WATERLOO METRO QUARTER OVER STATION DEVELOPMENT

Environmental Impact Statement
Appendix P – Structural Design Report

SSD-10440 Northern Precinct
SSD-10441 Amending Concept DA

Detailed State Significant Development
Development Application

Prepared for **Waterloo Developer Pty Ltd**

30 September 2020

Reference	Description
Applicable SSD Applications	SSD-10440 Northern Precinct
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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
ESD	ecologically sustainable design

Reference	Description
Etabs	Structural Engineering software
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
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

Reference	Description
VIA	Visual Impact Assessment
WMQ	Waterloo Metro Quarter
WMP	Waste Management Plan
WSUD	water sensitive urban design

2. Executive summary

This planning report has been prepared by Robert Bird Group to accompany a detailed State significant development (SSD) development application (DA) for the Northern Precinct over station development (OSD) at the Waterloo Metro Quarter site.

This report has been prepared to address the relevant conditions of the concept SSD DA (SSD 9393) and the Secretary's Environmental Assessment Requirements (SEARs) issued for the detailed SSD DA (SSD 10440).

This report concludes that the proposed Northern Precinct OSD is suitable and warrants approval.

3. Introduction

This report has been prepared to accompany a detailed State significant development (SSD) development application (DA) for the Northern Precinct over station development (OSD) at the Waterloo Metro Quarter site. The detailed SSD DA is consistent with the concept approval (SSD 9393) granted for the maximum building envelope on the site, as proposed to be modified.

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 detailed SSD DA seeks development consent for the design, construction and operation of:

- 17-storey commercial building (Building 1) comprising Commercial floor space, with an approximate capacity of 4000 workers
- ground level retail tenancies, loading facilities serving the northern and central precinct including Waterloo metro station
- landscaping and private open space at podium and roof top levels to support the commercial tenants
- new public open space including the delivery of the Raglan Street Plaza, Raglan Walk and expanded footpaths on Raglan Street and Botany Road and public domain upgrades
- external licensed seating areas
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

4. The site

The site is located within the City of Sydney Local Government Area (LGA). The site is situated about 3.3 kilometres south of Sydney CBD and eight 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 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 is a rectangular shaped allotment with 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 detailed SSD DA applies to the Northern Precinct (the site) of the Waterloo Metro Quarter site. The site has an area of approximately 5,120sqm. The subject site comprises the following allotments and legal description at the date of this report.

- 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).

The boundaries of the overall site are identified at Figure 1, and the subject site of the detailed SSD DA is identified at Figures 2 and 3. 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 image 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.

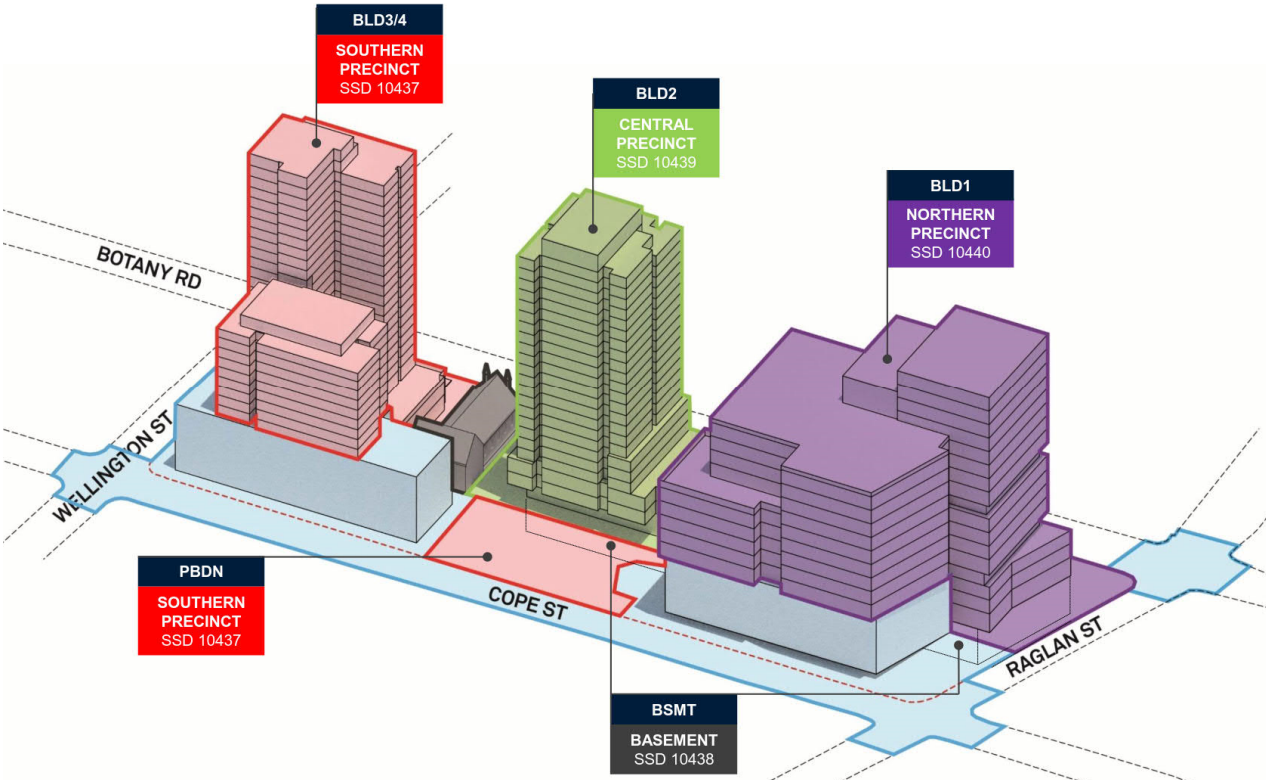

Figure 2 - Waterloo Metro Quarter site, with sub-precincts identified
Source: HASSELL

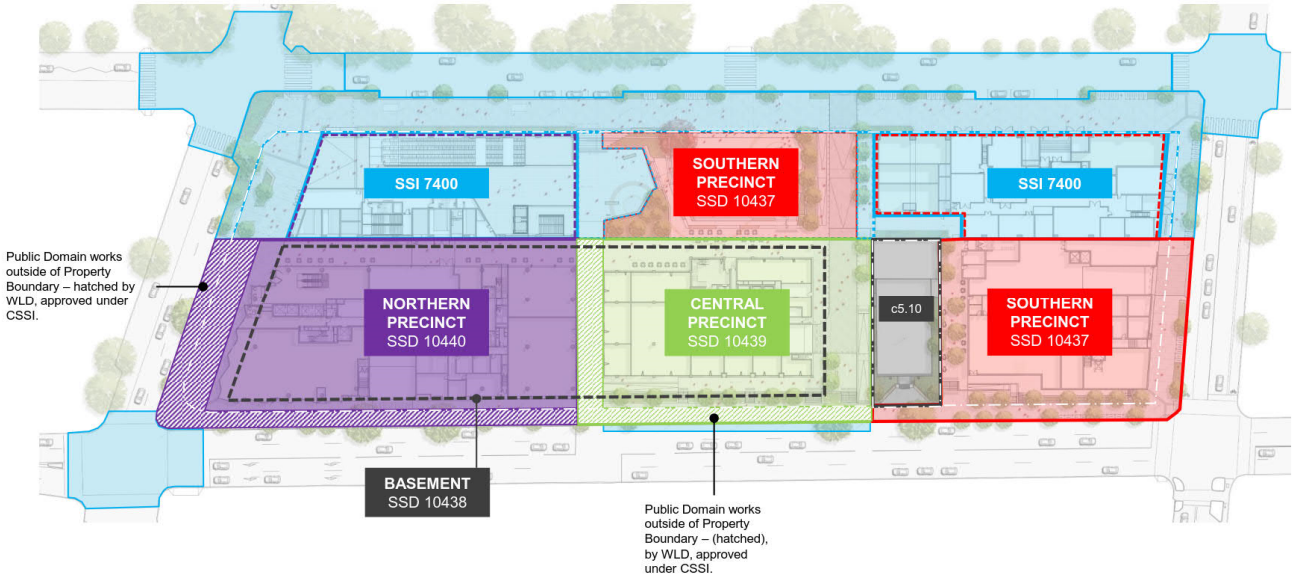

Figure 3 - Waterloo Metro Quarter site, with sub-precincts identified
Source: Waterloo Developer Pty Ltd

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 below.

