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Engineering Design Report – REF

Bradfield City Centre – Stage 2A

Client Reference No. 30013454
Prepared for: Western Parkland City Authority
29 April 2024

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Executive summary

The Bradfield City Centre (the Project) is located approx. 42km from the Sydney CBD in south-east of Sydney metropolitan area. The Project situated within the Aerotropolis Core Precinct is poised to become a dynamic, sustainable global city precinct which will serve as a key gateway to Western Sydney International (Nancy Bird Walton) Airport. The project is being developed and delivered by the Western Parkland City Authority (WPCA). The project is anticipated to generate approximately 20,000 jobs and is integral to the WPCA's mission to develop, coordinate, and attract investment to Western Parkland City. The strategical location and proximity to the Western Sydney Airport demand the Project to be developed with well-connected transport and pedestrian network and emerging technology utilities with greener public spaces in mind.

SMEC has been engaged with design delivery of Stage 2 of the Bradfield City Centre. This engineering design report accompanies the Review of Environmental Factors (REF) for the Bradfield City Centre Stage 2A development and captures civil engineering aspects such as erosion and sediment control, road design, drainage, earthworks and utilities. This report is submitted in accompaniment of the REF plans listed in Appendix A and serves as an overview of the engineering design criteria used to formulate the concept REF design documents, ensuring alignment with design guidelines and specifications.

Key areas of this report include:

Civil Engineering

- Design and implementation of erosion and sediment control measures prior to construction commencement.
- Maintenance of erosion and sedimentation controls including sediment basins during construction.
- Bulk earthworks.
- Design of new roads with priority and signalised intersections.
- Proposal of a Bus Transit Boulevard.
- Interface with the new Bradfield Metro station.
- Creation of new lots as a result of the creation of new roads.
- Connection to existing Badgerys Creek Road.

Utilities

- Assessment of existing utilities to ensure continuous service during construction.
- Design of Potable Water (PW), Recycled Water (RW) and Wastewater (WW) in accordance with the WSA 03.2011-3.1 Water Code of Australia Sydney Water Edition.
- Electrical, lighting and telecommunications design.
- Design of High Voltage (HV) and Low Voltage (LV) networks in accordance with Endeavour Energy (EE) specifications.
- Implementation of Smart Cities infrastructure.

This engineering design report ensures the concept design prepared for the proposed activity will meet engineering guidelines and authority approval.

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1. Introduction

SMEC has been engaged by the WPCA for the civil engineering and utility design of the proposed Stage 2A development at Bradfield.

Bradfield City Centre Master Plan was prepared in August 2023 and currently under exhibition. SMEC has prepared concept REF design of the civil engineering and utilities. The REF design will be submitted and approved under Part 5 Division 5.1 of the *Environment Planning & Assessment Act 1979 (NSW) (EP&A Act)*. The EP&A Act allows WPCA, as a public authority, to self-assess and grant the right to carry out development activities.

Subsequent to the approval of REF, a detailed design of the roads and drainage will be carried out. The design will be prepared for Issue For Construction (IFC) submission and approval. Figure 1 below shows Bradfield City Centre master plan and Stage 2A extent.

This report investigates the availability of services infrastructure near the site and documents the services required for the development of the project. The report covers major infrastructure supply requirements for the site development with respect to wastewater, potable water, recycled water, electricity, smart cities infrastructure and telecommunications. Regional stormwater infrastructure design is being prepared by Stantec (on behalf of the WPCA) and will be subject to a separate approval process.

There are two projects currently under construction near the site - Building 1 is a State Significant Development (SSD - 25452459) located on the northern side of Stage 2 and Sydney Metro – Western Sydney Airport (SM-WSA) Aerotropolis Station located on the eastern side of Stage 2. Coordination with various stakeholders including Liverpool City Council, Sydney Water, EE and SM-WSA were carried out during the design development of REF design. The design coordination will continue during the detail design. Civil and utility infrastructure design of the roads within the Metro Lease Area (Figure 1) will be carried out by SM-WSA and its contractor (Parklife Metro).

The proposed activity under this Review of Environmental Factors (REF) relates to the Stage 2A Enabling Works for the Bradfield City Centre. In summary, the proposed activity relates to site clearing, construction of new roads, the provision of service authority utilities, street landscaping, and drainage and stormwater infrastructure.

Specifically, the scope of works for the BCC Stage 2A REF will include the following:

- Construction of new roads, and associated stormwater, earthworks and civil works.
- Provision of waste water, potable water, recycle water infrastructure.
- Provision of electrical services network and reticulation infrastructure.
- Provision of data and telecommunications network infrastructure.
- Streetscape landscape works.

In addition, the BCC Stage 2A REF will also involve several activities which are ancillary to the construction of roads, including:

- Site clearance (including removal of vegetation).
- Provision of service authority utilities within the road corridors.
- Street landscaping.
- Drainage and stormwater infrastructure (including temporary stormwater basins. Stockpiling of excess soil.
- Construction of temporary haul roads during construction, (together with the construction of the new roads).
- Road works.

The REF is accompanied by concept plans and a range of supporting technical studies which have been prepared to inform the proposed design. The proposed road alignments and civil infrastructure for Stage 2A are generally in accordance with the Western Sydney Aerotropolis Precinct Plan and Western Sydney Aerotropolis DCP and is consistent with the BCC Master Plan.

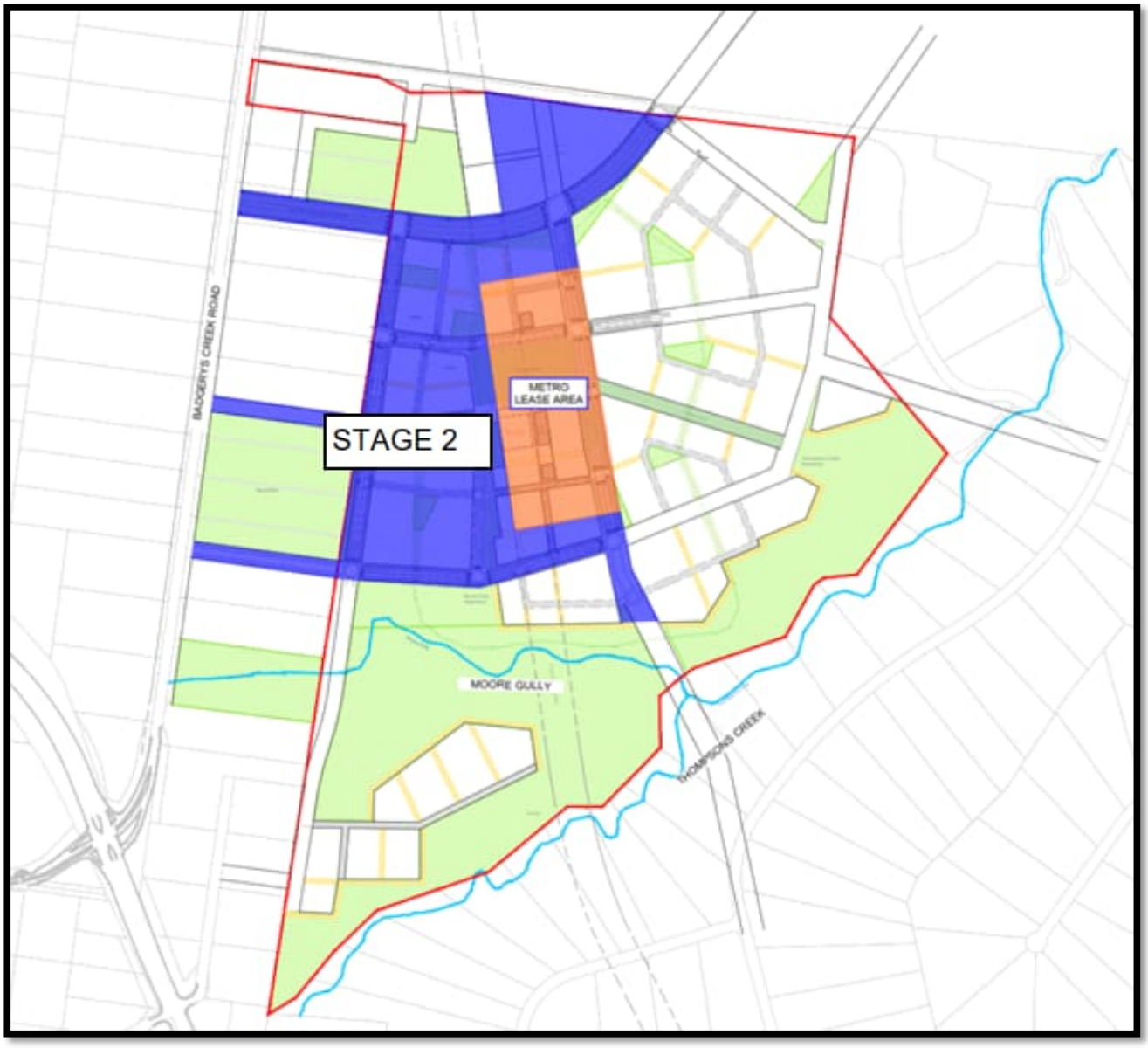


Figure 1 – Bradfield City Centre Masterplan

1.1 Existing site

The existing site is located at 215 Badgerys Creek Road, Bradfield - Lot 3101 DP 1282964. The lot area is approx. 115ha and shown in Figure 1. The existing site had been predominantly a rural landscape and does not have formal drainage. The site has moderate topography with slopes ranging from 2-6%. The existing site has a low-grade terrain which follows the natural topography of the land from north-west to south-east towards Moore Gully and Thompsons Creek. The site is bounded by rural lots to the north, Thompsons Creek to the east, Moore Gully to the south and Badgerys Creek Road to the west.

1.2 Future staging

The proposed Stage 2 of Bradfield City Centre will be developed in sub-stages with 5 REFs. The Figure 2 below shows the extent of each REF stage.

- Stage 2A proposes the largest area of works and will include the primary trunk stormwater lines, roads and interface with the Sydney Metro – WSA Aerotropolis Station area.
- Stage 2C, Stage 2D and Stage 2E proposes the road connection and linkage between existing Badgerys Creek Road and Stage 2A.

- Stage 2B proposes the northern interface with the Metro, the Metro link Boulevard and the northern most roads.

The design of Stage 2A is described in this report. Stage 2B-E require land acquisition and inputs from Transport for NSW (TfNSW) and therefore, these stages will form part of the future submissions for approval. The scope of this report is generally limited to the works required for Stage 2A and the report will be updated further in future to include other REF submissions.

