

Sovereign Wynyard Centre Pty
Limited

1 Carrington Street

Pedestrian Planning Report

REP/229289

Issue 2 | 30 April 2014

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Job number 229289-00

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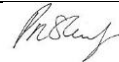
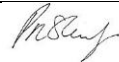
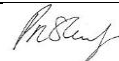
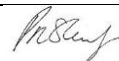
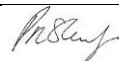
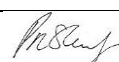
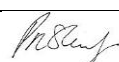
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1 Executive Summary

This report has been produced on behalf of Sovereign Wynyard Centre Pty Limited or its nominee referred to herein as Brookfield. The report details the pedestrian performance for the proposed One Carrington Street project and provides an overview of the methodology, assumptions, analysis and for the performance of the site with respect to:

- Future Year (2036) – maximum demand assumed by AECOM report based on existing station infrastructure
- Future Year (2060) – future demand potential recognising land use drivers around Wynyard Precinct
- Performance during construction (2015)

The report is based on the proposed design of 1 Carrington Street, the potential Wynyard Station upgrade and future demand and operational assumptions. Demand forecasts for 2060 have been developed based on 2020 data provided by Transport for New South Wales. This report recognises the previously submitted Concept Plan by Thrakral Holdings Limited, known as the CityOne Development. As such, the report has been prepared in accordance with the Director Generals Requirements issued for the project, specific to pedestrian movement which are listed in the table below.

Reference	Requirement	Response
Schedule 3, Chapter 2: Detailed Pedestrian Modelling:	Any future application for works east of Carrington Street shall be provided with detailed pedestrian demand modelling to ensure the necessary exit widths to meet pedestrian demand to 2060 and to demonstrate the performance of access ways and vertical transport (escalators, stairs, lifts etc..)	Arup have dynamically modelled the Wynyard Precinct at two design years and demonstrated that the design widths and corresponding circulation performance meet Level of Service C (walkways) during the peak 15 minutes of both morning and evening periods. Average density maps are provided in this report to show the performance for different years (2036/2060) and for the two peak periods (AM/PM).
Schedule 4, Subject 2: Design – Concourse Areas	The detailed design of the development east of Carrington Street is to provide a provisional minimum total combined pedestrian exit to the east via George Street and the Hunter Connection of 20metres (including the 4metre width of the Hunter Connection) and unimpeded flow to the street. The detailed design of the eastern exit is to demonstrate that the unimpeded combined exit width to the east is via the most convenient route from the concourse to street level, and must not be impeded by obstructions to pedestrian movement.	The design provides ~16m of accessible circulation width between the station concourse and the George Street vertical transport node. Two vertical transport nodes to the Hunter Connection are provided which exceed the noted 4m existing width. Overall the design meets or exceeds the noted requirements. The modelling and subsequent analysis has noted that the circulation width of 16m is not required at 2060 for normal movement (a width of closer to 12.5m would be sufficient). Vertical transport to Hunter Connection is a mix of stairs (~5m) and escalators (x 2) and therefore provides both capacity and operational flexibility. Vertical transport to George Street is again a mix of stairs (~5m) and escalators (x6). Stairs are provided for redundancy and emergency evacuation. The demand can be met by the escalators alone. The placement of vertical transport to each connection is all at one point and as part of one array. I.e. unlike the previous Concept proposal where the vertical transport was placed in series as two banks, the proposed design maximises the usage of the vertical transport as well as providing unimpeded pedestrian movement from concourse to street level. No estimated obstructions to movement from station to street are presented and the design encourages a direct and convenient route from concourse to street level.
	B (The developer) will undertake further detailed pedestrian demand modelling to confirm that the 20 metre provisional total combined width of pedestrian exit to George Street (including the 4m width of the Hunter Connection) is the appropriate requirement to ensure the necessary exit widths to meet pedestrian demand to 2060 and to test the performance of the proposed access ways and vertical transport as part of the resolution of the detailed design of the eastern concourse. (The developer) commits to ensuring the design of the eastern access way accords with TfNSW functional specification requirements.	The design meets Level of Service C (walkways) as an average across the peak 15 minutes of both the AM and PM demand at 2060. Queueing at the base of the vertical transport nodes is negligible and stair usage to George Street is minimal, ensuring additional capacity in the case of any escalator failure. The south side of the concourse is estimated to be more utilised as a result of assumed Wynyard Station gateline placement. However, this results in a positive benefit to the northern part of the concourse and provides a LoS A/B performance for through link pedestrian movement between George Street and the Barangaroo development. I.e. a functional station performance for pedestrians has been achieved as well as a City east-west connection performance has been achieved.
	C (The developer) will undertake further ongoing consultation and agreement with TfNSW in relation to resolution of the detailed design of the eastern concourse, and will ensure that the eastern concourse design will allow for full and seamless integration with the future Wynyard Station concourse designs west of Carrington	The design team has collaborated with TfNSW and the dynamic modelling has assumed an upgrade to Wynyard Station and the opening of the Wynyard Walk. The upgrade has assumed an increase number of ticket barriers to the station. Although both these elements have been modelled as inputs into the 1

	Street.	Carrington Street site, no outputs of these elements are provided within this report.
Schedule 4, Subject 16: Construction	B The Construction Management Plan will be prepared in consultation with TfNSW and City of Sydney Council and will include details: * on how compliant access between George Street and Wynyard Station will be maintained; * on the pedestrian access arrangements during construction works including the appropriate staging, methodology and management requirements to ensure that access to relevant adjoining development is maintained during construction.	Three construction methodologies have been tested and the pedestrian performance is detailed within this report. The first assumes all access to George Street via the existing ramps is removed. The second methodology has assumed a central portion (between the George Street ramps) can be maintained throughout the duration of the construction period. The third option is the preferred methodology by the developer which is a variant on the second option which again maintains a connection through to George Street. The results indicate that maintaining access through to George Street throughout the construction period is preferred. Removing access to George Street creates challenges both through the Metcentre and at street level. Activation along George Street in the vicinity of the entry to Wynyard Station is also reduced which may impact local businesses. The preferred option maintains a southern access to George Street and can operate at Level of Service C during 2015 construction period (i.e. the most onerous phase provides Level of Service C at 2015 demand for the peak 15 minutes). Maintaining a clear width of 5.5m and a maximum of 7m will provide similar performance to existing conditions.

In addition the Director Generals Requirements, the following points are noted.

- The design provides a greater connection between George Street and Carrington Street. The connection reduces the number of j-walking movements to the north/south ends of Carrington Street.
- DDA access across the site is improved. Level changes are removed and lift provision is provided across levels. Lift capacity is estimated to meet demand for DDA patrons up to 2060.
- The vertical transport meets the requirements of 2060 demand. However, other constraints with respect to capacity outside of the sites boundary should be noted. In particular the Metcentre corridor width and the Hunter Connection corridor width under George Street.

The demand assessed for the concourse area is provided in the graphics below.

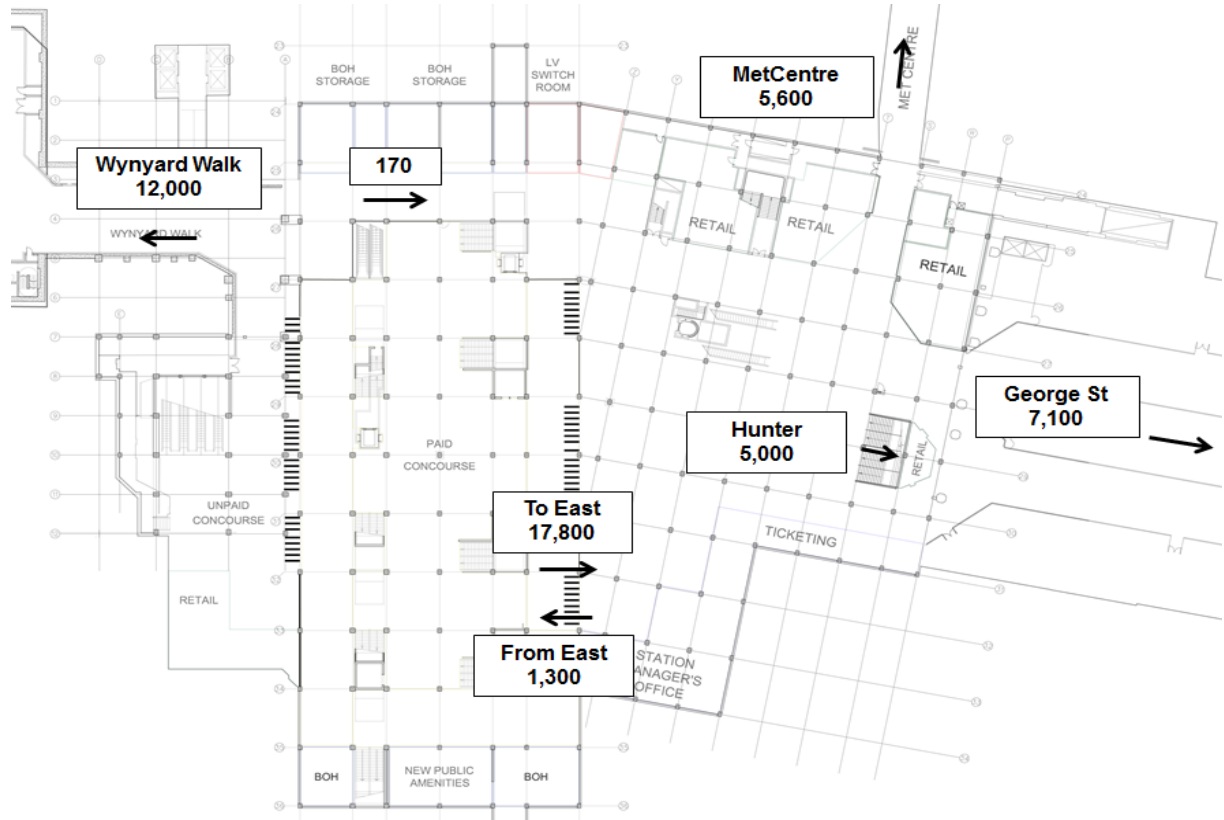


Figure 1 Estimated demand for key movements for 2036

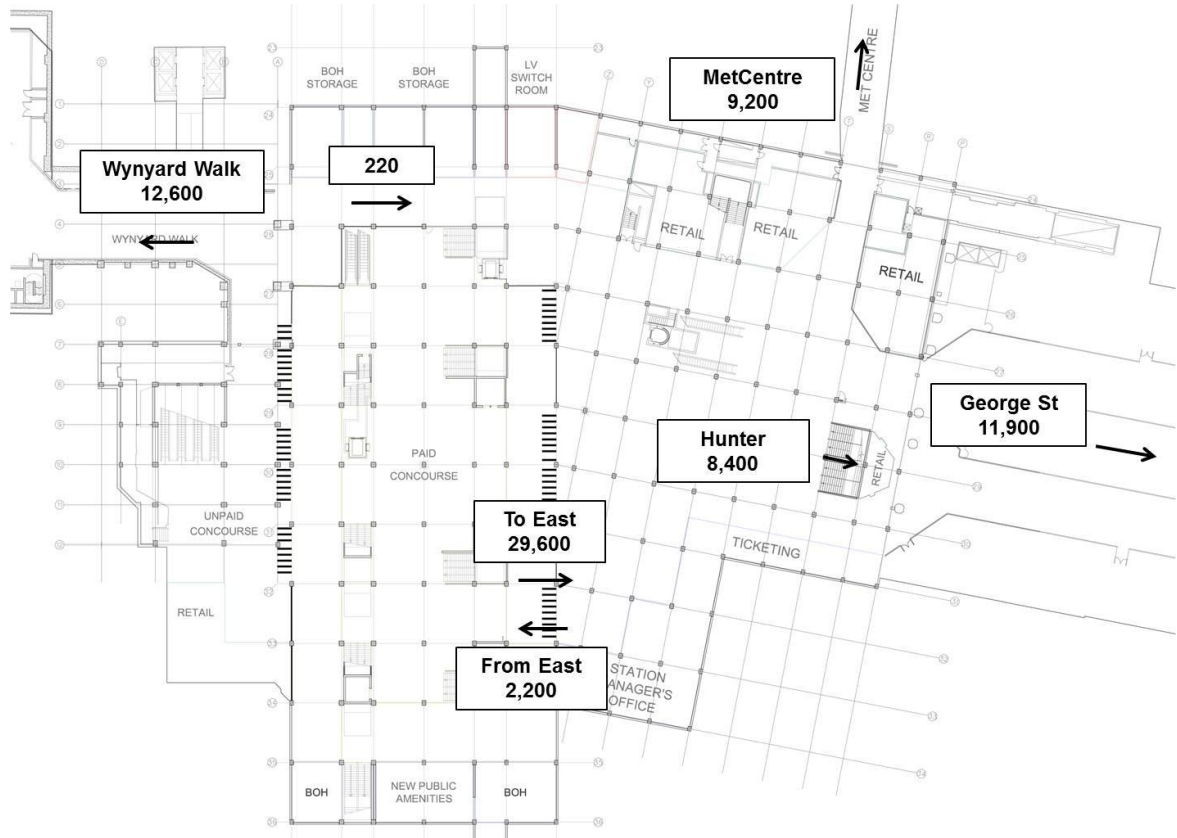


Figure 2 Estimated demand to key movements for 2060

2 Introduction

This report has been produced on behalf of Sovereign Wynyard Centre Pty Limited or its nominee referred to herein as Brookfield. This report details the pedestrian performance for the proposed One Carrington Street project. The report provides an overview of the methodology, assumptions, analysis and conclusions for the performance of the site with respect to:

- Future Year (2036)
- Future Year (2060)
- Performance during construction (2015)

The report is based on the proposed design of 1 Carrington Street, the potential Wynyard Station upgrade and future demand and operational assumptions provided by Transport for New South Wales. The analysis is based on normal AM and PM peak periods. Evacuation scenarios are covered within the fire engineering FEB report.

