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Project Name: **Humanities and Science Campus: Traffic Analysis of Master Plan Options**

Project number: **3002113**

Report for: **Spackman & Mossop Landscape Architects**

PREPARATION, REVIEW AND AUTHORISATION

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Final	28/03/2007	Khaled Abbas Lindsay Jacobsen Josh Everett	Khaled Abbas	Tim Hahn
Final	27/06/2007	Khaled Abbas Josh Everett Boyd Lejano	Khaled Abbas	Tim Hahn
Final	02/07/2007	Khaled Abbas Josh Everett Boyd Lejano	Khaled Abbas	Tim Hahn

ISSUE REGISTER

Distribution List	Date Issued	Number of Copies
Spackman & Mossop Landscape Architects	02/07/2007	1 electronic copy
SMEC Canberra	02/07/2007	1

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1 Introduction

SMEC was requested by Spackman and Mossop Landscape Architects in Conjunction with Lahz Nimmo Architects (SMLN) and the National Capital Authority (NCA) to provide expert feedback on two master plan stages proposed for the Humanities and Science Campus adjacent to the National Library (NLA) and Questacon in Canberra, ACT. In this context, SMEC reviewed the two master plan stages as well as the current base situation. Different components of the master plan stages were examined in an effort to identify changes, advantages, limitations and recommendations. These were laid out in a table format. The recommendations were also drawn in a sketch format to show the difference between SMLN proposal and SMEC recommendation.

SMEC was also requested by SMLN and the NCA to undertake a traffic study as part of Spackman & Mossop team to conduct a Design and Development Phase Study for the Humanities and Science Campus Square. The main objective of this study is to examine the traffic impacts of changes in the proposed Master Plan Stages 1 and 2 for the Humanities and Science Campus Square. This is meant to identify any traffic, circulation or safety issues that may arise out of the suggested Master Plan Stages and to recommend solutions.

2 Methodology

SMEC's methodology involves a number of steps. These are as follows:

1) Conduct fresh supplementary traffic counts to enable the calibration of a representative 2006 Origin-Destination (OD) matrix
2) Conduct a re-calibration of the Paramics micro-simulation model i.e. update the micro-simulation traffic model for the study area
3) Use SMEC TransCAD Strategic model to obtain an appropriate growth factors for extrapolation of the OD matrix to horizon years used to test the Master Plan
4) Conduct a Paramics "Do Nothing" simulation for the 2008 horizon year
5) Examine master plan stages and identify the changes to the land use, road network and traffic circulation
6) Update network coding to cater for Master Plan stages
7) Re-estimate future OD matrices to account for generated/attracted traffic due to new developments and parking lots
8) Conduct a Paramics simulation run for Master Plan Stage 1 for the 2008 horizon year
9) Conduct a Paramics simulation run for Master Plan Stage 2 for the 2013 horizon year
10) Conduct Level of Service Analysis for major intersection in the study area in the Do Nothing and Master Plan Stage 1 and Stage 2 both for AM and PM peak
11) Suggest remedial measures (if warranted) and conduct simulation runs to test the effectiveness of such measures.

3 Master Plan Stages

3.1 Review Master Plan Stages

In this task, a detailed review of the master plan stages is conducted. Such review is meant to identify changes in the road network, parking provision and land developments proposed within the Humanities and Science Campus, and to determine the planned type of land use, the floor area and the density of usage. The following two figures details the traffic changes as proposed in the Master plan stages.