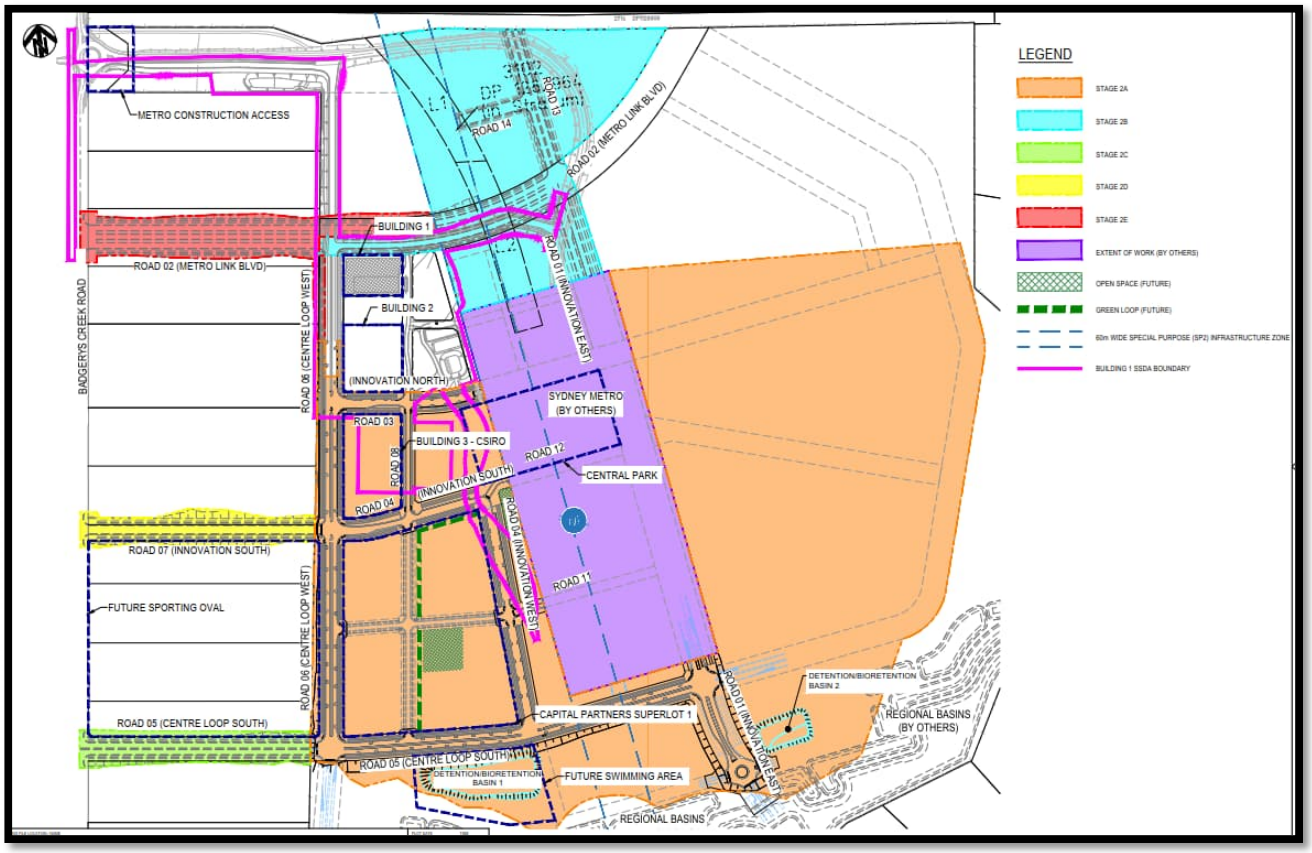


Figure 2 – Stage 2A Staging

2. The site

The Bradfield City Centre Stage 2A site is currently a greenfield site in a large rural open space.

The site is within the Aerotropolis Core rezone area. Aerotropolis DCP and Precinct Plan are applicable to the development. The site is located within the Liverpool City Council (LCC) Local Government Area (LGA) and Sydney Water is responsible for the trunk stormwater management in this area. The development site is predominantly zoned as mixed use. The extent of Stage 2A works is shown below in Figure 3.

The site can be accessed through a roundabout located on Badgerys Creek Road. There are two areas surrounding Stage 2A currently under construction:

- Advanced Manufacturing Research Facility (AMRF) Building 1 is a SSD located on the north of Stage 2A area. Building 1 and associated roads and utility infrastructure are currently under construction.
- SM-WSA's Aerotropolis station is located east of Stage 2A area.

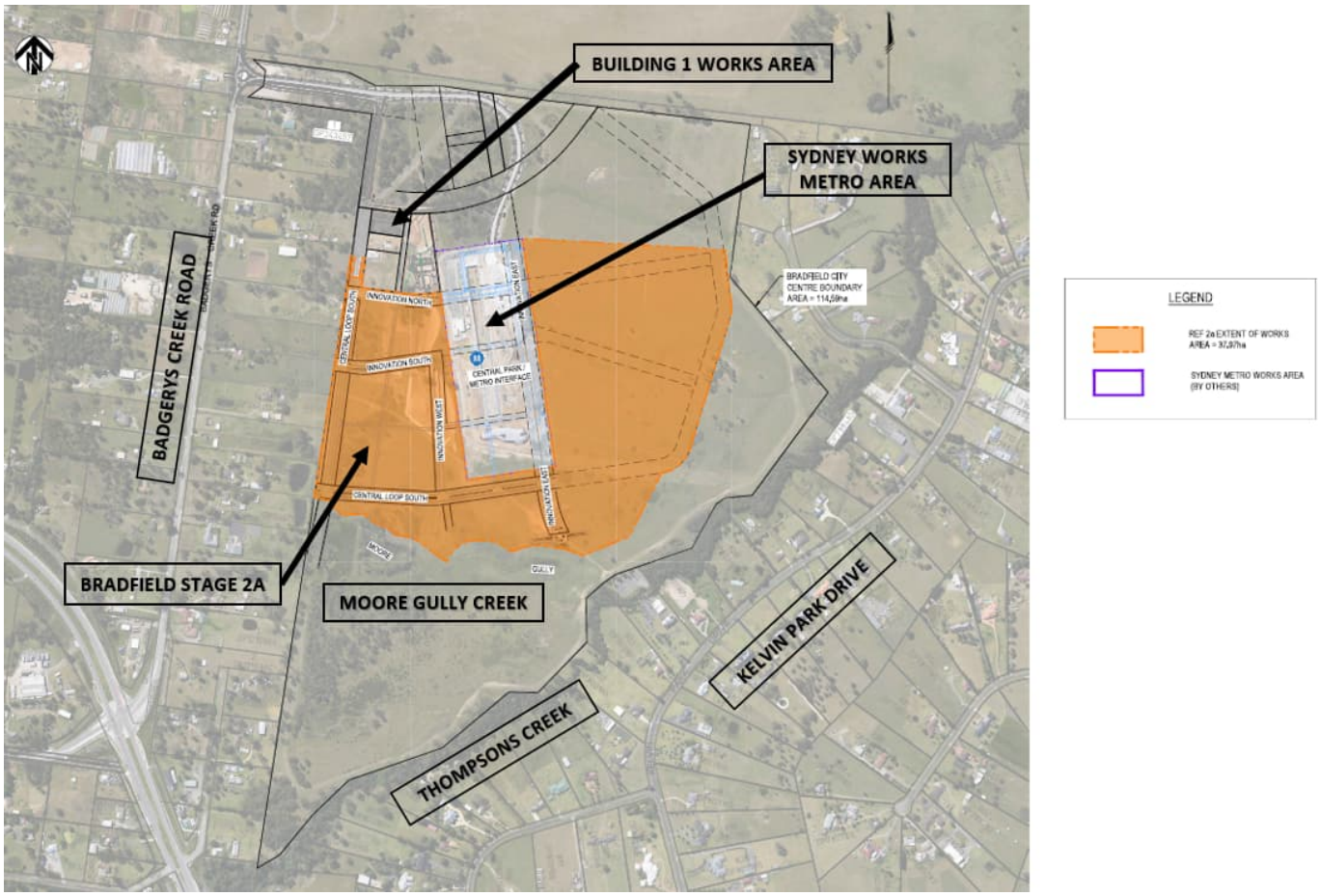


Figure 3 – Stage 2A Extent of Works

3. Civil engineering design

The concept design of works within Bradfield City Stage 2A has been prepared in accordance with the Bradfield City Centre Masterplan documentation, Aerotropolis Development Control Plan (DCP) and the Western Sydney Engineering Design Manual (WSEDM).

The proposed works in Bradfield City Stage 2A includes, but are not limited to:

- Construction of a new roads with priority and signalised intersections.
- Proposed works and interface to the new Aerotropolis Metro Station.
- Road drainage.
- Bulk earthworks.
- Creation of new lots as a result of creating new roads.

The development site is proposed to interface with, and will be constrained by, several elements within the surrounding the site. To the west, Badgerys Creek Road will be the main connection for traffic entering and leaving the site. Within Stage 2A the “purple area” as shown below in Figure 4 is the SM-WSA lease area which interfaces with Bradfield Stage 2A roads and services. To the south of the development is Moore Gully and Thompsons Creek which constrain the proposed levels and encroachment into the drainage channel.

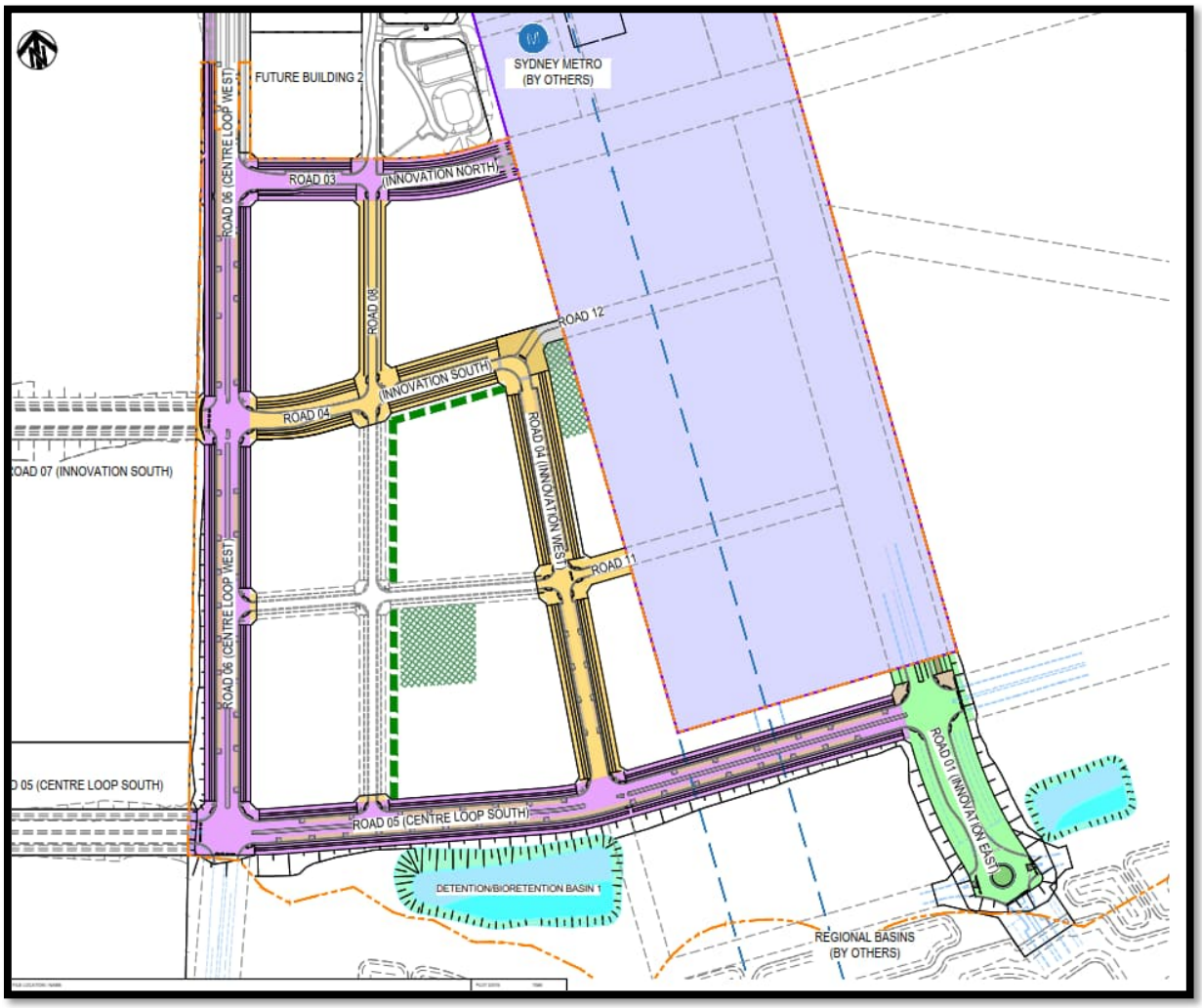


Figure 4 – Road Hierarchy

3.1 Reference documents/guidelines

The regulatory guidelines used for the design include:

- Austroads Guides
- TfNSW supplements to Austroads Guides
- TfNSW Pedestrian and Bicycle Guidelines
- Australian Standards
- Australian Rainfall and Runoff Volume 1 and 2 2016
- Western Sydney Engineering Design Manual rev PCG_03
- Western Sydney Aerotropolis Development Control Plan 2022
- Western Sydney Aerotropolis Precinct Plan May 2023
- Bradfield City Centre Master Plan Application - Utility Infrastructure and Servicing Report Aug 2023
- Bradfield City Centre Master Plan Application - Transport Management Accessibility Plan Report Aug 2023
- Bradfield City Centre Master Plan Application - Integrated Water Cycle Management Plan Aug 2023

3.2 Design software

The following design software were used in the development of the REF design:

- Road Design: 12D Model (12da)
- Drainage: Drains version 2023 (drn)
- CAD Drawings: AutoCAD 2023 (dwg)
- Turning Paths: Auto track (dwg)
- Music 6 HL

3.3 Road design

3.3.1 Road hierarchy

The proposed road network contains a well connected network of local, collector and transit boulevard. Innovation East (Road 01) is a transit boulevard. Centre Loop South (Road 05), Centre Loop West (Road 06) are 30m wide and Innovation North (Road 03) is a 27.4m wide collector roads. Other roads within Stage 2A are local roads. Footpaths and off-road bike lanes are proposed in road verges. On street parking will be provided on all roads except internal road Road 08. Tree pits are proposed on the roads to promote rainwater harvesting and Water Sensitive Urban Design (WSUD). Tree pits spacing on roads allow parking lengths as per AS 2890.

Innovation South and Innovation West are located near the SM-WSA Aerotropolis Station, and as a result allow for kiss and ride, taxi allocation and rail replacement bus parking. The road, pedestrian and bike network will provide an active interface and functionality between SM-WSA Aerotropolis station and other area of the development.

Table 1 – Bradfield – Stage 2 Roads

Road	Road Reserve	Verge
Innovation East (Road 1)	39.4m (16.4m carriageway)	3m wide footpath, 4m wide bike lane
Centre Loop South (Road 05) Centre Loop West (Road 06)	30m (15m carriageway)	3m wide footpath, 2m wide bike lane
Innovation South (Road 4)	28.4m (10m carriageway)	3m wide footpath, 2m wide bike lane

Road	Road Reserve	Verge
Innovation North (Road 3)	27.4m (11.2m carriageway)	3m wide footpath, 2m wide bike lane
Innovation West (Road 4)	30m (12.1m carriageway)	2m and 3m wide footpath
Road 08	17m (6m carriageway)	3m wide footpath

A comparison of the proposed Stage 2A road typical sections with the Aerotropolis DCP is shown below.

Table 2 – Bradfield – Stage 2A typical road sections comparison

ROADS NAMES	AEROTROPOLIS DCP	Stage 2A REF
Innovation East (Road 1)	25.6m road reserve with 15.4m road carriageway (Collector Road)	39.4m road reserve with 16.4m road carriageway
Innovation North (Road 3)	25m road reserve with 11m road carriageway (2x2.2m Parking Lane) (Local Road)	27.4m road reserve with 11.2m road carriageway (2x2.1m Parking Lane)
Innovation South (Road 4)	25m road reserve with 11m road carriageway (2x2.2m Parking Lane) (Local Road)	28.4m road reserve with 10m road carriageway (1x3m Parking Lane)
Innovation West (Road 4)	25m road reserve with 11m road carriageway (2x2.2m Parking Lane) (Local Road)	27.4m road reserve with 11.2m road carriageway (2x2.1m Parking Lane)
Centre Loop South (Road 05) Centre Loop West (Road 06)	25.6m road reserve with 15.4m road carriageway (Collector Road)	30m road reserve with 15.0m road carriageway (2x3.0m Parking Lane)
Road 08 and Road 11	-	17.0m road reserve with 6.0m road carriageway

3.3.2 Design vehicle

Design Vehicles as specified within AUSTROADS – Turning Path Template Guide have been adopted for the purposes of road and intersection design within Stage 2A.

Table 4.2: Guide to selection of the appropriate design and checking vehicle and the recommended turning radii

Intersecting road types	Design	Checking
Arterial/Arterial	Prime mover and semi-trailer (19 m) [1] Radius 15 m	Appropriate vehicle e.g. B-double (25 m) [2] **or** Prime mover and long semi-trailer (25 m) **or** Road train [3]
Arterial/Collector	Single unit truck/bus (12.5 m) Radius 12.5 m	Prime mover and semi-trailer (19 m) Radius 15 m
Arterial/Local (residential)	Service vehicle (8.8 m) Radius 12.5 m	Single unit truck/bus (12.5 m) Radius 12.5 m
Collector/Collector (industrial)	Prime mover and semi-trailer (19 m) [1] Radius 15 m	Prime mover and semi-trailer (19 m) [1] Radius 15 m
Collector/Collector (residential)	Single unit truck/bus (12.5 m) Radius 12.5 m	Prime mover and semi-trailer (19 m) [1] Radius 15 m
Collector/Local (residential)	Service vehicle (8.8 m) Radius 9 m	Single unit truck/bus (12.5 m) Radius 12.5 m
Local/Local (industrial) [4]	Prime mover and semi-trailer (19 m) [1] Radius 12.5 m [5]	Appropriate vehicle e.g. B-double (25 m) [2] **or** Prime mover and long semi-trailer (25 m) **or** Road train [3]
Local/Local (residential)	Service vehicle (8.8 m) Radius 9 m	Single unit truck/bus (12.5 m) Radius 12.5m

1 Select the appropriate vehicle for the design of sites that are frequently used by such vehicles.
2 B-double length may vary between jurisdictions.
3 Select appropriate road train from the *Guide to Road Design – Part 3: Geometric Design* (Austroads 2010b) or from relevant jurisdiction guide.
4 Also for intersections with industrial land use for collector/local intersections.
5 Simulations show that for this radius the maximum steering angle occurs at the exit of the turn and not applied at the crawl speed.

Source: Austroads (2009).

Figure 5 – Austroads – Design Template Guide Table 4.2

Due to the high volume of bus usage proposed within the City Centre, a Long Rigid Bus 14.5m is proposed as the design vehicle at intersections within the development. The design radius and turning templates have been adopted in accordance with Austroads as shown below.

3.3.3 Design speed

The road network implemented for Bradfield City Centre has been adopted from the Master Plan documentation including the AECOM-prepared Bradfield City Centre - Transport Management Accessibility Plan (Sep 2023 – V12). Considering active pedestrian movements in the Bradfield City Centre, the design speed of 50km/hr for transit boulevards and collector roads has been adopted. Other local roads are designed for 40km/hr design speed. Raised pedestrian crossings are proposed for the pedestrian movements and encourage slow speed environment. The posted speed will be adopted as per council's and Local Traffic Committee's advice. The Bradfield City Centre Master Plan Street network is shown in Figure 6 below.

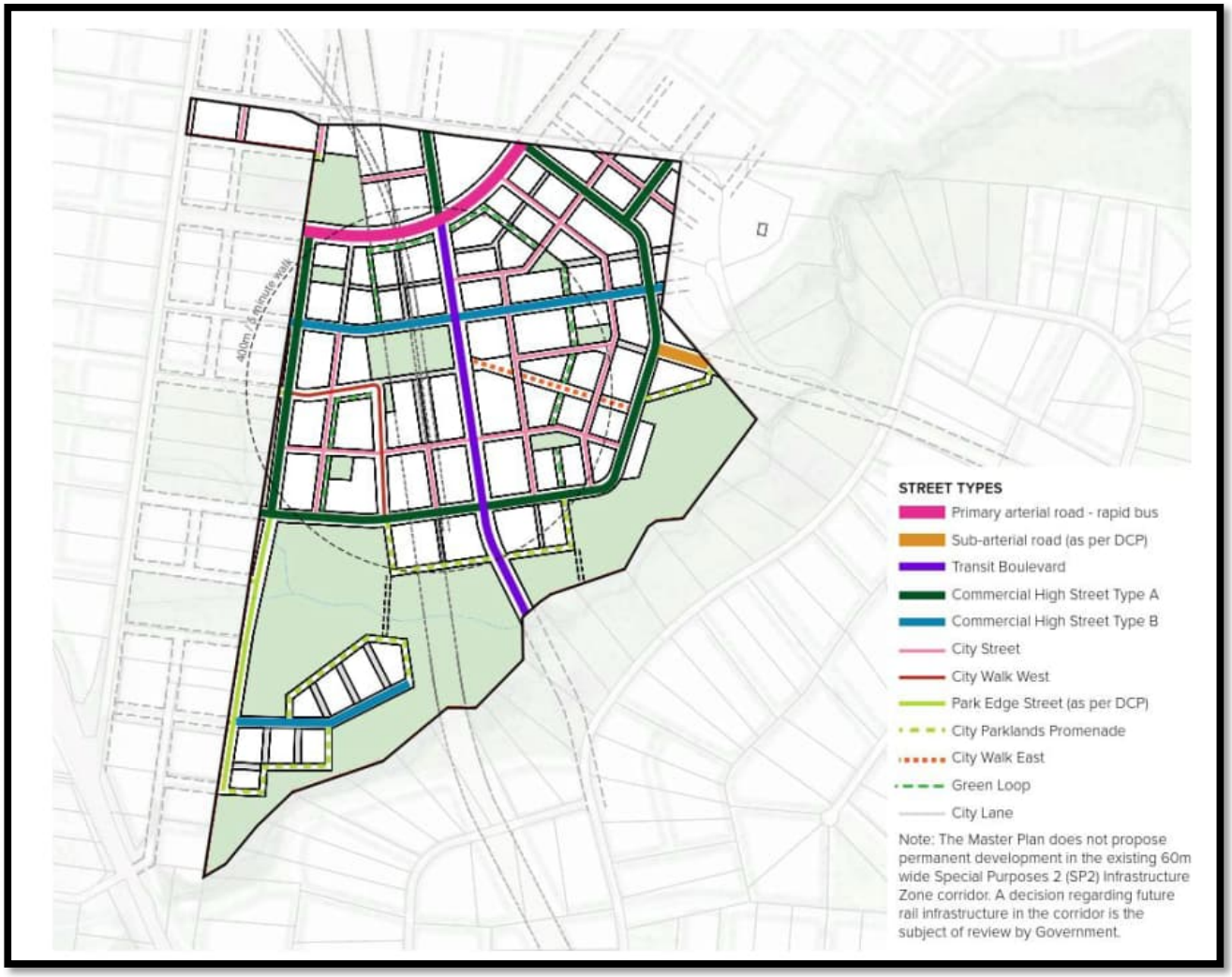


Figure 6 – Extract from AECOM Transport Management Accessibility Plan

3.3.4 Horizontal and vertical alignment

All roads have been designed to the requirments as specified in the WSEDM. Horizontal radii are provided as per the WSEDM.