The report has considered previous documentation and responses for the proposal known as the CityOne Thakral Development.

2.1 Previous Comments

In preparing the pedestrian modelling analysis, the team have recognised the previous Concept Plan for the site known as the CityOne Development. Key comments raised as part of this submission are outlined below:

Responds to SCHEDULE 3, Future Environmental Assessment Requirements:

Detailed Pedestrian Modelling: *Any future application for works east of Carrington Street shall be provided with detailed pedestrian demand modelling to ensure the necessary exit widths will meet pedestrian demand to 2060 and to demonstrate the performance of proposed access ways and vertical transport (escalators, stairs, lifts etc..)*

Construction Management: *The Construction Management Plan shall be prepared in consultation with Transport for New South Wales and the City of Sydney and is to include consideration of the following: (b) pedestrian accessibility, legibility, safety and prioritisation.*

Responds to SCHEDULE 4, Statement of Commitments

Design-Concourse Areas: *The detailed design of the development east of Carrington Street is to provide a provisional minimum total combined pedestrian exit to the east via George Street and the Hunter Connection of 20metres (including the 4m width of the Hunter Connection) and unimpeded flow to the street. The detailed design of the eastern exit is to demonstrate that the unimpeded combined exist width to the east is via the most convenient route from the concourse to street level and must not be impeded by obstructions to pedestrian movement.*

(The developer) will undertake further pedestrian demand modelling to confirm that the 20 metre provisional total combined width of pedestrian exit to George Street (including the 4m width of the Hunter connection is the appropriate requirement to ensure the necessary exit widths to meet pedestrian demand to 2060.

2.2 Report Structure

The structure and content of the report is summarised below:

- **Chapter 3: Assumptions and Demand**

The chapter details the assumptions used within the dynamic modelling. In particular, Arup have estimated pedestrian demand within the precinct based on provided demand data to generate 2060 forecasts. This is a requirement based on the Director General's requirements for future development applications. Demand is represented at 2015 (for construction), 2036 (constrained station demand year), and 2060 (future rail initiative year).

- **Chapter 4: Geometry**

The chapter details the geometry used for the 1 Carrington Development as well as assumptions for Wynyard Station. The Director General's requirements noted that the development will *"ensure that the eastern concourse design will allow for full and seamless integration with the future Wynyard Station concourse designs west of Carrington Street"*. In addition to end state requirements, this chapter also notes the geometry used to assess the construction stages which allows justification of the Director General's requirements *"on how compliant access between George Street and Wynyard Station will be maintained"*;

- **Chapter 5: Methodology**

This chapter describes the process used for the pedestrian modelling assessment

- **Chapter 5: Results**

This chapter documents the results at 2015 (construction), 2036 (constrained existing station) and 2060 (future rail initiative)

3 Assumptions

3.1 Approach / Intent

The 1 Carrington Street development has been analysed to determine the (normal) pedestrian performance of the site with respect to the wider Wynyard precinct. The performance of the end state has been analysed for two future years: 2036 and 2060. For each year, the objective is to provide the necessary circulation widths and vertical transport to an agreed performance criteria.

The acceptance criteria used for the future years is to provide an average Level of Service (LOS) C Walkways or better for circulation spaces during the peak 15 minute periods of the day. Queueing at vertical transport elements is to be negligible. During construction the most onerous phase is tested to ensure an average LOS D Walkways or better performance is maintained.

Construction phase assessments have been undertaken for two methodologies: Central and Retained Central, in 2015. It has been assumed that Wynyard Walk will be open at this time.

3.2 Data Summary

The data used for the models has been based on pedestrian modelling reports provided by Transport for New South Wales. The AM peak period (08:00-09:00AM) and PM peak period (17:00-18:00PM) have been modelled for the future year scenarios. Demand within the AM peak covers arrivals from Rail, Bus, Ferry, Light Rail and Walking. In the PM period, we have also considered the demand as a result of retail activity.

The peak 15 minute periods analysed are:

- 08:30-08:45 in the AM period
- 17:05-17:20 in the PM peak period.

3.3 Future Demand (existing station)

The demand used for the first set of demand is based on the maximum number of passenger exits from Wynyard Station prior to relief from a potential 2nd Harbour Crossing. Analysis outlined within an AECOM report¹ has indicated that the maximum number of peak hour exits for this time relates to just over 35,000 passengers.

The AECOM report also provides an indication of the splits from the station and movement to/from Wynyard Walk and non-rail movements at 2021. In particular, the data provides the proportional splits of station demand to the Metcentre, Hunter Connection and George Street (north / south). We have used this dataset to create a new set for 2036. The key flows are highlighted in Figure 3.

We have assumed 20 people getting off a Light rail vehicle every three minutes heading to/from the office. No other light rail station behaviour is modelled.

¹ :“Wynyard Station Precinct Pedestrian Modelling Review”, 13th September, AECOM

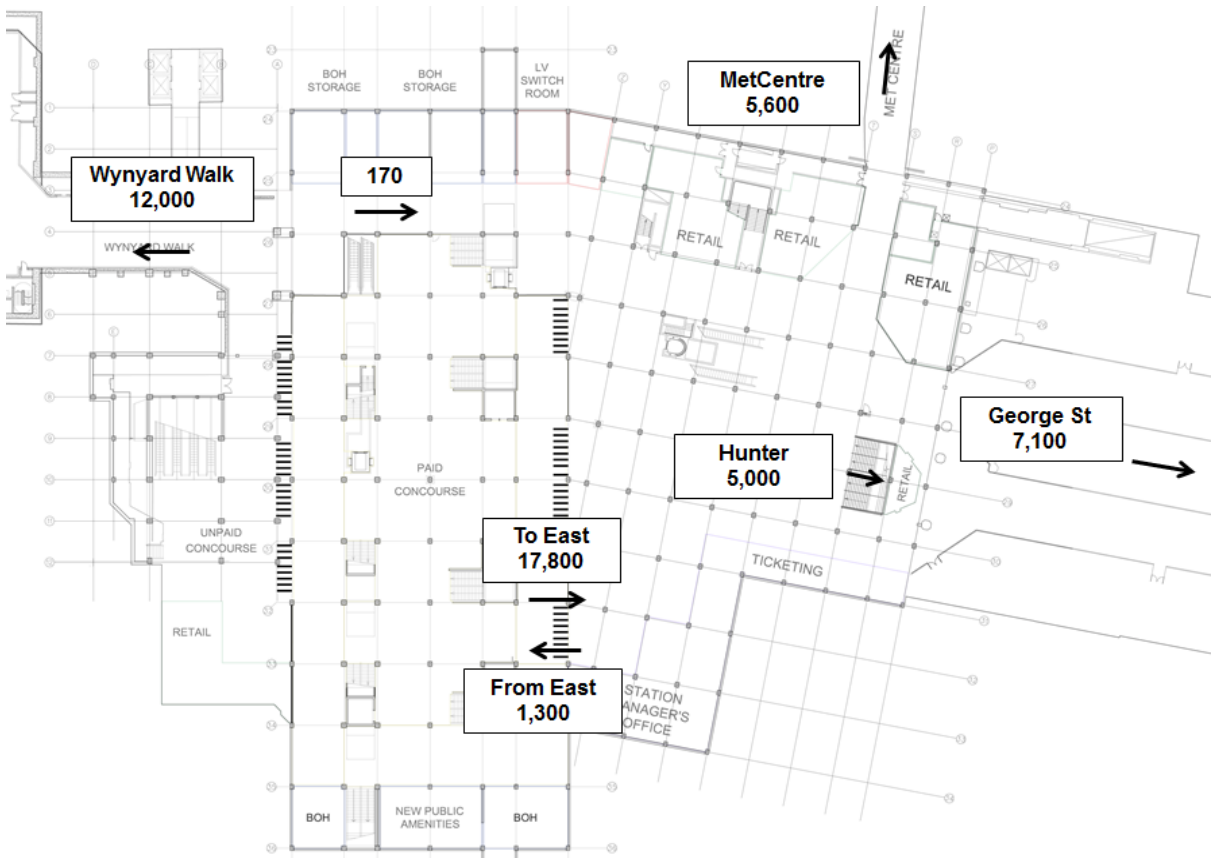


Figure 3 Station concourse splits at 2036

3.4 Future Demand at 2060

The previous DA Stage 1 responses for the CityOne development noted: “Any future application for works east of Carrington Street shall be provided with detailed pedestrian demand modelling to ensure the necessary exit widths will meet pedestrian demand to 2060 and to demonstrate the performance of proposed access ways and vertical transport (escalators, stairs, lifts etc..).”. Although the 2060 requirement has been noted, the detailed data forecasts for 2060 – reflecting the total demand and specific origin and destinations has not been provided by Transport for New South Wales.

In the absence of confirmed data, the design team has used the AECOM paper to generate a demand set suitable for testing. Our approach has been to apply an annual growth factor to the stated 2011 demand which reflects the long term trend.

Analysis of data provided by Transport for New South Wales based on the set “Heavy Rail Base and BITP High Barangaroo” scenario has indicated a growth rate of 2.1% p.a over a period of 20 years. The design team has used a growth rate of 2% p.a against 2011 demand to produce a forecast estimate of 58,000 AM peak hour exits at 2060. The 2% is likely to be conservative, given that the growth within the analysed period contains the introduction of the Barangaroo Development which will generate demand to Wynyard Station. For all other demand (e.g. background flows or bus demand) we have assumed an annual growth factor of 1% p.a.

Similarly to the previous data set used for our analysis, we have used the overall station demand as the basis to split demand within the precinct. In reality, a significant portion of the predicted station demand will originate from vertical transport (escalators) associated with a

potential new station within the Wynyard Precinct required to meet the forecast demand. Given details are not known/provided, we have assumed the demand originates to the east of the existing gateline as a proxy for a future station(s). The corresponding data set is provided in Figure 4.

