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25 November 2015

Dear Kate

## **Macquarie University Traffic Modelling**

### **1 Introduction**

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The following document summarises the micro-simulation traffic modelling undertaken in the Macquarie Park precinct over recent years, to inform the development of the Macquarie University Campus.

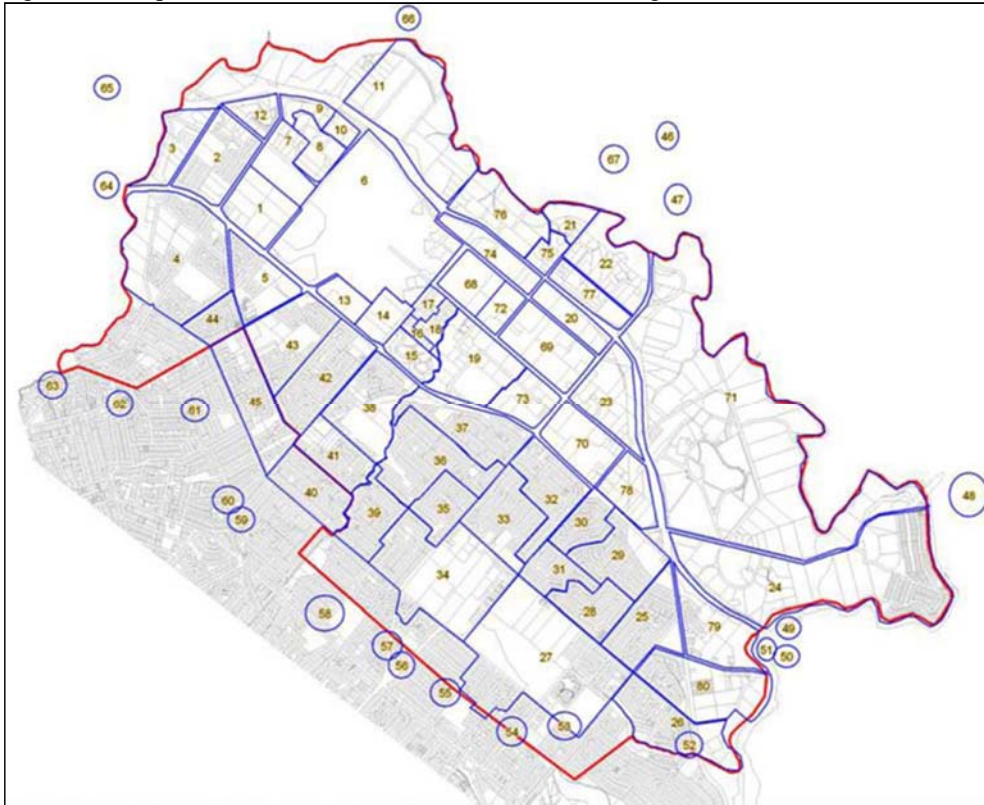
### **2 Traffic Model Development**

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#### **2.1 Macquarie Park Corridor Paramics Model (2007)**

The Macquarie Park Corridor Paramics Model (MPCPM) was developed by City of Ryde in 2007 in association with the RTA and other stakeholders including Macquarie University. The model has 80 zones, 1130 nodes and 2542 links. The model coverage is illustrated in Figure 1.

Figure 1 Macquarie Park Corridor Paramics Model – Coverage and Zones



The MPCPM is based on 2007 traffic volumes and infrastructure (post-opening of Lane Cove Tunnel but before the opening of the Epping – Chatswood Rail Link). Traffic signals were included based on data provided by the RTA.

## 2.2 Macquarie University Concept Plan (2010)

A condition of the Macquarie University Concept Plan was the development of a detailed micro-simulation model, to be prepared in liaison with Council, the RTA and the Ministry of Transport and submitted to the Department of Planning for approval prior to or with the submission of the first application for new commercial floor space on the site.

The traffic modelling involved extensive consultation with key agencies, including RMS, City of Ryde and Transport NSW. Four meetings in total were held with the RMS to agree key parameters for the modelling and to provide feedback at key stages of the modelling process.

The Base 2010 AM/PM model developed for this study was based on Version 1 of the City of Ryde's Macquarie Park Corridor Paramics Model (MPCPM). It was agreed with RTA that the first stage of the modelling process was to update the model to reflect 2010 road network and traffic conditions (e.g. to reflect opening of the Epping – Chatswood Rail Link).