The road vertical geometry and levels are set based on the discharge levels of the basins, creek invert levels, SW-WSA Aerotropolis Station interface and surrounding levels. Vertical curves are also provided as per WSEDM. Stopping Sight Distance (SSD) and Safe Intersection Sight Distance (SISD) have been checked as per AustRoads.

The WSEDM specifies a kerb return radius of 7.5m for local and collector roads. Increased kerb return radii are proposed in the design to allow the vehicle turning paths for a 14.5m Long Rigid Bus.

The road design criteria are listed in the Figure 7 below.

4.3.1 Design data

Table 7 Design Data: Street geometry

ID	DESIGN DATA DESCRIPTION	VALUE
1.	Longitudinal grade maximum - Local streets for short lengths up to 150m	20%
2.	Longitudinal grade maximum - Local streets	16%
3.	Longitudinal grade desired - Local collector	6.5%
4.	Longitudinal grade maximum - Local collector	10%
5.	Longitudinal grade maximum - Industrial street	6%
6.	Longitudinal grade minimum desirable	1.0%
7.	Longitudinal grade minimum absolute for short distances up to 50m, only and as agreed by the council	0.5%
8.	Half width road carriageway minimum width	5.5m
9.	Maximum distance between guideposts at dead ends and temporary turning heads	1.5m
10.	Minimum curve radii	
11.	Maximum cross fall at intersections	5%
	In Penrith	4%
12.	Minimum cross fall at intersections	1%

Minimum Deflection Angle	Minimum Radius (metres)
75	20
60	33
40	65
30	75
20	100

Figure 7 – Road Design Data - Extract from Western Sydney Engineering Design Manual

3.3.5 Road cross sections

The road typical cross sections have been adopted for the proposed road network for Bradfield Stage 2A which is generally in accordance with the Bradfield City Centre Master Plan and AECOM's Transport Management Accessibility Plan typical sections.

Consultation with various stakeholders including LCC and TfNSW was carried out in the preparation of the Master Plan. Stage 2A plans document road typical sections. Each section documents carriageway and verge widths, footpath, cycle lanes and landscape features. The proposed and future services allocations are also documented on road typical sections to demonstrate the location of utilities allocation and spacing.

A typical road section is shown below in Figure 8 below.

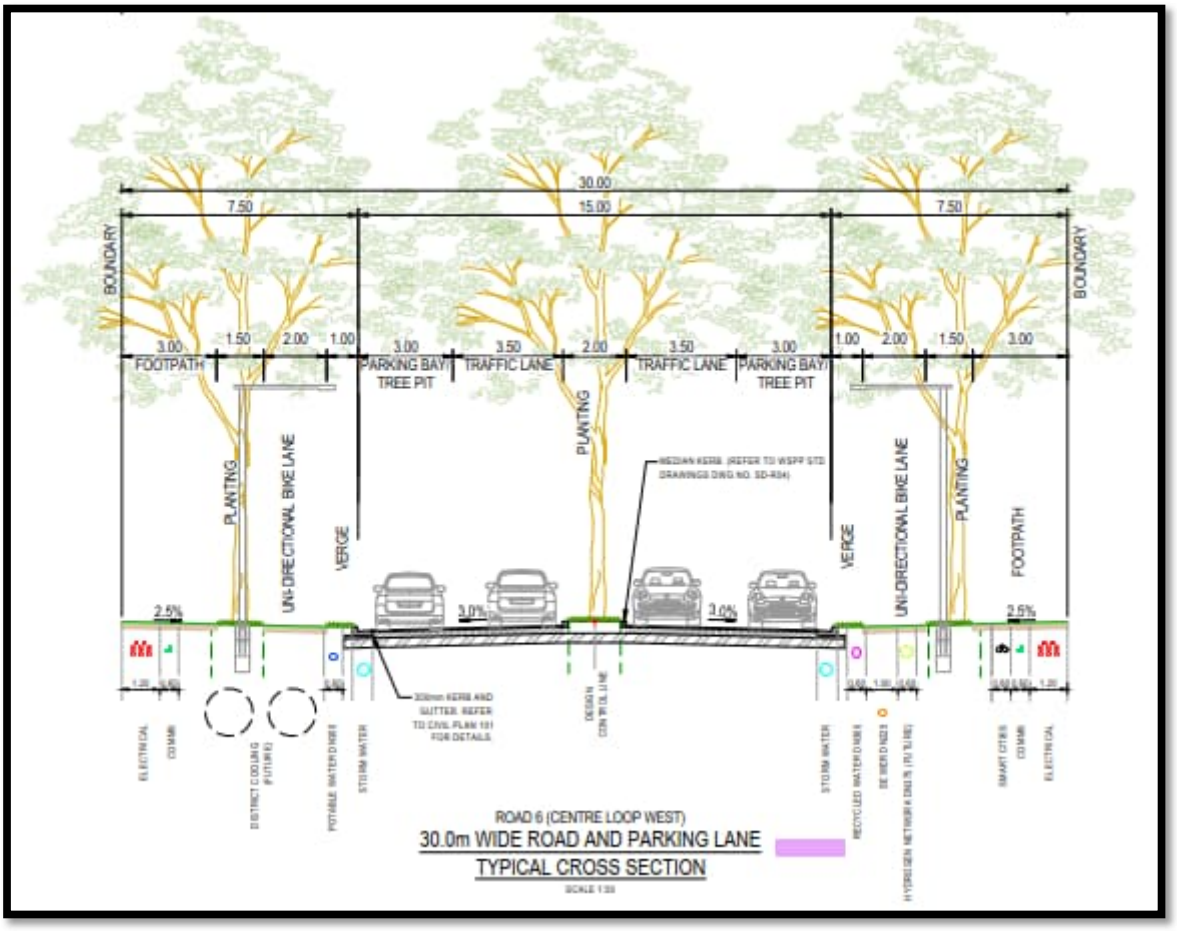


Figure 8 – Stage 2A Typical Road Cross Section

3.4 Intersection design

3.4.1 Stage 2A intersection layout

The proposed intersection design traffic modelling has been developed by SCT Consulting through the use of SIDRA to determine Levels of Service at each intersection and the best treatment required.

The Figure 9 below identifies the intersections within the Stage 2A area of works.

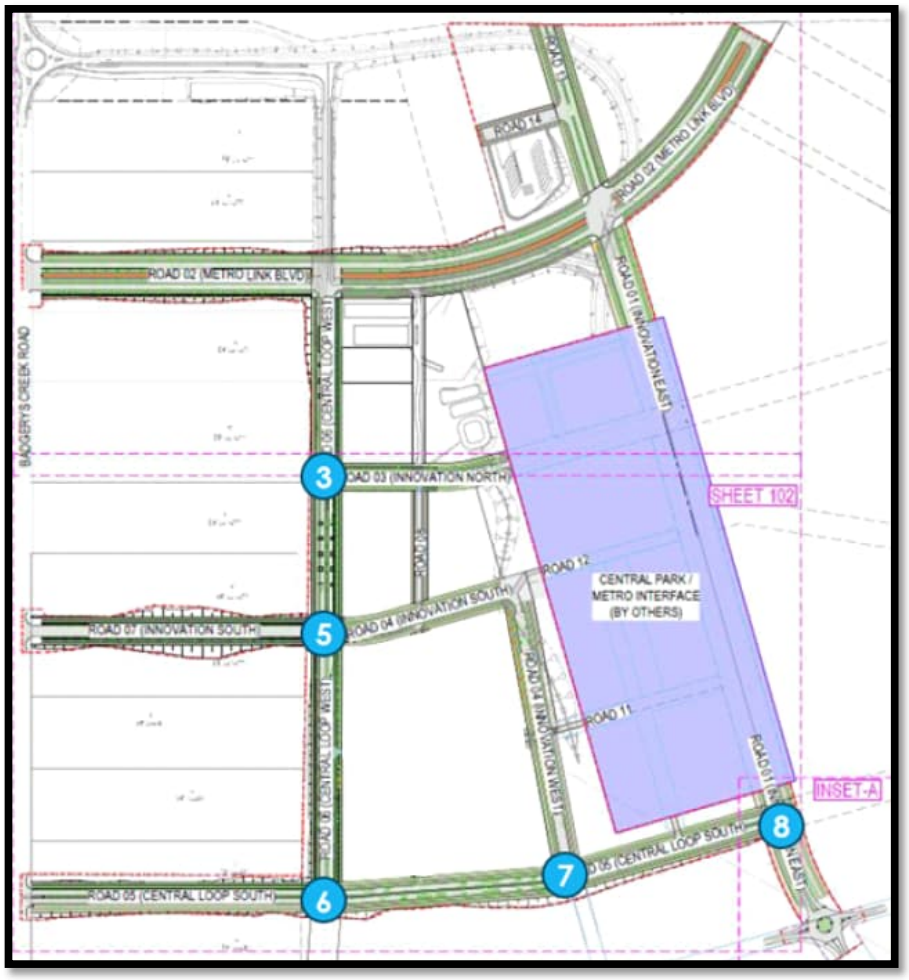
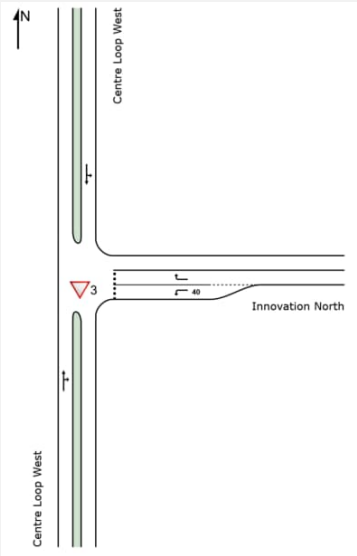
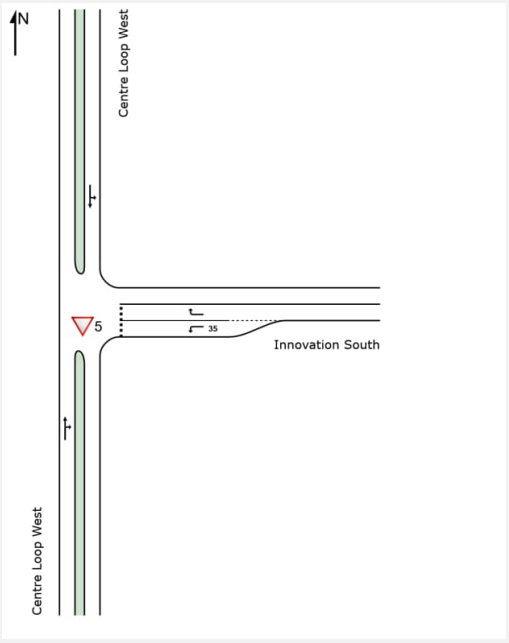
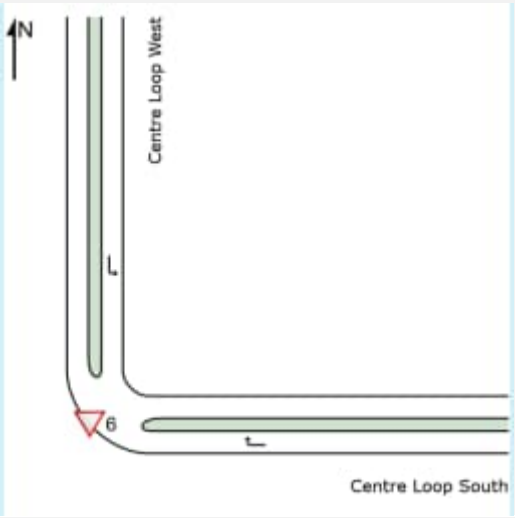
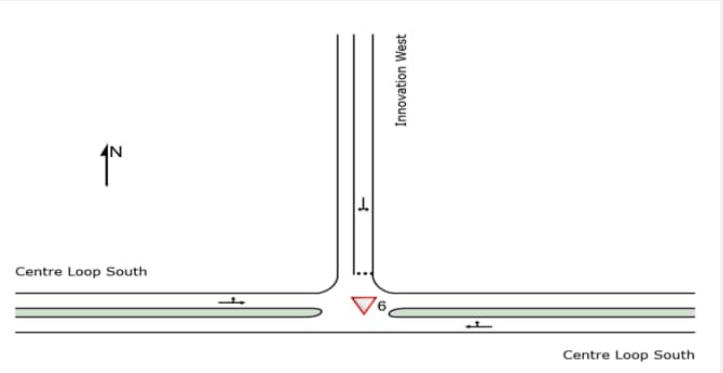