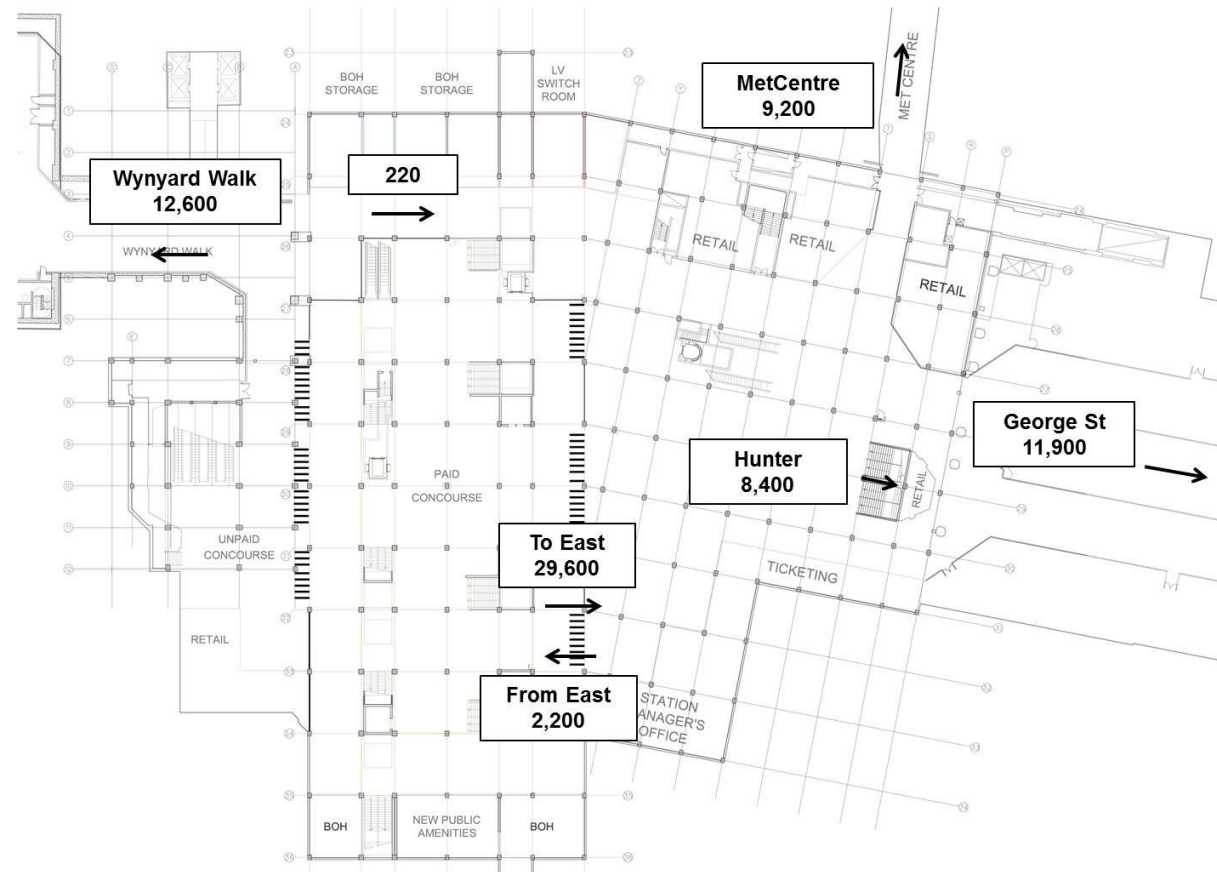


Figure 4 Station concourse splits at 2060

3.5 Construction Demand

The data for the 2015 construction scenarios was based on the AECOM *Wynyard Station Precinct Pedestrian Modelling Review* report. The design team has used 30,000 AM exits, and used directional splits based on a future occupancy of the Barangaroo development. This implies that the number of exits heading east of the station is approximately 15,700 in the AM peak period. The corresponding data set is provided in Figure 5.

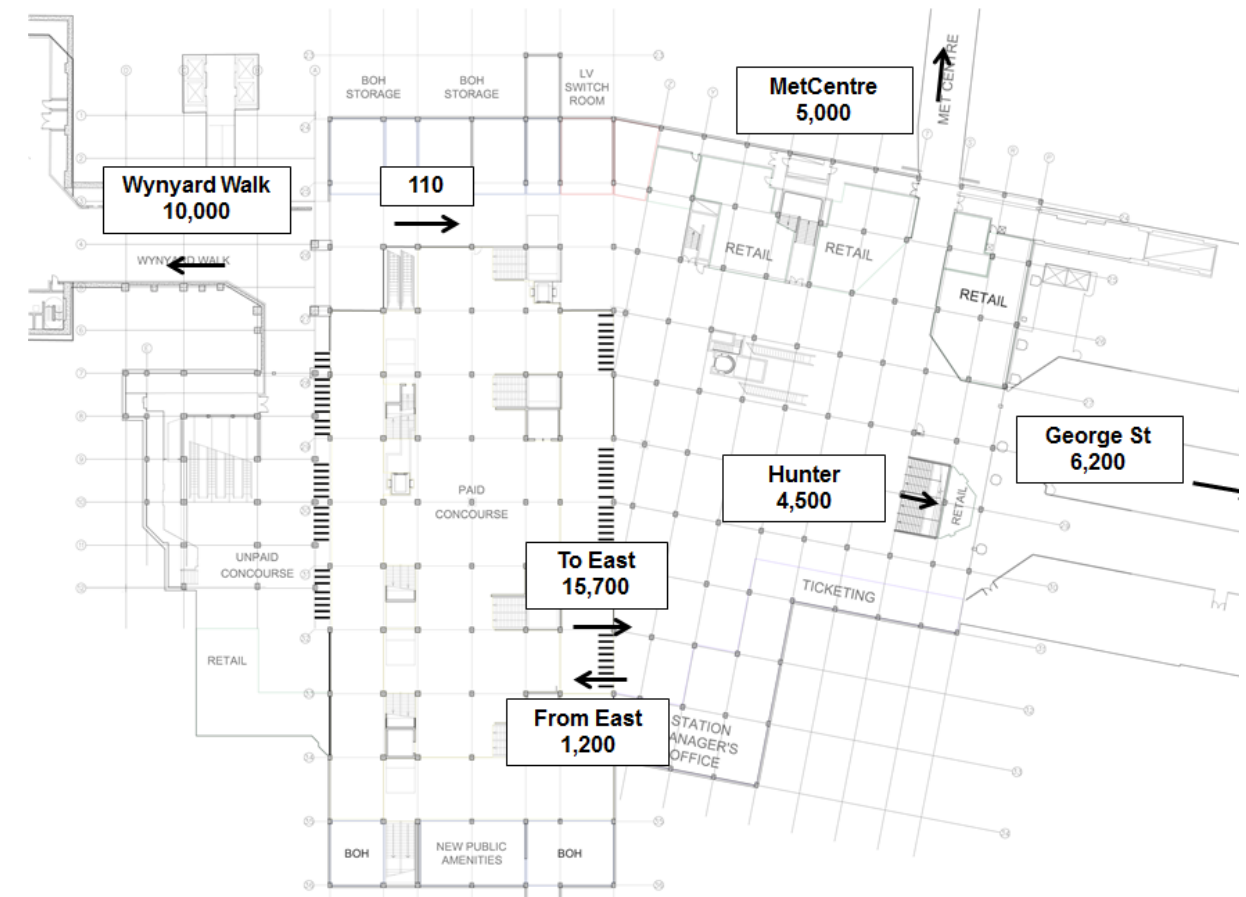


Figure 5 Station concourse splits at 2015

3.6 Other Assumptions

3.6.1 Timetable

The timetable used for all demand years is based on information provided within the AECOM report and reflects a 20tph service for P3/P4 and 16tph service for P5/P6.

For future demand at 2060, we have assumed the same timetable, yet the demand enters the models adjacent to the eastern station gateline.

3.6.2 Vertical transport Capacities

Escalators and stairs within the model are capped to 100 people per minute and 50 people per metre per minute. For stairs, this is the maximum permitted rate even though research has shown that we can provide higher rates albeit for short durations. These are maximum capacities, and not targets.

3.6.3 Gateline Capacities

The capacity of the each gate is capped at 30 people per minute per gate. This provides an average max gateline capacity of 25 people per minute per gate.

3.6.4 **Bus Operations (Carrington Street)**

The modelling has not included detailed operations of bus movements and passenger queuing behaviour along the west side of Carrington Street. However, where pedestrians are noted as crossing Carrington Street, then the volume and desire lines are noted. We assume that passenger pick up maintains as per existing situation during the PM peak period (i.e. from western pavement) and as such the 1 Carrington Street design does not spatially alter the existing conditions.

3.6.5 **Hunter Connection /Met Centre**

The previous Concept response requested that any future development applications to consider pedestrian modelling at 2060. The design team have provided geometry within their boundary and provided associated circulation and vertical transport suitable for the projected demand. However, other circulation zones around the site have not been modified to reflect any possible future changes. The two notable areas are the Metcentre as well as the width of the Hunter Connection directly under George Street.

3.6.6 **PM demand**

For the PM demand we have taken 80% of the AM peak hour demand and reversed the origin-destinations. We have also included additional demand, approximately 2,500 pedestrians, to reflect shopping behaviour within the 1 Carrington Street Development. The retail demand has been estimated based on NLA of available retail and that there are two cycles of and previous retail studies. It has been assumed that 20% will originate for the north-eastern portion of the site and 80% from the south-eastern portion.

3.6.7 **Escalator Operations**

Escalator operations have been assumed for the three escalator banks within the development. Assumptions have been based on peak directional flows and refined based on observation of model behaviour. Table 1 details the directionality of the escalators within the 1 Carrington Street development.

Table 1 Escalator operations used for all years

Escalator Bank	Peak Period	Direction
Concourse - Hunter Connection	AM	1 up, 1 down
	PM	1 up, 1 down
Concourse - George Street	AM	5 up, 1 down
	PM	3 up, 3 down
George Street - 1 Carrington Street	AM	1 up 1 down
	PM	1 up 1 down

4 Geometry

4.1 Wynyard Station

The modelling has assumed a potential Wynyard Station upgrade based on information provided by Transport for New South Wales. This is important as the capacity of the gateline contributes to the rate in which passengers can leave the station and enter the 1 Carrington Street site at concourse level. We have modelled the station based on information provided by TfNSW, reflecting Phase 12 of the “0.9 Constructability report, 27th July 2012”.

4.2 End State

The designs tested are based on the following drawings (based on DA2004 ,DA2005, DA2006 and DA2007). The key levels which influence the movement of pedestrians through the site are provided in Figures 3 to 5. Circulation of ~16m has been provided from station concourse to 1 Carrington Street Concourse. 10m of width is provided to accommodate both a stair (~5m) and 2 escalators to the Hunter Connection. The design meets the Director Generals requirements.

