Department of Planning and Infrastructure

Issue

Independent Transport Review

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1 Introduction

1.1 Background

The NSW Department of Planning and Infrastructure ("The Department") is currently assessing a major project application (MP09_0216) for a mixed-use development on the Shepherds Bay foreshore, within the Meadowbank Employment Area (MEA). In April 2012 Arup was appointed by The Department to provide independent transport advice relating to the proposed Concept Plan for the site. Information from Arup to The Department was provided in the form of verbal advice through meetings as well as through the following formal reports:

- Independent Transport Assessment (*Arup, 29 June 2012)*
- Response to Proponent's Recommendations (*Arup, 29 June 2012)*
- Stage 1 Advice (*Arup, 31 August 2012*)
- Review of Traffic and Transport Report (*Arup, 6 September 2012*)
- Response to TfNSW Submission (*Arup, 8 October 2012)*

1.2 Consultation

During the course of the review, Arup conducted consultation with the following agencies and stakeholders:

- Department of Planning and Infrastructure
- Transport for NSW
- Roads and Maritime Services
- City of Ryde Council
- The Proponent, comprising of:
    - The Holdmark Group
    - Robertson and Marks Architects
    - Varga Traffic Planning
    - Road Delay Solutions

1.3 Site Description

The Meadowbank Employment Area (MEA) is located in the south-western area of the Ryde Council Local Government Area (LGA). It is bounded by the railway line to the west, Constitution Road and Junction Street to the north, Church Street to the east and the Parramatta River to the south.

The Concept Plan site has a total site area of 6.8 hectares, and encompasses approximately 30% of the total MEA site. The key roads fronting the site are Constitution Road, Bowden Street, Belmore Street and Rothesay Avenue. Hamilton Crescent and Nancarrow Avenue provide localised vehicular access to the existing industrial land uses.

The indicative site areas and location for both the Concept Plan site and the wider Meadowbank Employment Area are shown in Figure 1.

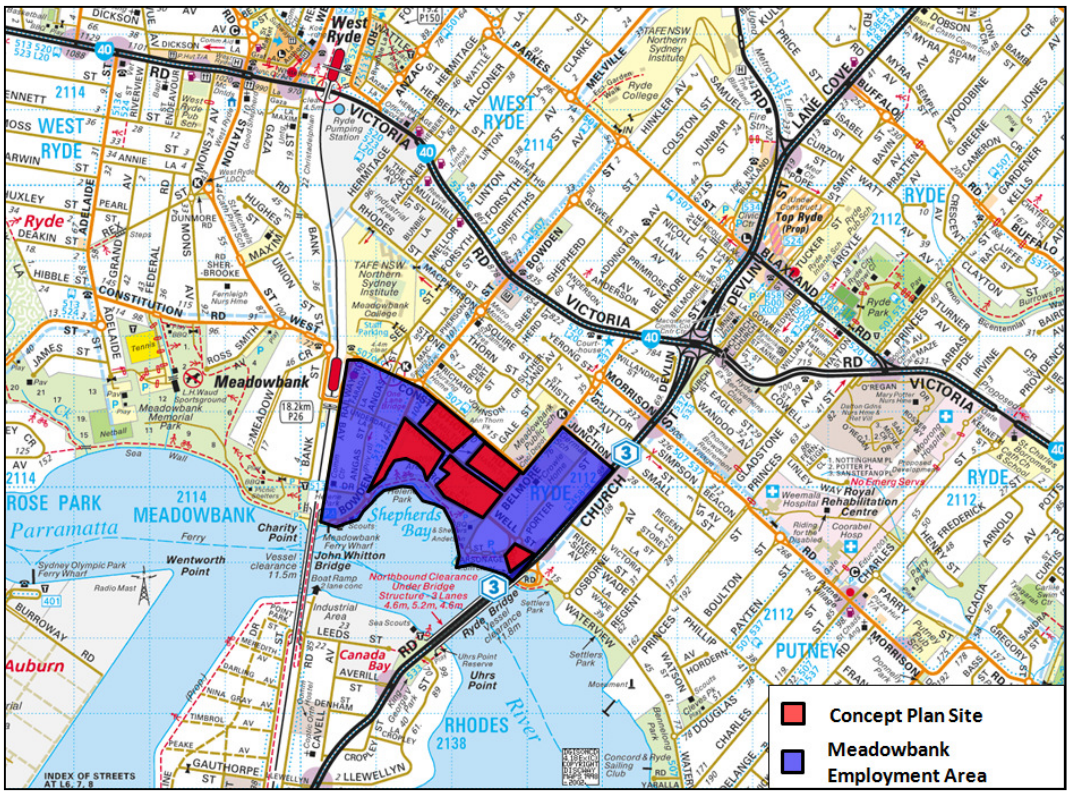

Figure 1 Site Location

2 Overview of Existing Documentation

The sections below provide an overview of existing traffic studies and agency submissions (in chronological order) related to the Shepherds Bay Concept Plan, from the point of Arup's engagement by The Department in April 2012.

2.1 Independent Transport Assessment (Arup)

Arup was engaged by the Department in April 2012 to provide an independent transport assessment of the transport work undertaken for the Shepherds Bay Concept Plan.

