WATERLOO METRO QUARTER OVERSTATION DEVELOPMENT

Environmental Impact Statement
Appendix DD Wind Impact Assessment

SSD-10441 Amending Concept DA

State Significant Development
Development Application

Prepared for **WL Developer Pty Ltd**

30 September 2020

Reference	Description
Applicable SSD Applications	SSD-10441 Amending Concept DA
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1. Glossary and abbreviations

Reference	Description
ACHAR	Aboriginal Cultural Heritage Assessment Report
ADG	Apartment Design Guide
AHD	Australian height datum
AQIA	Air Quality Impact Assessment
BC Act	Biodiversity Conservation Act 2016
BCA	Building Code of Australia
BC Reg	Biodiversity Conservation Regulation 2017
BDAR	Biodiversity Development Assessment Report
CEEC	critically endangered ecological community
CIV	capital investment value
CMP	Construction Management Plan
Concept DA	A concept DA is a staged application often referred to as a 'Stage 1' DA. The subject application constitutes a detailed subsequent stage application to an approved concept DA (SSD 9393) lodged under section 4.22 of the EP&A Act.
Council	City of Sydney Council
CPTED	Crime Prevention Through Environmental Design
CSSI approval	critical State significant infrastructure approval
CTMP	Construction Traffic Management Plan
DA	development application
DPIE	NSW Department of Planning, Industry and Environment
DRP	Design Review Panel
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	NSW Environment Protection Authority
EPA Regulation	Environmental Planning and Assessment Regulation 2000
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999

Reference	Description
ESD	ecologically sustainable design
GANSW	NSW Government Architect's Office
GFA	gross floor area
HIA	Heritage Impact Assessment
IAP	Interchange Access Plan
LGA	Local Government Area
NCC	National Construction Code
OSD	over station development
PIR	Preferred Infrastructure Report
POM	Plan of Management
PSI	Preliminary Site Investigation
RMS	Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEPP 55	State Environmental Planning Policy No 55—Remediation of Land
SEPP 65	State Environmental Planning Policy No. 65 – Design Quality of Residential Apartment Development
SRD SEPP	State Environmental Planning Policy (State and Regional Development) 2009
SREP Sydney Harbour	State Regional Environmental Plan (Sydney Harbour Catchment) 2005
SSD	State significant development
SSD DA	State significant development application
SLEP	Sydney Local Environmental Plan 2012
Transport for NSW	Transport for New South Wales
TIA	Traffic Impact Assessment

Reference	Description
The proposal	The proposed development which is the subject of the detailed SSD DA
The site	The site which is the subject of the detailed SSD DA
VIA	Visual Impact Assessment
WMQ	Waterloo Metro Quarter
WMP	Waste Management Plan
WSUD	water sensitive urban design

2. Executive summary

This report has been prepared by RWDI Anemos Ltd. (RWDI) to accompany a concept State significant development (SSD) development application (DA) for the Waterloo Metro Quarter over station development (OSD). This concept SSD DA is submitted as an 'amending DA', that modifies the previously approved concept SSD DA issued for the site (SSD 9393). The modifications contained within the amending DA relate to the northern precinct and central building only. No change is proposed to the original concept SSD DA as it relates to the southern precinct of the Waterloo Metro Quarter site.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the amending concept SSD DA (SSD 10441).

This report concludes that the proposed amending concept DA for the Waterloo Metro Quarter OSD is suitable and warrants approval subject to the implementation of the following mitigation measures:

- Consideration for the inclusion of awning elements around the perimeter of the site, primarily near corners of the development.
- Consideration for landscaping in the public domain. Consideration and allowance will need to be made for conditions while these trees mature.

Following implementation of the above mitigation measures, the remaining impacts are appropriate.

3. Introduction

This report has been prepared to accompany a concept SSD DA for the over station development (OSD) at the Waterloo Metro Quarter site. The concept DA seeks consent for an amended building envelope and description of development for the northern precinct and central building of the Waterloo Quarter site approved under SSD 9393. For clarity, this concept DA (formerly referred to as a 'Stage 1' DA) is made under Section 4.22 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Minister for Planning, or their delegate, is the consent authority for the SSD DA and this application is lodged with the NSW Department of Planning, Industry and Environment (DPIE) for assessment.

The concept DA seeks to modify the approved building envelope for the northern precinct (previously comprising 'Building A', 'Building B', 'Building C' and 'Building D' under SSD 9393) through:

- increasing the maximum building height for the southern portion of the building envelope from RL56.2 to RL72.60
- removing the 'tower component' of the northern precinct, reducing the overall height of the tower envelope from RL116.9 to RL90.40, to enable the redistribution of floor space to commercial office floor plates
- amending the description of development to refer to a mid-rise (approximately 17 storey) commercial office building, comprising approximately 34,125sqm of commercial office floor space within the northern portion of the site, rather than a third residential tower.

The concept DA seeks to modify the central building approved building envelope (previously comprising 'Building E' under SSD 9393) through:

- modifying the eastern extent of the podium envelope.

This proposal will not exceed the permissible building height for the site under the Sydney Local Environmental Plan 2012 (SLEP) or the maximum height approved under SSD 9393. Separate detailed SSD DA (s) will be lodged concurrently for the detailed design, construction and operation of the northern precinct and central building. No changes are proposed to the original concept DA as it relates to the southern precinct.

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 9 April 2020 and issued for the detailed SSD DA. Specifically, this report has been prepared to respond to the SEARs requirements summarised below.

Item	Description of Requirement	Section Reference (this report)
22 Visual and Amenity Impacts	provide a revised wind analysis report outlining any changes arising from the amended envelope to wind flow and wind impacts, in particularly any impacts to existing and proposed public domain areas and open space.	7, 8, 9, 10, 11

Table 1 - SEARs Requirements

4. The site

The site is located within the City of Sydney Local Government Area (LGA). The site is situated approximately 3.3 kilometres south of Sydney CBD and approximately 8 kilometres northeast of Sydney International Airport within the suburb of Waterloo.

The Waterloo Metro Quarter site comprises land to the west of Cope Street, east of Botany Road, south of Raglan Street and north of Wellington Street (refer to Figure 1). The heritage listed Waterloo Congregational Church located at 103–105 Botany Road is within this street block but does not form a part of the Waterloo Metro Quarter Site boundaries.

The Waterloo Metro Quarter site (the site) is a rectangular shaped allotment and an overall site area of approximately 1.287 hectares.

The Waterloo Metro Quarter site comprises the following allotments and legal description at the date of this report. Following consolidation by Sydney Metro (the Principal) the land will be set out in deposited plan DP1257150.

- 1368 Raglan Street (Lot 4 DP 215751)
- 59 Botany Road (Lot 5 DP 215751)
- 65 Botany Road (Lot 1 DP 814205)
- 67 Botany Road (Lot 1 DP 228641)
- 124–128 Cope Street (Lot 2 DP 228641)
- 69–83 Botany Road (Lot 1, DP 1084919)
- 130–134 Cope Street (Lot 12 DP 399757)
- 136–144 Cope Street (Lots A-E DP 108312)
- 85 Botany Road (Lot 1 DP 27454)
- 87 Botany Road (Lot 2 DP 27454)
- 89–91 Botany Road (Lot 1 DP 996765)
- 93–101 Botany Road (Lot 1 DP 433969 and Lot 1 DP 738891)
- 119 Botany Road (Lot 1 DP 205942 and Lot 1 DP 436831)
- 156–160 Cope Street (Lot 31 DP 805384)
- 107–117A Botany Road (Lot 32 DP 805384 and Lot A DP 408116)
- 170–174 Cope Street (Lot 2 DP 205942).