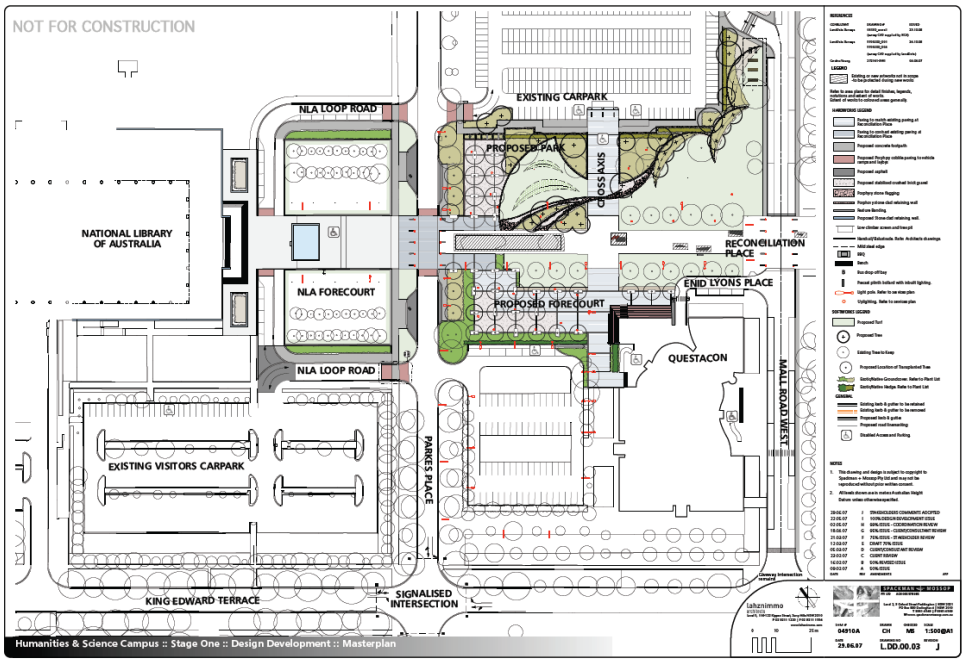


Figure 1: Master Plan Stage 1 (Refer to Appendix A for Proposed Coach Manoeuvring analysis Along Mall Road West)

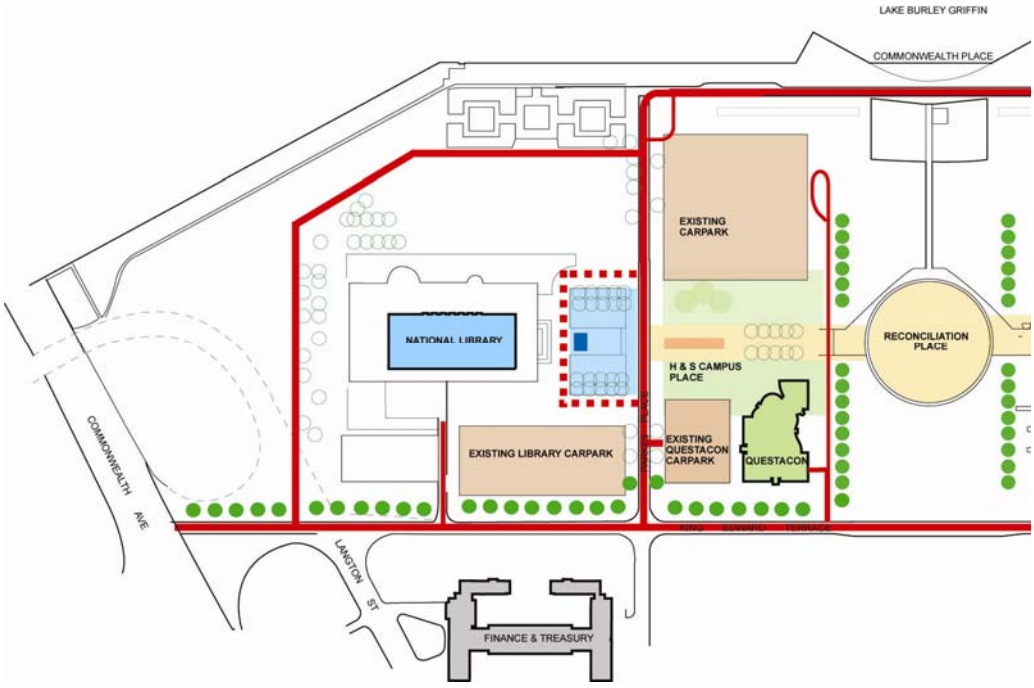


Figure 2: Master Plan Stage 2 (External loop Road Only with Possibility for Potential Developments)

The following represents a summary of changes proposed by SMLN and further refined by SMEC for each of the two stages.

Stage 1:

- Removal of Enid Lyons Street
- Entry/Exit to Questacon car parking from Parkes Place West.
- Newly asphalted surface car park between Parkes Place West and Mall road West – entry/exit via Parkes Place West
- Mall Road West to be dedicated for coach parking & maneuvering + taxi drop off + access to Questacon basement parking

Stage 2:

- Construction of internal loop road
- Other future development options
-

3.2 Identify Advantages and Limitations

Different components of the master plan stages were examined in an effort to identify advantages, limitations and recommendations, see Table 1.