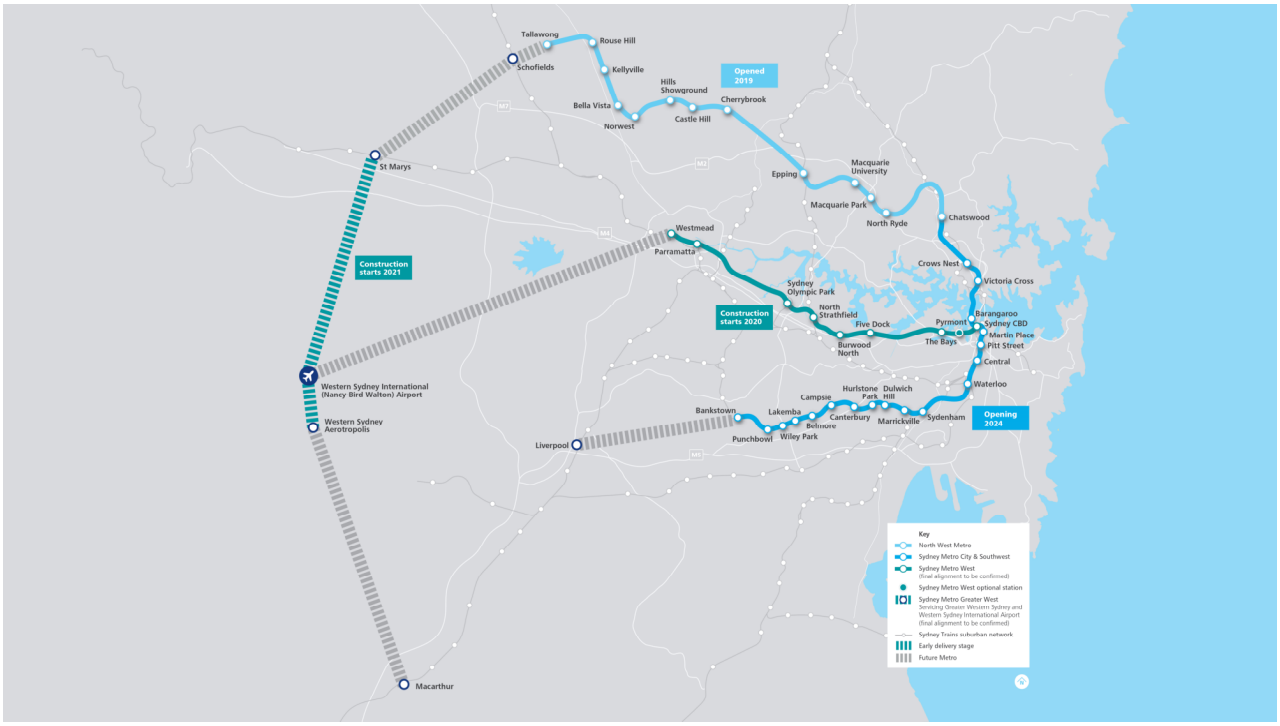

Figure 4 - Sydney Metro alignment map
Source: Sydney Metro

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 5.

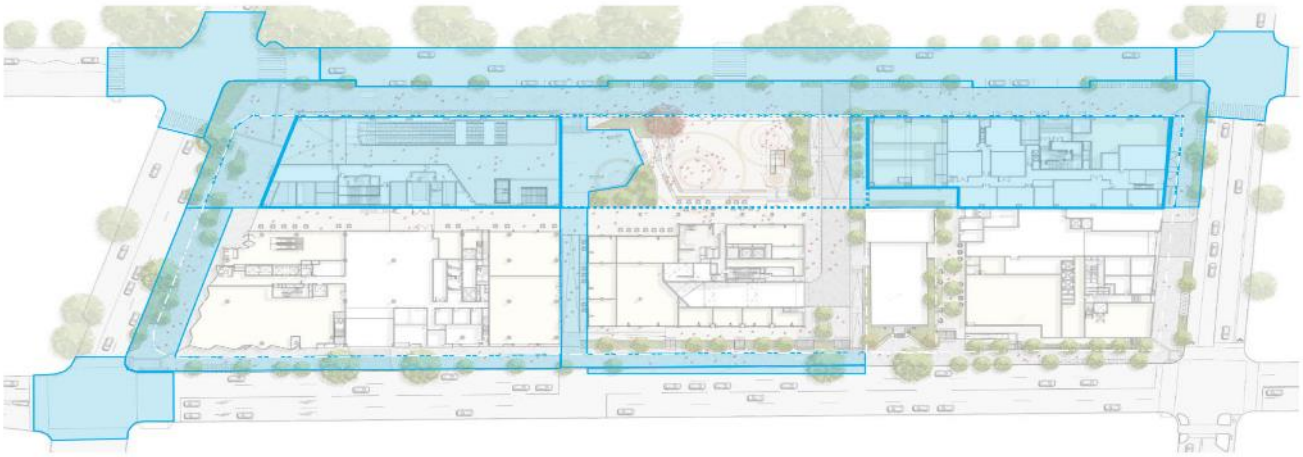

Figure 5 - CSSI Approval scope of works
Source: WL Developer Pty Ltd

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.

The detailed SSD DA seeks development consent for the OSD located within Northern Precinct of the site, consistent with the parameters of this concept approval. Separate SSD DAs have been prepared and will be submitted for the Central Precinct, Southern Precinct and basement car park proposed across the Waterloo Metro Quarter site.

A concurrent amending concept SSD DA has been prepared and submitted to the DPIE which proposed 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.

6. Proposed development

6.1 Waterloo Metro Quarter Development

The Waterloo Metro Quarter OSD comprises four separate buildings, a basement carpark and public domain works adjacent to the Waterloo Metro station.

Separate SSD DAs will be submitted concurrently for the design, construction and operation of each building in the precinct;

- Southern precinct SSD-10437,
- Basement Car Park SSD-10438,
- Central precinct SSD-10439, and
- Northern precinct-SSD-10440.

An overview of the Development is included below for context. This detailed SSD DA seeks development consent for the design, construction and operation of the Northern Precinct:

6.1.1 Southern Precinct

The Southern Precinct comprises:

- 25-storey residential building (Building 3) comprising student accommodation, to be delivered as a mixture of studio and twin apartments with approximate capacity of 474 students
- 9 storey residential building (Building 4) above the southern station box to accommodate 70 social housing dwellings
- ground level retail tenancies including Makerspace and gymnasium lobby, and loading facilities
- level 1 and level 2 gymnasium and student accommodation communal facilities
- landscaping and private and communal open space at podium and roof top levels to support the residential accommodation
- new public open space including the delivery of the Cope Street Plaza, including vehicle access to the site via a shared way from Cope Street, expanded footpaths on Botany and Wellington Streets and public domain upgrades
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

6.1.2 Basement Car Park

The Basement Car Park comprises:

- 2-storey shared basement car park and associated excavation comprising
- Ground level structure
- Carparking for the Commercial Building 1, Residential Building 2, social housing Building 4, Waterloo Congregational Church and Sydney Metro
- Service vehicle bays
- commercial end of trip and bicycle storage facilities
- Retail end of trip and bicycle storage facilities
- residential storage facilities
- shared plant and services.

6.1.3 Central Precinct

The Central Precinct comprises:

- 24-storey residential building (Building 2) comprising approximately 126 market residential and 24 affordable housing apartments, to be delivered as a mixture of 1 bedroom, 2 bedroom and 3 bedroom apartments
- Ground level retail tenancies, community hub, precinct retail amenities and basement car park entry
- level 1 and level 2 community facilities (as defined in the SLEP) intended to be operated as a childcare centre
- landscaping and private and communal open space at roof top levels to support the residential accommodation
- new public open space including the delivery of the Church Square, including vehicle access to the basement via a shared way from Cope Street, expanded footpaths and public domain upgrades on Botany Road
- external licensed seating areas
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

6.1.4 Northern Precinct – Subject DA

The Northern Precinct comprises:

- 17-storey commercial building (Building 1) comprising Commercial floor space, with an approximate capacity of 4000 workers
- ground level retail tenancies, loading dock facilities serving the northern and central precinct including Waterloo metro station
- landscaping and private open space at podium and roof top levels to support the commercial tenants
- new public open space including the delivery of the Raglan Street Plaza, Raglan Walk and expanded footpaths on Raglan Street and Botany Road and public domain upgrades
- external licensed seating areas
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

7. Structural Design Standards

The structural design for the proposed development shall be in accordance with the current revision of all relevant Australian Standards. These standards will include, but are not limited to:

Standard	Title	Edition
AS 1170.0	Structural Design Actions Part 0: General Principles	2002
AS 1170.1	Structural Design Actions Part 1: Permanent, Imposed and other	2002
AS1170.2	Structural Design Actions Part 2: Wind Actions	2009
AS1170.4	Structural Design Actions Part 4: Earthquake Loads	2007
AS 3600	Concrete Structures	2018
AS 3700	Masonry Structures	2001
AS 4100	Steel Structures	1998

7.1 Design Life and Importance Level

The design life and importance level of the structure is given by the NCC requirements for the following building classifications:

Usage	Classification
Retail	Class 6
Office / Commercial	Class 5

Design Life	Importance Level
50 years	3

8. Design Loads

All loadings and load combinations shall be in accordance with Australian standards AS1170 Parts 0 to 4. The relevant design loads are defined in Section 9.1.1 to 9.1.4 of this report.