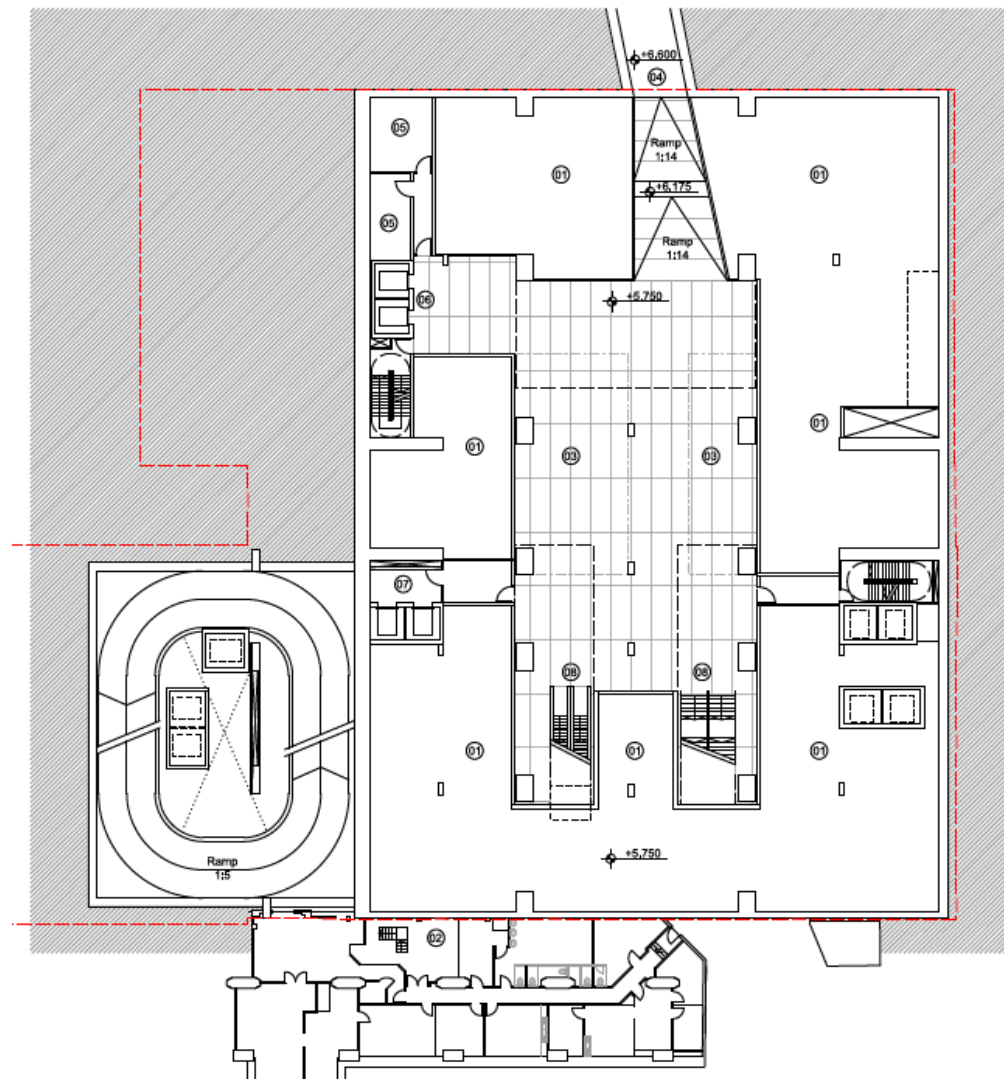


Figure 6 Hunter Connection

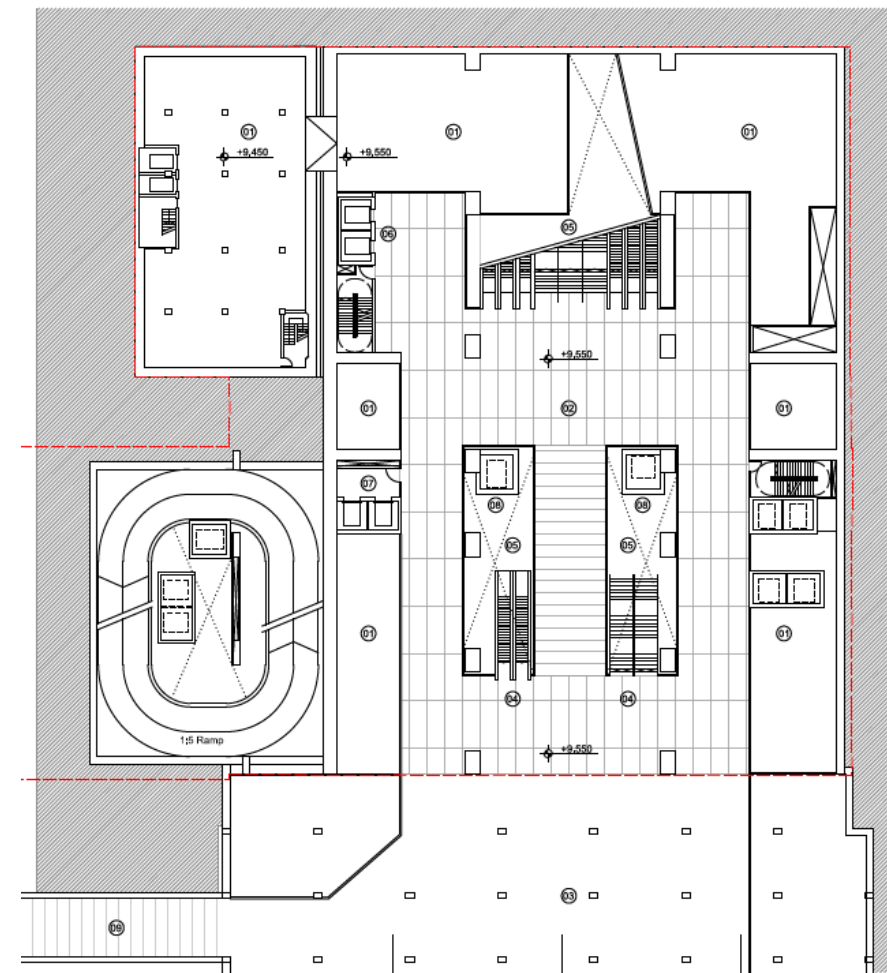


Figure 7 Concourse Level

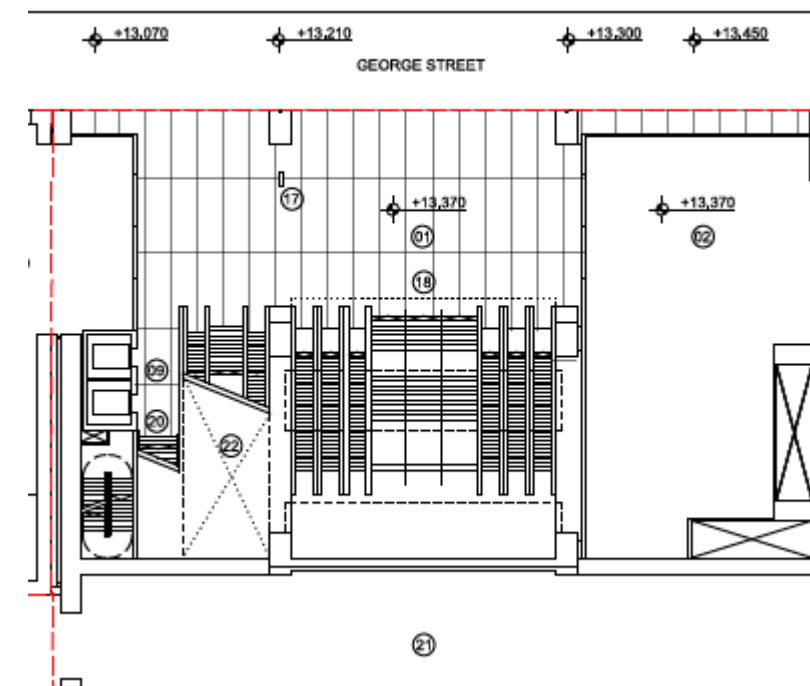


Figure 8 George Street Level

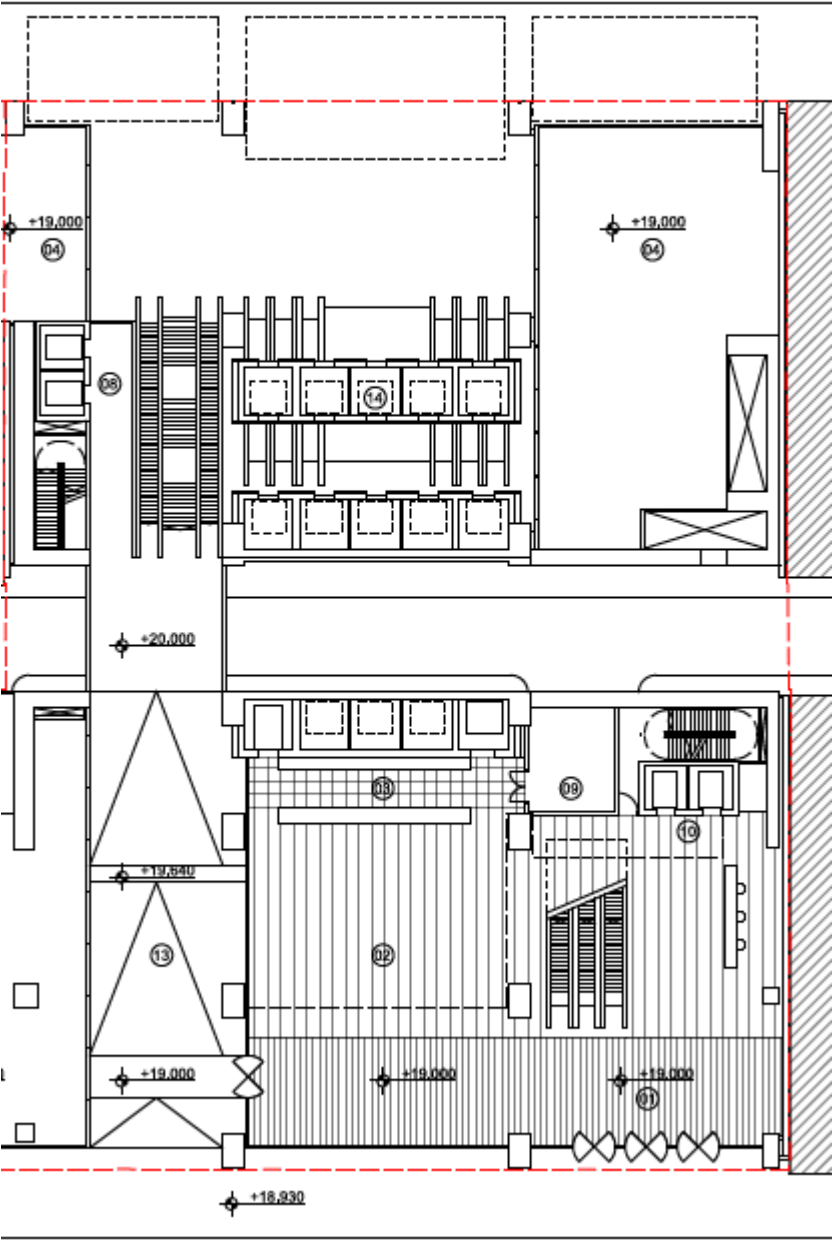


Figure 9 Carrington Street Level

4.3 Construction Methodologies

The intent during construction is to:

- preserve access;
- provide safe and efficient movement of pedestrians recognising desired origin-destination pairs, and consequential impacts on surrounding pedestrian network;
- maintain station operations and servicing to adjacent properties
- minimise duration of the construction works and opportunities for early handover

Construction methodology options were presented to Transport for New South Wales and outlined in the presentation *TfNSW Phasing Presentation 140122.pdf*. Following from this meeting, a preferred construction methodology option has been produced. This is referred to in this document as the *Preferred Construction Methodology* and relates to drawings produced 28 February 2014.

The first methodology minimises the risks of pedestrians travelling through a construction site by closing access to the two George Street ramps as well as access to Hunter arcade. This methodology is referenced as the '*Central option*'. Two sets of 2 x 3m temporary scissor stairs are installed which connect the concourse level to east side of Carrington Street.

The second methodology is referenced as the *Retained Central Option* involving the removal of the George Street ramps, to be replaced by a single 7m wide walkway connecting to a set of stairs up to George Street. These stairs form part of the completed building. The walkway section of the Hunter Connection will remain open in this scenario.

Following the analysis of these two options, a further design option has been proposed by Brookfield. This construction methodology is outlined in *03 - Construction Phasing Diagrams (Plans) for DA CMP 140228.pdf, Brookfield Multiplex, 28th February*. In essence the design is a variant on the *Retained Central Option*. In this option, Phase 1 closes the Hunter Connection for 4 months, with both ramps to George Street being maintained. In Phase 3, the Hunter Connection is open, and a modified southern ramp with a clear width of at least 5.5m is provided.

The most onerous phase within each methodology (Phase 2 for the first two, and Phase 3 for *Preferred*) has been tested.

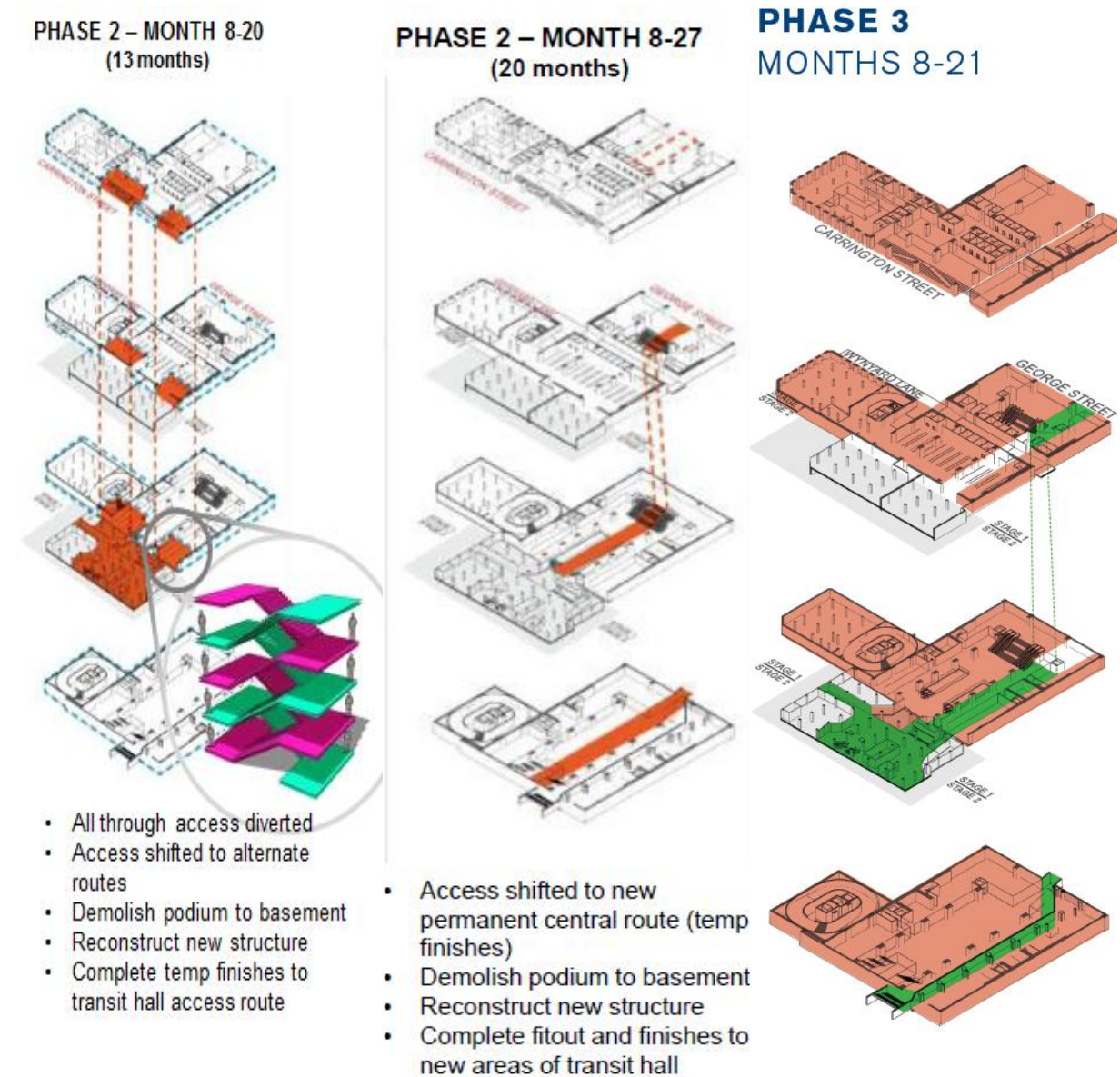


Figure 10 Most onerous stage for *Central*, *Retained Central Options* and *Preferred Options* respectively