Table 1: Comparison of Stage 1 and Stage 2

Component	Base	Stage 1	Comments	Stage 2	Comments
Enid Lyons Street	Exist	Removed	Advantages: ▪ Removal of Enid Lyons Street will allow for a clear area to establish Campus place. Buses parking in Enid Lyons Street will be provided by a separate Coach parking area as discussed below.	As per stage 1	As per stage 1
Mall Road West	Exist	Dedicated to Coach parking & maneuvering + taxi drop off + access to Questacon basement parking A dedicated well signed and lit pedestrian crossing will be provided	This will separate the coach manoeuvring and parking from other traffic. It will provide a dedicated area for this. This is expected to minimise vehicle/coach conflicts as well as pedestrian/coach conflict. The number of potential parking spaces compared to the current condition is expected to increase.	As per stage 1	As per stage 1 Off site location for coach parking to be examined once on site coach location is rendered unavailable.
Entry/Exit to NLA surface car park	Shared Entry/Exit Via NLA Loop road	Exit park along entry road rather than continuing along loop road. Drop off & commercial vehicles to use NLA loop road. Short term parking to north only	▪ Possible Queues along Parkes Place and towards Parkes Place/King Edward Intersection at Peak. Unless remedial measures are introduced. ▪ Reduced traffic in front of NLA ▪ Parking no longer allowed on loops ▪ Bus drop off to NLA on Parkes Place West.	As per stage 1	As per stage 1
Entry/Exit to 110 Parking Lot to south West of NLA	Shared Entry/Exit Via a car park access road intersecting with King Edward Terrace	No Change	None	No Change	None

Questacon Car Parking	Surface Car Parking (Capacity 95) with Shared Entry/Exit Point Via Enid Lyons	Surface Car Park with a reduced capacity of 64 + 5 additional disabled spaces and a Shared Entry/Exit via Parkes Place West	▪ The lost parking spaces are meant to allow for a more clear area to establish Campus place. These lost spaces will be compensated by the introduction of the new surface car park	This report examined the potential for the surface Car Park to be replaced by a New Structured Car Park with a capacity of 690 cars. Entrance and exit is via Parkes Place West.	Advantages: Providing sufficient car parking capacity to cater for the dirt park being used for the Garden of Wonder (around 500-600) as well as the current Questacon Car parking of around 95.
Section 55 Northern Car Park	Capacity around 300 and can be extended to cater for ~ 600 cars. Entrance and exit are shared and are mainly from Enid Lyons	Section 55, Northern Car Park to be converted to a proper surfaced car park with a capacity of around 419 car spaces + 10 designated spaces for disabled. Entry and exit is from Parkes Place West.	Advantages: ▪ Majority of car parking for Questacon will be occurring in one location. This will allow majority of car passengers to cross and view Campus place via the pedestrian cross axis. ▪ Formalising the surface car parking area ▪ It is recommended to provide another gated entry/exit point to the car parking along Parkes Place west to assist in emergency situations.	Questacon Expansion and section 55 northern car park to be converted to future development.	The traffic analysis in this report did not account for any future developments. Such examination can be conducted once developments type and Gross Floor Areas are specified.
Mall Road West	Currently ends at Section 55 car park d used for vehicle access to Questacon + egress from section 55 carpark	Further extended to end in a roundabout loop to allow for coach circulation and turning. No carpark egress allowed. Taxi drop off + access to Questacon basement parking are allowed	Providing a designated road to cater for visitor buses drop off and pick up as well as parking. This will clear Enid Lyons and assist in creating a clear view for intended Campus Place Allowing taxi drop off + access to Questacon basement parking are allowed A separate analysis of intended Coach Circulation and Manoeuvring along Mall Road West is presented in section 3.3.	As per stage 1	Offsite coach parking to be examined once on site coach parking is rendered as unavailable

Round About at far north corner of Parkes Place	No Change	None	None	None	None
New 2 way Road to surround the national library and connects to King Edward as well as to Parkes Place	Not Part of this stage	None	None	New 2 way Road to surround the National Library and connects to King Edward as well as to Parkes Place	Advantages: ▪ This will allow easy bus tour around the campus and for drop off and pick up to occur along the way.

3.3 Examination of Coach Parking Circulation and Manoeuvring in Stage 1

SMEC undertook an analysis of the geometric layout; see Appendix A, of the proposed dedication of Mall Road West to Coach parking, drop off/pick up in Stage 1. SMEC identified the main expected Coach manoeuvres to be examined. This involved checking the swept path of bus manoeuvring along Mall road and around the circular loop at the bottom and back to Mall road. This was checked using a rigid bus of dimensions of 14.5 metres long and 2.5 meters wide. Figure A-1 in Appendix A shows that the geometric dimensions as provided by the Master Plan – Stage 1 can accommodate the worst case scenario of buses parking at both sides as well as buses manoeuvring head to head. Further more 3 bus parking manoeuvres were checked:

- the first is the simple manoeuvre of parking the bus at a front or a rear bay. This can be accommodated.
- the second manoeuvre is parking the bus along the bay directly after manoeuvring the turning loop. This is shown in the Figure A-2. The figure shows the possibility of conducting such manoeuvre.
- The third bus parking manoeuvre is the most difficult one, where a bus have to park in between two already parked buses. In this context, SMEC examined the Bus stop style guide stating that for a bus of 14.5 meters long, a minimum of 22.5 meters parking bay per bus should be provided. This is based on the notion that the two other front and rear buses are centrally located within their parking bays. As stage 1 caters for this coach parking bay length, SMEC examined both parking manoeuvres which were found acceptable but a bit tight for both reverse and forward parking, see Figures A-3 and A-4. .