8.1.1 Permanent Actions – Dead Loads

Dead loads shall be the self-weight of the structure plus an allowance for toppings, partitions, ceilings and services. The additional dead loads are outlined below:

Usage	Uniform distributed load (kPa)
Retail	2.0
Commercial	1.5
Outdoor terrace / green roof • Paved • Planters	 4.0 7.5
Plantroom	2.5
Roof	1.0

8.1.2 Imposed Loads – Live Loads

The design floor loadings are to be in accordance with the minimum provisions of AS1170.1 and are outlined below:

Usage	Uniform distributed load (kPa)	Concentrated Load (kN)
Retail	5.0	4.5
Commercial	3.0	2.7
Outdoor Terrace	5.0	2.7
Plantroom	7.5	4.5
Roof	2.0	2.7

8.1.3 Wind Loads

Wind pressures are in accordance with AS1170.2 using the following parameters:

Criteria	Value
Location	Sydney NSW
Region	A2
Importance level	3
Design event for strength	1:1000
Design event for serviceability	1:25
V_{1000}	46m/s
V_{20}	37m/s
M_s	1.0
M_t	1.0
Terrain Category	3
Design Wind Speed	Varies 38m/s to 53m/s

Design of façade elements and their connections shall make provision for local peak wind pressure effects calculated using local pressure factors given in AS1170.2.

8.1.4 Earthquake Loads

Earthquake loadings are in accordance with AS1170.4 using the following parameters

Criteria	Value
Location	Sydney NSW
Importance level	3
Design event for strength	1:1000
Probability Factor K_p	1.3
Hazard Factor Z	0.09
Subsoil Class	C_e
Earthquake Design Category	EDCIII
Performance Factor S_p	0.77
Ductility Factor μ	2

8.2 Deflection Criteria

The deflection structural elements under service loads shall be controlled in accordance with the following criteria unless noted otherwise on Robert Bird Groups structural drawings:

Structural Element	Deflection Type	Limit
Overall Building Structure	Lateral sway from service wind load	Height/500
Overall Building Structure	Inter-storey drift from lateral sway due to ultimate earthquake load Inter-storey drift from lateral sway due to serviceability wind loading	Height/150 Height /500
Floor Slabs: No Sensitive Partitions	Long term total deflection	Lesser of Span/250 or 25mm
Floor Slabs: Sensitive Partitions	Long term incremental deflection	Lesser of Span/500 or 25mm

8.3 Fire Resistance

Structural elements are to be designed in accordance with the Building Code of Australia and the relevant Australian Standards to satisfy the required FRL levels for fire.

8.4 Durability

Structural elements will have a structural design life as nominated by their relevant Australian Standards.

Concrete works will be designed for the relevant exposure classifications.

9. Structural Design

9.1 Building 1 Overview

Building 1 is a steel framed building with composite concrete floor slabs. A reinforced concrete core resists the lateral loads due to wind and earthquake. The western portion of the building is positioned over 2 levels of basement which is linked with building 2 (SSD-10439) and subject to a separate SSD application (SSD-10438). The eastern portion of the building is positioned above and supported by the station structure which.

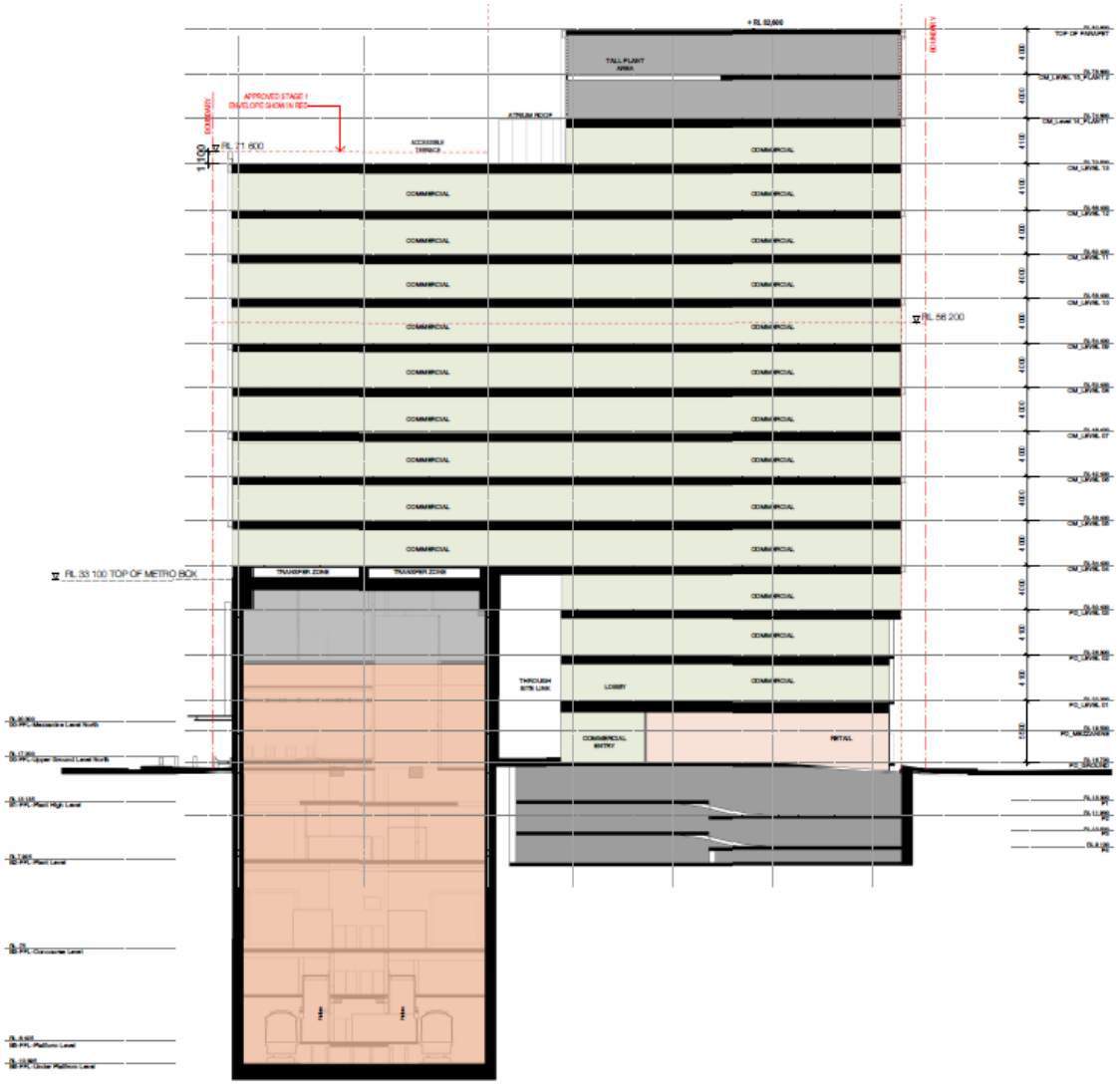

Figure 6 - Section through Northern Building and Station

9.2 Lateral Stability

The lateral stability system has been designed to resist the wind and earthquake loads for strength and serviceability. The lateral loads are resisted by an offset stair / lift core on the western side of the tower which is carried up through the tower. Additional vertical bracing is located on eastern elevation.

Building 1 will experience additional loads from the station structure from an earthquake event. These loads will be transferred to the building 1 core through a diaphragm slab at level 4. To model these actions a combined ETABS model was established to assess the lateral performance of the building and the station structure. The loads provided by the stations team account for the higher importance level (level 4) of the station structure.

Both the station design team and Building 1 teams have carry out this overall assessment to ensure each of the respective structures meets the earthquake requirements outlined in section 8.1.4.

It is also understood that the station design team will be required to ensure that the station meets lateral stability requirements should Building 1 not be constructed.