The boundaries of the site the subject of the amending concept DA is identified at Figure 5.1. The site is reasonably flat with a slight fall to the south.

The site previously included three to five storey commercial, light industrial and shop top housing buildings. All previous structures except for an office building at the corner of Botany Road and Wellington Street have been demolished to facilitate construction of the new Sydney Metro Waterloo station. As such the existing site is predominately vacant and being used as a construction site.

Construction of the Sydney metro is currently underway on site in accordance with critical State significant infrastructure approval (CSSI 7400).

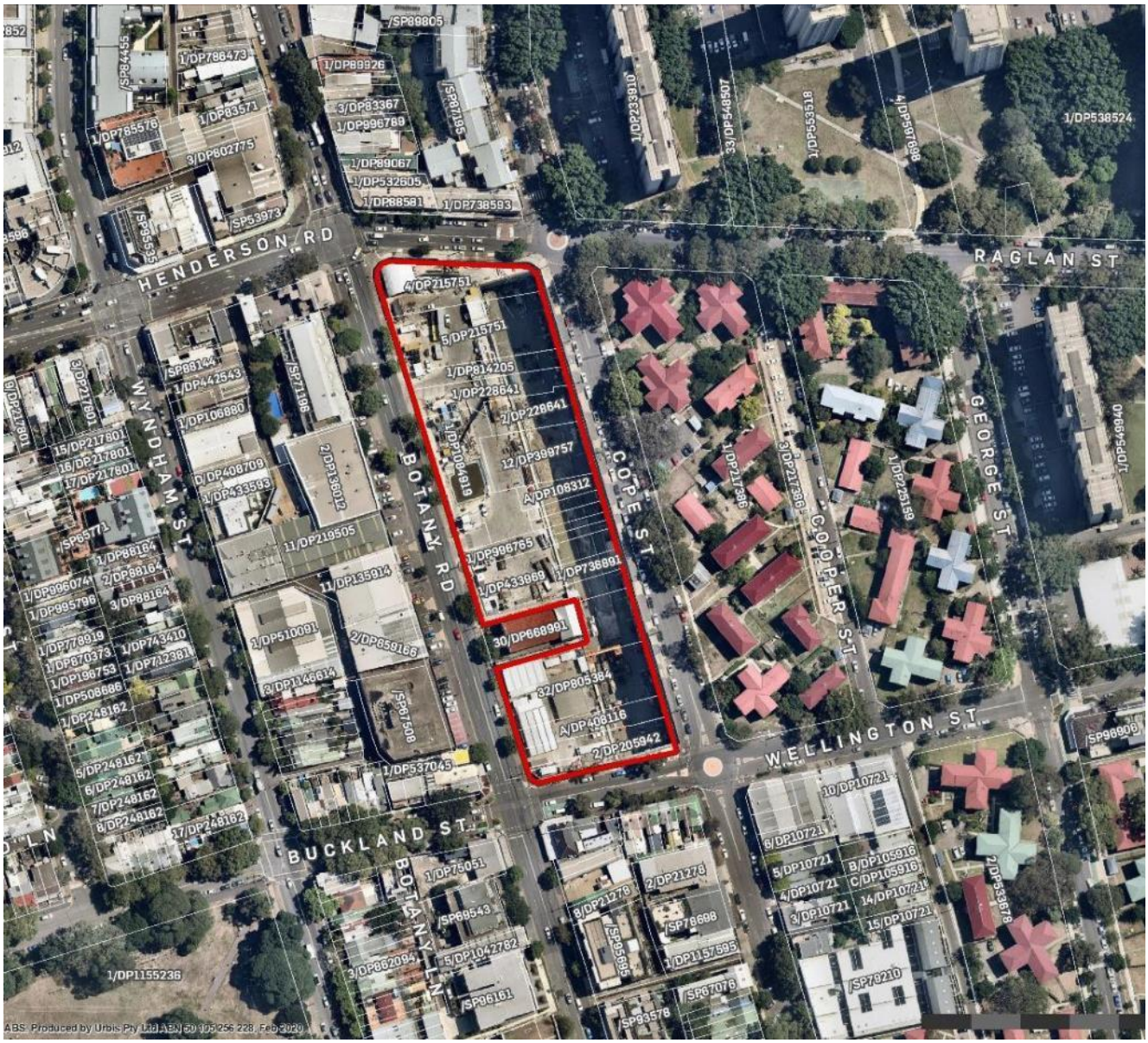


Figure 1 - Aerial of the site
Source: Urbis

The area surrounding the site consists of commercial premises to the north, light industrial and mixed-use development to the south, residential development to the east and predominantly commercial and light industry uses to the west.

5. Background

5.1 About Sydney Metro

Sydney metro is Australia's biggest public transport project. Services started in May 2019 in the city's North-west with a train every four minutes in the peak. A new standalone railway, this 21st century network will revolutionise the way Sydney travels. There are four core components:

5.1.1 Sydney Metro North West

This project is now complete and passenger services commenced in May 2019 between Rouse Hill and Chatswood, with a metro train every four minutes in the peak. The project was delivered on time and $1 billion under budget.

5.1.2 Sydney Metro City & Southwest

Sydney Metro City & Southwest project includes a new 30km metro line extending metro rail from the end of Metro Northwest at Chatswood, under Sydney Harbour, through new CBD stations and southwest to Bankstown. It is due to open in 2024 with the ultimate capacity to run a metro train every two minutes each way through the centre of Sydney.

Sydney Metro City & Southwest will deliver new metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, Waterloo and new underground metro platforms at Central Station. In addition, it will upgrade and convert all 11 stations between Sydenham and Bankstown to metro standards.

5.1.3 Sydney Metro West

Sydney Metro West is a new underground railway connecting Greater Parramatta and the Sydney CBD. This once-in-a-century infrastructure investment will transform Sydney for generations to come, doubling rail capacity between these two areas, linking new communities to rail services and supporting employment growth and housing supply between the two CBDs.

The locations of seven proposed metro stations have been confirmed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays.

The NSW Government is assessing an optional station at Pyrmont and further planning is underway to determine the location of a new metro station in the Sydney CBD.

5.1.4 Sydney Metro Greater West

Metro rail will also service Greater Western Sydney and the new Western Sydney International (Nancy Bird Walton) Airport. The new railway line will become the transport spine for the Western Parkland City's growth for generations to come, connecting communities and travellers with the rest of Sydney's public transport system with a fast, safe and easy metro service. The Australian and NSW governments are equal partners in the delivery of this new railway.

The Sydney Metro project is illustrated in Figure 2.