Report Scope

- Provide an overview of all current documentation related to the major project application to date
- Describe existing transport conditions surrounding the proposed site
- Outline the future development potential of the entire MEA
- Provide an assessment of the likely traffic related impacts of future development within the MEA focusing on the Constitution Road corridor
- Provide a transport assessment of road, public transport and walking/cycling networks

Conclusions and Recommendations

A final report was issued to The Department in June 2012 and included the following key findings:

- On-site observations during peak hours indicated significant vehicle queues develop along Constitution Road, particularly in the afternoon peak which extend back to the intersection with Belmore Street
- To provide acceptable road network performance on Constitution Road and facilitate pedestrian movement to public transport infrastructure, signalisation of the Constitution Road / Bowden Street intersection is required. It is recommended that the development of the concept plan site act as the trigger for the installation of these traffic signals
- The site is well located for public transport access, and has the potential to be a Transit Oriented Development. A future 10% mode shift away from private vehicle travel is considered realistic for the development
- Given the significant traffic flows along the Loop Road, it is recommended access into the signature building is to be restricted to left in-left out movements only
- There is an established and well developed cycling network surrounding the site, with further upgrades to the existing network not considered a priority
- Provision for car sharing initiatives should be considered in the future planning of the development to reduce reliance on private vehicles

2.2 Concept Plan 2026 Traffic Impact Assessment (Road Delay Solutions)

Report Scope

Based on advice received from The Department, Government agencies and Arup, Road Delay Solutions (on behalf of the Proponent) updated their traffic report as part of the revised PPR submission in August 2012. The traffic modelling undertaken for the assessment assumed that over 2,000 dwellings are envisaged to be developed on the Concept Plan site. Key objectives of the study included:

- Updating the strategic Netanal (traffic) model to reflect the revised Concept Plan and comments received from Arup
- Undertaking a 'mode share analysis' for the site
- Providing a suite of measures to manage the traffic impacts from the Concept Plan site

Conclusions and Recommendations

The traffic report identified a number of infrastructure improvements to the local road network to support the development, including:

- Widening of Constitution Road to 4 trafficable lanes during the commuter peaks at Bowden Street (as well as signalisation) is necessary to ensure adequate movement of vehicles
- Hamilton Crescent to be transformed to one-way southbound
- On-street parking restrictions to be implemented during peak periods
- Installation of left in-left out treatment at the intersection of Belmore Street and Nancarrow Avenue
- Access to the signature building on Well Street and Porter Street to act as left in left out only
- Traffic calming measures to be implemented on Nancarrow Avenue and Rothesay Avenue to restrict regional traffic movements

Arup Response

Since this report was published updated traffic analysis has been conducted by The Proponent which supersedes these recommendations.

2.3 Meadowbank Employment Area Traffic Needs Assessment (Bitzios Consulting)

Report Scope

Bitzios Consulting were engaged by Ryde Council to prepare a strategic traffic model for the entire Meadowbank precinct. This model considered the traffic impacts in the Meadowbank area not only from the Concept Plan site but also associated with the increased residential development planned over the next 20 years. Key objectives of the study were to:

- Prepare a mesoscopic traffic model which considers the traffic related impacts of future development in the entire Meadowbank Employment Area; and
- Identify a suite of infrastructure measures to manage these impacts

Conclusions and Recommendations

The Bitzios study recommended a total of 18 individual infrastructure upgrades required to be introduced in the Meadowbank Employment Area to manage the impacts of increased development in the precinct. These recommendations were the result of a comprehensive traffic modelling exercise which was conducted with the support of the RMS. The study concluded that the road network could accommodate the proposed Shepherds Bay development subject to these infrastructure works being completed.

Of the 18 recommended upgrades, 10 were determined to be partly or wholly attributable to the Concept Plan site. These recommended infrastructure upgrades, as well as indicative staging program are summarised in Table 1.

Table 1 Recommended Infrastructure Upgrades – Bitzios Report

Item	Upgrade Description	Timing	Shepherds Bay Funding Contribution
1	Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	Stage 1 of Concept Plan Development	50%
2	Roundabout at See Street/Constitution Road	Following installation of signals at Bowden/Constitution	None
3	Widening the Angus Street bridge	As determined by Council, before 2031	None
4	Signalising Bowden Street/Constitution Road	Stage 1 of Concept Plan Development	100%
5	See Street/Angus Street roundabout	When Angus Street bridge is widened	None
6	Completion of the Rothesay Avenue Link, connections to it plus the roundabouts at Rothesay/Bowden and Rothesay/Belmore	Stage 1 of Concept Plan Development	100%
7	Roundabout at McPherson/Rhodes/Mellor	As determined by Council, before 2031	None
8	Roundabout at McPherson/See	As determined by Council, before 2031	None
9	McPherson/Bowden left in/out	As determined by Council, suggested by 2017	None
10	Yerong/Belmont left in/out	Stage 1 of Concept Plan Development	50%