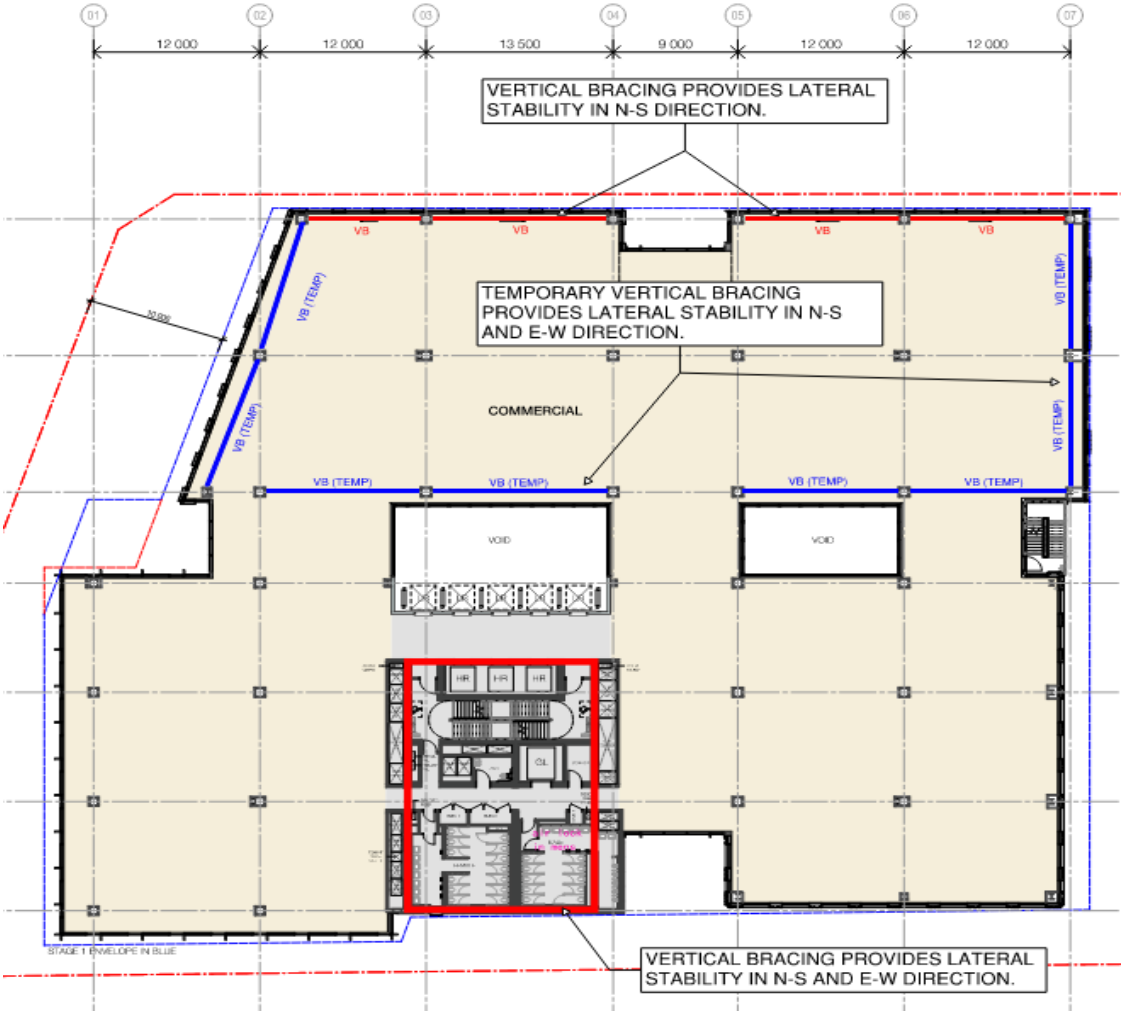

Figure 7 - Lateral Stability of Building 1

9.3 Floor Plates

The building is steel framed structure utilizing primary and secondary beams supporting a bondek floor slab. Shear studs are provided to the primary and secondary beams for composite action with the floor slab. The floors are typically 130mm thick to comply with strength, serviceability and fire requirements. Secondary beams are spaced to eliminate the need from temporary propping. The slab thickness at level 4 is increased to 300mm to accommodate the transfer of lateral loads from the station structure to the building core.

Steel columns are positioned on a 12 x 11.25 and 12 x 9 grid to suit commercial office tenancies. Columns are positioned uniformly throughout the building to eliminate column transfers.

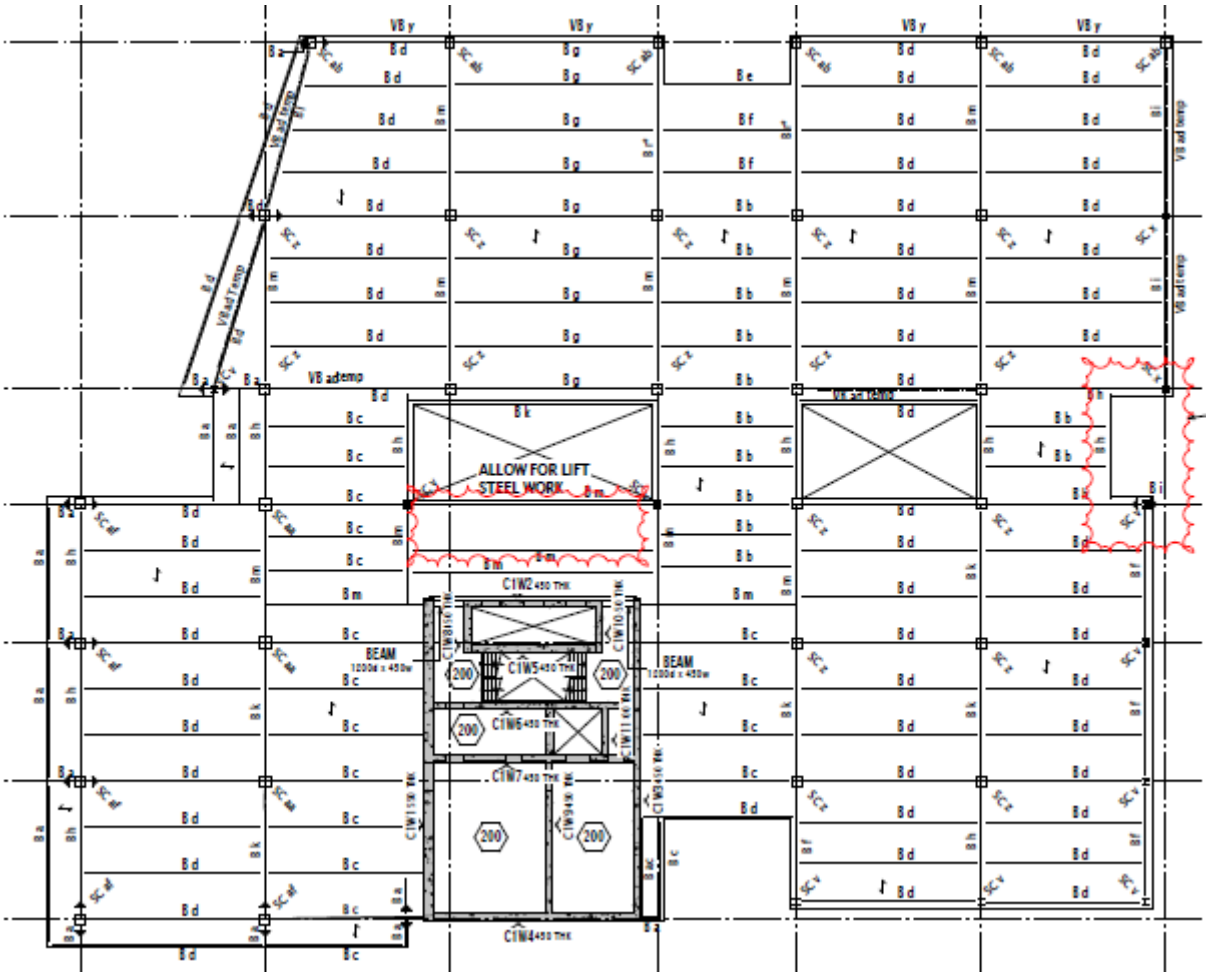

Figure 8 - Typical Floor Plate – Level 5

9.4 Basement slab and footings

A two-level basement is positioned below the western portion of building 1. The basement provides space for building services, residential storage, and car parking. The basement is linked with the basement to building 2 and share a common entry under building 2. The approval for the basement is subject to a separate SSD application (SSD-10438).

