Heffron Road, Heffron Road and Banks Avenue, Wentworth Avenue and Page Street. The changes are detailed below in Figure 39, Figure 40 and Figure 41.

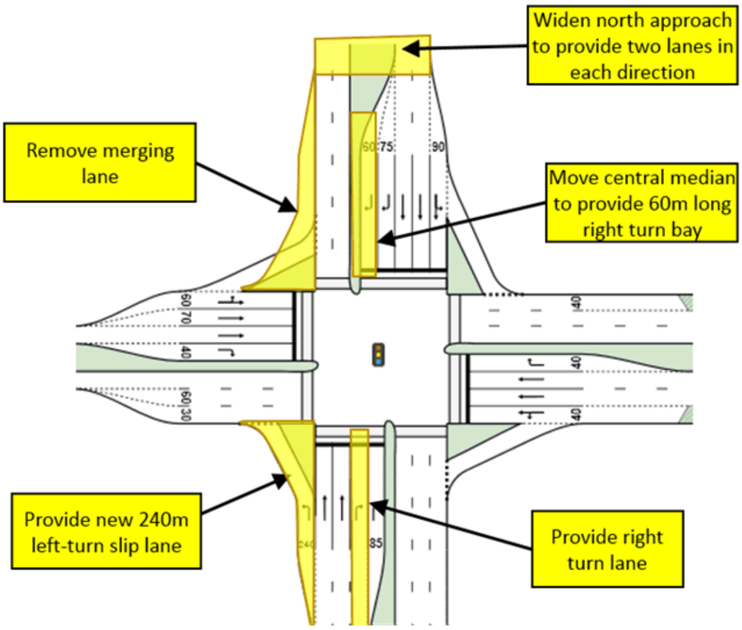


Figure 39 Bunnerong Road / Heffron Road changes, *source: Arup, 130-150 Bunnerong Road, Pagewood Section 34 Conference Report*

There has also been further signal optimisation of all the remaining signalised intersections with the exception of Bunnerong Road / Wentworth Avenue to cater for the increased demand to and from Eastgardens Shopping Centre.

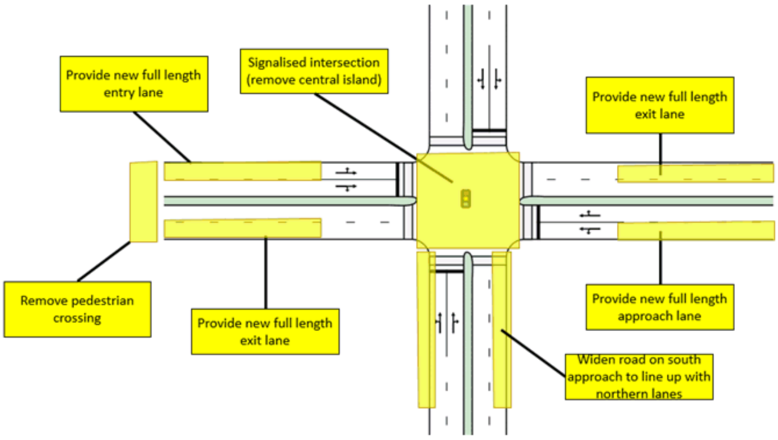


Figure 40 Heffron Road / Banks Avenue changes, *source: Arup, 130-150 Bunnerong Road, Pagewood Section 34 Conference Report*

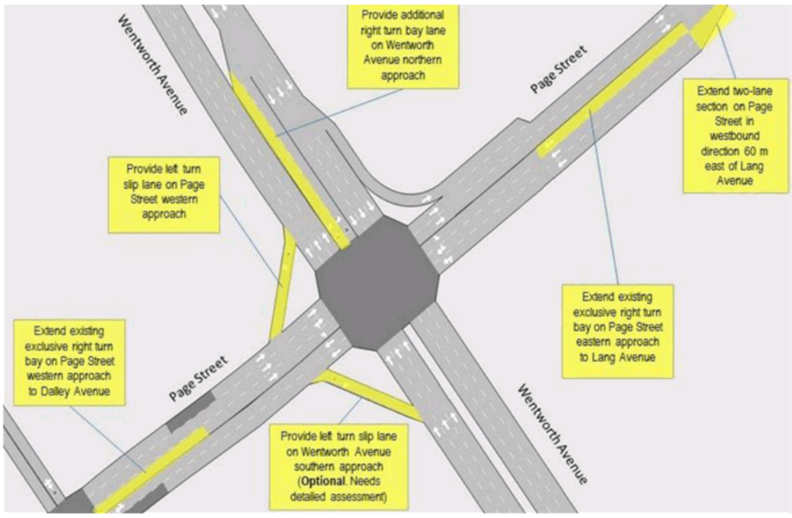


Figure 41 Wentworth Avenue and Page Street *source: SMEC*

Additional changes required as a result of background traffic included the expansion of Wentworth Avenue eastbound (with the removal of unused parking) to three lanes between Page Street and Banks Avenue allowed for the required additional capacity needed to reduce effective green time to the mainline movements. It is understood that this intersection is currently being tendered as a different layout, but no further information has been provided to update future traffic models.

8.2 Development network changes

8.2.1 Original masterplan

As per the original masterplan outlined in, *130-150 Bunnerong Road, Pagewood Section 35 Conference Report* the following network in the development site was coded as the future base model, see Figure 42.

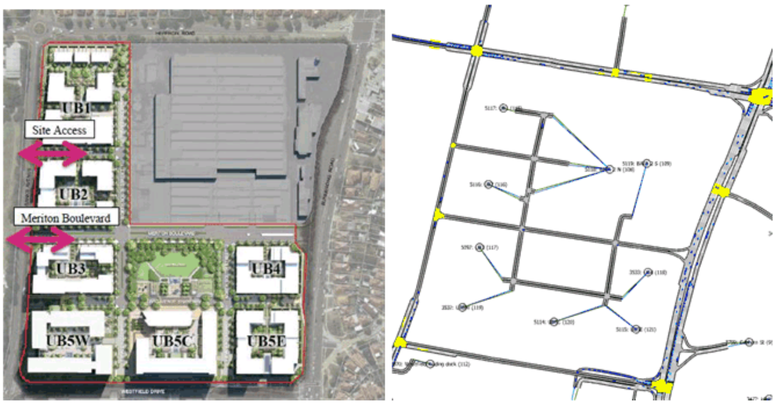


Figure 42 Original Pagewood masterplan

8.2.2 Future network testing

The proposed site intends to utilise the existing Meriton Boulevard accesses as external access arrangements (shown in **Error! Reference source not found.**.) which includes an all movements access to Banks Avenue to the west of the site (Meriton Boulevard only) and a left in and left out access to Bunnerong Road.