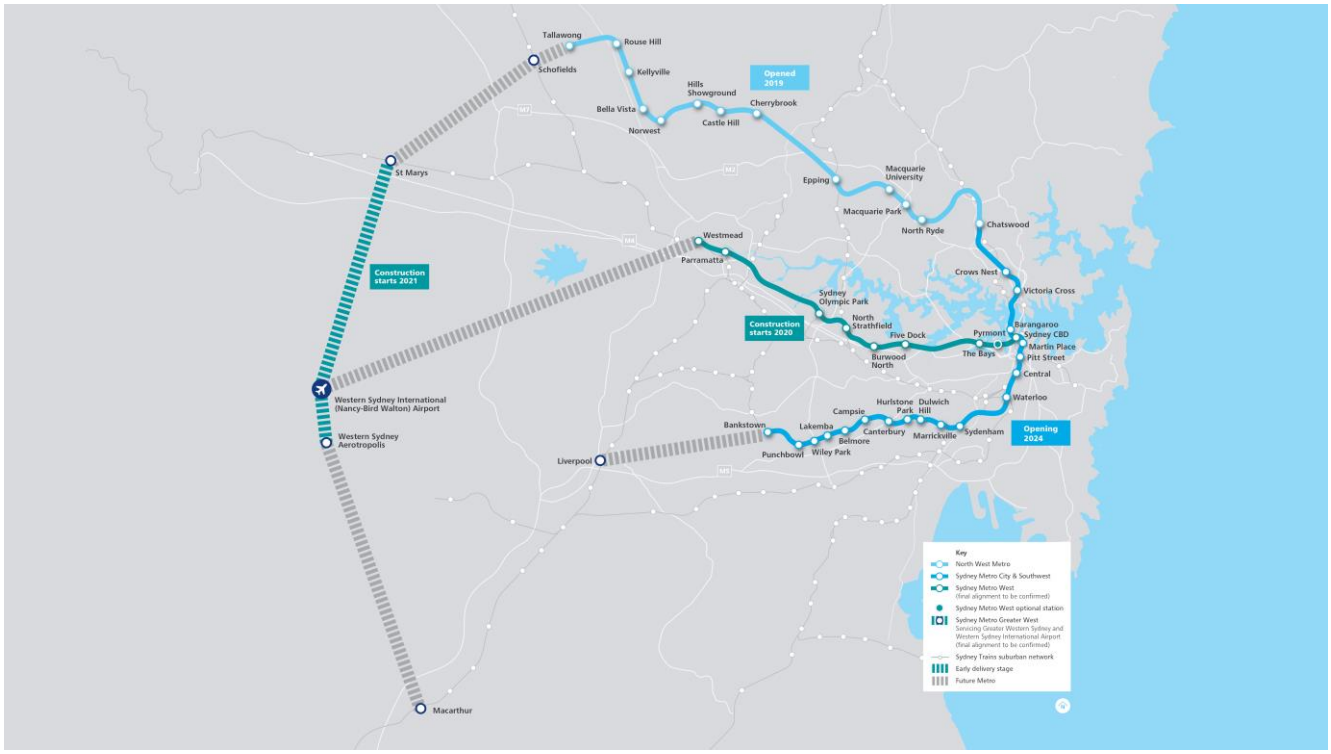


Figure 2 - Sydney Metro alignment map
Source: Sydney Metro

5.2 Sydney Metro CSSI Approval (SSI 7400)

On 9 January 2017, the Minister for Planning approved the Sydney Metro City & Southwest - Chatswood to Sydenham project as a critical State significant infrastructure (CSSI) project (reference SSI 7400) (CSSI approval). The terms of the CSSI approval includes all works required to construct the Sydney Metro Waterloo Station. The CSSI approval also includes the construction of below and above ground works within the metro station structure for appropriate integration with the OSD.

With regards to CSSI related works, any changes to the 'metro station box' envelope and public domain will be pursued in satisfaction of the CSSI conditions of approval and do not form part of the scope of the concept SSD DA or detailed SSD DA for the OSD.

Except to the extent described in the EIS or Preferred Infrastructure Report (PIR) submitted with the CSSI application, any OSD buildings and uses do not form part of the CSSI approval and will be subject to the relevant assessment pathway prescribed by the EP&A Act.

The delineation between the approved Sydney metro works, generally described as within the two 'metro station boxes' and surrounding public domain works, and the OSD elements are illustrated in Figure 3.

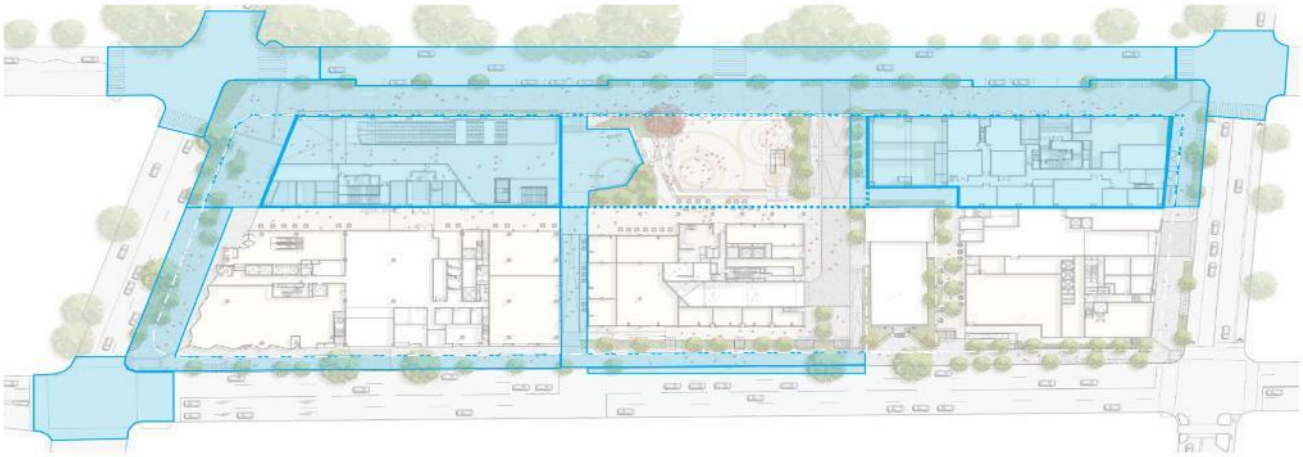


Figure 3 - CSSI Approval scope of works
Source: WL Developer Pty Ltd

5.3 Concept Approval (SSD 9393)

As per the requirements of clause 7.20 of the *Sydney Local Environmental Plan 2012* (SLEP), as the OSD exceeds a height of 25 metres above ground level (among other triggers), development consent is first required to be issued in a concept DA (formerly known as Stage 1 DA).

Development consent was granted on 10 December 2019 for the concept SSD DA (SSD 9393) for the Waterloo Metro Quarter OSD including:

- a maximum building envelope for podium, mid-rise and tower buildings
- a maximum gross floor area of 68,750sqm, excluding station floor space
- conceptual land use for non-residential and residential floor space
- minimum 12,000sqm of non-residential gross floor area including a minimum of 2,000sqm of community facilities
- minimum 5% residential gross floor area as affordable housing dwellings
- 70 social housing dwellings
- basement car parking, motorcycle parking, bicycle parking, and service vehicle spaces.

This concept DA has been prepared and submitted to the DPIE and proposes to make modifications to the approved building envelopes at the northern precinct and central building. This amending concept SSD DA does not impact the proposed development within the southern precinct.

A concurrent detailed SSD DA will seek development consent for the OSD located within the southern precinct of the site, consistent with the parameters of the original concept approval. Separate SSD DAs have been prepared and will be submitted for the northern precinct, central building, and basement proposed across the Waterloo Metro Quarter site consistent with the amending concept DA.

6. Proposed development

The amending concept DA seeks consent for an amended building envelope and description of development for the northern precinct of the Waterloo Metro Quarter site approved under SSD 9393. Specifically, the proposal seeks to modify the approved building envelope for the northern precinct (previously comprising 'Building A', 'Building B', 'Building C' and 'Building D' under SSD 9393) through:

- increasing the maximum building height for the southern portion of the Northern Precinct from RL56.2 to RL72.60
- removing the 'tower component' of the Northern Precinct, reducing the overall height of the tower envelope from RL116.9 to RL90.40, to enable the redistribution of floor space to commercial office floor plates
- amending the description of development to refer to a mid-rise (approximately 17 storey) commercial office building, comprising approximately 34,125sqm of commercial office floor space within the northern portion of the site, rather than a third residential tower.

The concept DA seeks to modify the central building approved building envelope (previously comprising 'Building E' under SSD 9393) through:

- modifying the eastern extent of the podium envelope.