9.5 Station loading

The eastern portion of building 1 (OSD) is positioned over and supported by the station structure. The Waterloo Station team have been provided with the full loadings from Building 1 in “Technical Memorandum – Metro Quarter Development – Northern OSD (Building 1) – Interface Loadings” (report ref WMQ-BLD1-RBG-ST-RPT-002). This report defines all vertical and horizontal loadings that are transferred from Building 1 to the station structure.

10. Conclusion

During the design development for the northern precinct SSD 10440, Robert Bird Group have provided advice and input into the architectural design by producing a structural scheme design for the architect to incorporate into the design. Review of the SSD architectural drawings confirms the structural scheme has been incorporated in the architectural design.

The structural design is compliant to the relevant design and planning criteria as outlined in this report. Preliminary coordination with other engineering consultants has been undertaken. Further design development will be required for Construction Certificate.

11. Appendices

11.1 **Appendix 1 –** Technical Memorandum – Metro Quarter Development – Northern OSD (Building 1) – Interface Loadings" WMQ-BLD1-RBG-ST-RPT-002.

Member of the Surbana Jurong Group

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Authors:	Kaldoon Hussain & George Andrianakos	**Reviewer:**	George Andrianakos

TECHNICAL MEMORANDUM

METRO QUARTER DEVELOPMENT | NORTHERN OSD – INTERFACE LOADINGS

1.0 Introduction

1.1 General Description

At the request of the Waterloo Developer (WLD), Robert Bird Group (RBG) have prepared this technical memorandum for the purposes of outlining the design loading requirements to the Waterloo Contractor (WC). This memorandum is intended to be used by the station design team, namely for the purposes of outlining structural loading requirements of the Over Station Development (OSD), so that adequate structural support can be provided by the Waterloo Station structure.

It is intended that this document be developed throughout the stages of station design, to ensure a collaborative approach to the finalised station design can be realised.

The WLD team understand that the proposed OSD development differs from that at bid stage. This document should be used to develop an understanding of the potential changes to structure. An iterative process may be required to ensure that an efficient design with the desired flexibility is achieved.

2.0 Terms of Reference

This assessment is provided to inform the WC of the required design criteria and loadings that is required to be within the base station structure design.

Structural framing plans for the adopted OSD Scheme are included in the Appendix B. These have been used in our analysis for assessment of loads.

The following documents have been considered and referred to in this memorandum;

- Northern OSD Architectural Drawings (Appendix C)
- Northern OSD Framing Plans (Appendix B)

All the loading information provided has been based on the architectural set out provided to RBG. Final set out locations of the loadings are to be provided to the WC by the Northern OSD architect (Woods Bagot). It is expected that these will be dimensioned off the station grid layout.

3.0 Basis of Design

3.1 Vertical Loads

The following values where used in calculation of loadings;

Type	SDL (kPa)	LL (kPa)
Office	1.5	3
Terrace / Landscaping	4.0	5.0
Roof / Plant	2.5	7.5

Table 1 – Loading Values

All vertical loads have been calculated as per the loading and structural framing options located herein. All vertical loads over the station will be transferred through structural steel columns. Base plates for these columns will be sized as design development progresses. Such details will be developed with Earthing & Bonding requirements being considered.

These loads will be transferred to the station at the top of station slab level (RL33.100)

Figure 1 – Section through Northern Building and Station

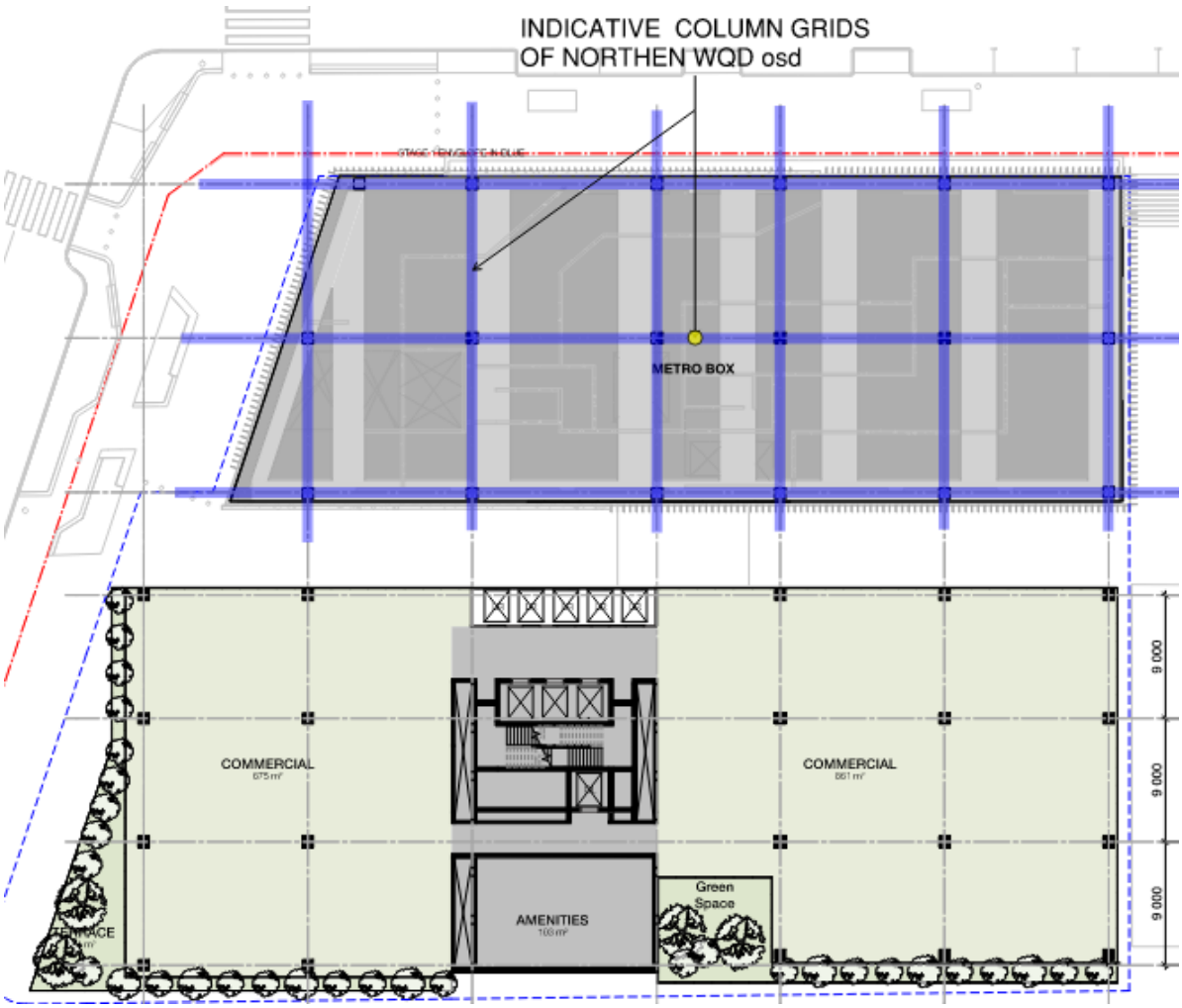


Figure 2 – Commercial Grid Layout over Station

The commercial grid differs from the station grid below – the OSD grid is shown indicatively in blue in Figure 2. Thus, it is expected that transfer beams spanning the width of the station will be required. Upon review of the locations it is expected that there will be transfer beams running in both directions. This is to be confirmed by the WLC.

It is also noted that RBG (WL Team) recommend a contingency of 5% be applied to the loads provided. This is reflected in the relevant sketch and loading information.

3.2 Lateral Loads

Below is the relevant wind and seismic loading requirements;

Wind Parameters					
Building	**Importance Level**	**Design Life**	**Wind Region**	**Serviceability Limit Stage design (used to check deflection and drift).**	**Ultimate Limit State Design**
OSD	3	50 Years	A2 (Sydney)	1:25	1:1000
STATION (Elements Below Interface Level and Starter Bars to Interface Level)	4	100 Years	A2 (Sydney)	1:50	1:2500

Table 2 – Wind Parameters

Earthquake loadings are to be determined in accordance with AS 1170.4:2007 for the following design parameters:

- BCA importance Level of 4
- For elements below the interface level and all starter bars to interface level (crash deck/ transfer level) – 1:2500
- Otherwise (i.e. for the Ultimate Limit State design of the OSD lateral structure – 1:1000

Probability Factor:
- For elements below the interface level and all starter bars to interface level (crash deck/transfer level) – Kp = 1.8
- Otherwise (i.e. for design of OSD lateral structure) – Kp = 1.3

Hazard Factor (Z):
- Hazard Factor Z = 0.09

Site Sub-Soil Class
- Site Sub-Oil Class Ce

Structural Ductility Factor m:
- Limited ductile shear walls (10 storey structure) m = 2
- Ordinary moment resisting frame (4 storey structure) m = 2

Structural Performance Factor Sp:
- Limited ductile shear walls (10 storey structure) Sp = 0.77
- Ordinary moment resisting frame (4 storey structure) Sp = 0.77

Earthquake Design Category
- Earthquake Design Category III

The lateral stability of the Northern MQD in each direction is dependent on the MQD lift core (located off the station footprint) and bracing along the eastern façade with loads transferred to the station. The columns are not intended to assist significantly with the lateral stability in frame action when the northern MQD has been constructed.