In the course of updating the MPCPM to 2010 conditions, a number of network and demand related problems inherent to the 2007 model were identified as further discussed below

### 2.2.1 Network

A number of network problems were identified in the MPCPM 2007 model including:

- Modelling of MQU as a single zone was inadequate for a site with over 5000 parking spaces and multiple access points which are likely to affect the route choice and may not be accurately reflected in MQU traffic patterns.
- Bus routes are not coded except for some in the south-eastern part of the model, noting that up to 60 bus movements per hour serve or travel through MWU.
- Some roads are classified as Major in one direction and Minor in the other e.g. Talavera Road.
- Speed limits on some MQU internal roads were coded as 50kph but are signposted as 30kph.
- Some roads have different speeds coded than signposted e.g. Talavera Road in eastbound direction is coded as 80kph instead of signposted speed of 50kph, Herring Road between Epping Road and Waterloo Road, and Balaclava Road south of Epping Road are coded as 50kph or below but are signposted as 60kph.
- The right-turn from Epping Road westbound to Culloden Road northbound is allowed in the model but is actually prohibited in the AM peak. Similarly the right-turn from Epping Road eastbound to Culloden Road southbound is allowed in the model but is actually prohibited in the PM peak.
- Coding of control points, especially stoplines, appears to have not received sufficient attention during the development of the model which has impacted on the capacity of the model in a number of areas.

### 2.2.2 Demand and Distribution

A number of demand and distribution problems were identified in the MPCPM 2007 model including:

- Trip distribution in the AM peak appears inaccurate from the MQU zone with a high proportion of trips (around 35%) travelling to a single zone in the eastern part of Macquarie Park (zone 78).
- Zone 76, which represents sports fields (Christie Park on Christie Road north of M2), has unrealistically high trip generation, especially in the AM peak hour (over 630 trips).
- Zones 14,15,16 and 17 which represent a hotel (zone 14) and residential areas (zones 15 – 17) have unrealistically high trip generation (over 1,340 trips in the AM peak hour and over 1,960 trips in the PM peak hour) with higher arrival rate than departure rate in the AM peak (the reverse would be expected).
- Unrealistic route trip assignment, e.g. it was identified that too many MQU-bound drivers from Epping Road east were turning into Wicks Road rather than into Herring Road or Balaclava Road.

The 2007 MPCPM model was converted to a 2010 model by:

- Updating to 2010 road network and traffic conditions; and
- Correcting the network and demand problems described above.

The Base 2010 AM/PM Model was primarily calibrated on the basis of:

- comparison of modelled turning movements to observed turning movements at key intersections around Macquarie University area; and
- comparison of modelled queue lengths to observed queue lengths at key locations.

Calibration of the model also involved a detailed visual review of the model during simulation including inspection of:

- node placement
- kerb placement
- stop line positioning to ensure realistic progression of vehicles between links
- logical lane changing characteristics, by reviewing signposting, next lanes and link characteristics
- merge characteristics on links

The Base 2010 AM/PM Model was validated on the basis of travel times on key routes demonstrating that average modelled travel times are within the range of observed minimum and maximum travel times.

The Base 2010 AM/PM Model was satisfactorily calibrated and validated. Adequate correspondence was been made between modelled turning movements compared to observed turning movements. Average modelled travel times, on all critical routes, were within the range of observed minimum and maximum travel times.

## 2.3 Macquarie University Gateway Project (2014)

To assess the impacts arising from the proposed reconfiguration of the road network around Herring Road supporting the Master Plan for the Macquarie University campus, Arup updated the Paramics models developed for the Concept Plan. This update required the following amendments to the previously developed model to reflect current traffic conditions, those being:

- Widening of the M2 to six lanes, and removal of toll gate arrangements to the west of Christie Road
- Addition of the off ramp from the M2 to Talavera Road, and associated intersection upgrade
- Addition of the on ramp to the M2 from Christie Road, and associated intersection / overpass upgrades
- Closure of Macquarie University Hospital access to the Christie Road / Talavera Road intersection
- Changing the speed limit along Epping Road from 80 km/h to 70 km/h
- Reduction of cost factors on road links within the university campus
- Signal timings at focal intersections were adjusted based on SIDRA phase time outputs (based on traffic count data and RMS traffic signal drawings)

A calibration exercise was undertaken which sought to compare modelled and observed turning movement volumes at key intersections in the study area. A high level validation exercise was undertaken which involved comparing recorded queue data against simulated queues in Paramics.

Arup received feedback on the updated Paramics model from the RMS Road Network Analysis Section in December 2014. Comments received were in relation to:

- Traffic redistribution methodology and findings;
- Model validation;
- Number of model seed runs; and
- Modelled road network.