The modification of the approved concept SSD DA will enable the detailed design of a new commercial building (comprising office and retail premises) to be pursued on the site, significantly increasing the proportion of employment generating floor space on the Waterloo Metro Quarter site. This new commercial building is proposed in replacement of four building envelopes approved under SSD 9393, which comprised one residential tower, and three mid-rise residential buildings.

This proposal will not exceed the permissible building height for the site under the SLEP or the maximum height approved under SSD 9393. As noted above, separate detailed SSD DA(s) will be lodged concurrently for the detailed design, construction and operation of the northern precinct, and central building.

This amending concept DA does not propose to the amend the original concept approval as it relates to the southern precinct.

7. Methodology and Approach

A wind tunnel study has been undertaken to understand any changes to the wind environment conditions for the pedestrian accessible areas within and around the subject site associated with the amended envelop of the proposed development.

This assessment has been provided to support the proposed amendment to the Approved Concept Envelope (the Amended Concept Envelope - and subject of this DA). To ascertain the ultimate wind conditions, a detailed scheme that is wholly contained within the proposed amended envelope (Proposed Detailed Scheme) has been assessed to demonstrate the ability for a detailed scheme to comply with the WMQ Design and Amenity Guidelines. The onus will remain on the Detailed Applications to demonstrate achievement of overall the compliance.

This quantitative assessment has been based on a review of the wind tunnel studies previously undertaken for the approved Reference Design Scheme and wind tunnel testing undertaken by RWDI for the amended envelope in one of RWDI's boundary-layer wind tunnels. The wind tunnel measurements were combined with the local wind records and compared to the wind comfort criteria required for the precinct. The assessment is focused on the effects of the amended envelope on the wind comfort conditions around the site and the ability for the amended envelope to achieve comfort conditions and safety limit wind speeds for critical pedestrian areas, public sidewalks and elevated terrace areas.

7.1 Approved DA Envelope Design Scheme

The Approved DA Envelope design scheme is noted in Figure 4 below. The Approved DA Envelope Scheme notes the tower forms in largely square plan shapes with the three main tower forms at the northern, central and southern portions of the site. This design is slightly different to the Reference Concept Scheme hence a direct comparison with the previously submitted wind tunnel results is not possible. While the submitted Amended Wind Report is somewhat closer to this massing scheme it is noted that the through site linked between Cope Street Plaza and Botany Road has been blocked by two significant baffle screens at either end of the laneway and also includes awning elements. These features will have a notable effect on the ground plane wind conditions. As such some comparison can be made to the original submitted Wind Report for the Reference Scheme. A summary of the results as presented in that report are discussed in the results section for reference.

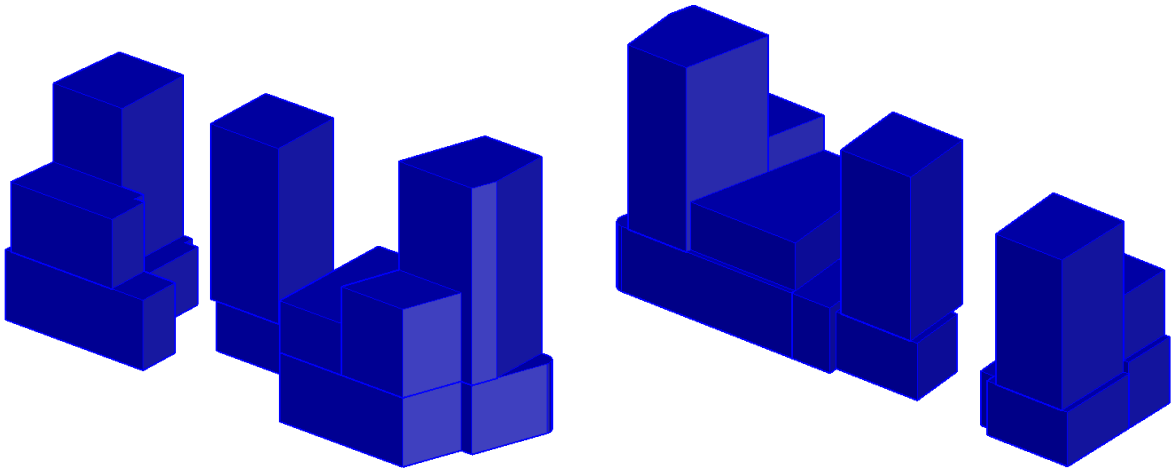


Figure 4 – Approved DA Envelope Design Scheme – View from North-East (Left) and South-West (right)

7.2 Wind Tunnel Study Model of Amended Envelope

To assess the wind environment conditions a reference scheme contained within the Amended Envelope of the development has been tested in the wind tunnel. A 1:400 scale model of the project site and surroundings was constructed to be used for the wind tunnel tests.

The wind tunnel model included all relevant surrounding buildings and topography within an approximately 480 m radius of the study site. The upstream wind and turbulence profiles in the atmospheric boundary layer beyond the modelled area were also simulated in RWDI's wind tunnel. The wind tunnel model was instrumented with 114 specially designed wind speed sensors to measure mean and gust speeds at a full-scale height of approximately 1.5 m above local grade in pedestrian areas and on terraces within and around the study site. Wind speeds were measured for 36 directions in 10-degree increments. The measurements at each sensor location were recorded in the form of ratios of local mean and gust speeds to the mean wind speed at a reference height above the model. The placement of wind measurement locations was based on our experience and understanding of the pedestrian usage for this site. Images of the Amended Envelope is presented in Figure 5 with photos of the wind tunnel model noted in Appendix 1.

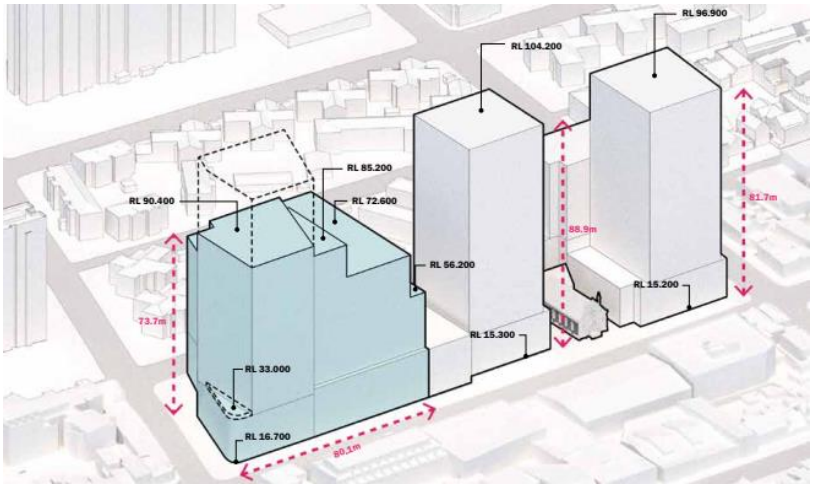
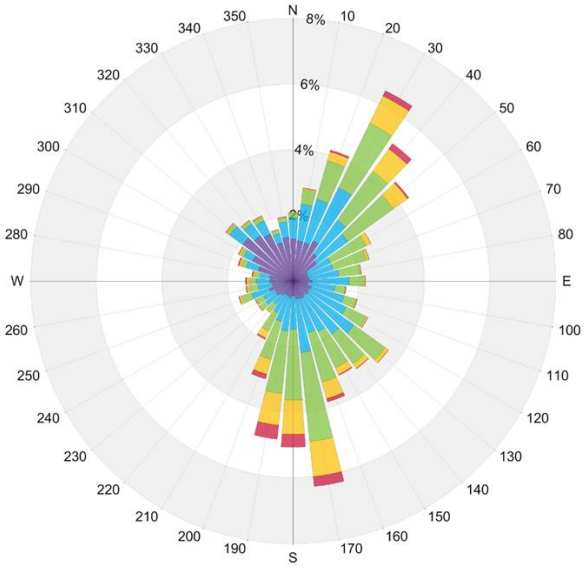