The design methodology for lateral stability is summarised below;

North-South Direction –

Dependant on the MQD Lift Core and Vertical Bracing on the Eastern elevation of the commercial building and transferred through the station via bracing to foundation level.

East-West Direction –

Dependant on the MQD lift core located off the station footprint.

This is indicatively illustrated by Figure 3 below.

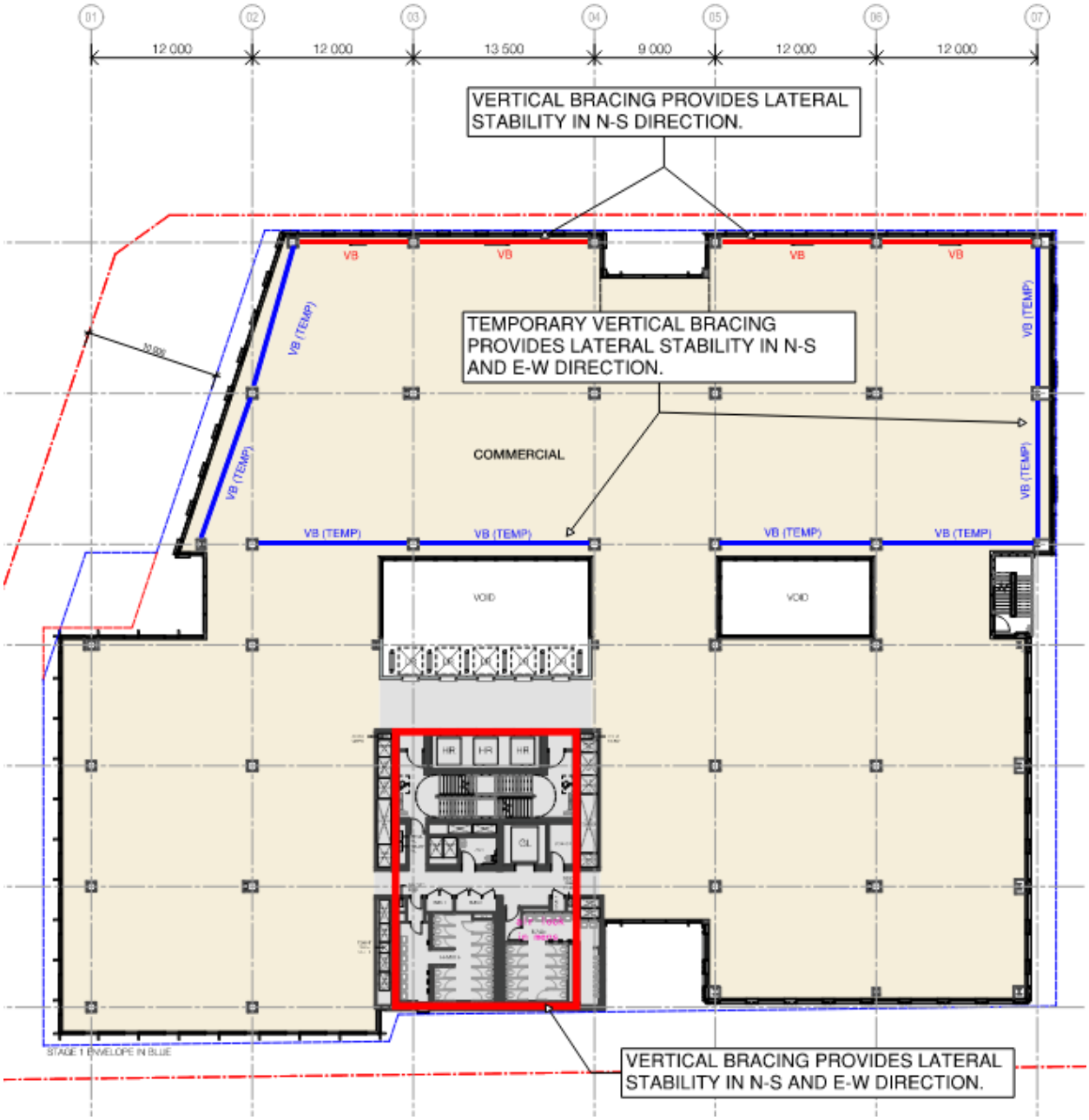


Figure 3 – Lateral Stability of Northern MQD.

4.0 Loading Information

Based on the above, RBG have carried out structural analysis for the purposes of providing the WC team relevant loads. The WLD developer team has carried out a lateral analysis which includes a combined ETABS model to quantify the loadings on the Building 1 by the station. The integrated model has been provided to the WC team via Aconex email (RBG-TRANSMIT-000027) and the current revision is:

WMQ-BLD1-RBG-ST-MDL-0001-ETB-R18

The framing assumptions and loads are included within Appendix B of this memorandum. WC and WLD teams required to coordinate and agree on model assumptions.

The vertical and lateral loadings that will be imposed on the Station structure are included within Appendix A of this memorandum.

5.0 Movements

Acceptable movements of the station structure supporting the OSD are to be agreed and confirmed after analysis is complete. This will be based on the lateral analysis and transfer models.

Upon preliminary information being received, the WLD team will access and review the movements to understand any impacts on the OSD structure. The structural movement will be based on importance Level 2 and 1/500 annual probability (50-year design life).

6.0 Earthing and Bonding

The WLD team understand that Building 1 and the station structure will be considered as 'discontinuous' electrically.

Practically we understand this to mean that at the connection between the station / Building 1 structure, there will be physical separation of all conductive material. The insulation required between the two will be an epoxy-based product or similar which is to be approved by the Earthing and Bonding specialist consultant.

An indicative sketch showing the current proposed solution is shown below. This is to be confirmed and coordinated through the next stages of design. Interface details are included within Appendix F of this memorandum.

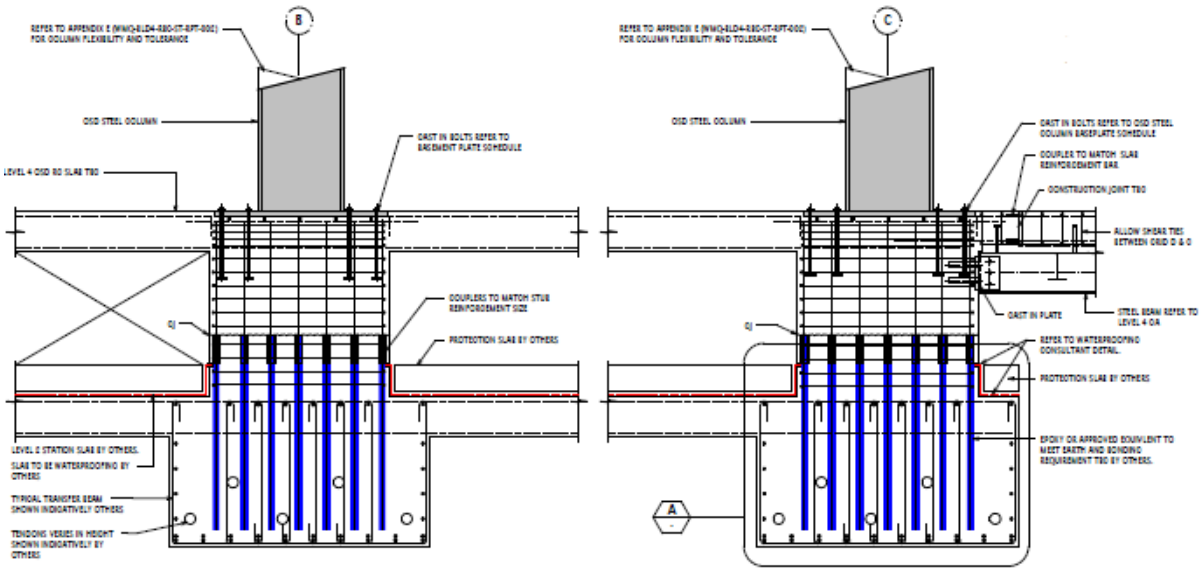


Figure 4 – Interface Detail between transfer beam and OSD column.