These accesses were the adopted access points for the traffic modelling, which create a balanced distribution across the external road network. Other access options were assessed, but this minimum layout forms the best-balanced approach

Figure 43 Future proposed masterplan

9 Results

In-total 15 models were run, three base models, six future year base case models and six development models. Table 25 below details each model scenario that was run for an AM, PM and Weekend peak period. For each scenario the intersection Level of Service (LoS), Travel time analysis and network performance will be explored.

Table 25 Model Scenarios

Model	Abbreviation	Design Year	Description
Base Model	Base	2016	Calibrated base model exploring existing conditions.
Future Base	FB	2021, 2031	Future base model that includes all likely and currently approved developments. This includes the original Meriton Properties Pagewood proposal. This model forms the benchmark for all future year models.
Future Development	FD	2021, 2031	Future options model that includes the changes to the previously proposed Meriton Properties development.

9.1 Intersection Level of Service (LoS)

9.2 Year 2021

Table 26 AM peak LoS results

Intersection	Future Base		Future Dev	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	41	C
Bunnerong/Meriton	1	A	2	A
Bunnerong/Westfield	10	A	13	A
Bunnerong/Wentworth	23	B	23	B
Wentworth/Dennison	35	C	31	C
Wentworth/Banks/Corish	32	C	24	B
Banks/Westfield entrance	4	A	3	A
Banks/Westfield	6	A	5	A
Banks/Meriton	1	A	2	A
Banks/Heffron	24	B	35	C
Wentworth/Page	63	E	59	E

The issues noted in the AM peak are also experienced in the PM peak period with an intensification of delays around Wentworth Avenue / Banks Avenue / Corish Circle intersection as retail traffic to Westfield Eastgardens intensifies.

Table 27 PM peak LoS results

Intersection	Future Base		Future Dev	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	39	C
Bunnerong/Meriton	1	A	2	A
Bunnerong/Westfield	10	A	16	B
Bunnerong/Wentworth	21	B	22	B
Wentworth/Dennison	32	C	32	C
Wentworth/Banks/Corish	21	B	37	C
Banks/Westfield entrance	2	A	3	A
Banks/Westfield	7	A	7	A
Banks/Meriton	1	A	3	A
Banks/Heffron	28	B	26	B
Wentworth/Page	68	E	46	D

The weakness in the network for the PM peak period occurs around Wentworth / Banks / Corish, with the intersection deteriorating to Level of Service E and F across the future scenarios. This intersection is the main access point to Westfield Shopping Centre as well as the primary access point to the site from the south. This performs worse in the future base because the combination of the Westfield and onsite retail results in a more pronounced peak. In the future development of the Meriton site, when retail is largely removed, this effect diminishes. A similar effect can be seen at the Banks/ Heffron intersection which is the primary northern access point. Wentworth / Page intersection also experiences some deterioration in the PM peak but this is less pronounced than the effect in the AM peak.

Table 28 Weekend peak LoS results

Intersection	Future Base		Future Dev	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	56	D	49	D
Bunnerong/Meriton	2	A	3	A
Bunnerong/Westfield	28	B	26	B
Bunnerong/Wentworth	32	C	30	C
Wentworth/Dennison	46	D	34	C
Wentworth/Banks/Corish	115	F	41	C
Banks/Westfield entrance	11	A	5	A
Banks/Westfield	7	A	7	A
Banks/Meriton	1	A	3	A
Banks/Heffron	54	D	26	B
Wentworth/Page	54	D	53	D

The weekend scenarios display a similar pattern of delay as the PM but with increased delays due to increased retail demand. Similar intersections deteriorate as in the PM peak. Intersections around the Westfield all experience increasing delays in the future scenarios.

Wentworth/Banks/Corish is unable to cope with the increased weekend demand and fails in all future scenarios (as opposed to only the future base in the PM peak). The result of this is a flow on affect to Dennison / Wentworth intersection which also deteriorates.

Worthy of note is Heffron/ Banks intersection where some evidence of "rat-running" is observed where people take unintended routes through the site to avoid signals on the main road network.

In the AM and PM peaks all the intersections along Bunnerong Road remain largely unaffected. However, in the Weekend peak these intersections come under increased pressure.

9.3 Year 2031

Despite the development traffic, the network capacity in 2031 was able to be improved over and above the existing future base scenario. Indicating that there is currently spare capacity on the network that is only restricted by the operation of a number of key intersections.

Table 29 Network Statistics

Peak Period	Average Speeds (Km/hr)		Average Delay (Seconds)		Travel Time (seconds)	
	Future Base	Development	Future Base	Development	Future Base	Development
AM	31	30	87	83	144	141
PM	25	30	160	84	218	142
WE	24	25	127	116	184	174

As the AM peak period model is relatively uncongested there is little change in the intersection level of service (LoS) as indicated in Table 30. Where the changes make the most difference is in the PM peak period (see

Table 31). The double diamond phasing at Wentworth Avenue and Page Street allows the intersections to effectively deal with the tidal peak demands competing with retail trips around the Westfield Eastgardens site. In the Weekend peak period (see Table 32), two of the intersections start to come under pressure again however overall there is still a network improvement even with the increased demand.

Table 30 AM Peak Period Intersection Level of Service

Intersection	Future Base		Development	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	45	D
Bunnerong/Westfield	10	A	15	B
Bunnerong/Wentworth	23	B	27	B
Wentworth/Denison	35	C	33	C
Wentworth/Banks/Corish	32	C	27	B
Banks/Westfield entrance	4	A	5	A
Banks/Heffron	24	B	33	C
Wentworth/Page	63	E	67	E

Table 31 PM Peak Period Intersection Level of Service

Intersection	Future Base		Development	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	42	C	43	D
Bunnerong/Westfield	10	A	22	B
Bunnerong/Wentworth	21	B	27	B
Wentworth/Denison	32	C	36	C
Wentworth/Banks/Corish	21	B	43	D
Banks/Westfield entrance	2	A	11	A
Banks/Heffron	28	B	36	C
Wentworth/Page	68	E	61	E

Table 32 Weekend Peak Period Intersection Level of Service

Intersection	Future Base		Development	
	Delay (s)	LOS	Delay (s)	LOS
Heffron/Maroubra/Bunnerong	56	D	54	D
Bunnerong/Westfield	28	B	33	C
Bunnerong/Wentworth	32	C	42	C
Wentworth/Denison	46	D	37	C
Wentworth/Banks/Corish	115	F	58	E
Banks/Westfield entrance	11	A	7	A
Banks/Heffron	54	D	32	C
Wentworth/Page	54	D	58	E

10 Summary

In order to assess the impacts of proposed developments, and works identified as part of the study, a micro-simulation model has been developed using software package Aimsun. The model has been calibrated and validated carried out using criteria defined by RMS' Traffic Modelling Guidelines. The key results of the models' calibration and validation against RMS criteria are as follows.