Item	Upgrade Description	Timing	Shepherds Bay Funding Contribution
11	LATM scheme in Squire Street	As determined by Council, suggested by 2017	None
12	Hamilton "Lane" and Nancarrow "Lane" LATM and two-way construction between Belmore and Bowden	Stage 1 of Concept Plan Development	100%
13	Underdale Lane/Bowden Street signalised intersection	Stage 1 of Concept Plan Development	100%
14	Underdale Lane LATM	Stage 1 of Concept Plan Development	100%
15	Roundabout at See Street/Stone Street	As determined by Council, before 2031	None
16	Hamilton Lane/Belmore Street left in/left out	Stage 1 of Concept Plan Development	100%
17	Well Street LATM	When 1,000 dwellings have been constructed at Shepherds Bay	50%
18	Belmore Street/Parsonage Street roundabout – remove u-turn potential and modify alignment	When 1,000 dwellings have been constructed at Shepherds Bay	50%

Arup Response

The meso-scopic model prepared for the Meadowbank Traffic Needs Assessment provides a comprehensive overview of infrastructure upgrades required to accommodate future growth in the precinct. In respect to the upgrades recommended as a result of the Shepherds Bay development, Arup fully or partially supports7 of the 10 upgrades suggested in the Bitzios assessment. Responses to each of the recommendations applicable to the Shepherds Bay development are provided in Table 2 below.

Table 2 Arup Response to Bitzios Recommendations

Item	Description	Arup Response	Reasoning
1	Pedestrian signals at Railway Road	Supported	Required to facilitate improved pedestrian movement between the Shepherds Bay development and Meadowbank Railway Station.
4	Traffic Signals at Constitution Road / Bowden Street	Supported	This intersection already operates at capacity in peak hours and is required to provide local vehicular and pedestrian access in the Meadowbank precinct.
6 (i)	Completion of Rothesay Avenue Link	Not Supported	Providing a vehicular connection between Belmore Street and Bowden Street on Rothesay Avenue would provide an additional east-west route through the Meadowbank precinct. This would encouraging additional regional traffic movements (i.e. 'rat runs') impacting local access and amenity and is therefore not supported.
6 (ii)	Roundabout at Rothesay Ave / Belmore Street.	Supported	To facilitate local traffic movements in the precinct, construction of a roundabout at Rothesay Ave / Belmore St is supported.
10	Yerong Street Left In-Left Out	Supported	Required to maintain capacity on Belmore Street following the increased development in the Shepherds Bay precinct.
12	Hamilton Lane / Nancarrow Ave LATM	Supported	Required to reduce through traffic potential along this new route and provide local access to the Shepherds Bay development

Item	Description	Arup Response	Reasoning
13	Traffic signals at Underdale Lane / Bowden Street / Nancarrow Avenue	Not Supported	This upgrade is not supported on two grounds: **1)** Signalising this intersection formalises the east-west route of Nancarrow Avenue / Underdale Lane as a through route in the Meadowbank precinct. **2)** Traffic modelling undertaken by Bitzios for a future year 2031 confirms that RMS warrants for the installation of traffic signals are not met at this intersection.
14	Underdale Lane LATM	Supported	To ensure good pedestrian/cyclist access to Meadowbank Station and reduce through traffic potential
16	Hamilton Lane Left-in Left Out	Supported	Required to maintain capacity on Belmore Street following the increased development in the Shepherds Bay precinct
17	Well Street LATM	Not Supported	Well Street is currently closed to vehicular traffic movements between Porter Street and Belmore Street. This was incorrectly modelled as open to traffic in the Bitzios traffic model.
18	Removal of roundabout at Belmore Street/ Parsonage Street	Not Supported	Removal of the roundabout at Belmore Street / Parsonage Street would allow higher vehicle speeds through this intersection. It is likely any u-turning traffic movements would occur at the new Rothesay Ave / Belmore Street as suggested by Bitzios in item 6.

2.4 Council Submission to PPR Lodgement (City of Ryde Council)

Submission Scope

City of Ryde Council submitted a formal submission to The Department on 14 September 2012 regarding their concerns with the Concept Plan application. This submission covered the following themes:

- Built form
- Consultation
- Open Space
- Flooding/Stormwater
- Building Design
- Contributions
- Traffic and transport

Conclusions, Recommendations and Arup Response

Arup is in broad agreement with the key conclusions and recommendations contained within Council's submission to the PRR document. These conclusions and recommendations, as well as Arup's response, are outlined in Table 3.

Table 3 City of Ryde Council Recommendations

Council Conclusion/Recommendation	Arup Response
Subject to the infrastructure works recommended in the Traffic Needs Assessment being completed, the local traffic network can cater to the proposed Shepherds Bay development	Supported, subject to the responses outlined in Table 2.
A Location Specific Sustainable Travel Plan should be prepared to encourage the use of non-car modes of transport	Supported
A reasonable level of access for cyclists to and from the site must be ensured	Supported
Footpaths are recommended to be provided on both sides of publically accessible streets within the Concept Plan site	Supported

2.5 TfNSW Submission to PPR Lodgement (Transport for NSW)

In October 2012 Transport for NSW provided their submission to the addendum PPR for the Shepherds Bay development. The submission outlined six key recommendations which, along with Arup's response, are summarised below:

- The Proponent obtains the agreement of the RMS in relation to its traffic modelling methodology
- The proponent submits a working paper responding to each issue identified in the March 2012 correspondence from TfNSW under the sub-heading of transport modelling
- The results of the traffic surveys provided by the proponent for the Meadowbank Precinct be used as the base case for traffic modelling comparisons
- TfNSW does not support the proposed 10% mode shift away from private vehicle and the Proponent should re-calculate residential traffic impacts with no reduction
- The Proponent considers reducing the on-site parking rate
- The Proponent provides cycleway and pedestrian linkages from the development to Meadowbank railway station

Arup Response

Arup's response to recommendations contained in the TfNSW submission are summarised in Table 4.

