EXECUTIVE SUMMARY

Background

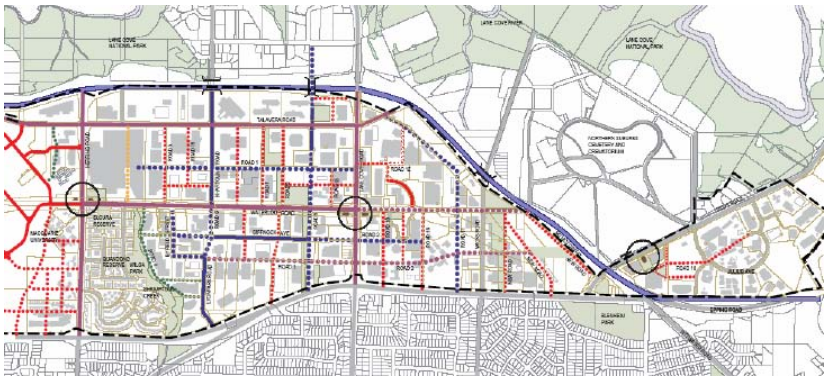
City of Ryde (CoR) is currently in the process of amending and translating its Local Environment Plan (LEP), DCP and Public Domain Plan (PDP) for Macquarie Park, in recognition of the significant growth potential of the area. With over 2,000,000m^2 in commercial floor space expected, including significant expansion of Macquarie Park Shopping Centre and Macquarie University, there is a need to ensure that there is sufficient transport infrastructure for access to, from and within the area.

CoR has initiated both a traffic study and a pedestrian movement study for Macquarie Park to consider the needs and effects of the proposed LEP, defined as LEP2008. This report is for the traffic study component and covers:

- the establishment of a base year (2007) Paramics micro-simulation model to be used as the basis for the assessment of traffic network options out to year 2031;
- using the Paramics model, developing an understanding of the traffic situation that would arise in 2031 if no changes to the current road network or LEP were made;
- presenting and understanding the likely traffic patterns in 2031 to, from and within Macquarie Park and importantly how the growth between 2007 and 2031 will evolve in particular parts of Macquarie Park;
- developing a case for a target public transport mode split for the area, given likely rail and bus improvements mixed with an emphasis on workplace travel plans and parking management, and hence determining what discounting of traffic demand would be reasonable to apply;
- developing and testing "local" network options and connections within Macquarie Park;
- developing and testing "major" road network improvements on roads such as Epping Road, Lane Cove Road the M2 Motorway and Delhi Road to determine what major road infrastructure is also required to support the growth of Macquarie Park; and
- recommending a preferred road network and set of traffic improvements that is complimentary with the intended role of Macquarie Park as one of Sydney's key employment nodes over the next 25 years.

Traffix and Bitzios Consulting have been commissioned to undertake the traffic study which has been directed by a steering committee comprising:

- City of Ryde;
- TransUrban (for the M2 Motorway interface);
- RailCorp (for the Epping-Chatswood Rail Line);
- AMP (as owners of the Macquarie Park Shopping Centre);
- Macquarie University; and
- Goodman International (as a major property owner in the area).



LEP2008 Street Network

The RTA has also been heavily involved in the study as a key stakeholder having attended all steering committee meetings and been involved through each stage of the option development and assessment process in recognition of the importance of the major road network in facilitating access to this key employment node in the future.

Data Collection and Model Development

Various data was sourced for input into the development of the Paramics simulation models. This data included:

- aerial photography and contour information;
- traffic signal phasing, timing and default coordination offsets;
- bus service and stop data;
- peak period (7:00am to 10:00am and 4:00pm to 7:00pm) traffic count data for most of the major intersections within the study area;
- strategic model outputs from both the RTA and Transport Planning and Data Centre (TPDC) models for the Sydney Metropolitan area;
- the TransUrban Paramics model for the M2 corridor (2007 model);
- Australian Bureaus of Statistics (ABS) Household Data for 2006;
- future bus lane and road network upgrades provided by the RTA;
- expected growth in key traffic generators in the study area including Macquarie University and Macquarie Park Shopping Centre; and
- LEP2008 and how it translates into commercial floor space and employment numbers (at individual lot level) by 2031.