It should be noted that in the existing parking arrangement, buses already park much closer than these recommended dimensions and allowances of the proposed design is expected to achieve a potential improvement to the current situation. `Coach entry/exit to KET via MRW only is conside5red to be a significant improvement to site safety as it separates coach manoeuvring and parking from other vehicle movements. In this context, this proposal is also expected to minimise vehicle/coach conflicts as well as pedestrian/coach conflict.

3.4 Analysis of On-street Bus Parking Bays Lengths in Stage 2

The following analysis examines whether in Stage 2, the designated bus drop off and pick up areas along Parkes Place West are sufficient in length to allow for the expected number of buses at peak times. The following data and assumptions were utilized:

Number of buses expected (mean) = 20 buses / peak hour (Source Cardno Young Report)

Arrival Pattern peak 15 minutes = 20/4 = 5 buses/15 minutes

Bus Capacity (14.5 meters long) = 55 seats

Boarding Time per passenger = 3 seconds

Alighting Time per passenger = 2 seconds

Total Time Required for Alighting of 5 buses = 5 * 55 * 2 = 550 seconds = 9 minutes

Total Time Required for Boarding of 5 buses = 5 * 55 * 3 = 825 seconds = 14 minutes

Maximum Length Required for Bus Parking if Obstructed on Approach and Departure = 33 meters

Maximum Loading length required for 5 buses = 5 * 33 = 165 meters

In conclusion, the two 120 meters loading spaces provided in stage 2 master plan are sufficient for expected bus arrival and departure during the peak 15 minutes.

4 Data Collection

4.1 Determine Required Supplementary Traffic Data

In order to calibrate the operational Paramics traffic model to current traffic conditions, SMEC identified the required supplementary traffic data and organised intersection turn counts to be performed, the locations of which are shown in Figure 3. These were selected based on the required level of detail in the network modelling and the availability and intensity of ACT traffic counts. SMEC has obtained SCATS counts and phasing for all signalised intersections in the area.