7.0 Flexibility / Tolerance

The WLD developer team understand the following typical tolerances (as a minimum) to be able to be accommodated by the WC station structure;

Columns (Centreline)

+ / - 1200mm (East / West Direction)
+ / - 500mm (North / South Direction)

The understood Flexibility / Tolerances are summarised in Appendix E. It is noted that the current proposed RC stub (1350 x 1350mm) does not achieve the proposed tolerance as it will increase stub size. The full extent of loading tolerances as indicated above. Refer to current interface details and general arrangement (Appendix F and Appendix B) for current set-out.

8.0 Transfer Beam Deflection

The WLD team understand that OSD columns will experience additional vertical displacement because of long span transfer beam deflection. This deflection will increase during the construction of the OSD building levels. It is expected that the WLD developer will provide loadings at each construction stage, so that the WC team can provided the predicted deflections at each construction stage. Furthermore, the WC will be required to provided long term deflection values which will need to consider creep and shrinkage for the station concrete elements.

This is to be reviewed at next stage of design when transfer beam design has been finalised by WC team. It will also need consideration due to the differential movements across the OSD levels. This will require the presetting of columns heights.

9.0 Earthquake Loadings - Additional Base Shear from Station Box

The WLD team understand that the level 4 OSD above the station transfer floor will experience additional base shear force from the station under an Earthquake event. The additional base shear will transfer through the diaphragm slab at Level 4 OSD and to be transferred to the Building 1 core wall.

The WLD developer team understand that the base shear from the station will be based criteria in Section 3.2. The effective mass used for this analysis will be taken from Ground to Level 2 (Station), as this is the portion of the building whose mass will contribute to the additional loading requirements of Building 1. This has been confirmed by the station team as an acceptable analysis approach.

Both the WC and WLD teams will carry out this overall assessment to ensure each of the respective structures meets the Earthquake requirements.

It is also understood that the WC will be required to ensure that the station meets lateral stability requirements should Building 1 not be constructed.

Refer to Appendix A for more information on updated OSD loading.

10.0 Temporary Vertical Bracing

The WLD team understand that level 4 OSD will have temporary bracing during construction phase as shown indicatively in Figure 3. Numbers, size and location of temporary vertical bracing are included in Appendix B of this memorandum.

Location of bracing needs to be coordinated with WC team and a review of the impact on level 2 station floor particularly members in E-W direction may be required.

The provided sizes are based on high seismic loading criteria for the station. These criteria to be revised and confirmed in the next phase once WLD team understand location restrictions by WC team.

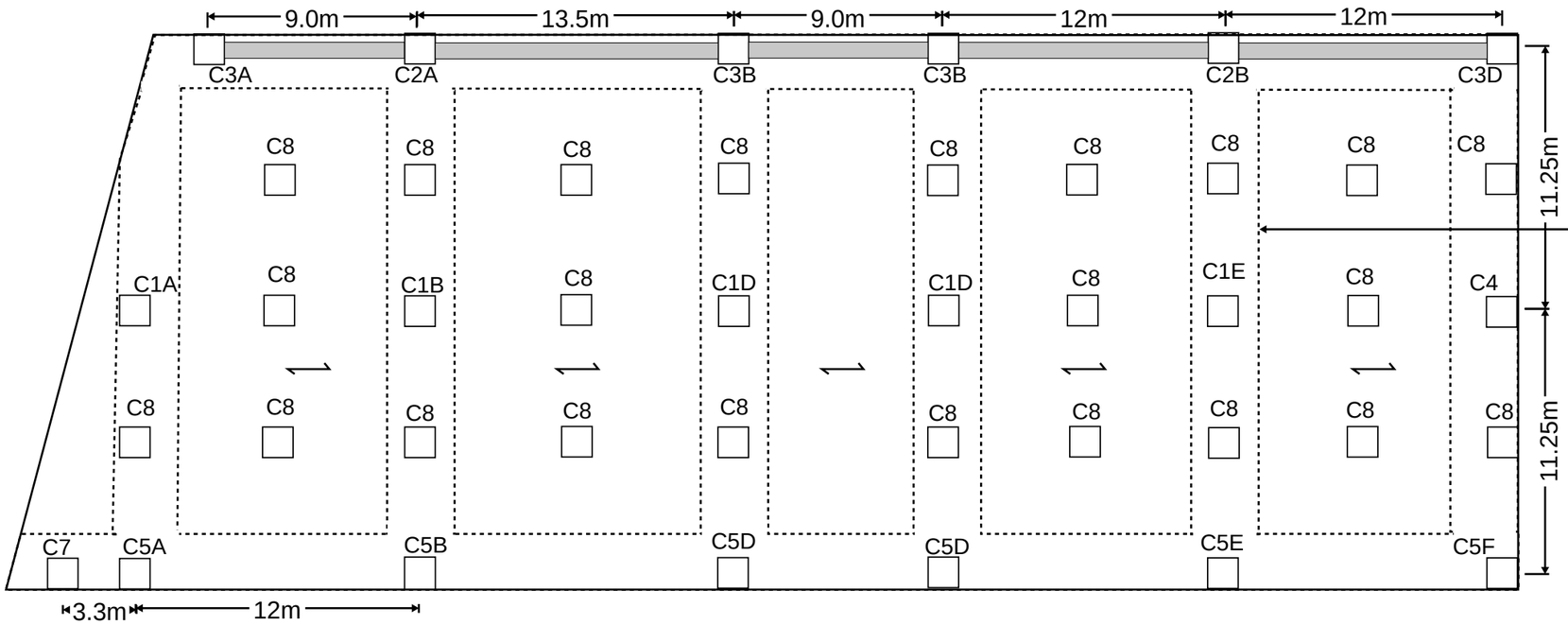
Temporary bracing load has not been provided in Appendix A. Lateral analysis for the temporary vertical bracing will be provided once WLD team understand final location of the bracing.

Refer to Appendix B for more information on bracing locations.

11.0 Further work and next steps

- It is the expectation that this memorandum and relevant loading information will be passed to the WC to determine the implications on station design. Further work may be required by both teams to finalise any information / station design.
- The architect will set out all final loading locations and this will be dependent on column locations and dimensioned off station grid.
- Development of connections to satisfy Earthing and Bonding, as well as structural adequacy is required to be worked through as the next stage. Preliminary details have been provided.
- Temporary bracing locations are to be coordinated with WC team and confirm structural adequacy of transfer beam during construction of OSD

Appendix A
Loading Information



TRANSFER BEAM LOCATION SHOWN INDICATIVLY. REFER TO STATION DRAWINGS.

COLUMN LABEL	DL kN	LL kN
C1A	6850	3350
C1B	10300	5400
C1C	9400	5500
C1D	9400	5500
C1E	8850	5100
C4	3750	1600
C5A	6750	3300
C5B	7850	3900
C5C	6750	3300
C5D	6750	3300
C5E	6950	3400
C5F	3600	1500
C7	1950	750
C2A	6250	3000
C2B	4000	1750
C3A	3500	1600
C3B	4850	2100
C3C	4850	2100
C3D	2500	1200
C8	500	150

STATION TRANSFER FLOOR RL33.100

NOTE:

1) Loads have been provided for review by Waterloo contractor.

2) Loads provided based on preliminary framing as indicated on drawings WMQ-BLD1-RBG-ST-DRG-S2450-B to S2590-B issued on 29.06.2020

3) All Loads indicated are working loads.

4) Relevant load combinations to be applied when considering station design.

5) Refer sketch WMQ-BLD1-RBG-ST-SKT-SK0004-D for relevant lateral loads.

6) Refer to Technical Memorandum (WMQ-BLD4-RBG-ST-RPT-002) which to be read in conjunction with these drawings.

7) Assume zero live load in uplift case.

8) For uplift case, minimum Dead Load for C2 and C3 are 1700 and 1000 respectively.

WHERE:

DL: Axial Load Due to Dead Load.
LL: Axial Load Due to Live Load.