Table 4 Arup Response to Transport for NSW Recommendations

TfNSW Recommendation	Arup Response
That the proponent obtains the agreement of the RMS to its traffic modelling methodology. This is a large development with potential to have significant impacts on the State Road Network. It is likely to require off-site works to mitigate traffic impacts but this cannot be determined on the basis of the work undertaken so far.	Arup is satisfied that The Proponent has adopted a suitable methodology in undertaking their traffic modelling. The development of a strategic traffic model (utilising NETANAL) supplemented by SIDRA intersection analysis is a standard method of assessing the impacts of a major new development such as the one at Shepherds Bay.
The proponent submits a working paper responding to each issue identified in the March 2012 correspondence from TfNSW under the sub-heading of transport modelling	The key concern for TfNSW relates to the impact on the state road network (i.e. Victoria Road and Church Street) from the development has not been assessed. This was addressed by The Proponent in the 2010 TMAP however significant changes in the traffic modelling methodology have occurred since that time. The Proponent has subsequently carried out traffic modelling which forecasts the operation of key intersections on Victoria Road and Church Street following the full development of the Concept Plan site. As suggested by TfNSW, it the software utilised (SCATES) assessed the flow of traffic through a series of linked signalised intersections
The results of the traffic surveys provided by the proponent for the Meadowbank Precinct be used as the base case for traffic modelling comparisons	Table 6 of The Proponent's traffic from August 2012 report considers the operation of the road network in 2026 compared with existing (2010) traffic conditions. Arup is therefore satisfied this recommendation has been addressed.
That Department of Planning and Infrastructure (DP&I) note Transport for NSW (TfNSW) does not agree and cannot support the proponent's 10% reduction in traffic volumes justified on the basis of improvements in public transport provision. The proponent should re-calculate residential traffic impacts with no reduction	The Proponent has adopted a peak hour traffic generation rate of 0.32 trips/dwelling, and then applied a discount factor to consider the 10% mode shift away from private vehicle use. After applying this factor, the generation rate utilised is 0.30 trips / dwelling. Based on site specific traffic generation surveys undertaken by Arup for high-density residential developments adjacent to the Concept Plan site, the trip rate adopted by the Proponent is considered appropriate.
That DP&I note TfNSW considers the parking rate remains high albeit an improvement to that originally proposed. The key considerations are the proponents stated intention to facilitate public service provision and the developments proximity to a range of existing public transport services	Arup considers the on-site parking provision provides an acceptable balance between managing site traffic generation and negating any adverse impacts on the on-street parking network. This parking provision supports the key objective of reducing traffic generation in the Meadowbank precinct.
TfNSW recommends that the developer provide the cycleway and pedestrian linkages from the development to Meadowbank Station	Marked on and off road cycleways are provided on Underdale Lane and Bay Drive adjacent to the Concept Plan site which both provide linkages to Meadowbank railway station. Given the relatively high traffic volumes on Constitution Road, as well as the physical constraints along this route, a dedicated cycleway facility is not considered feasible.

2.6 Voluntary Planning Agreement (Holdmark Group)

The Voluntary Planning Agreement (VPA) submitted by The Proponent in October 2012 outlines 7 recommended road infrastructure upgrades to mitigate the traffic impacts from the proposed development. These upgrades were developed following consultation with The Department and Ryde Council and largely reflect those outlined in the Bitzios Traffic Needs Assessment. These upgrades are summarised in Table 5.

Table 5 VPA Road Infrastructure Works

Item	Upgrade Description	Timing	Shepherds Bay Funding Contribution
1	Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	Stage 3 of Concept Plan Development	10%
4	Signalising Bowden Street/Constitution Road	Stage 6 of Concept Plan Development	30%
10	Yerong/Belmont left in/out	Stage 4 of Concept Plan Development	30%
14	Underdale Lane LATM	Stage 4 of Concept Plan Development	30%
16	Hamilton Lane/Belmore Street left in/left out	Stage 2 of Concept Plan Development	100%
19	Roundabout at Rothesay Ave / Belmore St.	Stage 2 of Concept Plan Development	100%
20	Raised pedestrian crossing on Bowden St	Stage 4 of Concept Plan Development	100%
23-27	Hamilton Lane and Nancarrow Lane LATM and two-way construction between Belmore and Bowden	Stage 4-10 of Concept Plan Development	0%

Arup Response

Arup supports the road infrastructure works proposed by The Proponent contained within the VPA. These works, along with recommended timing, are described in detail in Section 3.3 of this report.

2.7 Arterial Road Network Traffic Signal Operation Assessment (Road Delay Solutions)

Report Scope

Road Delay Solutions (on behalf of The Proponent) prepared an addendum traffic report which considered the impacts of the proposed development on the State Road network. Specifically, this review considered the future operation of intersections along:

- Victoria Road, from Bowden Street to Devlin Street; and
- Church Street, from the Ryde Bridge to Victoria Road

The SCATES network modelling software was utilised for this analysis, which assesses the flow of vehicles through a series of linked intersections.