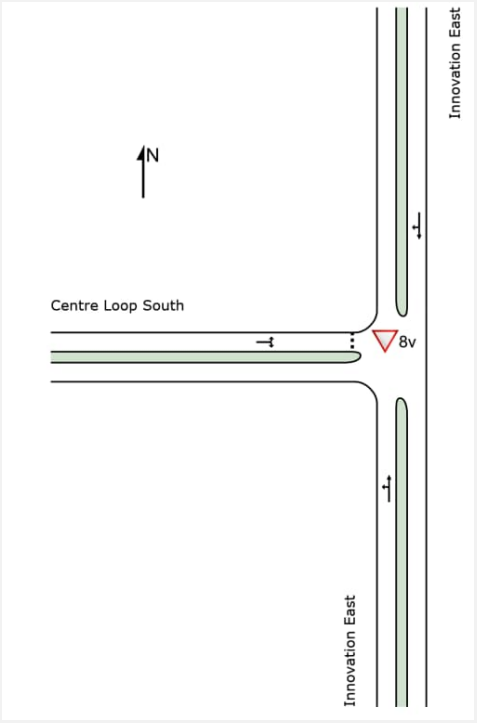
Figure 9 – Stage 2A intersections

Intersections 3 and 5 identified above are proposed to be priority intersections whereas intersections 6, 7 and 8 are proposed as future signalised (2056). The SCT Report identifies intersections for the years 2026, 2036 and 2056. The intersections geometrical design of Stage 2A has considered the ultimate intersection design for the year 2056. The intersection layouts documented in SCT report are shown in Table 3.

Table 3 – Intersection layouts.

Intersection	Proposed Intersection Layout - 2026
Centre Loop West Road / Innovation North Road (Intersection 3)	

Intersection	Proposed Intersection Layout - 2026
Centre Loop West Road / Innovation South Road (Intersection 5)	
Centre Loop West Road / Centre Loop South Road (Intersection 6)	
Centre Loop South Road / Innovation West Road (Intersection 7)	

Intersection	Proposed Intersection Layout - 2026
Innovation East Road / Centre Loop South Road (Intersection 8)	

3.5 Earthworks

For the discussion in this section, Area 1 represents the Stage 2A area west of the SM-WSA area and Area 2 represents the eastern side. Works in Area 1 include earthworks, roads, drainage and utilities. Minor earthworks and placement will be part of Area 2 works. This section discusses the proposed bulk earthworks design and grading strategy of the proposed works.

The site grading design criteria and site constraints described below are the controlling factors for the bulk earthworks design. The site grading is developed considering these criteria. Interface batter of 1:4 will be provided with surroundings. The earthworks proposed are generally in accordance with the Bradfield City Centre Master Plan and AECOM's Earthworks Report.

Existing Stage 2A site topography generally grades from north to the south, towards Thompsons Creek. The design grading generally follows the existing topography, maintains flow regime and creates flat, free-draining lots. The proposed design requires approximately 48,000 m^3 of material to be cut-to-fill, and approximately 59,000m^3 of excess material to be placed in Area 2. These volumes are preliminary and are subject to change during detailed design.

The above-stated volumes allow for topsoil strip of 150mm across the entire earthworks area, allowance for 150mm topsoil replacement in lots and landscape areas. The volumes do not include road boxing, utility trenching or bulking factor.

3.6 Sediment and erosion control

As part of the works, erosion and sedimentation controls will be constructed generally in accordance with the design drawings, Sydney Water requirements and Landcom's "Blue Book" – Managing Urban Stormwater: Soils and Construction. Sydney Water is the regional stormwater authority for the Aerotropolis, while the LCC are the responsible authority for the road drainage network.

The objectives of the erosion and sediment control for the development site are to ensure:

- Adequate erosion and sediment control measures are implemented prior to the commencement of construction and are maintained during construction.
- Construction site runoff is appropriately treated in accordance with the requirements of Liverpool City Council (LCC) and the Western Sydney Aerotropolis Development Control Plan – Phase 2.
- The Bulk Earthworks for Bradfield City Centre Stage 2A will involve lot grading and road construction. All sediment and erosion controls will be maintained as required during construction.
- The proposed sediment basins will be utilised and maintained during civil construction to control soil loss.

3.6.1 Construction measures

Prior to any earthworks commencing on site, all erosion and sediment control measures will be implemented and maintained generally in accordance with the above specifications. The measures shown on the drawings are intended to be a minimum treatment only. The contractor will be required to modify the erosion and sedimentation control measures to suit the actual construction program, sequencing, and techniques. These measures will include:

- A perimeter fence around the site and a security fence is to be placed around the proposed sediment basin as required.
- Construction of diversion swales to divert upstream clean water.
- Installation of sediment fencing around disturbed areas, including any topsoil stockpiles.
- Installation of silt arrestors to collect site runoff and retain suspended particles.
- Placement of straw bales around and along proposed catch drains and around stormwater drainage pits.
- Installation and maintenance of a stabilised access point at each site exit to avoid trailing of sediment onto the surrounding road network.
- Maintenance of the sediment basin.

3.7 Pavement

Concept pavement plans based on design CBR are prepared for the Stage 2A design. A detailed pavement design will be prepared by the geotechnical engineer to LCC requirements. One layer of 30mm AC10 will be constructed as a wearing course on all roads. The second layer of 30mm AC10 will be placed once majority of the lots are developed, or as agreed with the LCC during the construction approval and handover phase. Roundabout pavement will include a minimum 80mm AC14 SBS modified AC.

4. Stormwater management

The stormwater management within the Bradfield City Centre will be provided in accordance with the Bradfield City Centre Master Plan and AECOM's Integrated Water Cycle Management Plan. Tree pits are also proposed on the roads to promote rainwater harvesting.

Stantec have been separately engaged to progress with the detailed design of the regional stormwater infrastructure south of Bradfield Stage 2A, which involves a series of wetlands and detention basins along Moore Gully Creek. This work will be subject to a separate approval process. An interim stormwater management will be provided and discussed further in this report. Bioretention/ detention basins are proposed for the interim stormwater management. It is anticipated the basins will act as sediment basins during construction and site establishment over 10-12 months and will be converted to bioretention basin.

4.1 Catchment data

4.1.1 Existing catchment

The existing catchment analysis was conducted using LIDAR and detail survey contours.

The existing site topography grades towards south. The existing catchment is rural pasture and grades vary approx. 3-6%. There are two major catchments. Majority of the Stage 2A existing catchment discharges to the east towards the Thompsons Creek and remainder of the catchment discharges towards Moore Gully Creek in the south. The existing catchment overview is shown in Figure 10 below

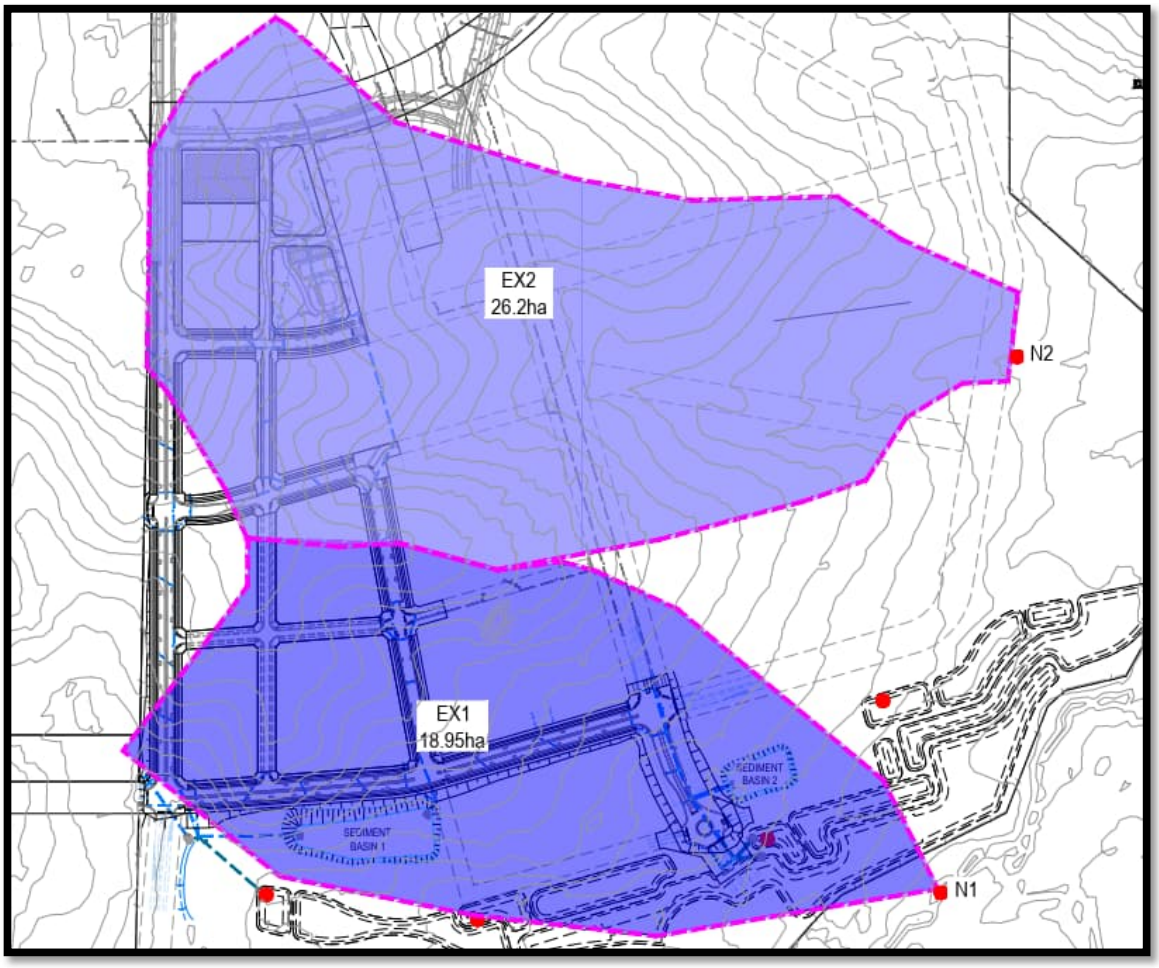


Figure 9 – Existing Catchment Plan

4.1.2 Proposed catchment

The proposed developed catchment (ultimate scenario) overview can be seen in Figure 11 below.