- Intersection turning movements satisfied GEH criteria for each of the three peak periods assessed with 85% of GEH below 5 and 100% below 10.
- The R^2 was greater than 0.9 for each peak period, when plotting modelled and observed traffic flows.
- The travel time routs were generally within approximately 15% or 1 minute with only one route in each peak period being slightly quicker than observed.
- Observations made onsite at areas of congestion were generally comparable to behaviours observed within the model

The input data, model development, calibration and validation is considered to have produced a model that is considered 'fit for purpose' for the type of study being undertaken.

Through the operational modelling process it was found that the development yields have little impact on the network with some increases in delays at intersection. In the weekend peak however development traffic has trouble accessing the wider network due to the intensification of retail traffic around Eastgardens with the associated congestion.

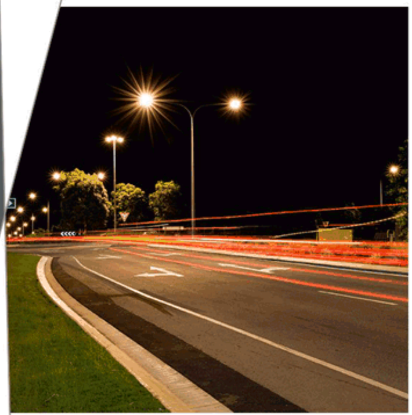
It was also found that as the road network is expanded and additional connections are added to the wider network delays increase. This is impart due to the intensification of traffic around Eastgardens from the growth in the retail catchment. This new traffic is using the expanded network for alternative routes increasing turning movements and the associated merging and weaving behaviour reducing road capacity.

In summary, the network operates satisfactorily with the expanded development and upgrades already committed to, however it is advisable that the road layout is refined as to minimise new connections onto Banks Avenue and Heffron Road. It is also advisable to assess possible changes to the network to account for the increased demand to Eastgardens shopping centre as it is retail traffic that has the largest effect on the network.

128 and 130-150 Bunnerong Road, Pagewood

Transport Impact Assessment Peer Review

80018011



Prepared for
Bayside City Council

23 October 2017

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0	11/08/2017	Daft (for internal review)	Koosha Dehghan	Hayden Calvey
1	29/08/2017	Draft (for client issue)		Hayden Calvey
2	18/10/2017	Final		Hayden Calvey

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Tables

1 Introduction

Cardno has been commissioned to undertake an independent peer review of the Planning Proposal Transport Impact Assessment and Traffic Modelling Report currently being considered by Bayside Council. The Planning Proposal involves the rezoning of an 8.95ha industrial site for over 2,068 dwellings, approximately 1,000m2 of retail floor space, a 100 place child care centre, and community facility of up to 4,060m2.

The follow documents have been reviewed as part of this peer review:

> Planning Proposal Report for 128 and 130-150 Bunnerong Road , Pagewood, Urbis (April 2017);
> Transport Impact Assessment Report, 128 and 130-150 Bunnerong Road , Pagewood, Arup (Rev A, April 2017); and
> Traffic Modelling Report, Arup (issue April 2017).

Cardno has reviewed these documents to ensure it meets the typical objectives of a transport assessment, and provide the findings and recommendations for further study or clarification. The objectives of the aforementioned documents are to investigate the proposed development with regard to the following:

> Identify the traffic and transport impact of the proposed development;
> Identify the number of trips and likely travel modes associated with the proposed land uses;
> Assess the impact the development will have on the capacity of the road system, in particular on intersections;
> Accessibility to public transport and other transport modes.
> Review the number of off-street parking spaces required to support the development; and
> Identify measures to limit the impact the development will make on the transport network.

1.1 Scope of works

The objective of this report is to prepare a technical report presenting the findings from the peer review of the Transport Impact Assessment and the Traffic Modelling Report (with associated AIMSUN model).

The documents have been reviewed to assess the:

> Car park, revision of parking rates reductions applied
> Public Transport accessibility and connectivity approach
  - Light Rail (Potential Network Extension)
  - Sydney Metro (Potential Network Extension)
> Assessment of the traffic and transport implications (two scenarios) with and without the extension of light rail.
> Cumulative traffic and parking impacts
> Review of modelling methodology and model parameters

1.2 Assumptions and exclusions

The following assumptions and exclusions were made whilst undertaking this peer review:

> Additional traffic surveys would not be conducted; and
> Site visits were not required.

1.3 Reference documents

The following documents were reference as part of this peer review:

> Planning Proposal Report for 128 and 130-150 Bunnerong Road , Pagewood, Urbis (April 2017);

> Transport Impact Assessment Report, 128 and 130-150 Bunnerong Road , Pagewood, Arup (Rev A, April 2017);

> Traffic Modelling Report, Arup (issue April 2017);

> RMS Guide to Traffic Generating Developments (2002); and

> Technical Direction TDT 2013/04a – Guide to Traffic Generating Developments Update.

1.4 Report structure

This report has been divided into three sections, detailed below:

> **Section 1: Introduction:** An introduction to this document, including report structure, scope of works and reference documents.

> **Section 2: Review of Transport Impact Assessment Report, 128 and 130-150 Bunnerong Road, Pagewood, Arup (Rev A, April 2017):** A review of the Transport Impact Assessment of 128 and 130-150 Bunnerong Road , Pagewood including trip generation rates, travel patterns, public and active transport review and impacts to the road network.

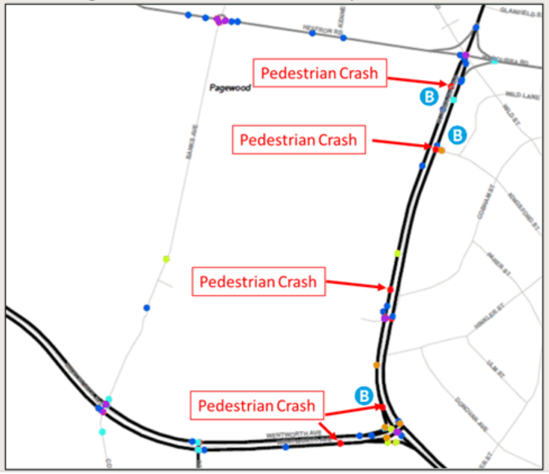
> **Section 3: Review of the Traffic Modelling Report, Arup (issue April 2017) and AIMSUN model:** A review of the AIMSUN model prepared for 128 and 130-150 Bunnerong Road, Pagewood, including model calibration, assumptions, inputs and set up.

> **Section 4: Summary of findings and conclusion:** An overall summary of the review and key items raised that require further assessment.