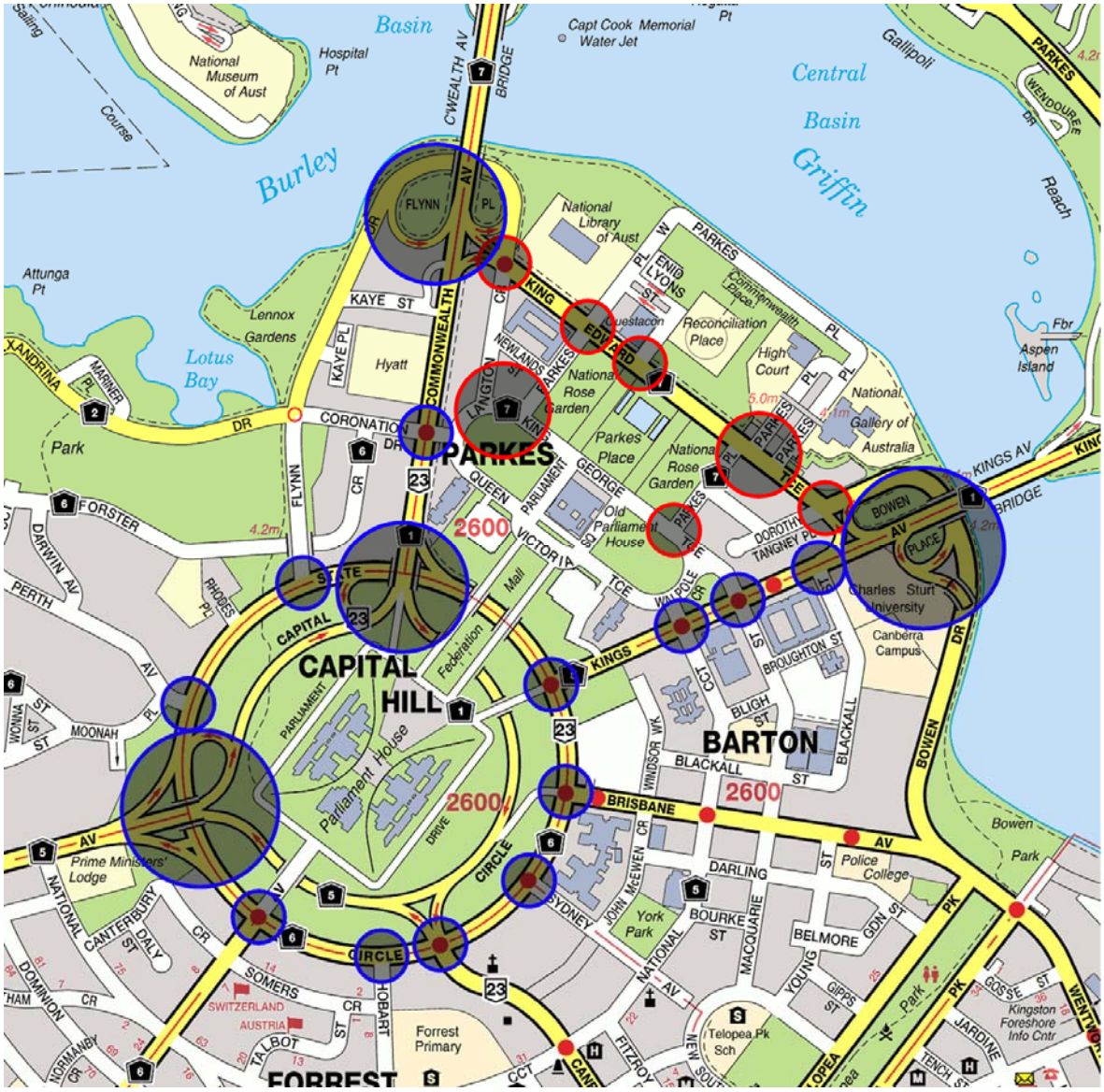


Figure 3: Locations of Traffic Counts Conducted by SMEC

4.1.1 Conduct Traffic Counts

In order to carry out the traffic counts, SMEC developed a traffic counting program, which included a time schedule for the above identified intersection turning movement counts.

5 Micro-simulation Traffic Modelling

As NCA is in the process of preparing a new Master Plan for the Humanities and Science campus, it is crucial to consider and test master plan stages. An operational traffic model is meant to demonstrate in detail the operability of traffic movements within a specified road network. This model is crucial for providing detailed traffic information for testing alternative intersection layout designs and micro road network changes. This model will be used to test and visualise the operability of traffic movements within the Humanities and Science campus as a result of proposed master plan options. In this context, SMEC will calibrate a micro simulation traffic model at an operational level using Paramics software. Paramics is a suite of high performance software tools used to model the movement and behaviour of individual vehicles on urban and highway road networks. Paramics provides a visualisation of road network and traffic demands using a graphical user interface. The Paramics models would provide a clearer understanding of particular traffic management issues and the performance of proposed treatments.

5.1 Study Area

The micro-simulation study area was taken from the Parliamentary Zone micro-simulation model maintained by SMEC in Paramics. This condensed model has 14 Origin-Destination zones as follows:

1) Flynn Place
2) Commonwealth Avenue (South of KET)
3) Commonwealth Avenue (North of KET)
4) Langton Crescent
5) National Library West car park
6) Parkes Place West (South of KET)
7) National Library East car park
8) Questacon car park
9) Parkes Place East (South of KET)
10) National Gallery West car park
11) Administration Place
12) National Gallery East car park
13) Kings Avenue Ramps
14) Bowen Place

5.2 Network Coding (Do Nothing)

A first step in network coding is to identify components of the road network to be modelled. This is limited to the road network leading to and within the Humanities and Science Campus. Such coding utilised aerial photography supplied by the NCA, with site inspections performed where required for verification of road and intersection layouts. Paramics was configured according to standardised settings developed by the Roads and Traffic Authority, NSW. The modelled road network includes the following details:

- Number of lanes on the carriageway;
- Speed zones;
- Signal phasing, green-splits, inter-greens and offsets were coded based on CATSS IDM data supplied by Roads ACT. These observed signal timings will be coded into Paramics.

The model was coded and calibrated for the entire Parliamentary Zone. The model was zoomed into the Humanities and Science Campus to provide a better visual representation of outputs.

The coded network for the Existing network continuing into the future as is i.e. “Do Nothing” is shown in Figure 4 and the Master Plan Stage 1 road network configuration is shown in Figure 5.