The study area for the traffic study extended beyond the LEP boundary to understand the effects of traffic accessing Macquarie Park on the broader road network. The Paramics model built for the study area included 80 zones. The boundaries of the study area and LEP as well as the zones used in the model are shown in Figure ES1.

Traffic matrices were created for the base year 2007 models using the strategic model traffic matrices, traffic generation rates/calculations and a comprehensive set of traffic counts. Matrix estimation was initially undertaken using the matrix "estimator" package available in the Paramics suite of programs with manual "fine tuning" of the matrices being undertaken to better represent turning count data at key intersections on Lane Cove Road, Epping Road and Delhi Road for the peak one hour in each period, being 7:45am to 8:45am and 4:45pm to 5:45pm.

The comparison of the modelled and observed count data for 2007 was undertaken using the commonly used GEH statistic, with the percentage of the results within each GEH band as follows:

GEH Band	AM Peak	PM Peak
0 - 2	33%	34%
2 - 5	41%	43%
5 - 10	20%	21%
>10	6%	2%

Note: based on 153 turning count records

2007 Congestion

GEH results in the 0 - 2 and 2 - 5 bands reflect very good matches between actual and modelled data whilst the 5 – 10 band indicates a reasonable match, demonstrating that the model is a valid representation of the available count data. Also, the congestion sources observed in the model (e.g. Waterloo Road and Talavera Road intersections with the Lane Cove Road) are also representative of observed conditions.

The year 2031 base models were then created for LEP137 (the current LEP) and LEP2008. The process for developing these models included:

- running the TPDC model with the updated demographics for Macquarie Park;
- extracting traffic matrices and link volumes out of the TPDC model and creating more detailed Paramics traffic demands matrices from these; and
- adjusting the Paramics traffic demands to reflect a target 40% public transport split, given that the comparison of the traffic and public transport matrices extracted from the TPDC model inferred a 23% modal split in 2031.

The target of a 40% public transport mode split has been based on the fact that the Epping-Chatswood Rail Line and stations are soon to open, a number of bus lane sections are proposed within the study area, there is an expectation of significantly more bus services with greater coverage and there is widespread implementation of workplace travel plans and workplace travel coordinators (as per the recent Optus plan).

Periodic (five-yearly) reviews of public transport mode splits will be undertaken to track progress against the target 40% mode split. Should these reviews identify under-achievement of public transport split requirements a "contingency plan" will be put into place including the following actions:

- lobby the RTA to review the proposed infrastructure plan and bring forward some of the road and intersection improvements identified in sections 9.1 and 9.2 of this report;
- lobby the State Transit Authority (STA) to review bus priority measures to and from Macquarie Park and to introduce new/additional improvements; and
- lobby Railcorp to review the capacity of the North-West Metro Line with the intention of increasing services in peak periods and to consider increasing passenger rail capacity to cater for future growth in the Macquarie Park precinct.

Traffic Demands, Issues and Options

Achieving a 40% public transport split for Macquarie Park will ensure that a large proportion of the area will generate similar levels of traffic to what is being generated in 2007 (that is, non-car access will absorb most of the growth for most of the area). Key exceptions include:

- Macquarie University which is expected to generate an additional (approximate) 21,000 vehicles per day (vpd) compared to year 2007;
- Macquarie Park east of Lane Cove Road which is expected to generate an additional 10,000 vpd;
- traffic on the M2 which is forecast to grow (in the TPDC model outputs) by 55,000 vpd west of the study area and 34,000 vpd east of the study area; and
- Lane Cove Road which is expected to grow by up to 15,000 vpd between 2007 and 2031.

The net effect is expected to be about a 20% increase in traffic in the study area in 2031 compared to 2007.

The key traffic issues/challenges in the study area to 2031 relate to:

- catering for the significant increase in through traffic on the M2, coupled with the demand generated by traffic originating in, or destined for, the study area;
- catering for the significant increase in University traffic and the attractiveness of the M2 for ease of access for this traffic;
- catering for the turning movements into and out of the Macquarie Park west of Lane Cove Road, given that many of these movements are already over capacity; and
- catering for the increase in demand into Macquarie Park east of Lane Cove Road, particularly considering the limited current opportunities for access and the prevailing capacity issues for turning right across Epping Road, particularly in the morning peak.