2 Review of ARUP Transport Impact Assessment

Table 2-1 Review of ARUP Transport Impact Assessment

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	Summary	Comment
2.3 Public Transport	The report documents that bus stops are located on Bunnerong Road near Heffron Road (northeast of the site) and at the Westfield Eastgardens bus terminal (southeast of the site).	No reference is made to the bus stops located midblock on Heffron Road between Banks Avenue and Bunnerong Road. This bus stop services routes 310 and X10. Whilst the same routes are services by bus stops located on Bunnerong Road, the stops on Heffron Road are likely to be used by commuters located in the north and eastern pockets of the development. This is particularly true for southbound services as the Heffron Road bus stop provides travel time savings as opposed to the Bunnerong Road bus stop by avoid the right turn at the Bunnerong Road/Heffron Road signalised intersection. The Transport Impact Assessment should make reference of this bus stop.
2.4.2 Walking	The Transport Impact Assessment mentions that there is ample pedestrian crossing opportunities in the area, with multiple signalised pedestrian crossing opportunities on Westfield Drive, Bunnerong Road and Maroubra Road.	Crossing opportunities from the development to the southbound bus stops are difficult in terms of direct route to and from the development; in particular for bus stops on both Heffron Road and Bunnerong Road. This may result in unsafe crossing movements or may result in residents and workers from the development being deterred from using bus services given the added walking distances required to cross. The Traffic Impact Assessment should note that future designs consider the safety of commuters crossing Heffron and Bunnerong Road to and from the development.
2.7 Crash Clusters	The Transport Impact Assessment notes that whilst there were no recognisable clusters for pedestrians, crash types were similarly 'emerging pedestrians' crash types surrounding the site. A review of Figure 11 of the document shows that these pedestrian crashes were located close to bus stops	Whilst potentially unrelated, the location of the pedestrian crashes along Bunnerong Road in relation to the bus stops could be alarming and concerning, especially as the Traffic Impact Assessment is considering bus travel as the preferred mode of travel choice with private vehicles.

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	Summary	Comment
		As previously mentioned, the Transport Impact Assessment should note that future designs consider the safety of commuters crossing Bunnerong Road to and from the development. 
3.4 Previously Approved Intersection Upgrades		Cardno understand there are currently tender designed documents for the intersection of Page Street / Wentworth Avenue. The Arup Aimsun model layout provide slip lanes (as per the SMEC report) however the tender design documents do not include this arrangement. This discrepancy should be reviewed and modified accordingly. Furthermore, it is unclear whether the identified upgrades will be delivered by the opening stage of the development. It is relevant to note that the intersection of Baker Street / Wentworth Avenue has been identified as requiring upgrade to a signalised intersection. Botany Council's Section 94 Contributions Plan outlines the required funding to implement this upgrade.

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	Summary	Comment
4.2 External Site Access	The Transport Impact Assessment identifies four external access arrangements to the proposed development, being: > Two current approved road accesses from Banks Avenue to the west of the site (unnamed); > The current Meriton Boulevard left in and left out access to Bunnerong Road; and > An all movement priority access to Heffron Road, north of the site.	Figure 19 of the Transport Impact Assessment identifies a single priority access point to Heffron Road, however Figure 17 and 18 identify two (2) access points onto Heffron Road. Clarification is sought with regard to the proposed access arrangement and detailed layouts of these intersections identifying any lost parking, kerb adjustments etc. Additionally, a turning warrant assessment should be provided to establish the need (or otherwise) for dedicated turning lanes along Heffron Road to facilitate safe and efficient turning.
5.1.1 Traffic Generation	The Transport Impact Assessment mentions that the trip generation rate was determined as a function of the mode share for the development by calculating the peak hour rations between the sites from the Technical Direction (TDT 2013/04a) and taking into consideration non-car mode share as 58% for the surveyed sites and 38% for the JTW data. The resulting trip generation rates are: • Weekday AM = 0.277 trips / unit • Weekday PM = 0.217 trips / unit • Weekday Noon = 0.246 trips / unit	For high density developments, the Technical Direction provided data for developments in St Leonards, Chatswood, Cronulla, Rockdale and Parramatta. Trip generation in the peak period vary from these sites between 0.07 to 0.32 trips per unit. These locations however have a train station located within close proximity which could result in a lower vehicle trip generation rate. As noted in Section 2.5 of the Transport Impact Assessment, JTW data indicates that inbound and outbound trips to the area are predominately made of car trips (62% and 57% respectively). Further information should be provided regarding the sites used as part from the Technical Direction and the travel similarities of the proposed developments to these developments. It is acknowledged that the adopted trip generation rates are generally consistent with the previous studies undertaken by Arup however the calculation / methodology is not clear where adjustments based on car mode share and factored Journey to Work rates are applied. Clarification is sought in regard to the methodology of the trip generation calculation, noting the discrepancy in existing journey to work patterns and the suggested modal shift (see further).
5.1.2 Forecast Mode Split	The Transport Impact Assessment provides average person per peak hour trips rates for high density residential developments	Further information is required to detail how the Transport Impact Assessment has come to the conclusion of the above average person

<table>
<tr><th colspan="2">Review of ARUP Transport Impact Assessment</th><th>Cardno</th></tr>
<tr><th>Section Reference</th><th>Summary</th><th>Comment</th></tr>
<tr><td></td><td>based on Journey to Work and the RMS Technical Direction (TDT 2013/04a). These trip rates are provided as follows:
> Weekday AM: 0.725
> Weekday PM: 0.592
> Weekend Noon: 0.660
The Transport Impact Assessment, in Table 4, outlines the forecasted mode split by type of travel and the number of trips per peak period. The mode split in this table varies quite significantly to the travel pattern data provided in Section 2.5 of the document. The two datasets are shown below.

Mode / Inbound trips to work / Outbound trips to work
Train / 4% / 3%
Bus / 11% / 19%
Car / 62% / 57%
Walk / 5% / 6%
Other / 3% / 4%
Did Not Travel / 15% / 12%
Total % / 100% / 100%
Total Trips / 4,466 / 3,622
Source: BTS, 2011

Mode / AM Peak Hour (% / Number) / PM Peak Hour (% / Number) / Weekend Peak Hour (% / Number)
Train / 6% / 71 / 5% / 60 / 5% / 66
Bus / 37% / 450 / 31% / 377 / 34% / 416
Car / 38% / 469 / 30% / 367 / 34% / 416
Walk / 12% / 142 / 10% / 119 / 11% / 131
Other / 8% / 95 / 6% / 79 / 7% / 88
Total / 100% / 1226 / 100% / 1002 / 100% / 1116</td><td>trip rate per peak hour. The average person trip rate per peak hour, in particular for the PM peak, seems low.
Comparing the two tables, bus travel for the proposed development against the surrounding travel zones increases by approximately 20% whilst car trips drop by approximately 40%.
The Transport Impact Assessment should provide evidence to back the decision to increase use of bus services and the decrease in car trips. No suggestion has been made in the Transport Impact Assessment that suggests the shift in travel mode. In particular, reference should not be made to the extension of the Sydney Light Rail and the Sydney Metro West, which:
> Are unlikely to be extended; and
> If extended, are unlikely to be a preferred mode of travel given the distance and the lack of supporting public transport connection and parking at the destination.
The JTW dataset provided as part of the Section 2.5 of the document groups ferry/tram, other modes and modes not stated into the categorisation of “other”.
No information has been provided as to why the aforementioned travel modes have increased from 3-4% to 8-9%. Reference to the Sydney Light Rail should be avoided for the reasons mentioned above.
No evidence has been provided regarding the increase in walking trips for the proposed development.
The Transport Impact Assessment should provide information regarding to the increase in walking trips as the preferred mode of travel. No details have been provided regarding changing land use have been suggested to support growth in walking trips in the peak period.</td></tr>
<tr><td>5.2.1 Car Parking</td><td>The Transport Impact Assessment provides newly proposed parking rates that are recommended to be updated based on the Bayside</td><td>The proposed car parking rates are considered quite low for the location of the development. The recommendation to support mode shift to</td></tr>
</table>