The use of a strategic model to assess the State Road impacts was a recommendation of Transport for NSW and supported by Arup. The study assessed the future performance of the State Road network, both with and without the full development of the Concept Plan.

Future year (2031) traffic volumes were taken from the Bitzios Traffic Needs Assessment meso-scopic model, with turn volumes interpolated from existing traffic counts. The modelling considered two scenarios:

1. Development of the Meadowbank precinct in line with current Ryde Council LEP controls and partial development of the Concept Plan site (~1,200 dwellings)
2. Development of the Meadowbank precinct in line with current Ryde Council LEP controls and full development of the Concept Plan site (~2,000 dwellings)

Conclusions and Recommendations

The analysis indicated little change in the operation of key intersections on Victoria Road and Bowden Street as a result of the full Concept Plan development. Negligible increases in queue lengths and vehicle delays between the two scenarios were reported.

These results were as expected given the additional peak hour vehicles forecast under the full development scenario (scenario 2) would be distributed over a number of routes and intersections in the Meadowbank area, resulting in only relatively small increases in intersection traffic volumes.

Given the significant existing traffic volumes on Victoria Road and Church, it is unlikely the extra traffic from the Concept Plan site, in itself, will require additional road network upgrades. The continued growth in background traffic associated with development in Rhodes, Homebush Bay and employment growth in the Macquarie Park area is likely to trigger the requirement for further upgrades along these corridors. Therefore a wider precinct study which considers future land use changes in the Ryde / Canada Bay areas would be required to properly assess the need for link or intersection upgrades along these corridors. This is considered outside the scope of works necessary for the Concept Plan application.

3 Recommended Works

3.1 Objectives of Upgrades

When determining the most appropriate works to be implemented in the Meadowbank area, the following key objectives were considered:

- To provide a high quality transport network which accommodates the future requirements imposed by the planned increase in residential development in the Meadowbank precinct;
- To manage the level of regional traffic movements through the Meadowbank precinct to maintain local residential amenity;
- To provide good local access in the precinct for residents by managing the performance of key intersections;
- To restrict the flow of through traffic on local streets in the precinct via local area traffic management (LATM) measures; and
- To provide high quality, safe pedestrian routes through the area to encourage the higher utilisation of public transport

3.2 Staging of Works

3.2.1 General Principles

The following principles have been applied in considering the timing of required infrastructure works for the Meadowbank precinct:

- Providing high quality pedestrian routes, particularly along key desire lines such as Nancarrow Avenue, Underdale Lane and Constitution Road, is considered a high priority. The development will ultimately see an additional 4,000 people introduced into the precinct. To ensure these people utilise non-car modes of transport, high quality pedestrian routes must be provided early in the development of the Concept Plan site - prior to residents forming other travel habits.
- The Constitution Road / Bowden Street intersection already operates at capacity in peak periods and is seen as a high priority infrastructure upgrade.
- Additional road network upgrades that relate to maintaining traffic capacity (e.g. roundabout construction) through the precinct are staged to occur later in the Concept Plan development in line with the growth in vehicular traffic.

3.2.2 Timing for Installation of Traffic Signals

The proposed infrastructure upgrades to support the development of the Concept Plan site include the installation of traffic signals at two locations in the Meadowbank area, those being:

- Constitution Road / Railway Road
- Constitution Road / Bowden Street

The RMS has specific requirements relating to vehicular and pedestrian volumes where it will consider the installation of traffic signals at an intersection. These are commonly referred to as signal warrants. Section 2 of the RMS Traffic Signal Design Manual (updated December 2010) outlines five different warrants for the installation of traffic signals at intersections. These are summarised in Table 6.

Table 6 Warrants for Traffic Signals at Intersections

Warrant	Requirements
Traffic Demand	For each of the four one-hour periods of an average day: (i) The major road exceeds 600 vehicles/hour in each direction; and (ii) The minor road exceeds 200 vehicles/hour in one direction
Continuous Traffic	For each of the four one-hour periods of an average day: (i) The major road flow exceeds 900 vehicles/hour in each direction; and (ii) The minor road exceeds 100 vehicles/hour in one direction; and (iii) The speed of traffic on the major road or limited sight distance from the minor road causes undue delay/hazards to the minor road vehicles; and (iv) There is no other nearby traffic signal site easily accessible to the minor road vehicles
Pedestrian Safety	For each of the four one-hour periods of an average day: (i) The pedestrian flow crossing the major road exceeds 150 persons/hour; and (ii) The major road exceeds 600 vehicles/hour in each direction or, where there is a central median at least 1.2m wide, 1000 vehicles/hour in each direction
Pedestrian Safety – high speed road	For each of the four one-hour periods of an average day: (i) The pedestrian flow crossing the major road exceeds 150 persons/hour; and (ii) The major road exceeds 450 vehicles/hour in each direction or, where there is a central median at least 1.2m wide, 750 vehicles/hour in each direction; and (iii) The 85th percentile speed on the major road exceeds 75km/hr
Crashes	(i) The intersection has been the site of an average three or more reported tow-away or casualty traffic accidents per year over a three year period, where traffic signals could have prevented the accidents; and (ii) The traffic flows are at least 80% of the appropriate flow warrants

Source: Roads and Maritime Services

It is understood that the Constitution Road / Railway Road and Constitution Road / Bowden Street intersections do not currently satisfy any of the above signal warrants. It is acknowledged that any upgrades at these locations involving the installation of traffic signals may not occur until such time that RMS warrants are met.