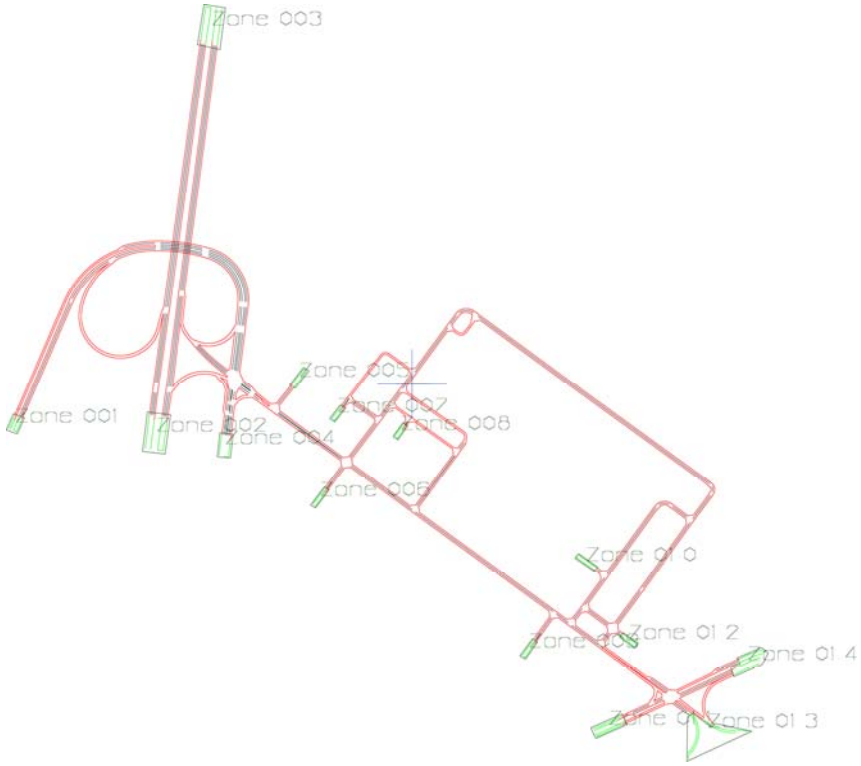


Figure 4: Existing Paramics Micro-simulation Study Area

5.3 Update network coding to cater for master plan changes

Identify components of the road network suggested in the Master Plan stages 1 and 2. This is limited to the road network within the Humanities and Science Campus. The coded network for the Master Plan Stage 1 road network configuration is shown in Figure 5. The coded network for the Master Plan Stage 2 road network configuration is shown in Figure 6.

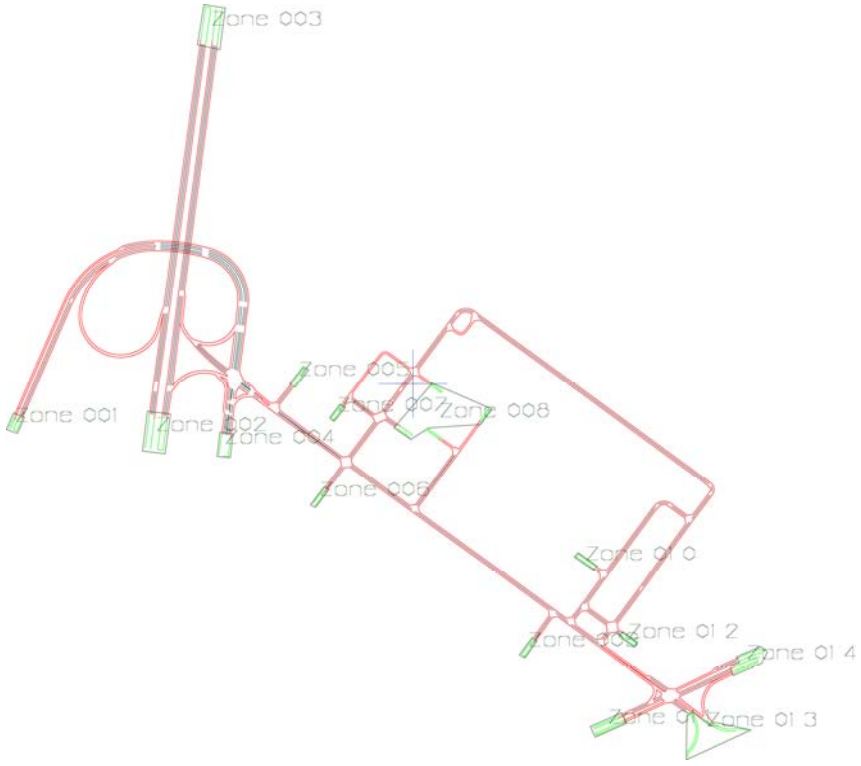


Figure 5: Master Plan Stage 1 (Expected in 2008)