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	Summary	Comment

DCP and the rates approved as part of the developments Stage 1 masterplan. The proposed parking rates at generally 50% less than those outlined in the DCP and the masterplan. Details of the car parking rates are provided below.

Development type	Part 3A/9D BBDCP	Approved Stage 1 masterplan	Proposed rates
Residential flat buildings			
Studio / 1 bedroom apartments	1 space per apartment	1 space per apartment	0.5 space per apartment
2 bedroom apartments	2 spaces per apartment	1.5 space per apartment	1 spaces per apartment
3 bedroom apartments	2 spaces per apartment	2 space per apartment	1.5 spaces per apartment
Visitor parking	1 space per 5 apartments	1 space per 10 apartments	1 space per 10 apartments
Commercial / Retail / Infrastructure			
Shops	1 space per 25m²	1 space per 40m²	1 space per 40m²
Childcare	1 space per 2 employees	1 space per 2 employees	1 space per 2 employees
	1 space per 5 children	1 space per 5 children	1 space per 5 children
	1 pick-up and set-down space per 20 children.	1 pick-up and set-down space per 20 children.	1 pick-up and set-down space per 20 children.

The Transport Impact Assessment reviewed 2011 Census data on car ownership for multi-dwellings in the surrounding suburbs (Botany, Pagewood, Hillsdale, Banksmeadow, Maroubra and Kingsford). These are rates are shown below.

Units (in area)	No. Units	No. Cars	Required Rate
One bedroom/studio	1245	895	**0.7189**
Two bedroom	5301	5376	**1.0141**
Three bedroom +	1940	2403	**1.2387**
Total	**8493**	**8685**	**1.0226**

public transport options is supported by this consultant however on this occasion, given the location and connection to public transport services, it is unlikely that is an opportunity to shift 50% of car parking needs.

The Transport Impact Assessment makes reference to the 2002 RTA Guide to Traffic Generating Developments, however comparing the parking rates to those in the Technical Direction (TDT 2013/04a) indicates that the proposed parking rates are too low.

The Technical Direction provides the number of units and parking spaces for high density developments in St Leonards, Chatswood, Parramatta, Pyrmont, Liberty Grove, Rockdale and Cronulla. The parking rates for these developments are generally 25-50% higher than those proposed for the development

Given the location of the development compared to public transport services and given the current Journey to Work data indicating that approximately 60% of inbound and outbound journeys are undertake by vehicles, it is unlikely that a reduction of car park rates will shift commuters to public transport; rather it is likely to push parking demands onto the external road network.

No information is provided on the type and location of these developments referred to in the Transport Impact Assessment review of Census data. Reference should be made to developments with similar characteristics and locality. Nevertheless, it has been successfully argued that analysis of Census data for the purpose of car parking provision is but one factor to consider. Referring to *Botany Development Pty Ltd v Council of the City of Botany Bay [NSW] NSWLEC 1073* where Commissioner Brown stated that *"census data is helpful in determining an appropriate parking however it should be the sole measure in determining whether a parking rate is appropriate in a certain area. In the absence of a more comprehensive parking survey, census data alone, in my view, is an insufficient reason to abandon the parking rate in DCP 2013 for the site"* (paragraph 76). Similarly, the same commentary was provided for *Turner Architects v City of Botany Bay Council [2016] NSWLEC 1186* where Commissioner O'Neill states "*In principle, actual demand for parking, as demonstrated by census data,*

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	**Summary**	**Comment**
	The Transport Impact Assessment justifies the reduced proposed rates by noting the support of the development by good public transport networks both planned and under construction. The report notes that the potential Light Rail extension and potential Sydney Metro connection may be within walking distance of the site and will further encourage mode shift away from the cars, hence reducing the parking rates.	*is a fact that would generally inform Council's approach for formulating their policy in regard to parking requirements and consequently the next iteration of a development control plan which reflects that policy, and is not necessarily an appropriate justification for exercising flexibility in regard a standard set by a development control plan. This is because Council policy regarding parking requirements will inevitable be informed by many factors, of which the current or historic parking demand as demonstrated by census data is but one" (*paragraph 40). In view of the above, the justification for a significant variation to Council's DCP parking requirement and the parking rate adopted for the Stage 1 development is not supported based on the current application. The discussion of extending the Light Rail and Sydney Metro is not applicable to be used as support of a reduced car parking rate. The Transport Impact Assessment itself in Section 5.4.3 on page 27 notes that "given the distance (of the stop of the extended Light Rail route) from the site, there is still expected to be less walk-up of this mode compared to bus and people will likely drive to a commuter car park". Additionally the report in Section 5.4.4 on page 27 questions the uncertainty of the Sydney Metro indicating that "given the uncertainty of the project (Sydney Metro), no mode split to this mode have been assumed". It is suggested that the parking rates for the development be considered without considering the likelihood of an extension to the currently proposed Light Rail and Sydney Metro routes.
5.4.1 Bus Infrastructure	The Transport Impact Assessment indicates that an additional eight bus services during each of the peak hours is required to service the development approximately 334-399 commuters.	No confirmation or guarantees are provided that the eight additional bus services required to service the development will be provided. The Transport Impact Assessment should give consideration in the likelihood that the additional eight bus services are not added to the service. Without the additional bus services, residents are likely to shift towards private vehicle mode. There is no assessment of the existing bus stop capacities or survey data / documentation of bus capacities to support the expected increase