As the Shepherds Bay development progresses, in conjunction with the increased residential development in the Meadowbank precinct allowable under the Ryde Council LEP, it is likely that signal warrants at these locations will be satisfied. The exact timing of this is uncertain however and will be dependent on the pace of construction of new residential developments in Meadowbank – at both the Concept Plan site and in the wider precinct.

To determine the appropriate timing for the installation of traffic signals at Constitution Road / Railway Road and Constitution Road / Bowden Street, it is recommended that traffic counts be undertaken at these intersections during the preparation of the development applications for each stage of the Shepherds Bay Concept Plan. The traffic reports prepared for these development stages should outline whether signals warrants are satisfied at each location. If the traffic counts demonstrate the warrants are met (at either intersection), traffic signals should be installed prior to the occupation of that development stage.

3.3 Summary of Infrastructure Upgrades

Considering the findings of the various studies undertaken for the Shepherds Bay site, Arup has prepared a schedule of works has been developed to mitigate the traffic impacts associated with the proposed Shepherds Bay development. It should be noted that the traffic modelling conducted Bitzios (Traffic Needs Assessment), The Proponent (Addendum PPR) and Arup (independent transport review) essentially arrived at the same conclusions in relation to the requirement for future infrastructure works. Subject to these works being implemented, it is Arup's opinion that the traffic impacts from the proposed development can be appropriately managed.

A summary of these recommended works, as well as suggested staging advice, is outlined in Figure 2 and Table 7.