Figure 5 – Amended Envelope Design Scheme

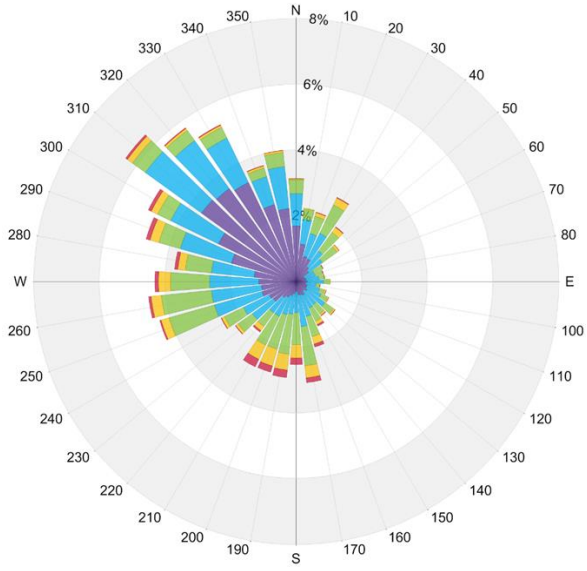
7.3 Meteorological Data

Wind statistics recorded at Sydney International Airport between 1995 and 2019, inclusive, were analysed for the Summer (November through April) and Winter (May through October) seasons. Figure 6 graphically depicts the directional distributions of wind frequencies and speeds for these two seasons. Winds from the northeast, south-southeast and south are predominant in the summer season, and winds from the west and northwest directions are predominant in the winter season as indicated by the wind roses. Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) occur for 10.6% and 8% of the time during the summer and winter seasons, respectively, and are predominantly from the southern directions in both seasons. Strong winds from the northeast are also common in the summer.

Wind statistics were combined with the wind tunnel data to predict the frequency of occurrence of full-scale wind speeds. The full-scale wind predictions were then compared with the wind criteria for pedestrian comfort and safety.



Summer (November – April)



Winter (May – October)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	0.3	0.2
1-10	30.1	38.1
11-20	30.3	31.9
21-30	28.6	21.8
31-40	8.5	6.0
>40	2.1	2.0

Figure 6 – Directional Distribution of Winds Approaching Sydney International Airport from 1995 to 2019

7.4 Pedestrian Wind Criteria

The pedestrian wind comfort and safety conditions are accessed based on the Lawson Criteria. In general, the combined effect of mean and gust speeds on pedestrian comfort can be quantified by a Gust Equivalent Mean (GEM).

Comfort Category	Mean/GEM Wind Speed (m/s)	Description
Pedestrian Sitting	≤ 4	Low wind speed where, for example, one could read a newspaper without having it blown away
Pedestrian Standing	≤ 6	Comfortable for standing for a short time of exposure at main building entrances, bus stops, and other places
Pedestrian Walking	≤ 8	Wind speeds that would be acceptable for window shopping or strolling along a downtown street
Notes: (1) GEM wind speed = gust speed / 1.85; and, (2) GEM wind speeds listed above are based on an exceedance of 5% of the time.		
Safety Criterion	**Gust Wind Speed (m/s)**	**Description**
Wind Safety Standard	> 24	Excessive gust speeds that can adversely affect a pedestrian's balance and footing.
Notes: (1) Based on an annual exceedance of 0.1% of the time.		

Table 2 - Pedestrian Wind Comfort Criteria

Based on the Development Consent approval for SSD8875, the wind conditions associated with the subject development are required to meet the comfort categories prescribed in the Lawson Criteria in the areas shown in Figure 7.

Figure 7 – Wind Comfort and Safety Targets for the Ground Level areas

7.4.1 Sydney Metro Entrance

Furthermore, requirements are noted by Sydney Metro with regards to anything that will or is likely to result in the Station Project Works, or any part of the Station Project Works, or the carrying out of the Station Project Works (whether on their won or combined with the MQD or the carrying out of the MQD Works), being unable to comply with the requirement set out below (Metro Impact):

Part A – Metro Impact Requirements notes in Table 1, under General Requirements, the following

Metro Impact Requirement
Wind effects in relation to Lawson Comfort Criteria for Business Walking Criteria (C1) at the station Entrance (note: Lawson Comfort Criteria are based on exceedance of the threshold wind speed occurring 5% of the time)

Table 3 - General Requirements for Metro Station Impacts

8. Results and Discussion

A comparison has been undertaken to understand the expected conditions with regards to the Amended Design Envelope Scheme for the Waterloo Metro Quarter. This comparison has focused on the massing envelope for the precinct with an aim to establish a more favourable starting position for wind comfort through the built form, prior to consideration for wind mitigation measures such as awnings, landscaping etc.

8.1 Approved DA Envelope Scheme

The wind conditions associated with the Approved DA Envelope has been considered for the massing envelope presented in the original submitted wind report for the precinct. This model had considered the wind conditions without consideration of awnings around the site and also detailed an open through site link between Cope Street Plaza and Botany Road. The Amended Wind Report included baffle screens in this through-site link which changed the noted flow patterns associated with the through site link, Cope Street Plaza and nearby areas on Botany Road.

The wind tunnel results, which have been interpreted from the data available, indicate that the majority of the areas satisfy either the standing (green) or walking (yellow) criteria for pedestrian comfort. Localised areas of uncomfortable wind conditions are noted at the four corners of the site, noted to be due to localised downwash and side-stream effects.

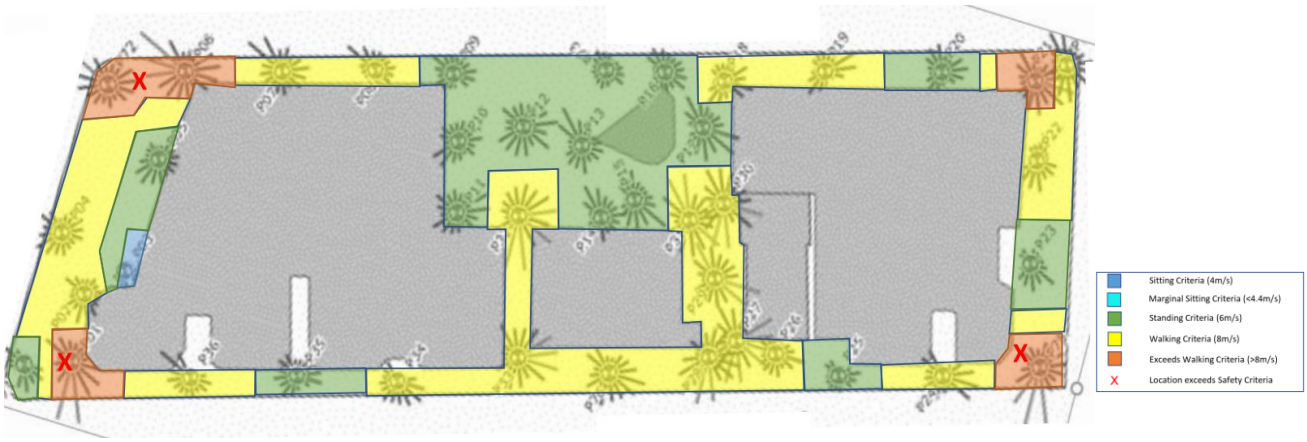


Figure 8 – Summary of Approved Reference Design Scheme Wind Tunnel Results

While a number of these areas didn't satisfy the wind comfort conditions, it was noted that mitigation measures could be included to improve these areas. In the Amended Wind Report that a number of these localised wind conditions could be improved through the inclusion of the following:

- Baffle Screens at either end of the east-west through site link between Cope Street Plaza and Botany Road.
- Awning Elements around the perimeter of the development to minimise downwash at the corner locations.