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	Summary	Comment
		in demand. Nor is there any indication that discussions have been held with Transport for NSW with regard to gaining certainty in achieving the additional eight services required as suggest by the Transport Impact Assessment.
5.4.2 Sydney Light Rail & 5.4.3 Potential Light Rail Extension	The Transport Impact Assessment suggests that it is likely that future residents of the site will drive and park at the stop.	Parking along streets near future Light Rail stops are likely to be reconfigured to minimise park and ride. This is to ensure that the street parking is utilised by residents and short stay visits. Additionally, it is unlikely that commuter parking will be provided near the Light Rail stops. The Transport Impact Assessment should consider a shift to other forms of transport, including bus services and private vehicles.
6.1 Traffic Generation	Using the aforementioned trip generation rates, the Transport Impact Assessment has provided the proposed change to development traffic over a two hour peak period (shown in the table below).	It is unclear how the two hour traffic generation was established. The conversion factor of 1.6 is not supported by any justification or document reference. This factor needs to be further explained as based on previous experience with RMS, conversion of two hour volumes to a one hour volume is based on conversion of 0.55. To replicate a two hour volume based on a one hour value the inverse would hold true i.e. a conversion factor of 1.82, not 1.6. It is unclear how the warehouse traffic generation was derived for the two hour time period. This provides a significant reduction during both the weekday AM and PM period (397 trips). It is unclear if the reduction of 397 trips is based on actual survey demand during the AM and PM period or whether this is a theoretical calculation based on GFA. It is understood that the current operation of the site relates to the operations of Port Botany and as such, heavy vehicle movements and / or peak hour generation may occur outside of commuter peak hours that have been assessed.
6.2 Traffic Modelling Methodology	The Transport Impact Assessment outlines that the future years of 2021 and 2031 were agreed to with Roads and Maritime in December 2015. Furthermore, the report acknowledges that background growth as well as surrounding key approved	No evidence is provided to demonstrate if the adopted background growth rate has been accepted by RMS, or whether it is to be informed by a strategic model of the area which takes into account potential network and land use changes in 2021 and 2031.

Review of ARUP Transport Impact Assessment		Cardno
Section Reference	Summary	Comment
	developments have been incorporated into the model, including Bunnings, Orica Industrial and Masters.	Furthermore, it is unclear whether the adopted traffic generation for Bunnings, Orica Industrial and Masters has been taken from the respective traffic assessments of these applications. Table 20 of the Traffic Modelling Report identifies two hour traffic generation however the source of this information is not provided. The respective traffic impact assessments for these sites should be referenced and incorporated into the modelling. In addition to the Bunnings, Orica Industrial and Masters sites, Westfield Eastgardens have recently lodged an application for increased development. The Arup assessment does not take this into consideration (likely as a result of timing behind the Westfield submission). A corporative approach should be embarked upon in detailing cumulative traffic generation and resulting impacts for the area for both the BATA and Westfield sites.

3 Review of Arup Traffic Modelling

Table 3-1 Review of ARUP Traffic Modelling

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	**Commentary**	**Recommendation**
The below review outlines whether an appropriate background image has been used to develop the model. It is critical that an appropriate background image is used for the model development to ensure that the correct road network and features of the road network are included in the model.		
A1 - Background image file	No background image file was provided for the model – refer item A2.	n/a
A2 - Scale of background	While no background image was provided, distance measurements within model corresponded within 2% to the measurements from online mapping imagery.	n/a
A3 - Background co-ordinate system	The background coordinate system has been set up with the correct longitude and latitude.	n/a
A4 - Seamless join of map tiles	N/A – refer item A1	n/a
A5 - Image legibility / resolution	N/A – refer item A1	n/a
The below review outlines whether the base model parameters and data used for the model development are accurate and reflect best practice.		
B1 - Car following parameters	No issues identified	n/a
B2 - Lane change parameters	No issues identified	n/a
B3 - Acceleration	No issues identified	n/a
B4 - Driver lane selection	No issues identified	n/a
B5 - Waiting time before diffusion	No issues identified	n/a
B6 - Speed profiles	No issues identified	n/a
B7 - Reduced speed areas	Traffic management measures have been implemented in the models to replicate the following real-line events / incidences: • Kerb-side lane closures on Wentworth Avenue (westbound) between Bunnerong Road / Denison Street to replicate when on-street parking is allowed	Reduction of the section of Heffron Road where Speed Change is implemented to account for the side island

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	Commentary	Recommendation
	on this road. The traffic management measure implemented in the model to replicate this is considered appropriate. • School zone on Bunnerong Road (south of Wentworth Avenue). The traffic management measure implemented in the model to replicate the school zone is considered appropriate. • Zebra-crossings at various locations within the network. The traffic management measure implemented in the model to replicate the traffic delays caused by the zebra crossings is considered appropriate. Traffic calming items on Heffron Road. While the Speed Change implemented for the raised platform (near the intersection with Cowper Avenue) is considered appropriate, the section of Heffron Road where Speed Change implemented to account for the side island (east of Page Street) is considered too long. However, this isn't likely to have a material impact on the model results	
The below review outlines whether any issues have been identified with the model simulation parameters.		
C1 - Model simulation time periods (including warm-up and warm-down periods)	Modelled peak hours as follow: - 7.30AM to 9.30AM (Weekday) - 4.30PM to 6.30PM (Weekday) - 11.15AM to 1.15PM (Weekend) Each model includes a 30 minutes warm-up period	n/a
C2 - Model time steps	Time steps are 0.8 as per default	n/a
C3 - Random seeds	Industry standard random seed values have been utilised throughout the models.	n/a
C4 - Ensure left-side traffic rule has been applied	Left-side traffic rules have been correctly applied.	n/a
C5 - Model units for distance, speed and acceleration	International Standard (SI) units have been utilised in the model.	n/a

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	Commentary	Recommendation
The below review outlines the findings of the review of the vehicle data parameters used for the model		
D1 – Vehicle types	Standard vehicles types have been utilised in the model. As the study area is adjacent to an operational container port, the model documentation should include additional data / justification of why larger trucks haven't been included in the model (note: modelled trucks only have an average length of 8m and a maximum length of 10m).	Model documentation provided to include justification for not modelling larger trucks.
D2 – Vehicle characteristics and model distributions	Standard vehicles characteristics have been utilised in the model. As the study area is adjacent to an operational container port, the model documentation should include additional data / justification to support the adopted vehicle profiles / distribution.	Model documentation to be updated to include justification for the adopted vehicle profiles / distribution.
D3 – Vehicle classifications	As the study area is adjacent to an operational container port, the model documentation should include additional data / justification to support the adopted vehicle profiles / distribution.	Model documentation to be updated to include justification for the adopted vehicle profiles / distribution.
D4 – Vehicle input flows	Traffic States have not been utilised in the model.	n/a
D5 – Vehicle demand matrix generation	The matrices have been generated for 15 minute intervals based on observed profiles.	n/a
The below review outlines the findings of the review of the link and centroid parameters used for the model.		
E1 - Lane widths	All lane widths in the model have been set to 3.00m. While it's unlikely that this is correct for all roads in the model, lane widths are only used for graphical purposes in model and have no impact on the model results.	n/a
E2 - Placement of lanes	Wentworth Avenue has been modelled with only 2 lanes in each direction between Page St and Bank Ave instead of 3 lanes in each direction. While this may have been intentionally implemented in the model to account for on-street parking, the model documentation does not describe	Model documentation to be updated to include justification for sections of Wentworth Avenue only having 2 lanes in each direction in the model.