FOR INFORMATION - NOT FOR CONSTRUCTION

WMQ-BLD1-RBG-ST-SKT-SK0003

Waterloo Integrated Station Development
A Joint Venture Project
JOHN HOLLAND mirvac

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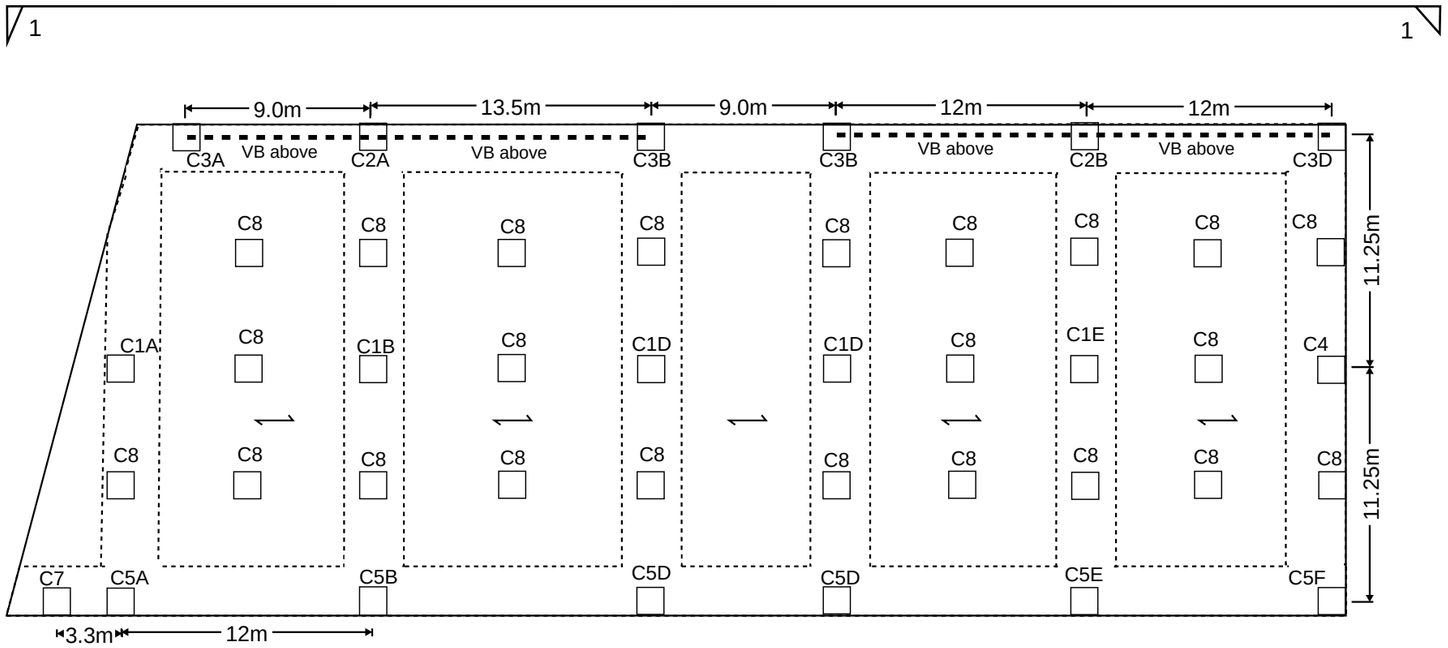
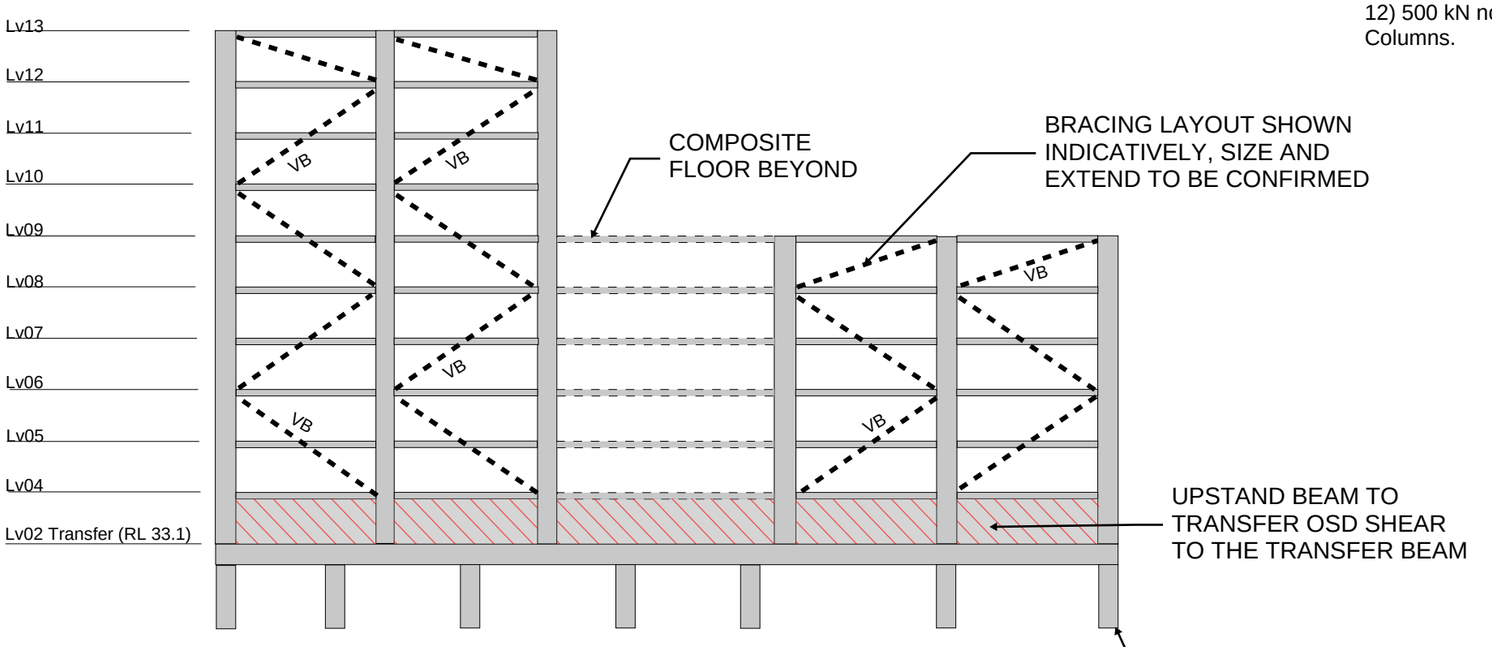
Member of the Surbana Jurong Group

Rev.	Revision Description	Date
D	ISSUE FOR INFORMATION	07/07/2020

Client:	WLD - WATERLOO DEVELOPER	Designer:	M.P	Job No:	18445B
Project/Job:	WATERLOO INTEGRATED STATION DEVELOPMENT	Checker:	K.A	Sheet No:	1 of 2
Subject:	BLD 1- GRAVITY LOADING	Approved:	G.A	Rev:	D





SECTION 1-1

LATERAL LOADING

NOTE:

1) Loads have been provided for review by Waterloo contractor.

2) Loads provided based on preliminary framing as indicated on drawings WMQ-BLD1-RBG-ST-DRG-S2450-B to S2590-B issued on 29.06.2020

3) All Loads indicated are working loads.

4) Relevant load combinations to be applied when considering station design.

5) Refer sketch WMQ-BLD1-RBG-ST-SKT-SK0003-D for relevant gravity loads.

6) Refer to Technical Memorandum (WMQ-BLD4-RBG-ST-RPT-002) which to be read in conjunction with these drawings.

7) RBG recommend a contingency of 5% to be stage of design.

8) Station designer must allow for minimum horizontal load as per Australian Standards.

9) Assumed Y-direction Earthquake load to be resisted by WMQ-PM1 core Wall.

10) This scheme is based on typical architecture drawing No. WMQ-BLD1-WBG-AR-DRG-A1000-E to A1062-E issued on 17.06.2020

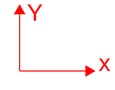
11) Set out of loads to be provided by architect.

12) 500 kN nominal base shear to be provided for C1A, C1B, C1D, C1E, C4 & C7 Columns.

Column Label	Px KN	Vx KN
C2A	9000	2500
C2B	9000	2500
C3A	9000	2500
C3B	9000	2500
C3D	9000	2500

WHERE:

EQx: Earthquake In X Direction.
Px: Axial Load Due to Earthquake In X Direction (Reversible).
Vx: Shear Force Due to Earthquake In X Direction (Reversible).



FOR INFORMATION - NOT FOR CONSTRUCTION

WMQ-BLD1-RBG-ST-SKT-SK0004

Waterloo Integrated Station Development
A Joint Venture Project
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Rev.	Revision Description	Date
D	ISSUE FOR INFORMATION	07/07/2020

Client:	WLD - WATERLOO DEVELOPER	Designer:	M.P	Job No:	18445B
Project/Job:	WATERLOO INTEGRATED STATION DEVELOPMENT	Checker:	K.A	Sheet No:	2 of 2
Subject:	BLD 1 - LATERAL LOADING	Approved:	G.A	Rev:	D