The inclusion of mature dense landscaping was also required throughout the precinct to be able to achieve the wind comfort criteria outlined in Section 8.4. This would not be the case at the time of planting hence as number of these locations would not meet the requirement at the early stages of the development.

8.2 Amended Concept Envelope Scheme

The wind tunnel study for the Amended Design Envelope scheme has been undertaken by RWDI to determine the wind comfort conditions associated with the updated massing scheme for the development. The Amended Design Envelope also includes two laneways off Cope Street Plaza one to the north (to Raglan Street) and one west (to Botany Road) to enable greater connectivity to the Metro Station in accordance with the Waterloo Metro Quarter Design and Amenity Guidelines document for the precinct. The guideline notes requires that the wind conditions within and around the precinct should be first addressed through built form changes where possible, with the inclusion of awnings and landscaping to be considered as secondary approach to address wind conditions.

The wind tunnel study was undertaken without the consideration for any awnings around the precinct or the inclusion of any landscaping elements. This enables a clear understanding of the wind flow patterns around the precinct associated with the overall built form of the Amended Design Envelope proposed. The results of the wind tunnel study with regards to wind comfort conditions are presented in Figure 9 below. Table 4 provides a breakdown in terms of the percentage of the time that the wind comfort criteria for Sitting, Standing and Walking is achieved throughout the year for each location.

Wind conditions throughout the precinct are generally governed by the prevailing north-easterly, southerly and westerly winds for the region. Wind conditions within the laneway connections from Cope Street Plaza to Botany Road to the west and Raglan Street to the north are due to pressure driven funnelling of the prevailing winds. Cope Street Plaza is currently exposed to the southerly winds due to the alignment and exposure of the Plaza upstream (around the eastern aspect of Building 4), and the north-easterly winds across the Plaza and between Building 2 and 3. The final landscaping design for the Plaza will be important in assisting to reduce the wind conditions for this area.

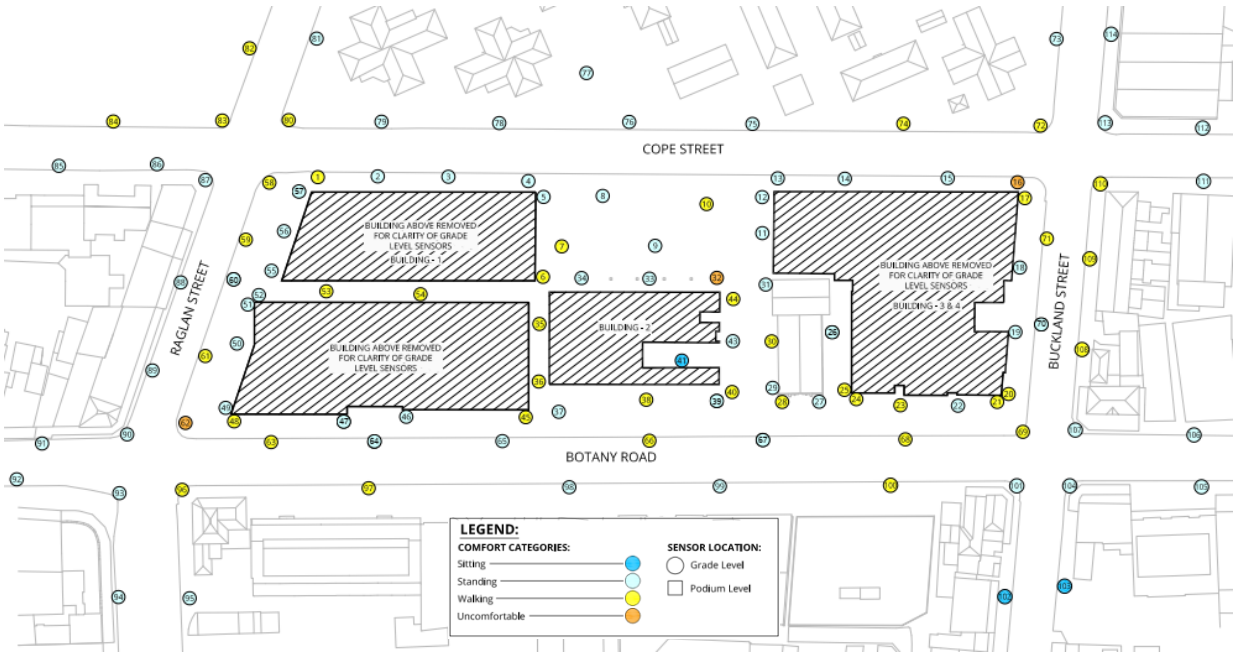


Figure 9 – Summary of Amended Design Scheme Wind Tunnel Results

As detailed in Table 4, the three locations noted in Figure 9 which are detailed as Uncomfortable, satisfy the Walking Comfort Criteria 94% of the time, hence is a marginal exceedance at this stage of massing design.

Noting the current wind conditions within and around the site, it is expected that the wind conditions will be further enhanced with the inclusion of façade articulation in the design, awning elements and landscaping throughout the precinct. This has been further investigated and included in the Detailed Development Application Reports.

The wind conditions within and around the precinct associated with the proposed built form scheme tested (Proposed Detailed Scheme) are found to be better than or similar to the wind conditions of the built form scheme contained within the Approved DA Envelope (Reference Scheme).

It is important to note that while the Design Guidelines note the requirement for laneway connections to the surrounding streets from the Metro Station, this may compromise the ability for the design scheme to achieve the wind comfort criteria in all areas including the laneways and Cope Street Plaza. Previous testing had indicated a need for significant baffling to block the laneways to help achieve these comfort conditions; as such, a balance between the connectivity of the development to the surrounding areas and the wind comfort conditions will need to be considered.