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	Commentary	Recommendation
	why this is the case (although there is a comment to state that this has been removed in the 2031 scenario).	Alternatively, model to be updated with correct number of lanes for Wentworth Avenue.
E3 - Placement of connectors	Connectors and zones have been placed at appropriate locations.	n/a
E4 - Link gradients	No gradients were used for this model. Best practice guidelines would suggest that link gradients should be coded in where significant gradients exist.	Update model documentation to justify the decision not to utilise link gradients / slopes in the model.
E5 - Lane change settings	Adopted lane change parameters considered appropriate.	n/a
E6 - Link/connection structure (roundabout approach)	No issues identified	n/a
The below review outlines the findings of the review into the priority behaviour parameters used for the model development.		
F1 - Placement of Priority Rules (priority intersections)	No incorrect priority rules have been identified in the models.	n/a
F2 - Placement of Priority Rules (roundabouts)	No incorrect priority rules have been identified in the models.	n/a
F3 - Headway and gaps	Standard values have been adopted in the models.	n/a
F4 - Blocking back / Yellow Boxes	No issues identified.	n/a
F5 - Pedestrian crossings	Pedestrian crossings at various locations within the network have been appropriately accounted for by the use of Section Incidences throughout the models.	n/a
The below review outlines the findings of the review into the vehicle routing dynamic assignment parameters used for the model development.		
G1 – Dynamic Assignment Parameters	Modelled as 50% static and 50% stochastic (50% static path is according to the shortest path found in static assignment) as explained in the traffic report	n/a
The below review outlines the findings of the review into the data used for the signalised intersections within the model.		

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	Commentary	Recommendation
H1 – Signalised controlled intersections	The signalised intersections within the study area have been modelled appropriately with actuated traffic signal control in the models. It is noted that no SCATS (IDM) data was reviewed as part of this review.	n/a
H2 – Cycle times	Based on the documented Green Time Proportions, the cycle times adopted are considered appropriate.	n/a
H3 – Intergreen times	Intergreen times of 6 seconds have been utilised in the model. This value is considered appropriate and in line with standard practise.	n/a
H4 – Phase times	Based on the documented Green Time Proportions, the cycle times adopted are considered appropriate.	CBB to request phase data
H5 – Phase movements	No data available	SCATS maps and/or IDM data to be included in report appendix.
H6 – Priority behaviour within signalised intersection	Priority behaviour at signalised intersections have been set up correctly, with the exception of the left turn from Page Street (S) to Wentworth Avenue (W) in the future year models.	Priority marker to be included for the left turn from Page Street (S) to Wentworth Avenue (W) in the future year models.
H7 – Pedestrian behaviour at signalised pedestrian crossing	Pedestrian crossings at various locations within the network have been appropriately accounted for by the use of Section Incidences throughout the models.	n/a
H8 – Detector Locations	Detector have been included for actuated signalised intersections and located at appropriate locations.	n/a
The below review outlines the findings of the review into the public transport parameters used for the model development.		
I1 – Public transport routes	The relevant public transport lines have been implemented in the model.	n/a
I2 – Public transport stop locations	A bus stop is missing in each direction along Bunnerong Rd between Kingsford St and Maroubra Rd.	No action required as the impact is likely to be minimal
I3 – Public transport type/characteristics	Standard parameters have been adopted for the public transport vehicles	n/a

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	Commentary	Recommendation
I4 – Service frequencies / start times	Spot-checks undertaken for the public transport plans show correct timetables have been adopted in the model.	n/a
I5 – Dwell times	A dwell time of 0 seconds has been used for all public transport timetables.	The dwell time adopted in the model is not considered realistic for all stops/routes. It is recommended that at least non-zero dwell time be adopted through the model. It would be desirable if timed PT stops could be accounted for in the model, especially if these are observed to impact on vehicle travel times.
The below review outlines the findings of the review into the model calibration.		
J1 – Turning counts	All existing scenarios were run and all scenarios exceeded the minimum model calibration requirements (note: no independent validation of the data included in the RDS was undertaken). It is noted that some minor variations were found in the modelled calibration results compared to the results included in the model documentation.	n/a
J2 – Link counts	No link count data was included in the model and not considered necessary due to the extent of the turning count data.	n/a
J3 – Screenline Traffic	No screenline / cordon calibration was undertaken and not considered necessary due to the extent of the turning count data	n/a
J4 – Check vehicle release	No issues identified relating to unreleased vehicles	n/a
The below outlines the findings of the review into the model validation.		
K1 – Journey time for general traffic	All existing scenarios were run in order to replicate the modelled travel times included in the model documentation. Minor variation was found in all travel times and with the exception of Route 2 for the AM scenario, was found to be within the tolerance limits.	Modelled travel times for Route 2 AM scenario to be reviewed / revised as necessary.

Review of AUP Traffic Modelling Report	Cardno	
Input Parameter / Model Reference	**Commentary**	**Recommendation**
	For Route 2 in the AM scenario, the modelled travel times were not found to be within the 15% tolerance limits. The variation may be due to the model developers utilising Aimsun version 8.1.1 which is considered outdated (superseded in November 2015).	
K3 – Journey time for buses	Journey times have not been reported separately for buses. While desirable, this is not likely to have a material impact on the model results due to the relatively low proportion of buses within the study area.	n/a
K2 – Queue lengths	Journey travel time was adopted for validation, therefore queue lengths are not required for this instance	n/a
The following issues have also been noted as part of the model review		
	• The traffic growth methodology for the future year scenarios have been based on estimates and assumptions. However, to account for non-linear traffic growth issues (e.g. construction of external infrastructure), the traffic growth assumptions should have been sourced from a strategic transport model. If a strategic transport model does not exist for the study area, the traffic growth assumptions should have been discussed and agreed with the Council. • Section 9.3 of the Traffic Modelling Report (Year 2031) states that "*The Year 2031 models were becoming unstable under the future base models and were prone to lockups as such it was difficult to deduce meaningful results from the 2031 models*". However, Cardno notes the following: ○ Only "Do-Nothing" scenarios have been modelled based on the existing transport network. No attempts have been made to investigate whether mitigation measures could be implemented to address the issues identified (e.g. upgrades of intersections or optimisation of traffic signal operation). ○ A RMS memo was issued in July 2016 to provide 'interim suggested practice' for congested traffic models to avoid lock-ups and provide meaningful results. The model documentation does not provide evidence that any of the suggested methodologies were adopted or attempted.	

4 Summary

Cardno has been commissioned by Bayside Council to undertake an independent peer review of the Planning Proposal submitted for the British American Tobacco Australasia (BATA) site. Specifically, the Transport Impact Assessment and Traffic Modelling Report prepared by Arup and currently under consideration of Bayside Council. The Planning Proposal involves the rezoning of an 8.95ha industrial site for over 2,068 dwellings, approximately 1,000m^2 of retail floor space, a 100 place child care centre, and community facility of up to 4,060m^2.