For all construction methodologies the following operations were assumed:

- Wynyard Walk is open
- A sensitivity test has been conducted with directional changes to the escalators between the concourse and the Wynyard Park rotunda. The test determines if running both escalators in the upward direction would relieve some of displaced demand resulting from the removal of the George Street ramps and Hunter Connection.
- No reduction in demand through the precinct as a result of the construction activities. In reality, we may have some reduction in demand or a shift in arrivals/departures as a result of construction activities.

5 Methodology

5.1 Dynamic Modelling - MassMotion

Dynamic pedestrian modelling of the 1 Carrington Street development was undertaken to assess the performance of the design. The site forms a major part of the Wynyard Precinct which forms a critical east-west city link from Barangaroo to the west through to Pitt Street to the east.

Our approach has been to model the whole Wynyard Precinct, recognising that the site is impacted by a range of pedestrian connectivity opportunities and different arrival/departure modes. Figure 11 shows the extent of the model. The model is in 3D reflecting the various level changes around the precinct. Connections have been included to reflect movement through the Metcentre as well as movement through the Hunter Connection to Pitt Street as well as connections to the west via the Wynyard Walk. Although the model reflects a wide precinct area, the analysis for this study is focussed on areas to the east of the existing station.

Note our modelling reflects a George Street pavement width of 5.5m and does not consider wider pavements as a result of the pedestrianisation project. As such, the reporting for George Street pavements is likely to be a worse case.

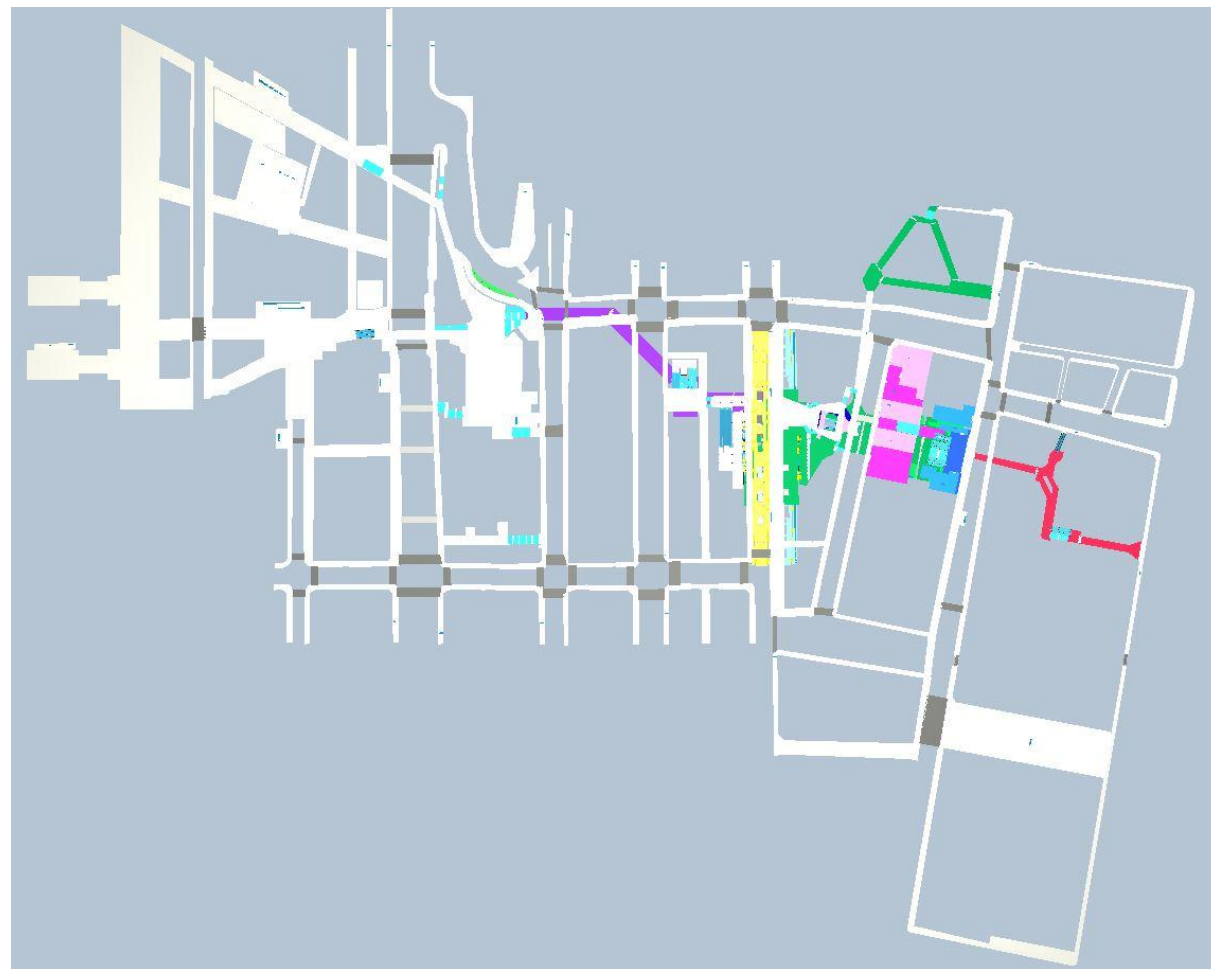


Figure 11 3D model of Wynyard Precinct

5.2 Criteria Adopted

The models have been assessed in consideration of the following:

- Provide a continuous and easy route between station entries, operational and customer facilities
- Incorporate connections between the station and surrounding local context, public roads and spaces to provide safe and direct pedestrian links.
- Provide connections to other modes of transport which are as direct as possible.
- Accommodate anticipated (vertical transport) queues free of obstructions both in regular and peak conditions
- Satisfies the Fruin Level of Service C Walkways during peak 15 minutes

The pedestrian assessment is based on the Fruin Level of Service (LOS) principles (Fruin, 1971), which are internationally used and recognised. The principles are based on research into how much space is required per person, to allow a certain level of comfort. This can be summarised as LoS A, which represents a comfortable LoS, where free movement is possible and pedestrians do not interrupt each other's movement and LoS B, which allows for comfortable circulation, so that people can freely select their own walking speed, through to LoS F where a breakdown of flows may occur.

Figure 12 illustrates the pedestrian density associated with each level of service.



Figure 12 Fruin Level of Service

For this investigation an average LOS C should be provided for the future year assessments on walkways for the peak 15 minutes of the peak periods. For the construction phase an average LOS D should be provided.

6 Results – End State

The following sections provide results direct from the pedestrian simulation models across the peak 15 minutes for each demand year and peak period. The colours reflect Fruin Level of Service metrics (for walkways and stairs as appropriate). As noted in section 5.2, the criterion assessed is against:

- A Fruin LoS C (walkways) during the peak 15 minutes.
- Appropriate vertical transport to cater for estimated demands
- Intuitive, direct and continuous access

6.1 Future Demand (2036)

6.1.1 AM Demand 2036

Hunter Connection

The performance of the Hunter Connection shown in Figure 13 is predominantly LoS B at 2036 although the performance decreases to LoS C directly underneath George Street (outside of the project boundary) as the corridor narrows to under 4m. The performance associated with Hunter Connection within the site boundary is therefore excellent and suitable for a retail environment. Through the retail area a walkway width 4.6m should be maintained to achieve the results shown in the analysis. Furniture will need to consider these desire lines.

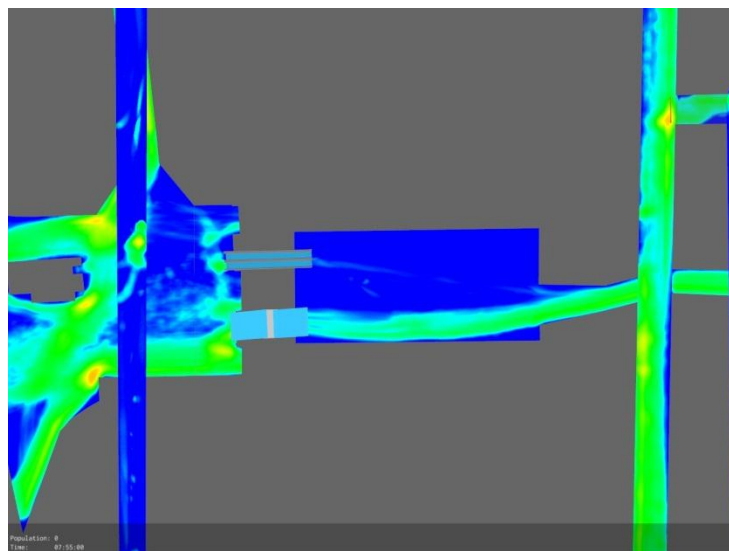


Figure 13 Average density (Fruin Walkways) AM -2036 -Hunter Connection

Concourse Level

Figure 14 shows the performance during the peak 15 minutes at the concourse level. All areas operate at Level of Service C or better. Indeed the northern part of the site performs at LoS A /B. The south side operates at Level of Service C because:

- Locality of the station's gateline.
- There is a greater proportion of George Street demand that heads south than north.

If the modelling has exaggerated these two impacts and greater demand originates from the central part of the station's concourse, then there is sufficient room in the centre and northern parts of the concourse to provide excellent performance across the site. Minimal queueing is shown at the base of escalators. Stair use from concourse to George Street is negligible showing additional capacity if required. The south retail outlets should be such that they do not encourage queueing within the circulation.

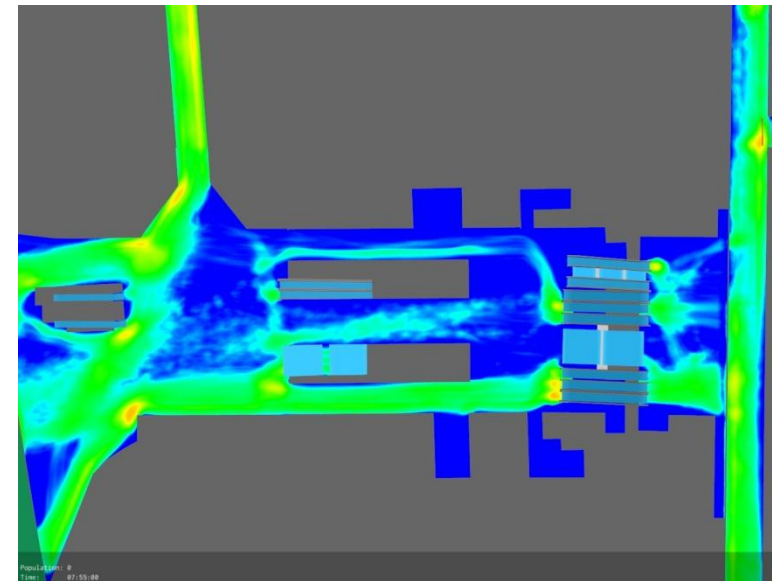


Figure 14 Average density (Fruin Walkways) AM -2036 -Concourse

Carrington Street Level

Link between George Street and Carrington operates at LoS A, implying that there is sufficient capacity to cater for additional through link pedestrian movement. The number of people crossing Carrington Street in the models is approximately 1,300 people during the peak hour. The Carrington Street crossing has been modelled to simulate J-walk behaviour. There is a clear desire line to cross Carrington Street mid-block to access the office and walkway through to George Street.