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
1	Amended Design	Annual	69	91	97	Walking	20.9	Pass
2	Amended Design	Annual	82	97	100	Standing	17.8	Pass
3	Amended Design	Annual	86	99	100	Standing	15.1	Pass
4	Amended Design	Annual	82	98	100	Standing	16.4	Pass
5	Amended Design	Annual	84	99	100	Standing	16.1	Pass
6	Amended Design	Annual	78	90	96	Walking	22.3	Pass
7	Amended Design	Annual	78	92	98	Walking	21.5	Pass
8	Amended Design	Annual	82	98	100	Standing	15.8	Pass
9	Amended Design	Annual	82	98	100	Standing	17.5	Pass
10	Amended Design	Annual	73	91	98	Waking	21.2	Pass
11	Amended Design	Annual	83	97	100	Standing	17.9	Pass
12	Amended Design	Annual	89	100	100	Standing	13.9	Pass
13	Amended Design	Annual	85	99	100	Standing	14.3	Pass
14	Amended Design	Annual	88	100	100	Standing	14.4	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
15	Amended Design	Annual	83	98	100	Standing	16.5	Pass
16	Amended Design	Annual	69	86	94	Uncomfortable	22.7	Pass
17	Amended Design	Annual	81	94	99	Walking	19.7	Pass
18	Amended Design	Annual	87	97	100	Standing	17.8	Pass
19	Amended Design	Annual	87	98	100	Standing	17.8	Pass
20	Amended Design	Annual	73	91	98	Walking	21.5	Pass
21	Amended Design	Annual	74	91	97	Walking	22.3	Pass
22	Amended Design	Annual	86	99	100	Standing	15.1	Pass
23	Amended Design	Annual	74	93	99	Walking	19.9	Pass
24	Amended Design	Annual	74	94	99	Walking	18.9	Pass
25	Amended Design	Annual	68	88	96	Walking	22.6	Pass
26	Amended Design	Annual	79	95	99	Standing	17.5	Pass
27	Amended Design	Annual	86	98	100	Standing	16.4	Pass
28	Amended Design	Annual	76	95	99	Standing	18.9	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
29	Amended Design	Annual	75	96	100	Standing	16.9	Pass
30	Amended Design	Annual	74	94	98	Walking	23.6	Pass
31	Amended Design	Annual	77	96	100	Standing	17.6	Pass
32	Amended Design	Annual	72	88	94	Uncomfortable	22.1	Pass
33	Amended Design	Annual	92	100	100	Standing	13.3	Pass
34	Amended Design	Annual	90	100	100	Standing	13	Pass
35	Amended Design	Annual	76	90	97	Walking	20.6	Pass
36	Amended Design	Annual	73	89	95	Walking	21.8	Pass
37	Amended Design	Annual	79	96	100	Standing	17.9	Pass
38	Amended Design	Annual	78	95	99	Standing	19.5	Pass
39	Amended Design	Annual	78	95	99	Standing	21.7	Pass
40	Amended Design	Annual	75	92	97	Walking	24.5	Exceeds
41	Amended Design	Annual	100	100	100	Sitting	5.3	Pass
43	Amended Design	Annual	78	96	100	Standing	17.7	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
44	Amended Design	Annual	64	88	97	Walking	20.2	Pass
45	Amended Design	Annual	76	94	99	Walking	19.4	Pass
46	Amended Design	Annual	84	98	100	Standing	16.3	Pass
47	Amended Design	Annual	78	95	100	Standing	17.8	Pass
48	Amended Design	Annual	69	88	97	Walking	21	Pass
49	Amended Design	Annual	87	98	100	Standing	16.2	Pass
50	Amended Design	Annual	91	98	100	Standing	18.3	Pass
51	Amended Design	Annual	84	98	100	Standing	17.4	Pass
52	Amended Design	Annual	89	98	100	Standing	19.5	Pass
53	Amended Design	Annual	79	93	97	Walking	20	Pass
54	Amended Design	Annual	75	92	97	Walking	20.8	Pass
55	Amended Design	Annual	92	98	100	Standing	17.7	Pass
56	Amended Design	Annual	88	99	100	Standing	15.5	Pass
57	Amended Design	Annual	72	95	99	Standing	17.4	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
58	Amended Design	Annual	68	92	99	Walking	18.8	Pass
59	Amended Design	Annual	79	94	99	Walking	19.2	Pass
60	Amended Design	Annual	82	95	99	Standing	20	Pass
61	Amended Design	Annual	81	94	99	Walking	21.1	Pass
62	Amended Design	Annual	66	85	94	Uncomfortable	21.7	Pass
63	Amended Design	Annual	71	90	98	Walking	19.3	Pass
64	Amended Design	Annual	75	95	100	Standing	17.6	Pass
65	Amended Design	Annual	78	96	100	Standing	18.8	Pass
66	Amended Design	Annual	72	94	99	Walking	19.1	Pass
67	Amended Design	Annual	75	95	99	Standing	19.4	Pass
68	Amended Design	Annual	71	92	98	Walking	20.4	Pass
69	Amended Design	Annual	67	89	97	Walking	20.7	Pass
70	Amended Design	Annual	79	95	99	Standing	20.2	Pass
71	Amended Design	Annual	76	93	98	Walking	21.3	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
72	Amended Design	Annual	72	92	99	Walking	19.2	Pass
73	Amended Design	Annual	81	96	100	Standing	18.9	Pass
74	Amended Design	Annual	77	94	99	Walking	19.8	Pass
75	Amended Design	Annual	85	99	100	Standing	15.1	Pass
76	Amended Design	Annual	78	96	100	Standing	18.1	Pass
77	Amended Design	Annual	92	100	100	Standing	13.4	Pass
78	Amended Design	Annual	80	98	100	Standing	15.6	Pass
79	Amended Design	Annual	80	96	99	Standing	18	Pass
80	Amended Design	Annual	72	92	98	Walking	20.9	Pass
81	Amended Design	Annual	80	96	99	Standing	20.4	Pass
82	Amended Design	Annual	71	92	97	Walking	22.3	Pass
83	Amended Design	Annual	71	93	99	Walking	21.3	Pass
84	Amended Design	Annual	68	91	97	Walking	22.6	Pass
85	Amended Design	Annual	81	97	100	Standing	16.3	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
86	Amended Design	Annual	87	99	100	Standing	13.9	Pass
87	Amended Design	Annual	85	99	100	Standing	15	Pass
88	Amended Design	Annual	80	96	99	Standing	19.9	Pass
89	Amended Design	Annual	77	96	100	Standing	17.2	Pass
90	Amended Design	Annual	80	96	100	Standing	19.3	Pass
91	Amended Design	Annual	88	99	100	Standing	15.4	Pass
92	Amended Design	Annual	88	100	100	Standing	13.8	Pass
93	Amended Design	Annual	77	96	100	Standing	15.4	Pass
94	Amended Design	Annual	88	100	100	Standing	14.9	Pass
95	Amended Design	Annual	89	100	100	Standing	14.9	Pass
96	Amended Design	Annual	77	94	99	Walking	19.3	Pass
97	Amended Design	Annual	73	92	98	Walking	20.2	Pass
98	Amended Design	Annual	79	97	100	Standing	17.3	Pass
99	Amended Design	Annual	78	97	100	Standing	17.2	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
100	Amended Design	Annual	73	95	100	Standing	18.2	Pass
101	Amended Design	Annual	82	98	100	Standing	17	Pass
102	Amended Design	Annual	97	100	100	Sitting	10.8	Pass
103	Amended Design	Annual	95	100	100	Sitting	13.1	Pass
104	Amended Design	Annual	89	100	100	Standing	13.6	Pass
105	Amended Design	Annual	93	100	100	Standing	12.4	Pass
106	Amended Design	Annual	91	100	100	Standing	13.9	Pass
107	Amended Design	Annual	79	97	100	Standing	18.2	Pass
108	Amended Design	Annual	78	94	98	Walking	20	Pass
109	Amended Design	Annual	72	91	98	Walking	22.8	Pass
110	Amended Design	Annual	74	94	99	Walking	19.7	Pass
111	Amended Design	Annual	90	100	100	Standing	14.1	Pass
112	Amended Design	Annual	90	100	100	Standing	13.7	Pass
113	Amended Design	Annual	81	98	100	Standing	16.2	Pass

Wind Comfort Criteria			Sitting	Standing	Walking	Rating	Wind Safety	
GEM Wind Speed (m/s)			0-4	0-6	0-8		Gust Speed (>24m/s)	
% of Time			≥95%	≥95%	≥95%			
Location	Configuration	Season	%	%	%		m/s	Rating
114	Amended Design	Annual	86	99	100	Standing	14.9	Pass

Table 4 - Occurrence Frequencies of Predicted Wind Speeds

9. Mitigation measures

The Amended Design Envelope Scheme built form is noted to enable conditions which are an improvement from the initial massing scheme for the site. However, there were found to be areas which currently do not satisfy the wind comfort criteria outlined in Section 8.4 for pedestrian wind comfort conditions. This has been observed to be due to localised ground level wind effects around the site. Noting the current wind conditions for the Amended Design Envelope, these wind conditions are expected to be further improved with the consideration for the following:

- Awning elements around the perimeter of the site to minimise localised downwash.
- Landscaping elements in the form of densely foliating trees and hedges throughout the ground plane in accordance with the Landscape Plan for the precinct. Consideration will however need to be made for the wind conditions expected at the time of planting of the trees throughout the precinct before they have sufficient time to mature.
- Localised screening for the Upper Level terrace spaces to minimise the direct exposure to the prevailing winds due to their elevated locations.