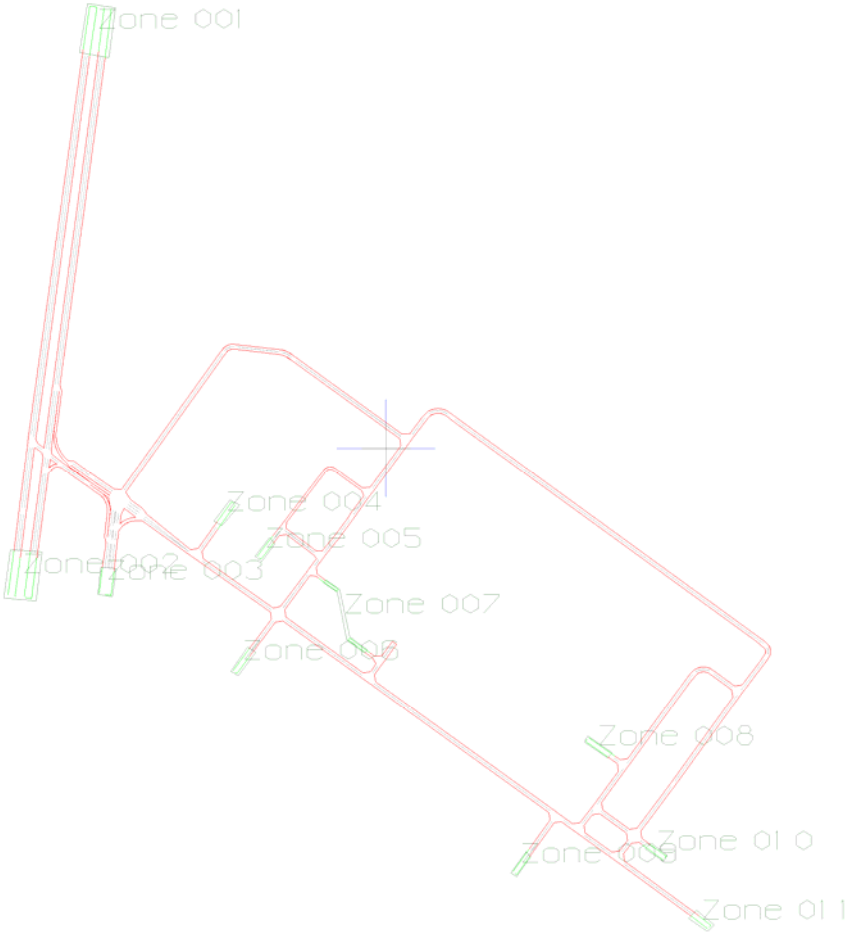


Figure 6: Master Plan Stage 2 (Expected in 2013)

5.4 Traffic Modelling

5.4.1 OD Matrix Estimation

Required input for Origin-Destination matrix estimation using Paramics Estimator includes intersection turn counts and cordon flows, which simply specify the number of vehicles entering and exiting each OD zone in the network. Counters Plus were contracted to perform intersection turn counts at every major intersection along King Edward Terrace on November 21 and 22, 2006.

Cordon flows for most zones were derived from these turn counts, however some zones represent car parks, and a generalised estimate of demand for these zones was obtained by scaling the demand at Zone 11 by the number of parking spaces available to each zone. Zone 11 is unique in that it effectively represents the John Gorton Building car parks, but unlike the other car park zones in the network has had turn counts performed for it. As it is not the only access point for the Administration Building car parks, for the purposes of deriving car park demand elsewhere a conservative estimate of 50% was made for the number of John Gorton Building parking spaces served by Administration Place. The main difference in this respect between the Existing and Stages 1 and 2 matrix estimation is the number of parking spaces in Zone 8, which represents the Questacon car parks in both models.

Paramics Estimator generates OD matrices through an iterative process that makes small changes to each OD pair in the matrix and gauges the effect of the chances, incrementally converging on a reasonable match. Exact matches are rare due to the uncertainty in the input data and route choice (if any) in the Paramics network itself, and this leaves some uncertainty in the OD matrix.

5.4.2 OD Estimation Accuracy

The accuracy of OD estimation is determined by the GEH statistic, which was developed to compare two sets of data. It is a self scaling test which increases the significance of a difference between two values as the values increase. Accordingly, it takes the form of the following equation:

$$GEH = \sqrt{\frac{2 \cdot (M - C)^2}{M + C}}$$

Where M is the modelled volume and C is the counted volume.

In general, a GEH of less than 5 is considered to indicate good match between modelled and counted volumes. As an example of the self-scaling properties of the GEH statistic, this would represent a modelled flow of 33 compared to a count of 10, or a modelled flow of 1164 compared to a count of 1000. The former case represents only 23 vehicles but would be assigned a much larger significance than the 164 vehicles in the latter case if the percentage difference were used for comparison.

The UK Design Manual for Roads and Bridges (Volume 12) specifies that 85% of the GEH values in a model should be less than 5, and 100% less than 10. The 2006 AM Existing OD matrix developed for this study produces 93% of turn flows with a GEH less than 5 and 100% with a GEH less than 10.

5.5 Growth Factor Estimation and Determination of Future OD Matrices

To develop a 2008 and 2013 AM OD matrices, a strategic transport model of Canberra was used to determine the growth rates between 2006 and 2008 as well as between 2006 and 2013. This model is maintained in TransCAD, and uses Land Use data supplied by ACTPLA as input. Individual growth rates were obtained for each zone in the network, and the average total growth within the study area was determined to be 4%.