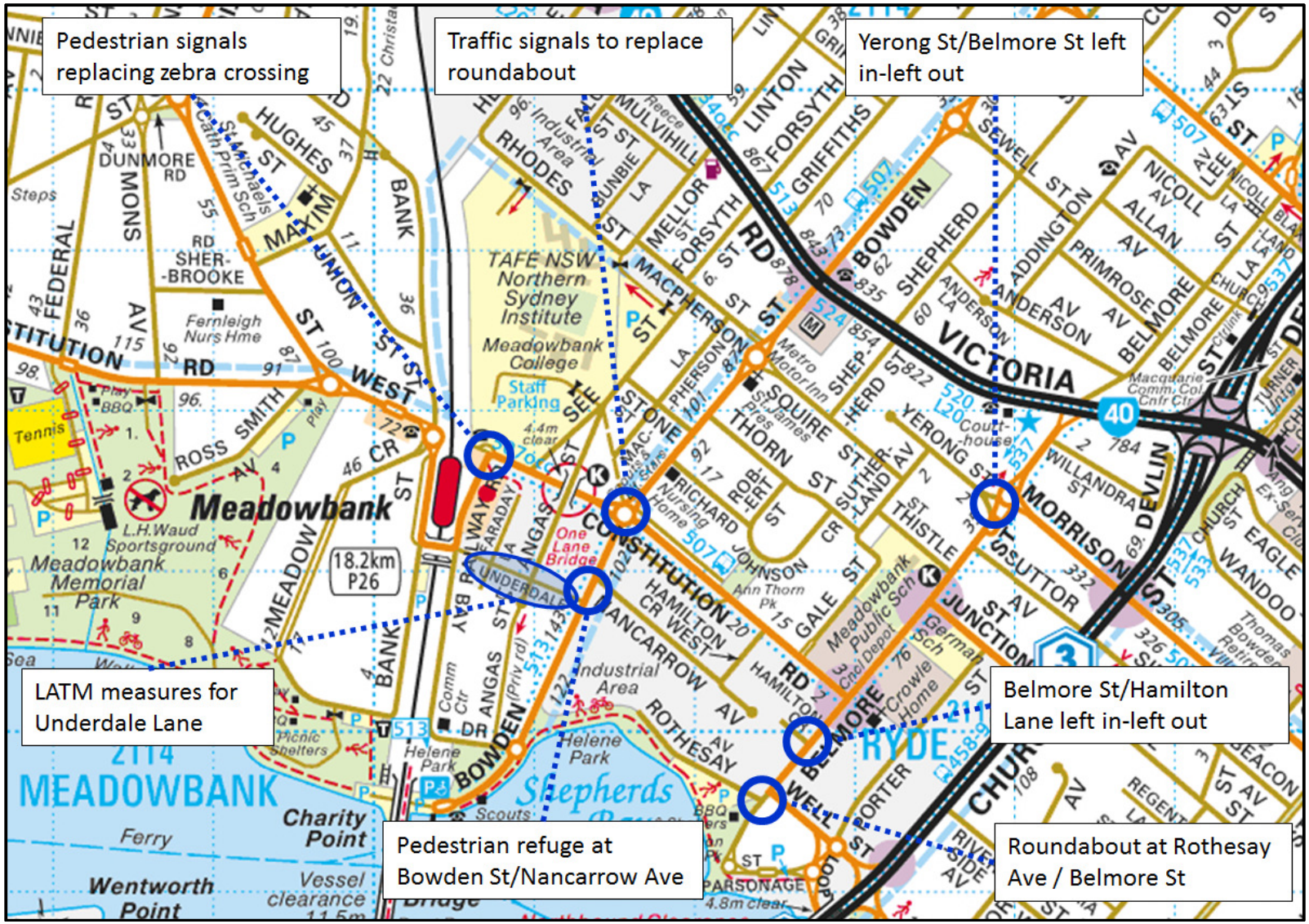

Figure 2 Recommended Infrastructure Works

Table 7 Schedule of Infrastructure Works

Infrastructure Upgrade	Description of Works	Construction Requirements	Justification for Works	Suggested Staging
Pedestrian signals replacing the existing zebra crossing on Railway Road at Meadowbank railway station.	As per Bitzios Report, Appendix D, Concept Plan #1	As per Proponent's VPA (item 1)	Increased residential development in the MEA will increase the number of pedestrian movements across this intersection. Signals are required to control vehicle queuing on Constitution Road and improve pedestrian safety.	When the relevant RMS warrants are satisfied (see Section 3.2.2)
Installation of traffic signals at the Constitution Road / Bowden Street intersection	As per Bitzios Report, Appendix D, Concept Plan #4	As per Proponent's VPA (item 4)	This intersection currently operates at capacity in peak hours and this is forecast to deteriorate following further development in the MEA. Traffic signals are required to provide sufficient capacity and accommodate pedestrian movements to Meadowbank Station	When the relevant RMS warrants are satisfied (see Section 3.2.2)
Implementation of left-in / left-out arrangement at Belmore Street / Yerong Street intersection	As per Bitzios Report, Appendix D, Concept Plan #10	As per Proponent's VPA (item 10)	Required to mitigate impacts of increased traffic volumes in the precinct and conflicts with right turning vehicles in and out of Yerong Street.	Prior to the occupation of more than 800 dwellings on the Shepherds Bay site
Underdale Lane Local Area Traffic Management (LATM) measures	As per Bitzios Report, Appendix D, Concept Plan #14	As per Proponent's VPA (item 14)	To facilitate good pedestrian connections between the Shepherds Bay development and Meadowbank railway station. LATM measures will also reduce the extent of through traffic utilising this local street, improving pedestrian and residential amenity	Prior to the occupation of the second stage of the development within the main Concept Plan site
Implementation of left-in / left-out arrangement at Belmore Street / Hamilton Lane intersection	As per Bitzios Report, Appendix D, Concept Plan #16	As per Proponent's VPA (item 16)	Required to ameliorate traffic impacts from Shepherds Bay development and maintain a satisfactory level of service on Belmore Street	Prior to the occupation of the second stage of the development within the main Concept Plan site

Infrastructure Upgrade	Description of Works	Construction Requirements	Justification for Works	Suggested Staging
Installation of roundabout at Belmore Street / Rothesay Avenue	As per Bitzios Report, Appendix D, Concept Plan #6	As per Proponent's VPA (item 19)	Required to manage the increased traffic flows on Belmore Street following the development of the Concept Plan site	Prior to the occupation of the second stage of the development within the main Concept Plan site
Installation of a pedestrian crossing facility at Bowden Street / Nancarrow Avenue	Zebra crossing with raised threshold at the southern approach of the Bowden Street / Nancarrow Avenue intersection	As per Proponent's VPA (item 20)	The key desire line for pedestrians accessing Meadowbank station from the development will be via Nancarrow Avenue and Underdale Lane. A zebra pedestrian with a raised threshold is recommended to facilitate safe pedestrian crossings of Bowden Street. Based solely on pedestrian and vehicle volumes, warrants for the introduction of a zebra crossing are unlikely to be met at this location. The zebra crossing can be justified however on safety grounds on safety grounds as a number of schoolchildren will be walking from the Shepherds Bay development to Meadowbank Station. In the event that a zebra crossing is not acceptable due to failure to meet relevant warrants, a pedestrian refuge is recommended at this location.	Prior to the occupation of the second stage of the development within the main Concept Plan site
Provision of pedestrian footpaths on Nancarrow Avenue and Rothesay Avenue	3m wide footpaths	Pavement construction Footway modification works	To facilitate pedestrian movement between the proposed development key locations, particularly Meadowbank Railway Station, footpaths should be provided on both sides of all publically accessible roads adjacent to the Concept Plan site. These footpaths should be a minimum of 3m wide to accommodate the significant number of pedestrians expected from the development.	Prior to the occupation of the second stage of the development within the main Concept Plan site

Infrastructure Upgrade	Description of Works	Construction Requirements	Justification for Works	Suggested Staging
Nancarrow Avenue Area Traffic Management (LATM) measures	As per Bitzios Report, Appendix D, Concept Plan #12	Single lane roundabout Splitter islands Kerb blisters Speed humps Pavement markings	These measures are proposed to reduce the level of through traffic along this new route and provide local access to the Shepherds Bay development.	Prior to the occupation of **Stage 2** of the Shepherds Bay development
Nancarrow Avenue extension	Extension to Belmore Street	As per Proponent's VPA (item 24)	To provide a publically accessible road link between Belmore Street and Nancarrow Avenue to service the proposed development.	Prior to the occupation of **Stage 2** of the Shepherds Bay development

3.4 Additional Recommendations

A number of additional upgrades and non-infrastructure measures are recommended to complement the road network upgrades described in Table 7. These are described in the sections below:

3.4.1 Site Travel Plan

The main objectives of the travel plan are to reduce the need to travel and promotion of sustainable means of transport. The more specific objectives include:

- To reduce the level of single occupancy car borne trips associated with commuting.
- To facilitate the sustainable and safe travel of visitors to the site.
- To reduce site traffic congestion and associated pollution in order to enhance, improve and make safe journeys of minority/sustainable transport mode users.
- To work in partnership with neighbouring organisations/developments, local authorities, retailers and other relevant bodies in achieving the maximum mode shift away from the private car.
- To facilitate all residents' access to key facilities such as retail, leisure, health and education.