Options have been developed in consultation with the steering committee. The sets of options tested have been grouped into the following:

- "internal" LEP road system and connections to the major road system – tested first to determine whether the dense grid of internal roads and intersections would have sufficient capacity to 2031, and to identify the effects of various levels of connections to the major road system;
- "major" road system – tested to identify a "base" network and associated set of major improvement works which would provide sufficient capacity to cater for 2031 traffic demands; and
- supplementary option testing – requested primarily by the RTA to test what effect a variety of connectivity/accessibility/capacity, pedestrian provision and tolling changes would have on the performance of the 2031 base network.

Internal Road System Assessment

LEP2008 proposes a dense grid of streets which operate effectively in 2031. The density of the grid and the variety of route options provided ensures that there are no capacity issues within the local road area in 2031. Proposed traffic signals/roundabouts within the LEP area are also shown in the modelling to work effectively.

The internal road system was also tested with three levels of restriction to the major road system, that is: least restrictive, moderately restrictive and most restrictive. The most restrictive network was essentially based on existing connections with the least restrictive option including a number of additional left in/out access points as well as new signalised intersections onto Epping Road and Lane Cove Road. The connections which appeared in the modelling to work the best for access to/from Macquarie Park were:

- left in/out at all of the new local road connections onto Epping Road, east of Lane Cove Road with the New Road (west of Pittwater Road) intersection with Epping Road being signalised to make this area more accessible at more locations rather than focussing turning movements at one or two locations;
- signalising Lyon Park Road/Epping Road with right turn movements included to provide better egress from the western area of Macquarie Park to Epping Road and the south; and
- new traffic signals at Road 1/Lane Cove Road and Road 2/Lane Cove Road primarily to provide alternative right turn and left turn opportunities to leave Macquarie Park.

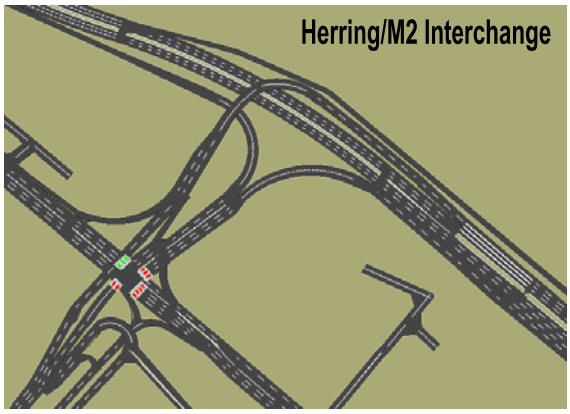
Major internal roads such as Waterloo Road and Talavera Road need to be maintained as four lane roads primarily for intersection storage capacity reasons whilst all other existing and new local roads within the LEP area have sufficient capacity as single lanes each way with localised widening at four way intersections for traffic signals or roundabouts.

Major Road System Assessment – 2031 Base Model

The first option tested was LEP137 traffic demands in 2031 on the existing road network. Within minutes of the model commencing, major congestion sources were revealed. In the morning peak, this mostly involved traffic demand identified from the strategic model not being able to enter the study area due to edge capacity constraints. In the PM peak, traffic was not able to leave Macquarie Park without excessive queuing and delays (and eventually "grid lock"). This "do nothing" assessment quickly revealed that major network improvements were required if the current approved growth for Macquarie Park were to be accommodated in the traffic system.

The iterative development of the 2031 Base Model Network under LEP2008 commenced with the "internal" road system defined above and progressively implemented and refined intersection and interchange upgrades based on a list of options provided by the steering committee as well as observations of the causes on congestion pinch points within the model.