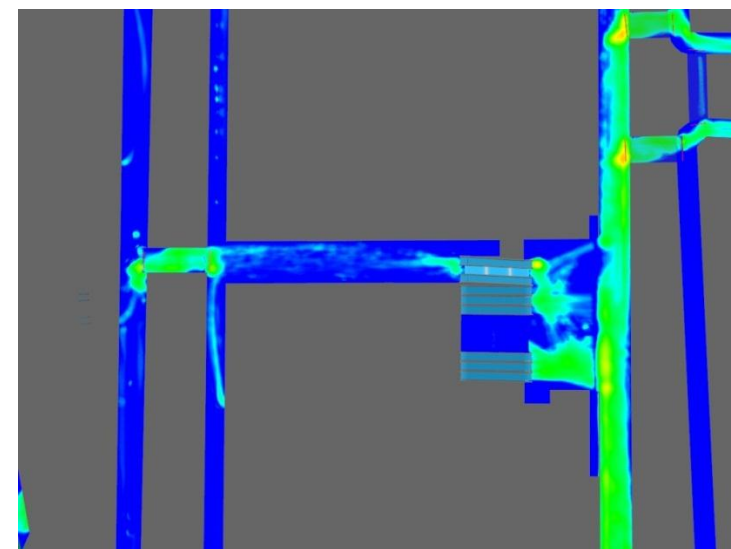


Figure 15 Average density (Fruin Walkways) AM -2036 - Carrington Street

6.1.2 PM Demand 2036

Hunter Connection

The performance of the Hunter Connection shown (Figure 15) during the PM peak period is predominantly Level of Service A. People choose to use the escalators from Hunter to the concourse given their higher amenity. Minor queuing at the base of the escalators occurs but this is due to pedestrian choice as the nearby stair is significantly underutilised.

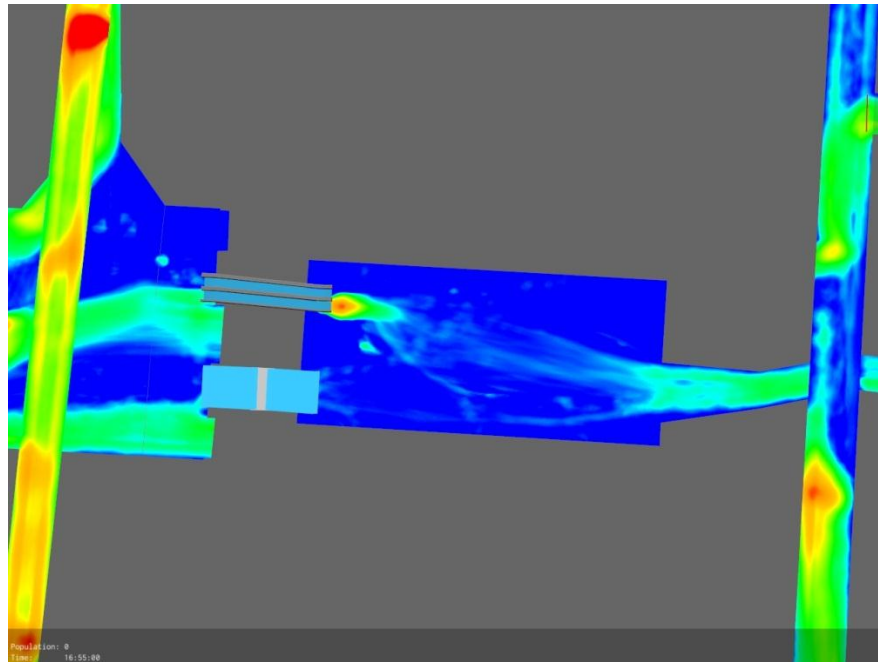


Figure 16 Average density (Fruin Walkways) PM – 2036 - Hunter

Concourse Level

The south side of the concourse is more utilised given the George Street demand is predominantly (60:40) from the south. However, all areas operate at comfortable Level of Service C and with direct and continuous access the design meets guidelines and previous DA Stage 1 comments.

George Street west pavement operates at Level of Service C with one small pocket of Level of Service D/E at the south side. This is caused by bi-directional flow on the pavement between non-rail pedestrians and movement into the building. As noted previously we have not assumed pedestrianisation of George Street in our models and as such, the performance is a worse case response. With a wider pavement, these congestion issues will be minimised.

Carrington Street Level

The number of people crossing Carrington Street in the PM peak hour is 3250 people. In the PM there is a desire line between the office and the rotunda to access Wynyard Station (rather than via George Street entry) and the bus stops on the western side of Carrington Street (buses are not modelled in detail). Further analysis is required to understand what treatments are feasible at the midblock given the demand, and opportunities for signalisation subject to RMS providing warrants. This requires a review of bus operations and wider Transport for New South Wales strategies to allow the storage and safe movement of pedestrians crossing Carrington Street, recognising the performance of existing conditions.

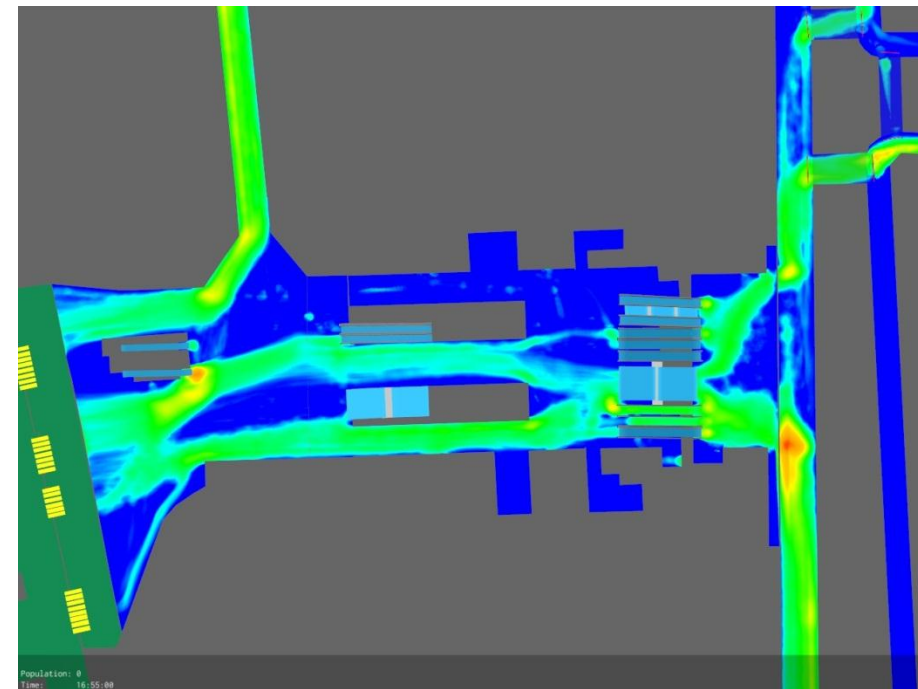


Figure 17 Average density (Fruin Walkways) PM – 2036 - Concourse

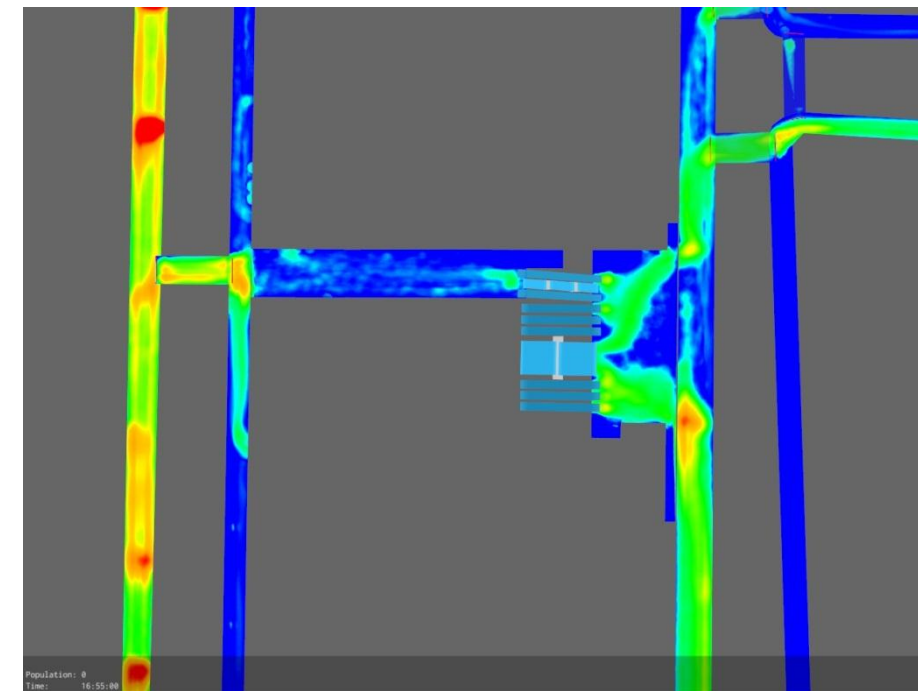


Figure 18 Average density (Fruin Walkways) PM – 2036 – Carrington Street

6.2 Future Demand at 2060 (with additional infrastructure)

6.2.1 AM Peak - 2060

Hunter Connection

The performance of the Hunter Connection shown in Figure 19 during the peak 15 minutes is Level of Service C. Level of Service D performance is observed along the Hunter Connection underneath George Street as the corridor narrows to under 4m. The vertical transport to the Hunter connection performs well with negligible queuing at both the stairs and escalators.

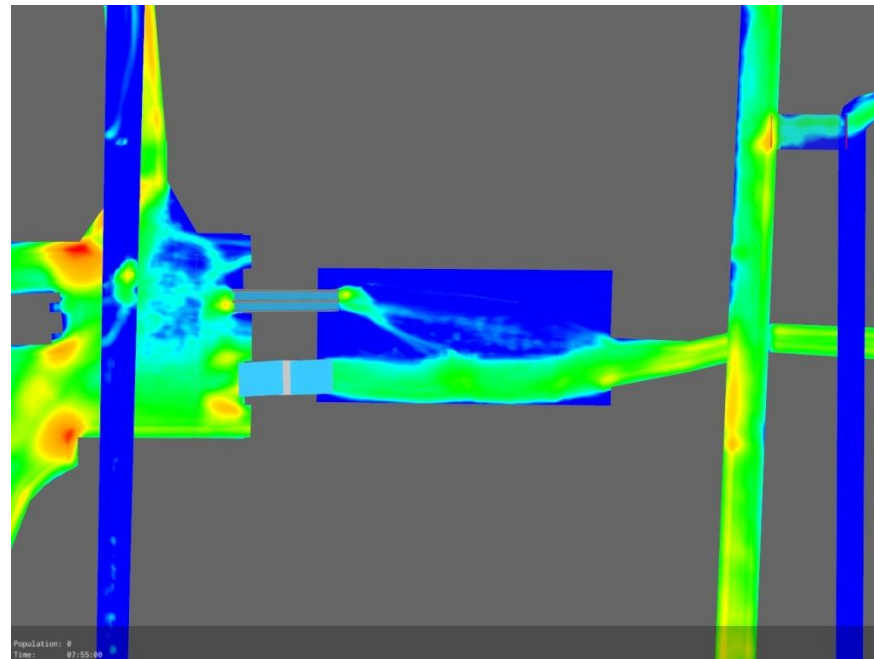


Figure 19 Average density (Fruin Walkways) AM – 2060 – Hunter Connection

Concourse Level

Modification to the concourse was necessary to achieve a continual flow in a 2060 AM scenario where agents were allowed to select routes. The Metcentre ramp was widened to 6.5m in the analysis shown here. Arup have also kept the Metcentre ramp as is and all additional traffic which the Metcentre cannot comfortably accommodate is transferred to the George Street node. The result is shown in Figure 21.