Arup updated the traffic model to incorporate this RMS feedback.

## 2.4 Macquarie Square Interchange (2015)

Arup developed an updated 2015 base model as part of planning for the Macquarie Square interchange project, utilising the existing Macquarie Park Paramics model. This process was undertaken in accordance with the RMS Traffic Modelling Guidelines (February 2013) as well as the Paramics Micro-simulation Modelling RTA Manual, (RTA 2009). The key role of the micro-simulation model is predominantly as an assignment tool, allowing an assessment of the relative impact of growth.

### 2.4.1 Road network updates

A review of the previously developed model yielded the following required changes to the network to reflect the current situation:

- Addition of slip lane on the western approach to the Balaclava Road/ Epping Road intersection, opened in June 2012
- Updated Macquarie Shopping centre access roads following the expansion of the site in October 2014.
- Updated bus routes and timetable information within the model

### 2.4.2 Model Calibration

The calibration of the base AM/PM model was performed using the seed value 2849, as was used in the original Paramics model. Once the model was calibrated, a further four runs were completed using Roads and Maritime specified seed values, as summarised in Table 1. The modelled results reported show the average of these five runs.

Table 1 Seed values used for Paramics modelling

Seed Value				
28	560	2849	7771	86524

### Intersection Turning Counts

A key part of the calibration of a micro-simulation model involves an adequate correspondence of modelled turning movements to observed turning movements. The statistic most commonly used to measure modelled turning movement counts against observed turning movement counts is the GEH statistic<sup>1</sup>:

$$GEH = \sqrt{(M-C)2/(\frac{1}{2}(M+C))}$$

Where M is the modelled flow and C is the observed flow.

The GEH statistic is a chi-squared statistic which accounts for the magnitude of the difference between the observed and modelled values together with the magnitude of the observed value.

<sup>1</sup> Formula derives its name from Geoffrey E. Havers

## Queue Lengths

The model was calibrated to reflect queuing in the model on the basis of visual inspections undertaken by Arup on a number of different days throughout the study period. Key locations for calibration included:

- Epping Road from Herring Road to Culloden Road
- Waterloo Road from Byfield Street to Herring Road
- Herring Road from Epping Road to Talavera Road
- Talavera Road from Culloden Road to Lane Cove Road

The calibration process yielded a GEH value of 5 or less for greater than 90% of turning movements in both peak hours. The calibration statistics meet the adopted criteria in the PM peak for all turning movements with a GEH less than 10. The criteria is also met in the AM peak with the exception of:

- Balaclava Road right turn into Epping Road, GEH marginally greater than 10 (11). This movement is outside the core study area and not considered to have a material impact on the future year transport analysis.

Critically, through the core study area (Herring Road between Waterloo Road and Talavera Road), there was a good correlation between observed and modelled counts. Differences between the modelled and observed turning movements for the Herring Road corridor are no more than 100 vehicles with GEH values less than 5. This demonstrates the model is ‘fit for purpose’ and suitable to model future year traffic impacts.

Table 2 Model calibration results

Peak Period	Total turn movements	GEH < 5		GEH > 10	
		Number	%	Number	%
AM	48	<b>44</b>	92%	1	2%
PM		<b>44</b>	92%	0	0%

### 2.4.3 Model Validation

The model was validated on the basis of travel times on key routes possessing an average modelled travel time within the range of the observed maximum and minimum times. This method has previously been used to validate the Macquarie Park Paramics model.

## 2.4.4 Future Year Traffic Growth

Future year traffic demand forecasts for the forecast year 2026 were comprised of the following components:

- Changes to traffic demand on the wider road network (background traffic growth)
- Increased traffic demand attributable to the growth of the Macquarie University campus
- Increased traffic demand attributable to the Herring Road Priority Precinct

Future year AM/PM origin-destination demand matrices were developed (as part of the micro-simulation traffic modelling exercise) according to the following methodology:

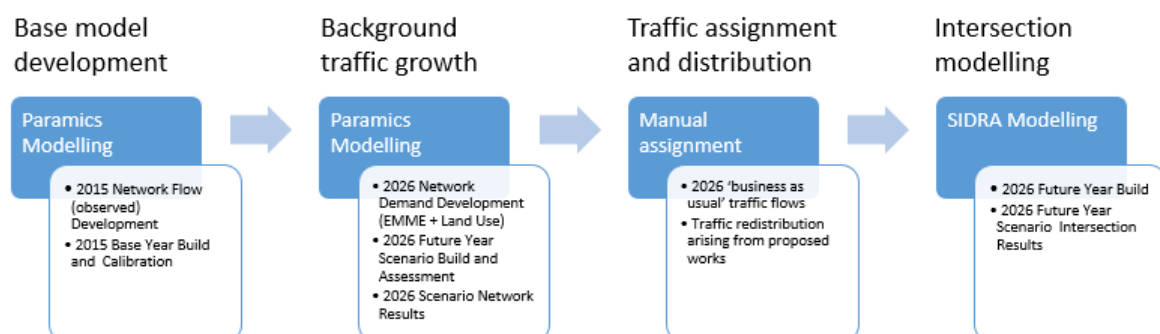
- Base AM/PM demand matrix as the starting point
- For trips between internal to external and external to external zones of the model network, traffic growth rates were derived from a combination of the Strategic Travel Model (STM) traffic forecasts and a cordon matrix from the RMS's strategic EMME model (excluding trips to/from STM zone representing MQU).
- Addition of forecast Macquarie University traffic generation
- Addition of forecast Herring Road Priority Precinct traffic to/from a number of modelled zones along the Herring Road corridor.

The origin-destination demand matrices indicate global traffic growth across the Macquarie Park network in the future year 2026 were found to be as follows:

- AM peak hour: 1.5% per annum
- PM peak hour: 1.1% per annum

## 2.4.5 Future Year Traffic Modelling

The figure below illustrates the traffic modelling methodology used to generate outputs for the intersection performance.



## 2.4.6 Modelling Approvals

On 4 August 2015 the Paramics traffic modelling and associated SIDRA intersection modelling was submitted to Roads and Maritime for review. On 17 August 2015 email correspondence was received from Martin Oaten (General Manager Network Optimisation) at Roads and Maritime noting:

*Roads and Maritime Services (RMS) has reviewed Arup traffic analysis that outline the traffic impacts of both the Macquarie Square Interchange (MSI) and Macquarie University Gateway (MUG) proposals. RMS accepts in principle Arup's analysis findings on traffic redistribution, and preliminary SIDRA traffic modelling.*

Full email correspondence is appended to this letter.

## 2.5 Bus Operations

The micro-simulation traffic modelling undertaken by Arup for the Macquarie Park precinct included an assessment of the operation of the internal street network with the Macquarie University campus. This assessment considered both existing and future bus flows through Macquarie Park.

The micro-simulation modelling undertaken demonstrates that additional bus priority measures to facilitate increased capacity are not required to support bus and traffic movements through the campus.

Should you have any further questions please do not hesitate to contact the undersigned.

Yours sincerely



Joshua Milston  
Senior Transport Planner MIEAust CPEng

## Joshua Milston

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**From:** OATEN Martin <Martin.Oaten@rms.nsw.gov.au>  
**Sent:** Monday, 17 August 2015 9:20 AM  
**To:** Lloyd, Darryl; Joshua Milston  
**Cc:** BOBRYK Janusz J  
**Subject:** Arup report - Macquarie Square Interchange and Macquarie University Gateway

Daryl and Josh,

I refer to Arup's email and enclosed supporting documents, dated 4 August 2015.

Roads and Maritime Services (RMS) has reviewed Arup traffic analysis that outline the traffic impacts of both the Macquarie Square Interchange (MSI) and Macquarie University Gateway (MUG) proposals.

RMS accepts in principle Arup's analysis findings on traffic redistribution, and preliminary SIDRA traffic modelling. However, RMS requests additional traffic analysis at the MSI and MUG projects further development as follows:

1. SIDRA modelling of Herring Road/Talavera Road/M2 Motorway Ramps and Herring Road/Waterloo Road will need to be updated and traffic impact revised, when the intersections layout and geometry details are determined.
2. SIDRA modelling shows that MSI and MUG projects would have unfavourable impact on traffic movement performance (increase in delay and queuing, and decrease in spare capacity) at the following intersections: Herring Road/Talavera Road/M2 Ramps, Talavera Road/Khartoum Road and Khartoum Road/Waterloo Road. The Herring Road/Waterloo Road intersection preliminary modelling results show mixed impact on traffic performance.  
Improvements will need to be considered at the intersections where because of MSI and MUG projects, traffic performance would decline.
3. Modelling of Herring Road pedestrian crossing has incorrect signals settings, and needs to be remodelled. Existing signals should be modelled as a staged crossing. MSI proposed signals should have a pedestrian phase similar to the existing, of 20-30 seconds.

Please contact Janusz Bobryk if you have queries to the above.

Regards

Martin

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