With the shift in major traffic movements towards the M2 and the university, most of the major road network improvements needed in the traffic model are associated with the northern end of the study area. These included:



- an all movement grade separated interchange at Herring Road/M2 with two lane east-facing on and off ramps;
- a grade separated right turn overpass from north to west at the Lane Cove Road/M2 interchange (to cater for heavy demands to the M2 westbound as well as the University) plus a dual left turn off ramp from the M2 into Lane Cove Road southbound (to cater for heavy demands into Macquarie Park east of Lane Cove Road);
- a grade separated right turn from Epping Road into the Delhi Road westbound on ramp to the M2 to cater for the heavy demand from the Pittwater Road catchment;
- an overpass in Epping Road over Herring Road due to the heavy turning movements at this intersection associated with the University as well as with access to the new M2 ramps;
- additional turn lanes at Epping Road/Wicks Road and Epping Road/Balaclava Road intersections;
- a new road 150 metres west of Plassey Road linking Delhi Road to Epping Road and intersecting with Pittwater Road; and
- new signalised intersections at Road 1/Lane Cove Road and Road 2/Lane Cove Road with additional capacity at Waterloo Road/Lane Cove Road and Talavera Road/Lane Cove Road intersections also provided.

It is important to note that with the new ramps and associated weaving on the M2, the modelling demonstrates a need for five lanes eastbound and five lanes westbound on the M2 between the Herring Road and Lane Cove Road interchanges. Also, the attractiveness of the east-facing ramps on the M2 means that there is a reduced demand for traffic travelling all the way through the study area on Epping Road, providing more capacity on Epping Road to accommodate heavy turn movements into/out of Macquarie Park.

Even with these improvements the Lane Cove Road approach from the north into the study area in the morning peak was still well over capacity (the only severely over capacity link in the 2031 base network) mostly due to the weaving and traffic signals on the approach to the M2 interchange. An additional option for a tunnel extending under Lane Cove Road from north of Fontenoy Road to the south of Epping Road was tested. This tunnel was not found to provide significant benefits to offset the very large cost expected due to a relatively low volume of traffic which passes all the way through the study area from north to south in 2031 (approximately one lane's worth of traffic) and the need to extend the tunnel entry much further to the north to remove this through traffic from the queue on the approach to the M2 interchange so as to try and bypass this congestion.

Supplementary Options Assessment

The supplementary options tested as requested by the RTA (below), using the 2031 base model as a starting point included:

- Item A: Modify Base Model connections onto Epping Road.
- Item B: Adjust signal times at signalised intersections on Lane Cove Road to allow single-stage pedestrian crossings.
- Item C: Left in only (no signals) at the intersections of Road 1/Lane Cove Road and Road 2/Lane Cove Road.
- Item D: Remove the left turn off ramp from the M2 into Lane Cove Road southbound and replace this with a new off ramp from the M2 into Waterloo Road; and re-instate the Lane Cove Road to M2 westbound loop on-ramp and remove the right turn overpass from Lane Cove Road southbound to M2 westbound.

- Item E: M2 ramp tolling tests for the new Herring Road ramps ($1.50, a toll which results in 50% of the "un-tolled" usage and a toll which results in 75% of the "un-tolled" usage).
- Item F: Delete the left turn on-ramp from Lane Cove Road onto the M2 eastbound.
- Item G: Constrain the Lane Cove Tunnel (i.e. the eastern end of the M2 in the model) to two through lanes eastbound and two through lanes westbound.

The above items were combined to form the following supplementary model runs:

- Supplementary Option 1 – Base 2031 + Item A;
- Supplementary Option 2 – Base 2031 + Item A + Item B;
- Supplementary Option 3 – Base 2031 + Item A + Item C;
- Supplementary Option 4 – Base 2031 + Item A + Item D;
- Supplementary Option 5 – Base 2031 + Item A + Item E;
- Supplementary Option 6 – Base 2031 + Item A + Item D + Item F; and
- Supplementary Option 7 – Base 2031 + Item A + Item G.

Key results of the modelling of the supplementary options are as follows:

- converting the three proposed left in/left out connections onto Epping Road into cul-de-sacs does not have any noticeable effect on traffic patterns within Macquarie Park as left turners appear to simply move to the next available left in/out access. Only minor increases in travel times compared to the 2031 base model occur as a result of this option;
- extending phase times by approximately ten seconds for the side streets at the signalised intersections of Lane Cove Road with Talavera Road, Road 1, Waterloo Road and Road 2 to accommodate single-stage pedestrian crossing movements has no significant effect on traffic congestion on Lane Cove Road. This is primarily due to the capacity relief provided on Lane Cove Road by the new Herring Road east-facing ramps, the ability to cross Lane Cove Road at these signals (removing the amount of through, left and right turning traffic on Lane Cove Road itself) as well as the reduced ability for southbound traffic to reach Lane Cove Road south of the M2 due to congestion on Lane Cove Road north of the M2. Pedestrian capacity at the Waterloo Road intersection associated with the new station may however be an issue and on grade separated facility may be required for pedestrian capacity purposes;
- removing the signals from Road 1/Lane Cove Road and Road 2/Lane Cove Road and replacing them with left turn in movements only does affect the ease of access into and egress out of Macquarie Park, particularly west of Lane Cove Road. Whilst this additional traffic congestion/delay does not result in excessive queuing and "gridlock" of the model, travel times for trips using Epping Road and Lane Cove Road are increased significantly. Also, there are safety issues associated with additional weaving manoeuvres for access into Road 2 westbound from Lane Cove Road that would otherwise be cross movements at the Road 1/Lane Cove Road signalised intersection;
- removing the two lane off ramp from the M2 into Lane Cove Road southbound and replacing it with a single lane off ramp into the eastern end of Waterloo Road does not show any significant effects in the Paramics model as most of the traffic using these facilities is destined for the eastern end of Macquarie Park in any case. This option does in fact show some benefits to Lane Cove Road compared to the base case;
- testing the sensitivity of the new east facing M2 ramps at Herring Road to tolling identified that the westbound off ramp is very sensitive to a toll and even a small toll would divert traffic onto Talavera Road instead (via the alternative off ramp from the M2 into Lane Cove Road southbound). This testing also identified the far lower sensitivity of the eastbound on ramp to tolling. In fact the toll would need to be set to more than $3.00 to reduce the usage of this ramp to 65% of its "free" usage volume in the AM peak. Importantly, any further increase in the toll and consequent usage of the ramp significantly affects Epping Road and Lane Cove Road to the point where extensive queuing occurs and "gridlock" in the simulation model is observed;

- removing the left turn provided in the 2031 Base Case from Lane Cove Road north to M2 east has only a marginal effect on traffic performance compared to the base case. This is a relatively low demand movement (identified from the strategic modelling matrix) which can be easily absorbed into Lane Cove Road and Epping Road given the reduced flow on these links due to the improvements at the Herring Road interchange with the M2; and
- constraining the eastern end of the model to two lanes each way has no noticeable effect on traffic movements within Macquarie Park as the congestion pinch point on the M2 is located further to the west. Also, there is only one eastbound on-ramp in this section which has sufficient storage capacity to accommodate any congestion wave which passes back along the M2 temporarily blocking the ramp. In the westbound direction the two lane constraint delays traffic exiting the M2 and accessing Macquarie Park reducing arrival rates to the LEP area.

Conclusions and Recommendations

Key conclusions of the assessment of the traffic infrastructure needs for Macquarie Park under LEP2008 using Paramics micro-simulation modelling are:

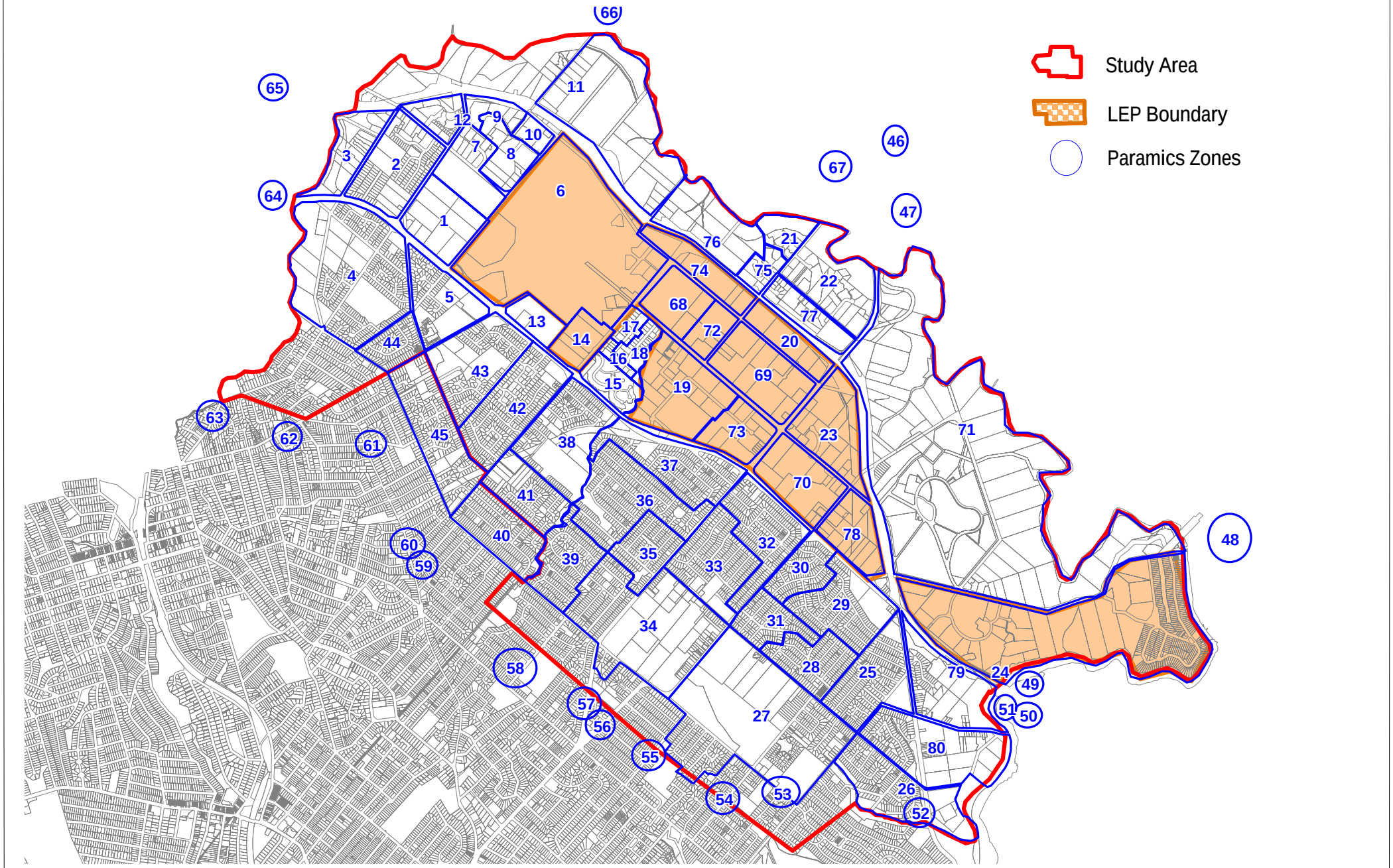
- the year 2007 model is sufficiently validated for the purposes of developing the 2031 model and for being used for testing the effect of immediate improvements and land use developments;
- a target 40% public transport mode share is achievable with the significant improvements in public transport in Macquarie Park and the introduction of workplace travel plans and workplace travel co-ordinators;
- key traffic generators in 2031 will be the Macquarie University, Macquarie Park Shopping Centre and Macquarie Park east of Lane Cove Road, as well as a significant increase in through traffic on the M2 and to a lesser extent on Lane Cove Road;
- the internal road network and intersections proposed under LEP2008 will operate effectively in 2031 due the density of the street grid proposed and the route choices available;
- major infrastructure improvements are required at key locations on the major road system, particularly at Herring Road and Delhi Road interchanges with the M2, with an additional westbound off ramp from the M2 needed at Lane Cove Road or Waterloo Road;
- a tunnel under Lane Cove Road from north of the M2 to south of Epping Road does not provide significant enough traffic benefits to warrant its cost;
- limiting the number of left in/left out connections from Macquarie Park onto Epping Road has a negligible effect on travel times and congestion in the network;
- removing the proposed traffic signals at Road 1/Lane Cove Road and Road 2/Lane Cove Road intersections and replacing them with left turns in only has a noticeable effect on travel times. Whilst making these changes does not cause the model network to "gridlock" removing the ability for movements across Lane Cove Road puts extra pressure on Epping Road and Lane Cove Road in the morning peak and on the Waterloo Road and Talavera Road intersections with Lane Cove Road in the afternoon peak. These changes also reduce pedestrian and traffic accessibility across Lane Cove Road. Also, there is a strong weaving manoeuvre associated with right turns from Epping Road into Lane Cove Road and then left into Road 2, introducing potential safety issues. This manoeuvre is significantly reduced if through movements across Lane Cove Road from one side of Road 2 to the other are allowed;
- the proposed signalised intersection of Road 1 with Lane Cove Road only requires a single lane right turn out of Road 1 to cater for a relatively localised catchment. Importantly, the key benefit of this intersection is the free left turn providing an alternative location away from Waterloo Road and Talavera Road intersections where this can be made;
- the proposed new signals at Lane Cove Road/Road 1 and Lane Cove Road/Road 2 can be configured to accommodate single-stage pedestrian crossings across Lane Cove Road without significantly affecting travel times or congestion, due to the capacity relief provided by new ramps to/from the M2. However, there are expected to be significant pedestrian volumes at the Waterloo Road intersection with Lane Cove Road associated with pedestrians entering and leaving the new rail station. This may introduce pedestrian capacity issues and therefore may warrant some form of pedestrian grade separation across Lane Cove Road which would in turn provide an improvement to traffic operational capacity on Lane Cove Road;