At 2060, the concourse is predominantly Level of Service C. However, there are areas which show Level of Service D. These are noted in Figure 20 and referenced below

1. The main issue at 2060 is that the Metcentre cannot cater for future demand. Those passengers heading to Bond Street still would benefit from going via Metcentre rather than via the 1 Carrington Street site. We have tested a variety of scenarios including widening MetCentre by 1.5m (as a proxy for future opportunities to change retail façade line) and shifting the excess demand from Metcentre through the 1 Carrington Street site to understand if the demand can be accommodated. The results (Figure 20 and Figure 21 respectively) show that our design is flexible to accommodate this demand – if passengers choose to shift. Escalators in this case are at capacity, but their queue zones are appropriate and the stair is still underutilised.
2. Localised pinch point caused at the corner of the Carrington street escalators
3. There is a localised pinch point caused at the corner of retail which could be mitigated by the design of retail at this corner and minor modifications to gateline placement on the east side.

The results indicate that a change (number / placement) to the Carrington Street escalators (to the Rotunda) should be investigated as well as the future traffic through the Metcentre. However, these elements are outside of the boundary of the 1 Carrington Street site, and indeed the 1 Carrington Street site provides relief of movement if future works are necessary.

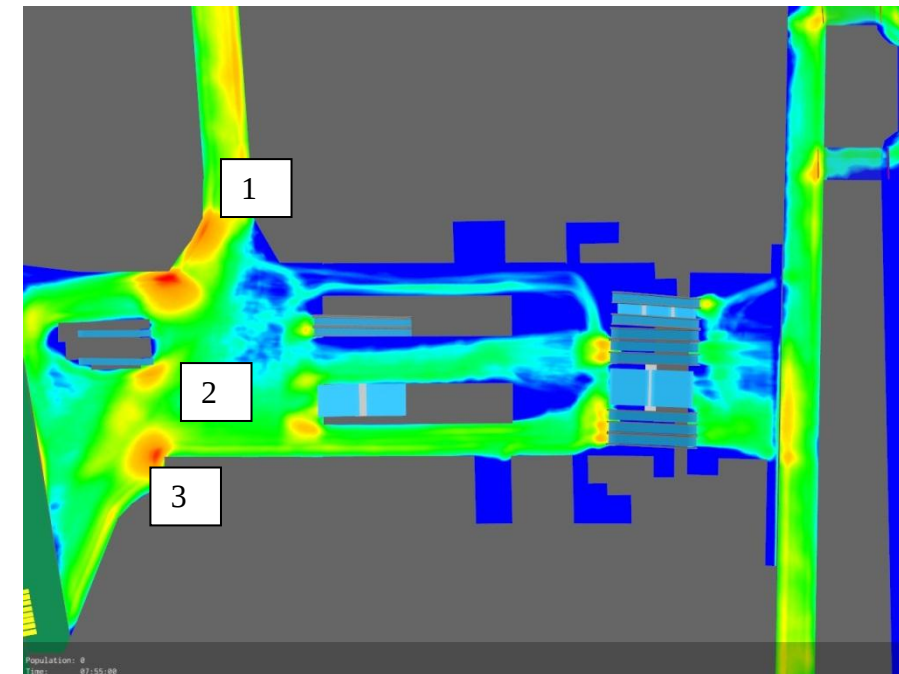


Figure 20 Average density (Fruin Walkways) AM – 2060- Concourse (Metcentre widened)

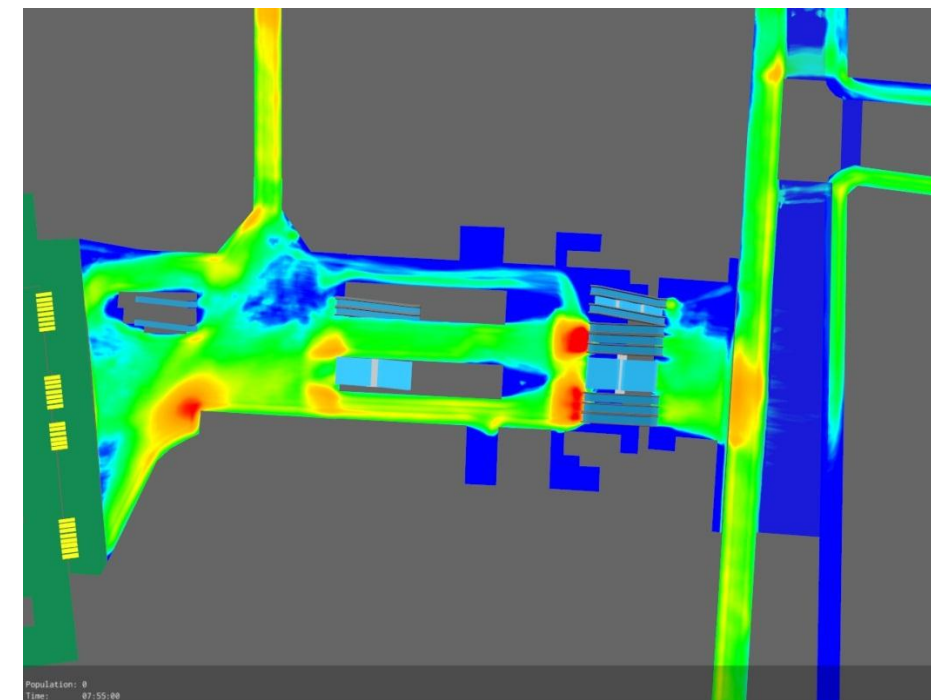


Figure 21 Average density (Fruin Walkways) AM – 2060- Concourse (Metcentre demand transferred)

Carrington Street Level

Link between George Street and Carrington operates at LoS A, implying that there is sufficient capacity to cater for additional through link pedestrian movement.

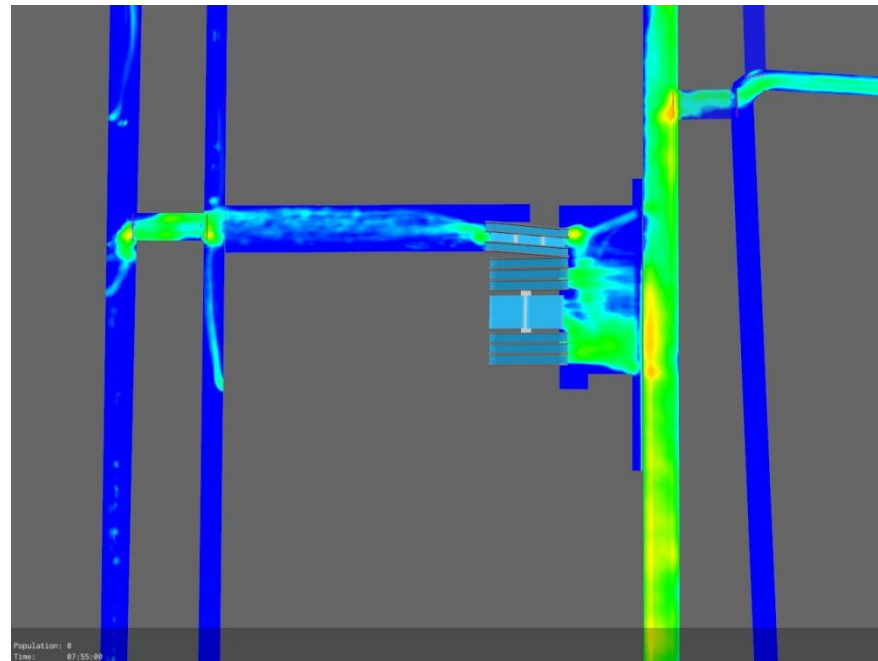


Figure 22 Average density (Fruin Walkways) AM – 2060 - Carrington Street

6.2.2 PM Peak – Demand 2060

Hunter Connection

The performance of the Hunter Connection shown (Figure 23) during the PM peak period is predominantly Level of Service B/C. People choose to use the escalators from Hunter to the concourse given the higher amenity. In the tested operation, we have assumed a one Up, one Down configuration, whereas a 2 UP operation may be more appropriate given the level of queueing. The stair is still highly underutilised indicating there is sufficient vertical transport to cater for the demand. If necessary, an additional escalator would provide flexibility and redundancy, but from a capacity perspective is not required. Indeed, given the 4m limitation under George Street, the amount of vertical transport is appropriate and balanced.

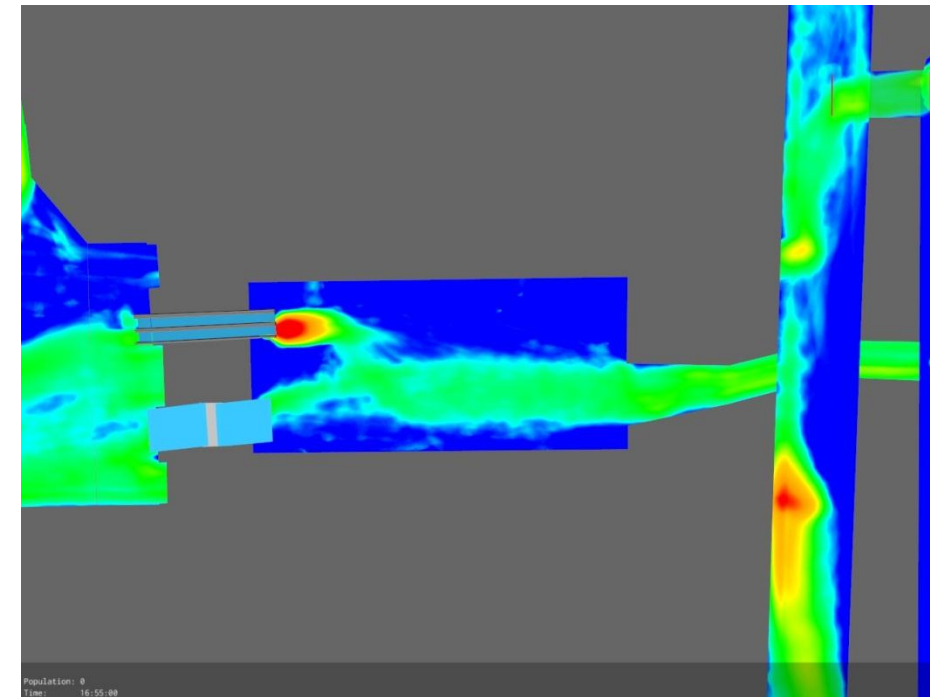


Figure 23 Average density (Fruin Walkways) PM – 2060 - Hunter

Concourse Level

The predominant performance of the concourse is Level of Service B/C. Pockets of poorer service is observed and referenced in Figure 24. Commentary for each of these three points is given below.

1. Metcentre. Level of Service D is observed along the Metcentre which is outside of boundary of 1 Carrington Street development.
2. Three pedestrian desire lines meet in this location; station central gate bank to Metcentre, Hunter Connection escalators to central gate bank, and pedestrians alighting off the escalators to the station gates.
3. George Street demand and pavement width is insufficient. However these models do not assume pedestrianisation of George Street.

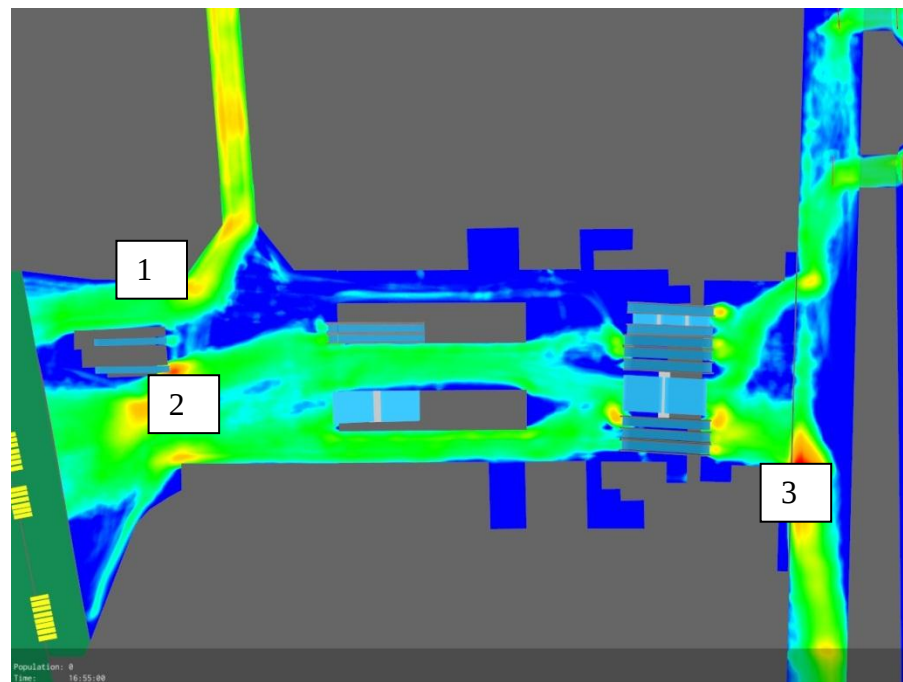


Figure 24 Average density (Fruin Walkways) PM – 2060 - Concourse

Carrington Street Level

The demand to the buses has been increased by 1% from the 2036 demand (rather than 2% rail demand) given constraints on curb capacity along Carrington Street. Again, detailed bus queueing has not been modelled. The through link is activated by bus demand as well as from the commercial demand. A review and further analysis with future bus movements is required to understand the opportunities for safe storage and movement across Carrington Street. The crossing demand is estimated to be 3415 pedestrians across the hour. Areas which are red reflect the bus waiting areas (colours reflect Fruin walkways, not Fruin Queueing). Detailed queueing behaviour for the buses has not been modelled.