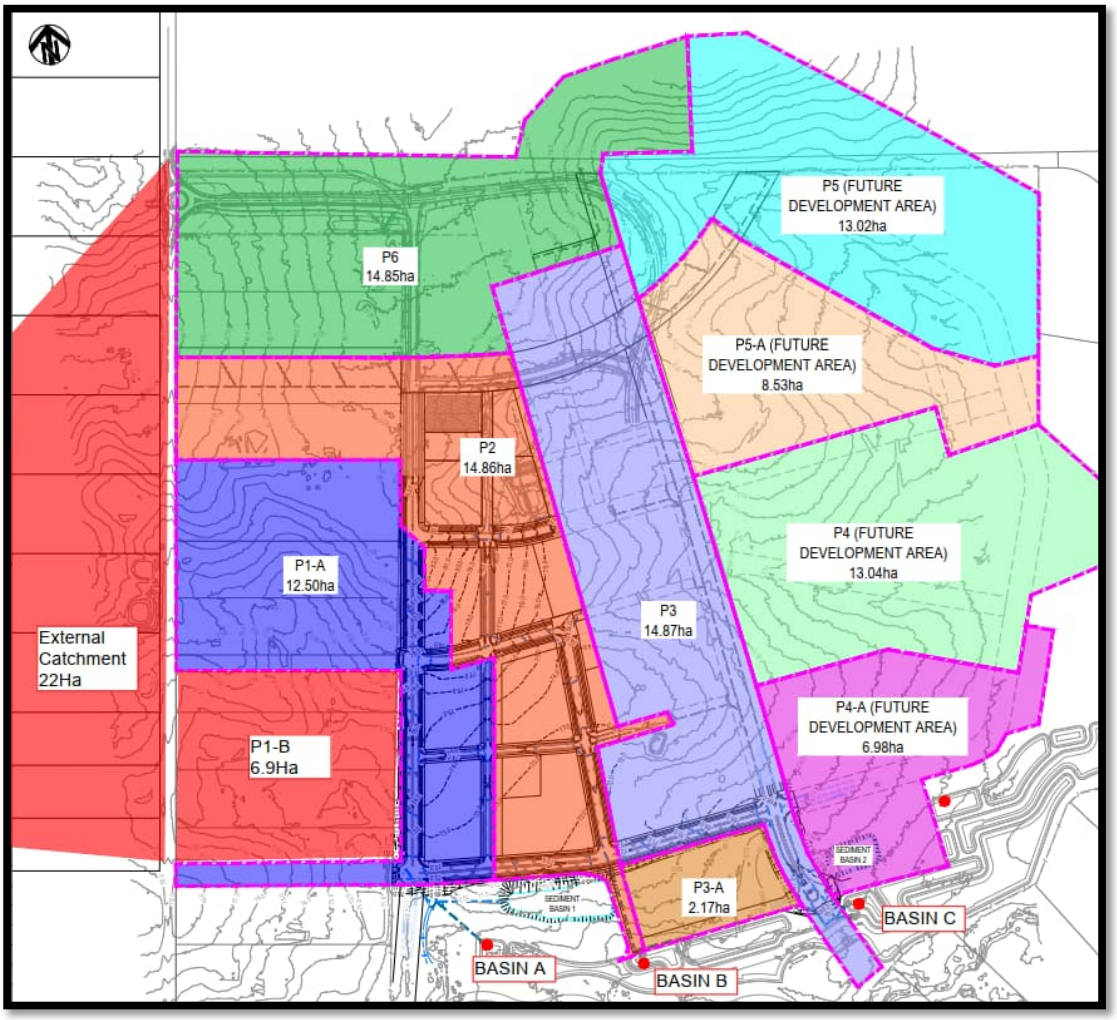


Figure 11 – Proposed Catchment Plan

There are three main sub-catchments within Stage 2A:

1) P1-A - 12.5Ha catchment discharges to upstream Basin A;

2) P2 - 14.86Ha catchment discharges to Basin B;

3) P3 - 14.87Ha catchment discharges to Basin C.

Catchment P1-B is approx. 6.9Ha. This catchment will be developed as drainage reserve and sporting field. Upstream catchment of 22Ha located on the western side of Badgerys Creek Road will discharge to this drainage reserve. A cross drainage pipeline is provided at the intersection of Centre Loop South and Centre Loop West Loop West to convey flows from these catchments.

The proposed development site catchments were delineated into sub catchments related to the stormwater pits. These catchments were modelled in 12D modelling software. The modelling allowed discharge levels of the basins, cover requirements and 132 kV electrical feeder within Centre Loop South and Innovation East.

The proposed catchments were adopted as 90% impervious based on WSEDM from Table 4.2 “Percentage of Impervious for Various Land uses”.

4.2 Road drainage

All internal road drainage for Bradfield City Centre will be designed in accordance with WSEDM specifications. The preliminary drainage design is prepared to confirm the pit spacings, pipe sizes. The purpose of this component of the report is to:

- Discuss a hydrologic and hydraulic assessment of the stormwater discharged from the site to demonstrate compliance with statutory requirements and to ensure that proper public amenity and safety is provided for the management of site flows; and
- Demonstrate compliance with the flood management measures outlined in the WSEDM.

Site hydrology has been analysed in DRAINS using the ILSAX method. The parameters for the ILSAX model and a level of impervious, pervious storage and soil type are documented below. Time of concentration values have been calculated using the kinematic wave equation. Rainfall IFD data was obtained from Bureau of Meteorology.

All proposed drainage pipes have been analysed with a pipe roughness of 0.6mm using the Colebrook-White equation. All overflow routes have been analysed using the required Manning's 'n' roughness values in accordance with WSEDM.

The overflow routes for roads are assumed to include 100% of the downstream pit catchment areas. Pit pressure coefficient Ku were calculated using the DRAINS inbuilt analysis.

The minor design storm (5% AEP event) is conveyed by the proposed storm water drainage system whilst maintaining the minimum freeboard requirements for a minor system in accordance with LCC's specifications. Near the areas where stormwater conveyance through an overland flowpath is not possible, the stormwater trunk drainage has been designed to convey 1% AEP flows. A stormwater pipe through Central Park will convey 1% AEP flows.

Modelling of the major design storm (1% AEP event) has indicated that all flows within the development are contained within the proposed road reserves and are at safe levels for flow depth (less than 200mm) and velocity depth product (less than 0.4m2/s).

The road drainage will allow climate change scenario as per the requirements from WSEDM and ARR2019 in the detail design.

Table 4 – DRAINS Parameters

DRAINS	Parameter
Hydrological Model	
Soil Type	3
Depression storage, grass (mm)	5
Depression storage, paved (mm)	1
Storm Data	ARR2019 Storm Ensemble
Road Drainage	
Pit	1.8m EKI lintel
Type of Pipe	RCP
Pipe roughness (COLEBROOK-WHITE)	0.6
Minimum grade (%)	1%
Pit blockage – Minor Storm	0
Pit blockage – Major Storm	0.2 (ongrade), 0.5 (sag)

4.3 Interim Water Quantity

An interim stormwater strategy of the detention basins is proposed until the regional basins are constructed. To calculate design flowrates at the development site, computer-based models of the existing and proposed catchments were modelled using DRAINS. Assessment of these models include but is not limited to, proposed detention basin, pipe, pit and overland flow path sizes for the proposed development.

The post-developed conditions DRAINS model for the site was developed using Liverpool city Council design parameter. This model was used to size the detention basins to ensure Permissible Site Discharge (PSD) for the development was achieved.

The proposed DRAINS model is based on the proposed subdivision road and lot layout along with the resultant modified overland flow paths. As discussed previously for Stage 2A works involve the construction of the roads and utilities. Individual lots will be developed at later stage. Considering this, the road catchments are modelled as developed and individual lots as undeveloped. Roads within the Sydney Metro area (Catchment F – Figure 12) are modelled as developed.

The proposed site will consist of two interim basins: Basin 1 and Basin 2. These basins will be used to attenuate the flows during the design storm periods and meet the pre-developed PSD flows.

The proposed basins will utilise a Primary, Secondary and Weir outlet system to meet the required PSD flows at point of discharge N1. The discharge control within the Basins have been calculated via Elevations Vs Discharge graphs and input from DRAINS.

Basin 1 will attenuate flows from Catchments A, B, C, D and E at point of discharge N1.

Basin 2 will attenuate flows from Catchments G and F at point of discharge N1.

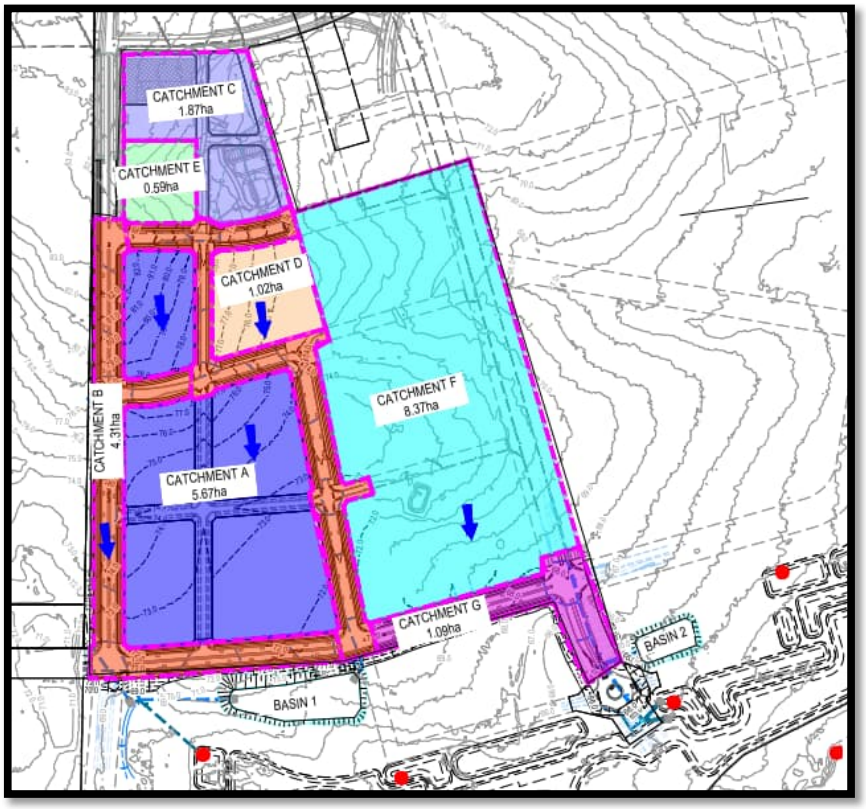


Figure 12 – Proposed WSUD Catchment Plan

The outlet configurations for Basin 1 and Basin 2 are shown below.

Table 5 – Basin Outlet Details

	Basin 1	Basin 2
Primary Outlet	900x900 GSIP RL 67.3 Outlet Pipe 375mm dia.	900x900 GSIP RL 63.2 Outlet Pipe 525mm dia.
Secondary Outlet	900 x 900 GSIP RL 67.7 Outlet Pipe 600mm dia.	900 x 900 GSIP RL 64.5 Outlet Pipe 750mm dia.
Weir Outlet	RL 68.1	RL 64.8
Peak Storage Volume (m3)	4500	2100

The table below demonstrates the flows discharging at N1 in the developed scenario meet the required PSD. These proposed flows include the outflow from the proposed detention basins as well as any flows generated from the bypass catchments.