These elements will need to be further investigated as the design of the development progresses.

10. Conclusion

Wind tunnel testing has been undertaken for the expected wind environment conditions associated with the proposed Amending Design Scheme for the Waterloo Metro Quarter precinct.
Wind conditions within and around the precinct associated with the Amending Design Scheme are expected to be similar to or better than the noted wind conditions associated with the Approved DA Envelope Scheme.

It is important to note that while the Design Guidelines state the requirement for laneway connections to the surrounding streets from the Metro Station, this may compromise the ability for the design scheme to achieve the wind comfort criteria in some areas including the laneways and Cope Street Plaza. Previous testing had indicated a need for significant baffling to block the laneways to help achieve these comfort conditions; as such, a balance between the connectivity of the development to the surrounding areas and the wind comfort conditions will need to be considered.

11. Appendices

11.1 Appendix 1 – Wind Tunnel Photos of the Amended Design Envelope Scheme

Figure A-1 – Wind Tunnel Model of Amended Design Scheme (View from South)

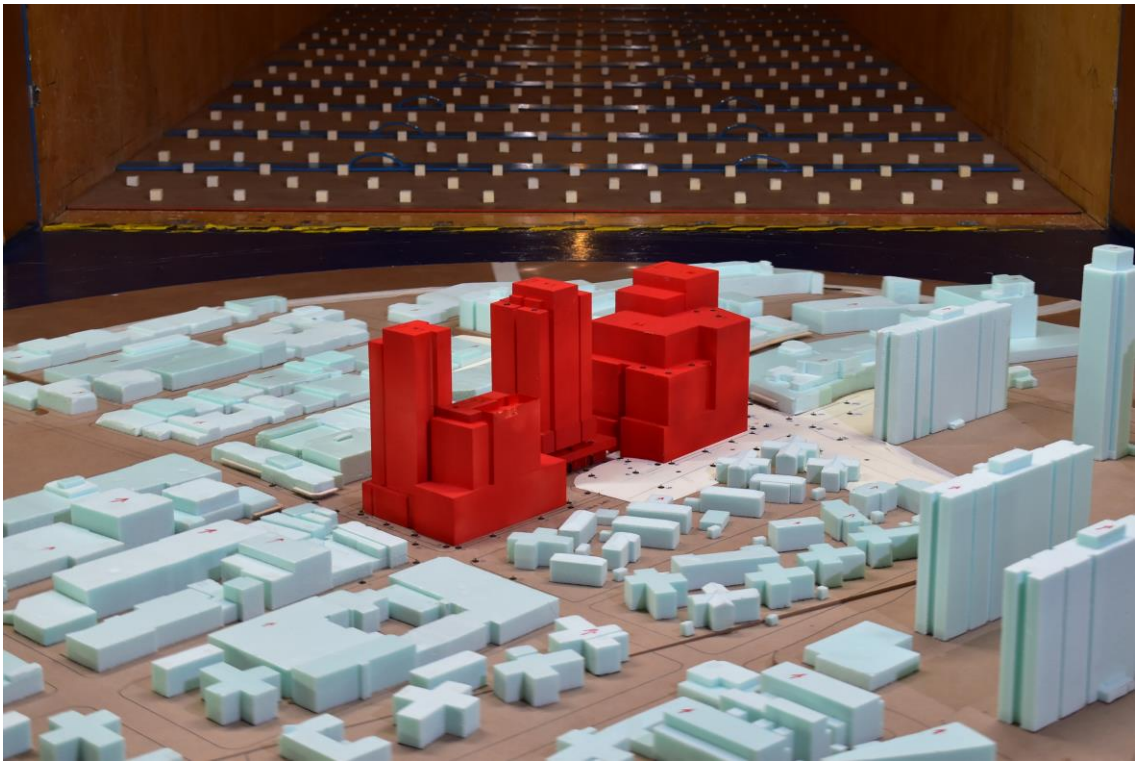


Figure A-2 – Wind Tunnel Model of Amended Design Scheme (View from South-East)

Figure A-3 – Wind Tunnel Model of Amended Design Scheme (View from East)

Figure A-4 – Wind Tunnel Model of Amended Design Scheme (View from North)

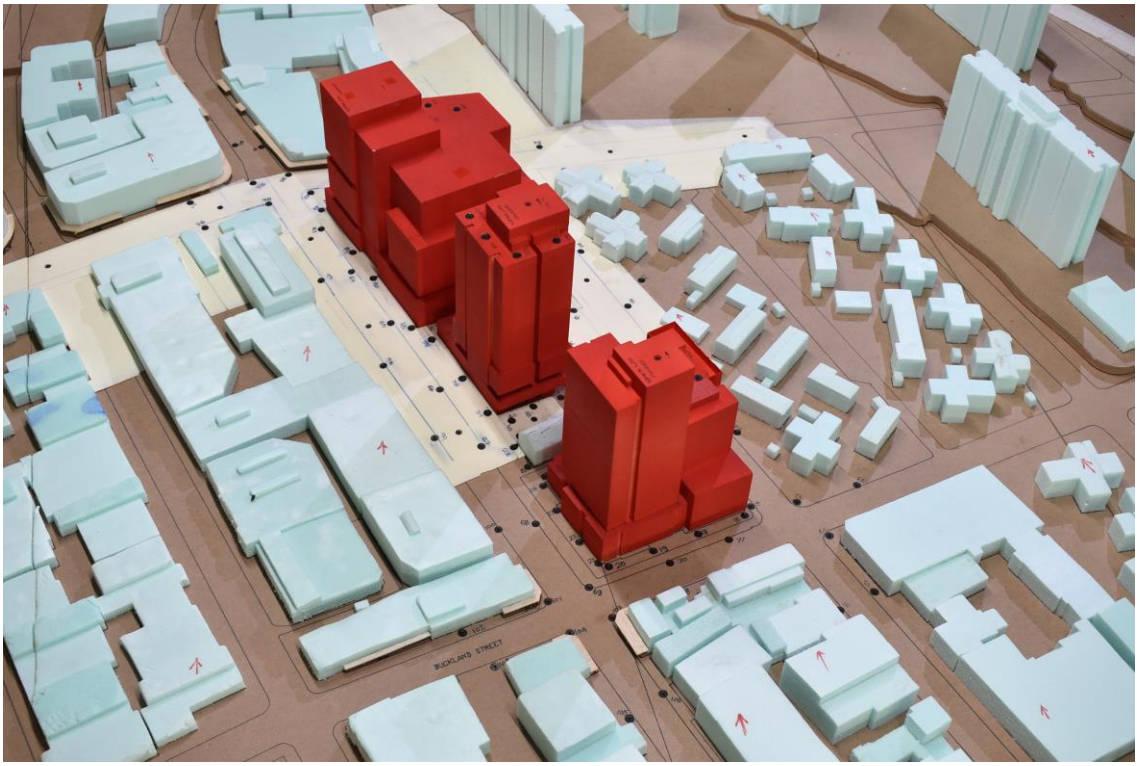


Figure A-5 – Wind Tunnel Model of Amended Design Scheme (View from West)

Figure A-6 – Wind Tunnel Model of Amended Design Scheme (View from South-West)