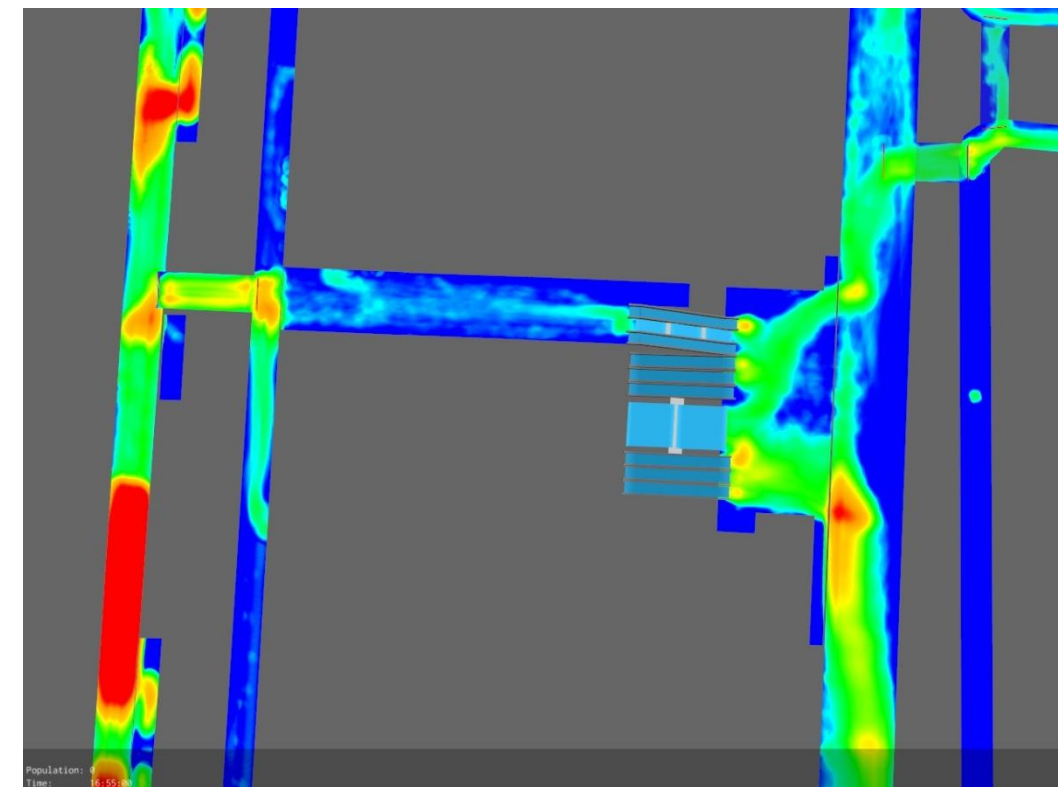


Figure 25 Average density (Fruin Walkways) PM – 2060 – Carrington Street

6.3 DDA Movement

Arup have estimated the theoretical handling capacity of the two retail passenger lifts serving the Hunter Connection level, Concourse and George Street. Demand forecasts have been calculated to estimate the number of people with mobility impairment (who are unable to use stairs or escalators). We have assumed the following:

AM 2036 Demand (exiting)

- 17,800 going east
- 7100 going to George, 5000 going to Hunter Connection
- 3% of the population will require lift usage (over stairs and escalators)

For passengers using to the Hunter Connection we have assumed these passengers will use the vertical transport at the George Street node.

- So 3% of Hunter/George = 363 people per hour
- Additional 22 people per hour from Barangaroo / Ferry (from Wynyard Walk)

Arup have then simulated system performance using the below design assumptions.

- A total DDA passengers requiring lift access = 385 passengers per hour.
- A balance of incoming, outgoing and inter-floor traffic profile.
- A 5 minute handling capacity of 10% to allow for some up lift.
- George Street nominated as the main entrance floor.
- Max car loading of 50% to accommodate additional space for wheelchairs, prams and the like.

Based on the above, the analysis provides an estimated average waiting time of 20 seconds. A doubling of demand (to reflect a future scenario) results in an average waiting time of 45 seconds. Based on the above design assumptions it is our opinion that retail passenger lifts are sufficient to provide DDA services with sufficient surplus capacity for other users.

7 Results – Construction - 2015

The subsequent sections outline the performance of the two construction options during the peak 15 minutes at 2015.

7.1 Central Option

The Central option proposes two sets of 2 x 3m scissor stairs rising 12m between the concourse level and Carrington Street.. A 12m rise is significant and equivalent to walking up 3 floors in a commercial building. The dynamic model applies a penalty for using the stairs but this is based on research comparing stairs to escalators in the 5-6m range. Given the stairs reflect a rise of 12m, an additional penalty, and equivalent to 2m per tier has been applied.

For the Central Option, the following key points are noted:

1. Metcentre operates at Level of Service E as those that would currently choose the George Street north ramp switch routes with a higher percentage preferring the Metcentre than the temporary scissor stair.
2. Those passengers wishing to head south on George Street have the option of the temporary stairs and the Carrington escalators up to the Rotunda. Both escalators are set in the upward direction. The noticeable queueing at the base of the Carrington escalators reflects the preference for the escalators in comparison to the stairs. The eastern pavement along Carrington operates at LoS B/C – which is acceptable during construction and no worse than Wynyard Walk diversions via Margaret Street. The operation of the escalators has impacts to retail shopping at Coles.
3. The additional movement along George Street as a result of the closure of Hunter Street puts pressure on the crossings along George Street. Background flows in these areas have not been modelled, so care needs to be taken about the viability of this pavement width to accommodate this flow.
4. Activation of retail outlets around the existing entry of Wynyard Station on George Street is reduced.
5. Movement by patrons with a reduced mobility that would have used the ramps would be required to use either the Metcentre (for travel northwards) or will use the Rotunda lifts to head south. The increased pedestrian movement to the Rotunda escalators and onwards to Carrington Street will need to be investigated further to understand the impacts with respect to pedestrians with disability impairment.

The option has a number of challenges given the impact to the Metcentre and the behaviour associated with the Rotunda escalators.



Figure 26 Average density (Fruin Walkways) for peak 15 minutes in AM, 2015 during construction stage, Central Option

7.2 Central Retained Option

For the Central Retained Option, the following key points are noted:

1. Metcentre operates at Level of Service C
2. The central portion of the George Street connection and Hunter Connection operates at LoS C.
3. The performance during the AM is similar to existing conditions.

The minimum corridor width required to maintain LoS C on a George Street connection is estimated to be 5.5m, if gateline throughput is maximised.



Figure 27 Average density (Fruin Walkways) for peak 15 minutes in AM, 2015 within Concourse, Central Retained Option

7.3 Proposed Construction Methodology

Following the analysis of these two options, a further phasing option has been proposed by Brookfield. This construction methodology is outlined in *03 - Construction Phasing Diagrams (Plans) for DA CMP 140228.pdf, Brookfield Multiplex, 28th February*. In essence the design is a variant on the *Retained Central Option* and provides a southern access to George Street.

In Phase 1, the Hunter Connection is temporarily closed (4 months) and all Hunter Connection patrons are assumed to use the existing George Street ramps. Pedestrians using the Hunter connection can be accommodated within the two existing 7m ramps provided to George Street.

Phase 3 provides >5.5m of accessible width which provides LoS C even if the gateline throughput is maximised. These widths assume no retail activity along this route, or any obstructions (e.g. buskers / entertainment). This phase has been dynamically modelled and the corresponding peak 15 minute density map is provided in Figure 28. A small reduction in stair width to Hunter (8m to 6m) has been assumed to improve the performance of the route from gateline to southern modified ramp.

The pedestrian performance of the preferred construction plan is similar to performance of the *Retained Central Option*. I.e. that during the peak 15minutes, the performance is Level of Service C (walkways).

The *Central Retained* and *Preferred Options* are preferred from a pedestrian movement perspective.

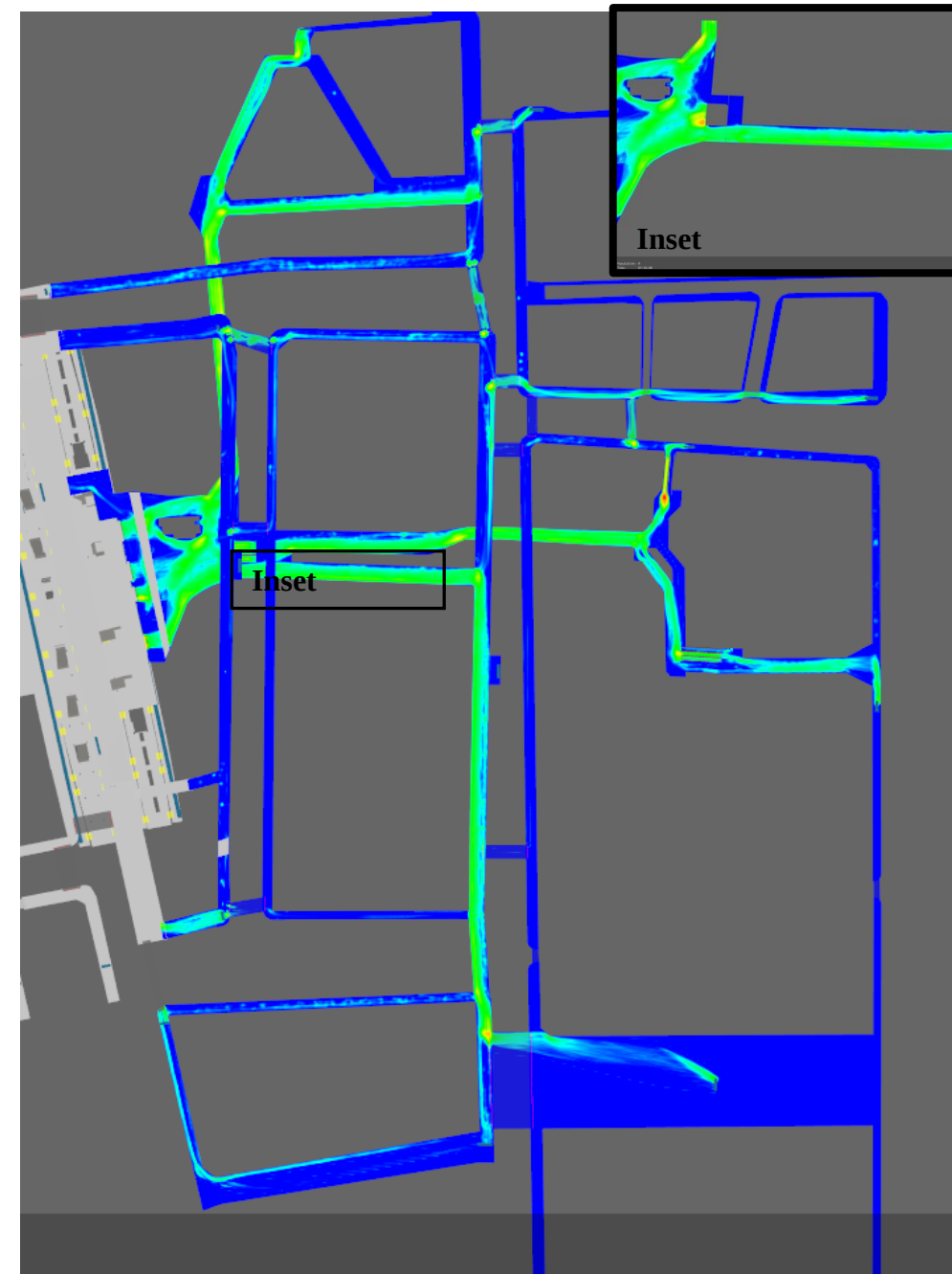


Figure 28 Average density (Fruin Walkways) for peak 15 minutes in AM, 2015 within Concourse, *Preferred Option*