Table 6 – DRAINS Point of Discharge Modelling Results

Storm Event	Pre-Developed Flowrate (m3/s)	Developed Flowrate (m3/s)
0.5EY	0.56	0.52
0.2EY	1.30	1.23
10% AEP	1.99	1.97
5% AEP	2.77	2.56
1% AEP	4.97	3.58

4.4 Interim Water Quality

Site water quality management is provided to ensure that stormwater runoff from the post-developed site meets the minimum required treatment standard before site discharge. This will ensure that local receiving waterways are protected from pollution such as excessive levels of nitrogen, phosphorous and sediment which could cause environmental damage such as erosion or algal blooms.

4.4.1 Bio-Retention basins

Two bio-retention basins have been proposed to achieve water quality treatment for the development. The filter material has been designed with a 0.5 m filter depth. Filter media parameters are in accordance with FAWB specifications. Refer to Figure 12 which outlines the locations of each bio-retention location.

Table 7 – DRAINS Point of Discharge Modelling Results

	Raingarden 1	Raingarden 2
Filter Area (m2)	2000	600
Extended Detention Depth (mm)	300	300
Filter Depth	500	500

4.4.2 Methodology

To achieve stormwater quality targets a treatment train has been developed. The stormwater treatment train has two stages of treatment; a gross pollutant trap (GPT) will provide primary treatment by capturing gross pollutants. The secondary treatment is provided by a bio-retention/raingarden basin with sand filter and vegetation to remove nutrients such as nitrogen and phosphorous.

The proposed treatment train has been designed to cater for a treatable flow rate equal to the 3 months ARI storm event in accordance with Council requirements and common practice. Pits with an internal diversion weir will divert the treatable flow to the proposed bio-retention/raingardens for secondary treatment.

4.4.3 Water quality modelling results

The proposed treatment train incorporates the use of gross pollutant traps and Bio-retention/Raingardens. The combination of these products in series will help to reach councils reduction targets. The overall stormwater quality strategy meets Western Sydney Aerotropolis Development Control plan and Wianamatta–South Creek stormwater management targets as noted in Table 7 below.

Table 8 – MUSIC Modelling Results

Pollutant	Sources	Residual Load	% Reduction	% Target
Total Suspended Solids (kg/yr)	22900	1160	94.5	90
Total Phosphorus (kg/yr)	39.2	7.7	80.1	80
Total Nitrogen (kg/yr)	213	72.8	65.7	65
Gross Pollutants (kg/yr)	2700	0	100	90

5. Utilities

The proposed development will require various utilities that will be provided in the road reserve. Concept designs of potable water (PW), recycled water (RW), wastewater (WW), electrical, lighting and telecommunication have been prepared for Stage 2A. The provision of services to the Bradfield City Centre will be in accordance with the Bradfield city Centre Master Plan and AECOM's Utility Infrastructure and Servicing Report. The design criteria are discussed in the respective sections further.

The development of the Bradfield City Centre will see increased the use of emerging modern technology. Aerotropolis DCP stipulates certain objectives and performance outcome for the services and utilities including allowance for the District Cooling and Hydrogen. The provisions have been provided in the road reserve to allow for these potential utilities. District Cooling System – a feasibility study is currently underway to consider the viability of providing a district cooling network throughout the Bradfield City Centre. Hydrogen – A provision has been provided in the road verges for the future installation. Potential allocation of these utilities has been allowed in the road reserve.

A search of existing utilities was undertaken using Before You Dig Australia (BYDA). It is noted that any existing redundant service will be removed prior to the commencement of works.

The proposed design has taken into consideration the location of existing utilities being currently constructed as part of the First Building. The utility design will ensure that continuous supply of services to First Building is provided throughout the proposed construction works. The Bradfield City Centre is a mix use development with commercial and residential, with the highest building approx. 25 storeys. A summary of the proposed development is provided in Table 9.

Table 9 – Bradfield development land use categories.

Land Use	Area (m^2)	From Total Area (%)
Mix Use	458,949	40
Enterprise	57,800	5
Infrastructure Corridor	45,571	4
Open Space	375,051	33
Roads	209,435	18

The concept REF design of PW, RW, WW, electrical, lights and telecommunications are prepared. The detail design will follow after Stage 2A lodgement and will be submitted to each relevant authority for approval.

Table 10 – Bradfield – Stage 2A Authority

Utility	Approving Authority
PW, RW and WW	Sydney Water
Electrical	Endeavour
Lighting	Liverpool City Council
Smart City	WPCA
Telecommunications	To be determined

5.1 Existing utility infrastructure and lead-In

Majority of the utility connections are available near the Bradfield City Centre site, and therefore lead-in works are not expected. Existing utility infrastructure upgrades will be required to service the Bradfield City Centre. Some interim arrangements will also be required till the ultimate utility infrastructure is built.

- Potable Water – A 450dia PW main has been recently constructed in Badgerys Creek Road. The commissioning of this PW main is expected in early 2024. Sydney Water has indicated supply of water in 450dia PW main will be available from Oran Park reservoir.

- Wastewater – No WW is currently available. Sydney Water is currently designing Thompsons Creek catchment WW infrastructure gravity main. This carrier main will service the Bradfield City Centre. Sydney Water has indicated the carrier main is expected to be operational by late 2026. An Interim Operating Procedures (IOP) will be implemented till the WW connection to the carrier main in future.
- Recycle Water – Recycle water is currently not available.
- Electricity – The electrical connection near First Building will be available. A new zone substation is currently under construction north of the Bradfield City Centre, and future zone substations will be constructed within the City Centre to service development as it evolves.
- Telecommunication – the comms connection near Building 1 will be available for connection.

5.2 Potable water

5.2.1 Points of connection and available capacity

There is no existing watermain within the Bradfield City Centre development site and an existing DN450 DICL trunk watermain in Badgerys Creek Road will be servicing the development. This trunk asset will provide sufficient water supply, fire flow and security of supply to the entire development via a couple of connection points which will be determined at detail design stage. Two connection options 1) through the existing road to the north or 2) through the existing property to the west will be investigated further in the detail design.

5.2.2 Network demand requirements and layout

The ultimate Equivalent Population (EP) used for calculating the design flow is detailed in Table 11. The water demand load has been calculated and verified in accordance with the WSA 03.2011-3.1 Water Code of Australia Sydney Water Edition for the entire Bradfield City Centre development. The total potable water demand is calculated based on Water System Planning Guideline – V1 Appendix B & C and is shown in Table 11. Based on the project schedule, it has been assumed that Stage 2A includes 6 catchments (7, 8, 11, and 12) with total EP of 1,464.12 which will be assessed at the initial stage.

The watermain is sized to service the entire development and is allocated within the proposed road verge which slightly varies depending on the road width and footpath (Section 3.6.5). The proposed watermain allocation must have sufficient vertical and horizontal clearances from other utilities (WSA 03.2011-3.1 Table 5.5).

Table 11 – Total building area and anticipated EP's.

Land use	Total Area (in HA)	Total Residential & Commercial/HA (Excl. 30% for open space & Roads)	Residential/ Ha	Commercial/ Ha	82Units per Ha @ 2.5EP per Unit for Residential	500EP/Ha Commercial	Equivalent Population (EP)
Catchment 1*	23.00	16.10	8.05	8.05	1650.25	4025.00	5675.25
Catchment 2A	2.30	1.61	0.81	0.81	165.03	402.50	567.53
Catchment 2B	7.00	4.90	2.45	2.45	502.25	1225.00	1727.25
Catchment 3	6.87	open space @ 20 Ep's/Ha	0.00	0.00	0.00	137.40	137.40
Catchment 4	1.23	0.86	0.43	0.43	88.25	215.25	303.50
Catchment 5	1.05	0.74	0.37	0.37	75.34	183.75	259.09
Catchment 6	8.70	6.09	3.05	3.05	624.23	1522.50	2146.73
Catchment 7	0.88	0.62	0.31	0.31	63.33	154.46	217.78
Catchment 8	0.95	0.66	0.33	0.33	67.88	165.55	233.43
Catchment 9	0.72	0.50	0.25	0.25	51.65	125.97	177.61
Catchment 10	1.07	0.75	0.37	0.37	76.56	186.73	263.28
Catchment 11	0.88	0.62	0.31	0.31	63.40	154.63	218.03

Land use	Total Area (in HA)	Total Residential & Commercial/HA (Excl. 30% for open space & Roads)	Residential/ Ha	Commercial/ Ha	82Units per Ha @ 2.5EP per Unit for Residential	500EP/Ha Commercial	Equivalent Population (EP)
Catchment 12	1.43	1.00	0.50	0.50	102.93	251.06	353.99
Catchment 13	1.00	0.70	0.35	0.35	71.75	175.00	246.75
Total	57.09	35.15	17.57	17.57	3602.83	8787.38	12527.61

* 23 HA has been added (Catchment 1) for the sewerage calculation as this area will be drained through Bradfield site.

Table 12 – Potable Water Demand for catchments within Stage 2A.

Land Use	Area (in Ha)	Drinking Water (KL/Ha/day)	PW demand (KL/Day)	Source
Commercial	11.55	21	242.55	Water System Planning Guideline - V1 September 2014, Table 3 - 6
Residential – Multi units (61-100 unit/net/Ha)	11.55	0.6	6.93	Water System Planning Guideline - V1 September 2014, Table 3 - 5
Total Demand in KL/day			249.48	

5.3 Wastewater

5.3.1 Points of connection and available capacity

The downstream sewer network is currently under design by Sydney Water. This network has sufficient capacity to accommodate the load from entire Bradfield City Centre development. Consequently, no upgrade will be proposed in the downstream side of sewer network. In general, the catchment slopes from north to south and west to east side. The proposed sewer network is designed to handle the ultimate flow, mitigating the need for any future upgrades. An IOP will be designed and constructed (by others) near the proposed Sediment Basin 2 in the South- East corner of the site. This arrangement will continue until the ultimate connection to the sewer carrier across the Thompsons Creek.

The future development of the buildings within the lots will be as per the street setbacks documented in Section 7 of the Masterplans. Due to the reduced setback and close proximity of the future buildings within the lot boundary, no services are proposed within the lots. Hence, the sewer main is situated within the road verge, maintaining sufficient clearance from other utilities to comply with Sewerage Code of Australia WSA 02-2002-2.2 Table 4.2. The initial assessment has confirmed that the proposed sewer main is sized from DN225 to DN375, as detailed in Table 13.