It is recommended that site specific travel plans be prepared as a component of the development application process for each stage of the Concept Plan site development.

3.4.2 Bicycle Network

The Shepherds Bay development benefits from being located adjacent to a number of on and off road cycling routes. Linkages to Meadowbank Station are provided by Underdale Lane and Bay Road.

Given the low speed environment to be introduced on Rothesay Avenue and Nancarrow Avenue following the LATM works, it is recommended these roads are designated as mixed-traffic streets. This would be achieved through the use of on-road pavement marking indicating the presence of cyclists, with typical markings shown in Figure 3.

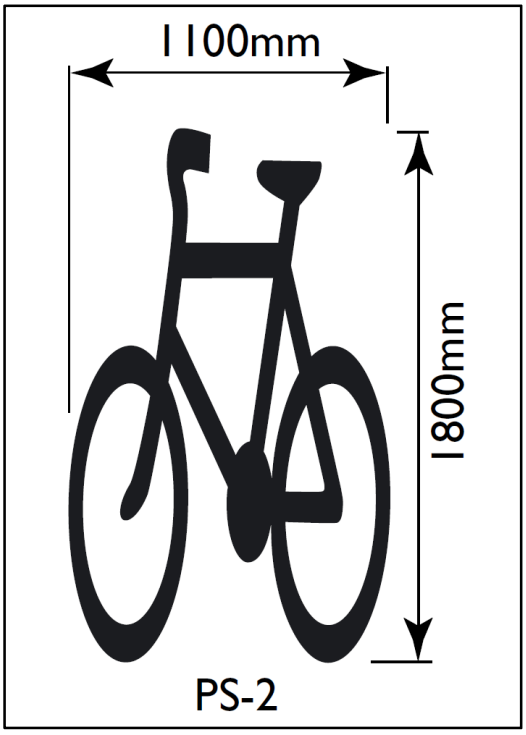

Figure 3 Suggested On-Road Bicycle Symbol

3.4.3 On-Site Bicycle Parking

The proposed development should ensure appropriate levels of secure bicycle parking are provided to promote future growth in cycling levels and reduce the reliance on private vehicles. The documentation provided by the proponent has not indicated what bicycle facilities are to be provided within the development. The NSW Planning Guidelines for Walking and Cycling recommends the following bicycle parking rates for residential developments:

- 20% - 30% of total dwellings (residents)
- 5% - 10% of total dwellings (visitors)

On this basis between 500 and 800 bicycle parking spaces should be provided as part of the residential component of the proposed development. The site benefits from being located adjacent to a number of cycling routes, however without the proper bicycle parking provision much of this benefit will be lost.

3.4.4 Car Sharing

An opportunity to reduce the reliance on private vehicle use would be to utilise the popular car sharing initiatives that are in place across Sydney. A recent study commissioned by City of Sydney Council has shown that each car share vehicle normally replaces about 12 private motor vehicles. While there are currently no car share schemes in the Meadowbank area, the popularity of car sharing is growing and it is likely that the initiative will be introduced in the area in the near future. Car share spaces could easily be provided on the sites' internal streets. It is recommended the developer liaise with car share companies to introduce this scheme into the precinct for use of residents, including providing parking bays for these vehicles within the site boundary.

4 Conclusions

Arup has prepared this independent transport assessment for the Department of Planning and Infrastructure which provides advice in relation to the Shepherds Bay Concept Plan. The assessment has identified a schedule of infrastructure works which are required to adequately address the traffic impacts from the proposal. These works are as follows:

- Installation of pedestrian signals on Railway Road at the Meadowbank station.
- Installation of traffic signals at the Constitution Road / Bowden Street intersection
- Implementation of left-in / left-out arrangement at Belmore Street / Yerong Street intersection
- Underdale Lane Local Area Traffic Management (LATM) measures
- Implementation of left-in / left-out arrangement at Belmore Street / Hamilton Lane
- Installation of roundabout at Belmore Street / Rothesay Avenue
- Installation of a pedestrian facility at Bowden Street / Nancarrow Avenue
- Pedestrian footpaths on Rothesay Avenue and Nancarrow Avenue
- Nancarrow Avenue LATM measures
- Extension of Nancarrow Avenue from Belmore Street to Hamilton Lane

To complement these infrastructure works, the following additional measures are recommended:

- Site specific travel plans are to be prepared as a component of the development application process for each stage of the Concept Plan development
- Roads within the Concept Plan site are to be low speed environments with appropriate signage and line-marking indicating the presence of cyclists
- Between 500 and 800 bicycle parking spaces to be provided as part of the residential component of the proposed development
- The developer liaise with car sharing operates to introduce car sharing into the Meadowbank precinct, and provide car parking bays for these vehicles within the internal road network

It is concluded that, subject to the implementation of the above measures, the impacts from the proposed development can be managed appropriately.