As a result of the review, Cardno has identified a number of issues that require additional justification and information to support the findings of the Arup assessment and the Planning Proposal. In summary, the review has found:

i. Given the location of the development compared to public transport services, in combination with current Journey to Work data indicating that approximately 605 of inbound and outbound journeys are undertaken by vehicles, it is unlikely that a reduction in car parking rates will shift commutes to public transport, rather it is likely to push parking demands onto the external road network.

   The use of Census data for the purpose of determining car parking provision cannot be solely relied upon to justify a parking reduction. Council's DCP would take into consideration Census data as well as another of other factors to determine the appropriate car parking rate.

ii. There is no assessment of the existing bus stop capacities or survey data / documentation of bus capacities to support the expected increase in demand. Nor is there any indication that discussions have been held with Transport for NSW with regard to gaining certainty in achieving the additional eight services required as suggest by the Transport Impact Assessment

iii. It is unclear whether the identified upgrades will be delivered by the opening stage of the development.

   It is relevant to note that the intersection of Baker Street / Wentworth Avenue has been identified as requiring upgrade to a signalised intersection. Botany Council's Section 94 Contributions Plan outlines the required funding to implement this upgrade. For high density developments, the Technical Direction provided data for developments in St Leonards, Chatswood, Cronulla, Rockdale and Parramatta. Trip generation in the peak period vary from these sites between 0.07 to 0.32 trips per unit. These locations however have a train station located within close proximity which could result in a lower vehicle trip generation rate.

iv. As noted in Section 2.5 of the Transport Impact Assessment, JTW data indicates that inbound and outbound trips to the area are predominately made of car trips (62% and 57% respectively). Further information should be provided regarding the sites used as part from the Technical Direction and the travel similarities of the proposed developments to these developments.

   Clarification is sought in regard to the methodology of the trip generation calculation, noting the discrepancy in existing journey to work patterns and the suggested modal shift

v. Bus travel for the proposed development against the surrounding travel zones increases by approximately 20% whilst car trips drop by approximately 40%.

   The Transport Impact Assessment should provide evidence to back the decision to increase use of bus services and the decrease in car trips. No suggestion has been made in the Transport Impact Assessment that suggests the shift in travel mode. In particular, reference should not be made to the extension of the Sydney Light Rail and the Sydney Metro West, which:

   - Are unlikely to be extended; and
   - If extended, are unlikely to be a preferred mode of travel given the distance and the lack of supporting public transport connection and parking at the destination.

   The JTW dataset provided as part of the Section 2.5 of the document groups ferry/tram, other modes and modes not stated into the categorisation of "other". No information has been provided as to why the aforementioned travel modes have increased from 3-4% to 8-9%. Reference to the Sydney Light Rail should be avoided for the reasons mentioned above.

No evidence has been provided regarding the increase in walking trips for the proposed development. The Transport Impact Assessment should provide information regarding to the increase in walking trips as the preferred mode of travel. No details have been provided regarding changing land use have been suggested to support growth in walking trips in the peak period

vi. The forecast traffic generation has been provided as a two hour volume based on a conversion factor of 1.6 for one hour trip generation rates. This conversion factor is not explained with supporting justification or referencing. This factor needs to be further explained as based on previous experience with RMS, conversion of two hour volumes to a one hour volume is based on conversion of 0.55. To replicate a two hour volume based on a one hour value the inverse would hold true i.e. a conversion factor of 1.82, not 1.6.

vii. The forecast traffic generation takes into consideration the existing warehouse us on the site, by reducing the overall traffic generation by 397 trips in the AM and PM peak (two hour peak flows). It is unclear how the warehouse traffic generation was derived for the two hour time period. This provides a significant reduction during both the weekday AM and PM period (397 trips).

It is unclear if the reduction of 397 trips is based on actual survey demand during the AM and PM period or whether this is a theoretical calculation based on GFA. It is understood that the current operation of the site relates to the operations of Port Botany and as such, heavy vehicle movements and / or peak hour generation may occur outside of commuter peak hours that have been assessed

viii. It is unclear whether the adopted traffic generation for Bunnings, Orica Industrial and Masters has been taken from the respective traffic assessments of these applications. Table 20 of the Traffic Modelling Report identifies two hour traffic generation however the source of this information is not provided. The respective traffic impact assessments for these sites should be referenced and incorporated into the modelling.

In addition to the Bunnings, Orica Industrial and Masters sites, Westfield Eastgardens have recently lodged an application for increased development. The Arup assessment does not take this into consideration (likely as a result of timing behind the Westfield submission). A corporative approach should be embarked upon in detailing cumulative traffic generation and resulting impacts for the area for both the BATA and Westfield sites.

ix. A detailed sample audit has been undertaken for the Bunnerong Road AIMSUN micro simulation models developed by Arup. This audit has detailed a number of concerns and potential areas of improvement.

Many of the items identified within the audit process are undesirable and would ideally be corrected, their presence is unlikely to affect the overall operation of the model on a network wide basis. Their presence will however affect the localised, detailed operation of the network in specific locations and could impact on the assessment of potential options. Nevertheless, the items raised above with regard to seeking clarification on trip generation rates, cumulative traffic impacts and forecast traffic generation need further justification that may impact the underpinning assumptions of the modelling which could significantly impact the reported results.

Transport
Roads & Maritime
Services

00777444

12 April 2019

Cr Bill Saravinovski
Mayor of Bayside Council
PO Box 21
ROCKDALE NSW 2213

Dear Cr Saravinovski

Thank you for your letter to the former Minister for Roads, Maritime and Freight about the Wentworth Avenue intersection upgrades at Page and Baker Streets, Pagewood. I have been asked to respond to you.

Roads and Maritime Services does not have funding in its current forward works program to provide additional funds for this project. Roads and Maritime understands the upgrades are developer funded and Council delivered to improve the efficiency of a local road.

While it is appreciated that Council is carrying out works on Wentworth Avenue, it is understood that the local road upgrades on approach to the intersections on Wentworth Avenue are required to offset the traffic impacts of the proposed development. Roads and Maritime understands the project is also intended to improve traffic exiting Page Street and improve efficiency of school arrivals and departures.

Roads and Maritime is aware of other developments and planning proposals in the area which may also contribute to delays on these local roads. Council may consider seeking additional developer contributions towards the provision of local and regional road upgrades such as this project (for example, through Council's Section 7.11 plans and other planning agreements).

If you would like to discuss this matter further, please contact Rachel Davis, Senior Strategic Land Use Coordinator on (02) 8849 2702.

Yours sincerely

James Hall
A/Senior Manager Strategic Land Use
Sydney Planning, Sydney Division

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