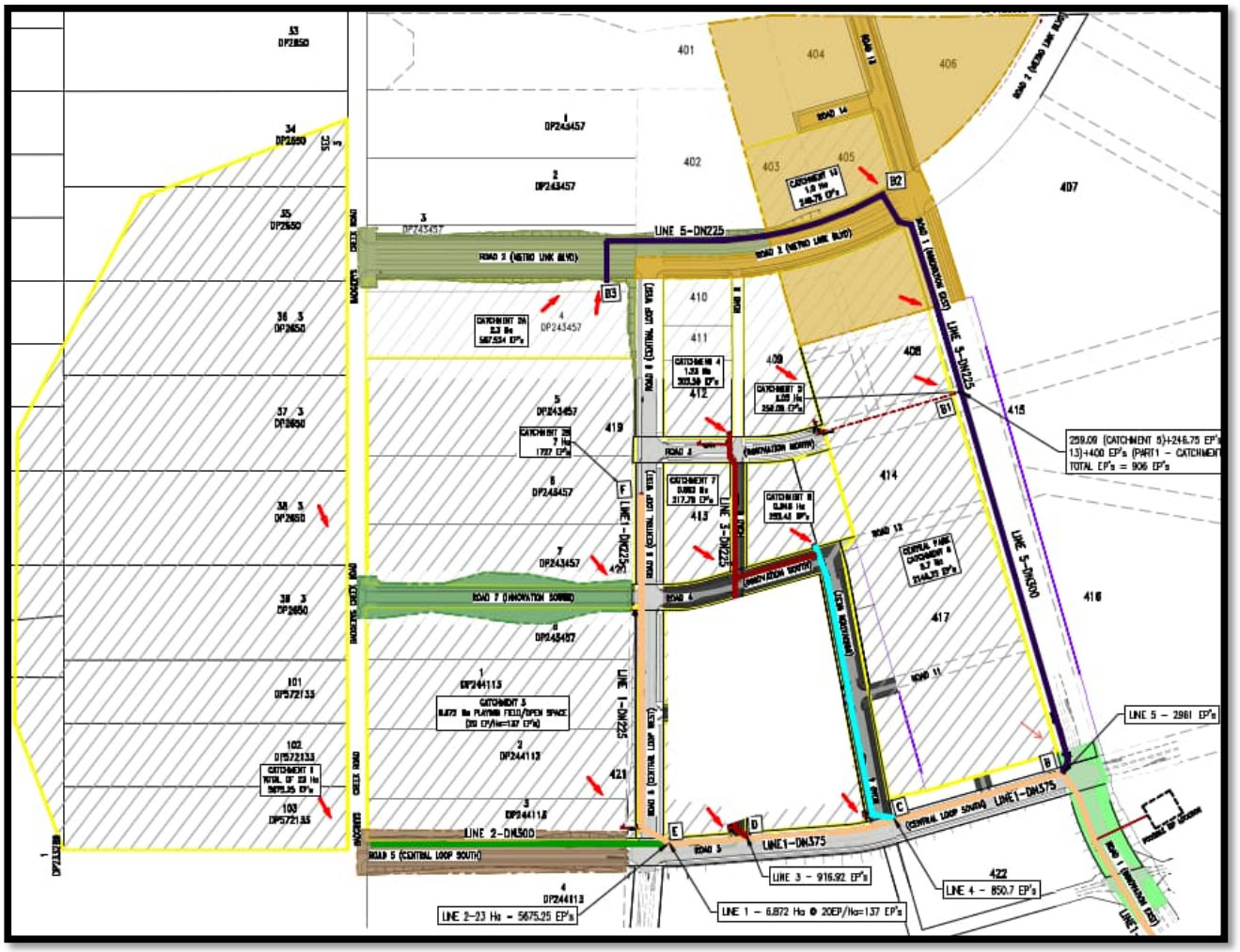


Figure 13 – Stage 2A sewer main layout

5.3.2 Initial parameters

The sewer layout for Bradfield development will gravitate to Sydney Water network and the connection point parameters are provided in Table 13 below.

Table 13 – WW Connection

Connection Point	Invert Level (m)	Surface Level (m)
Manhole in Thompsons Creek Catchment	54.24	64.00

5.3.3 Flow schedule

To conduct an initial assessment of the system performance based on the incoming flow, the sewer flow schedule version May 2023 has been utilised. This aids in designing the reticulation sewer system and pipe sizing. The pipe sizing adheres to Sewerage Code of Australia Sydney Water Edition WSA 03-2022-2.2. As per the sewer main layout, Line 1, Line 3 and Line 4 will be situated within Stage 2A and the flow schedule are as the below table.

Table 14 – Flow schedule for lines included in Stage 2A

Section	Total Gravity (EP)	Pipe Size (mm)	Grade (%)	Design Flow (L/s)	Pipe Capacity (L/s)	Actual Peak Dry Weather Flow (L/s)	Capacity and Self Cleansing Check
Line 1	12282	375	1	130.03	177.04	43.34	OK
Line 3	944	225	1	15.73	45.62	5.24	OK

Section	Total Gravity (EP)	Pipe Size (mm)	Grade (%)	Design Flow (L/s)	Pipe Capacity (L/s)	Actual Peak Dry Weather Flow (L/s)	Capacity and Self Cleansing Check
Line 4	864	225	1	14.77	45.62	4.92	OK
Line 5	2968	225	1	37.98	45.62	12.66	OK

5.4 Recycled water

Recycled watermain will be situated within the road verge, maintaining similar clearance requirements as the potable water main (WSA 03.2011-3.1 Table 5.5). The recycled watermain is designed to accommodate needs of the ultimate development, with main sizes ranging from DN200 to DN300. The total demand for recycled watermain is calculated in accordance with Water System Planning Guideline – V1 Appendix B & C.

Table 15 – Recycled Water Demand for catchments within Stage 2A

Land Use	Area (in Ha)	Recycled Water (KL/Ha/day)	RW Demand (KL/Day)	Source
Commercial	11.55	21	242.55	Water System Planning Guideline - V1 September 2014, Table 3 - 6
Residential - Multi units (61-100 unit/net/Ha)	11.55	0.7	8.085	Water System Planning Guideline - V1 September 2014, Table 3 - 5
Total Demand in KL/day			250.635	

5.5 Electrical

The site is located within the supply boundary of EE.

Current electrical supply will be provided from North Bradfield Zone Substation. The ultimate development of the Bradfield City Centre will require two (2) additional zone substations. The development of these substations will be required progressively as the city centre develops further.

Stage 2 (West Bradfield City) zone substation (approximately required in 2035) is anticipated to be located near the corner of Innovation East and Centre Loop South. This will generally service developments located on the western side of Innovation East. Two 132kV feeders will be constructed from Badgerys Creek Road to Stage 2 zone substation through Centre Loop South and Innovation East. The feeders and joint bays will be constructed in Badgerys Creek Road and Centre Loop South carriageway as part of Stage 2A works. Stage 2 (East Bradfield City) zone substation (anticipated to be required by 2045) will be located north of Metro Link Boulevard (future REF 3). This substation will be connected to Stage 2 via 1 x 132kV feeder and 1 x 132kV feeder from Kemps Creek BSP. This will generally service developments located on the eastern side of Innovation East.

Electrical High Voltage (HV) and Low Voltage (LV) network will be designed to EE specifications and as documented below. Provision for Electrical Vehicle (EV) charging will be provided on Centre Loop West and Centre Loop South. Design application for the development has been lodged with EE.

The steps involved in the design process are:

- Submit application to EE for subdivision
- Complete preliminary reticulation plan
- Submit proposed method of supply (PMOS) to EE
- Receive design brief from EE
- Complete detailed design
- Submit to EE for certification

The design is proposed to have the following specifications:

- All roads to be reticulated with minimum 6 ducts for future 11kV use.
- All super lots to have 11kV cable at the frontage to cut in future padmounts as required.
- Padmount substation to be provided for LV supply to smart cities infrastructure, vehicle charging and traffic signals.
- LV pillar to be provided at future signalised intersections.
- All work to comply with Endeavour Energy Standards.

5.6 Smart Cities and lighting

Bradfield City Centre will provide Smart Cities infrastructure generally in accordance with the Bradfield City Centre Master Plan and AECOM's Smart Cities Implementation Plan and Assessment Report. The design is currently being developed to future proof and deliver key initiatives. Lighting will be private with option to provide Multi-Function Poles in future.

The multifunction poles are intended to reduce clutter in the streetscape and incorporate several services including streetlights, traffic lights, 4G/5G antennas, etc. All streets will be reticulated with spare conduits to allow additional services to be installed on the poles at a future date. All locations where smart poles are not initially installed will have a universal footing used to allow the columns to be swapped to smart poles in the future.

The following steps are expected for the lighting design process:

- Receive required illumination levels from LCC.
- Preparation of the preliminary lighting illumination plot.
- Preparation of the concept layout and reticulation plans.
- Prepare final illumination plot and reticulation design.
- Submit drawings to council and TfNSW (for arterial roads) for approval.

The lighting is proposed to have the following specifications:

- Lighting to be provided at PR3 lighting category to AS/NZS 1158 requirements. Arterial roads to be provided lighting to V3 category.
- MSBs to be provided to provide supply to smart cities lighting and other smart cities infrastructure. ALL MSBs to comply with AS/NZS 61439.
- All works to comply with AS/NZS 3000 & AS/NZS 3008.
- All roads with smart poles to be reticulated with spare conduits for future increased electrical load on poles.
- Lights to be mounted on smart poles to allow other smart cities infrastructure to be co-located on the same poles.

5.7 Telecommunications

Telecommunication design is completed to G:645 Communications alliance standards and will also comply with the NBN Co guidelines.

The following design criteria are adopted:

- 4 x P100 conduits along all roads
- In most cases 3 x P100 conduits are express conduits with 1 x P100 picking up smart poles.

Multi-Function Poles will be serviced with a P50 conduit to a demarcation pit and then a P20 conduit to the Multi-Function Pole.

6. Conclusion

The engineering design controls outlined in this report including civil and utilities will ensure that the development of the Bradfield City Centre Stage 2A will meet the criteria for overall acceptance and approval by various Authorities.

The design is consistent with the Bradfield City Centre Master Plan, Western Sydney Aerotropolis Precinct Plan and Western Sydney Aerotropolis Development Control Plan – Phase 2. Detailed design will be further developed.

Appendix A – List of REF Plans

SHEET SCHEDULE

DRAWING	DESCRIPTION
30013454.01.REF001	COVER SHEET & LOCALITY PLAN
30013454.01.REF002	SHEET SCHEDULE & NOTES
30013454.01.REF030	STAGING PLAN
30013454.01.REF031	GENERAL ARRANGEMENT PLAN
30013454.01.REF032	ROAD HIERARCHY PLAN
30013454.01.REF041	TYPICAL ROAD CROSS SECTIONS SHEET 1
30013454.01.REF042	TYPICAL ROAD CROSS SECTIONS SHEET 2
30013454.01.REF043	TYPICAL ROAD CROSS SECTIONS SHEET 3
30013454.01.REF044	TYPICAL ROAD CROSS SECTIONS SHEET 4
30013454.01.REF051	CUT AND FILL PLAN
30013454.01.REF061	CUT AND FILL SECTIONS
30013454.01.REF101	CIVIL PLAN SHEET 1
30013454.01.REF102	CIVIL PLAN SHEET 2
30013454.01.REF103	CIVIL PLAN SHEET 3
30013454.01.REF104	CIVIL PLAN SHEET 4
30013454.01.REF201	ROAD LONGITUDINAL SECTIONS SHEET 1
30013454.01.REF202	ROAD LONGITUDINAL SECTIONS SHEET 2
30013454.01.REF203	ROAD LONGITUDINAL SECTIONS SHEET 3
30013454.01.REF204	ROAD LONGITUDINAL SECTIONS SHEET 4
30013454.01.REF205	ROAD LONGITUDINAL SECTIONS SHEET 5
30013454.01.REF206	ROAD LONGITUDINAL SECTIONS SHEET 6
30013454.01.REF207	ROAD LONGITUDINAL SECTIONS SHEET 7
30013454.01.REF208	ROAD LONGITUDINAL SECTIONS SHEET 8
30013454.01.REF351	PAVEMENT PLAN
30013454.01.REF501	CATCHMENT PLAN
30013454.01.REF801	SIGNAGE AND LINE MARKING PLAN
30013454.01.REF811	VEHICLE TURNING PATHS SHEET 1
30013454.01.REF812	VEHICLE TURNING PATHS SHEET 2
30013454.01.REF813	VEHICLE TURNING PATHS SHEET 3
30013454.01.REF851	SOIL & WATER MANAGEMENT PLAN
30013454.01.REF861	SOIL & WATER MANAGEMENT DETAILS

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