- traffic using the proposed Herring Road eastbound on ramp is relatively insensitive to tolls whereas a small toll on the westbound off ramp diverts the majority of this traffic down Talavera Road;
- providing an M2 off ramp to the western end of Waterloo Road, instead of the double left turn off ramp onto Lane Cove Road southbound is an effective alternative which also allows the north to west loop-ramp to be maintained at the Lane Cove Road/M2 interchange;
- not providing a north to east on ramp from Lane Cove Road to the M2 has a negligible effect on the traffic performance of the network; and
- if the Lane Cove Tunnel remains two lanes each way there is not expected to be any significant effects back into Macquarie Park based on the "pinch point" for the M2 being expected to be further to the west.

The following list of recommended improvements is required to facilitate the road network within the study to operate without excessive congestion in 2031:

- The internal/local road network as advertised for LEP2008, except for:
  - Road 3 intersection with Lane Cove Road to be removed and replaced with cul-de-sacs either side;
  - connections from Road 8 (extension), Road 16 and the unnamed new road east of Wicks Road to Epping Road to be replaced with cul-de-sacs;
  - Road 9 and Road 11 intersections with Epping Road to be left in/left out;
  - new traffic signals be provided at Road 1/Lane Cove Road and Road 2/Lane Cove Road intersections;
  - Talavera Road (east of Herring Road), Waterloo Road and Herring Road to include four traffic lanes (and parking where relevant) with localised widening at intersections;
  - Talavera Road to include six traffic lanes between Herring Road and Christie Road;
  - Road 2 to have a three traffic lane cross-section plus parking lanes (between Lane Cove Road and Road 9);
  - Lyon Park Road from Epping Road to Byfield Street to have four trafficable lanes with no parking lanes; and
  - all other local roads to have widths and cross sections as per the advertised DCP street network.
- Major road network upgrades to include:
  - new two-lane east facing on and off ramps at the Herring Road interchange with the M2;
  - a two lane overpass from Herring Road across Talavera Road to the ramps for the M2;
  - the M2 to be upgraded to at least six lanes with 9-10 lanes required between Lane Cove Road and Herring Road ramps (subject to more detailed engineering investigations);
  - a new westbound off ramp from the M2 to the western end of Waterloo Road;
  - a new grade separated right turn from Epping Road into Delhi Road and onto the westbound on ramp of the M2;
  - a new road linking Delhi Road (150m west of Plassey Road) to the Epping Road/Pittwater Road intersection to be included as a four lane "major road" link catering predominantly for through traffic;
  - grade separation (overpass) of Epping Road over the Herring Road intersection with associated re-orientation of the existing intersection;
  - Lane Cove Road to be widened to provide bus lanes in selected sections, as per RTA planning; and
  - Delhi Road to be widened to a seven lane cross section between the M2 ramps and Plassey Road to cater for intersection turn pocket requirements.

It is expected that the local road network and intersections within Macquarie Park will be funded as development occurs in specific areas. Major road network and intersection/interchange upgrades required by 2031 could be in the order of $300 million to $500 million.



Date:	Project No:	Project Name:		Figure No:
14/04/2008	P0272	Macquarie Park Traffic Study	Study Area, LEP Boundary and Paramics Zones	ES1

BITZIOS consulting