The growth rates were applied to the intersection turn counts and cordon flows, and then used to estimate a 2008 and a 2013 AM OD matrices.

5.6 Use Paramics to conduct assignment future runs

Paramics output is a dynamic assignment and simulation of traffic flows along the road network. In this step, assignment runs for the years 2008 and 2013 are conducted using Paramics. This is meant to simulate the traffic conditions in the future in light of the Do Nothing scenario as well as in light of the Master Plan Stage 1 in 2008 and the Master Plan Stage 2 in 2013.

Static output shots are shown in Figure 7, Figure 8 and Figure 9. These represent the 2008 AM Do Nothing scenario, the 2008 AM Master Plan Stage 1 scenario and the 2013 AM Master Plan Stage 2 scenario.

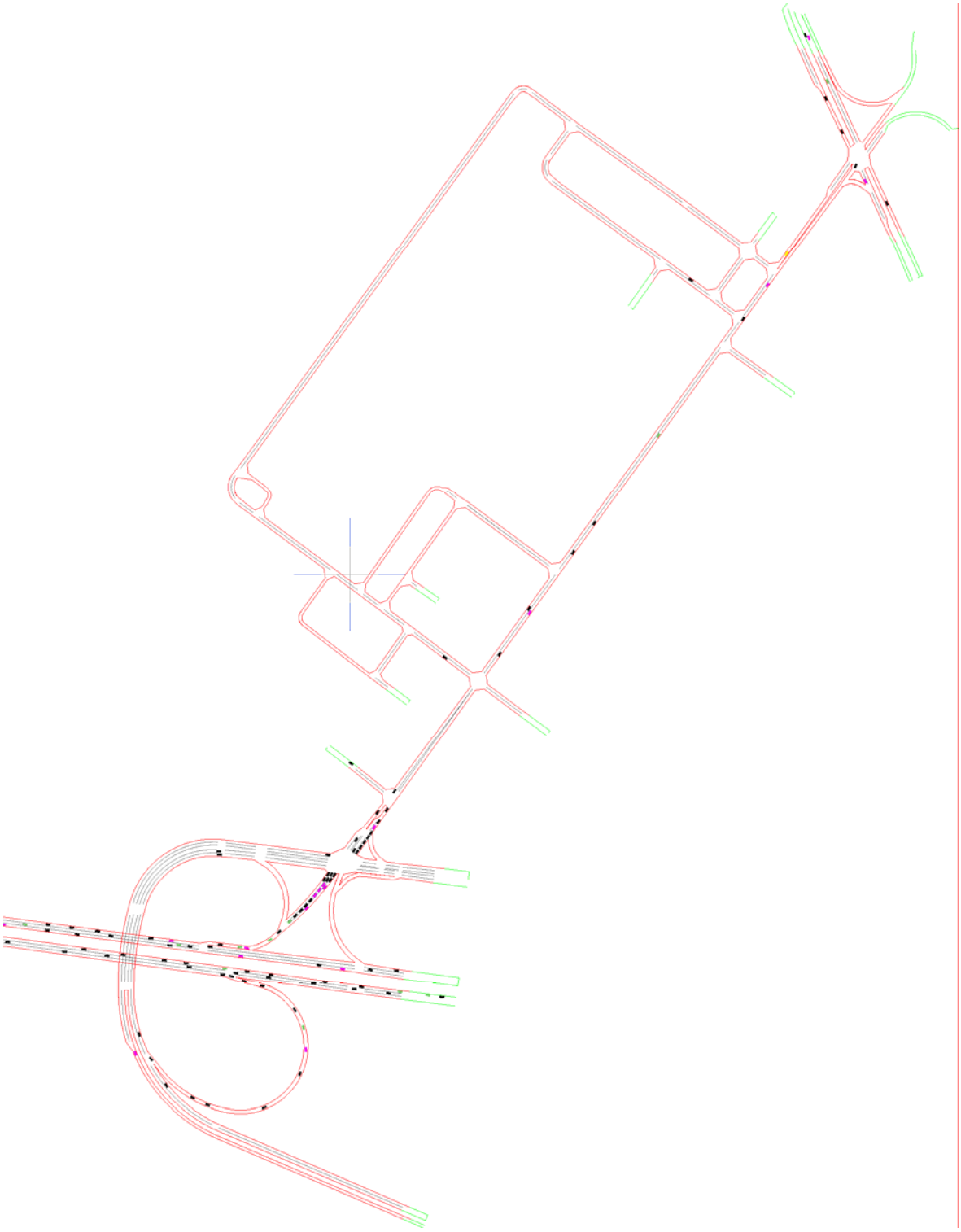


Figure 7: Loaded 2008 AM One-Hour Peak Existing Network ("Do Nothing") (Static Shot)

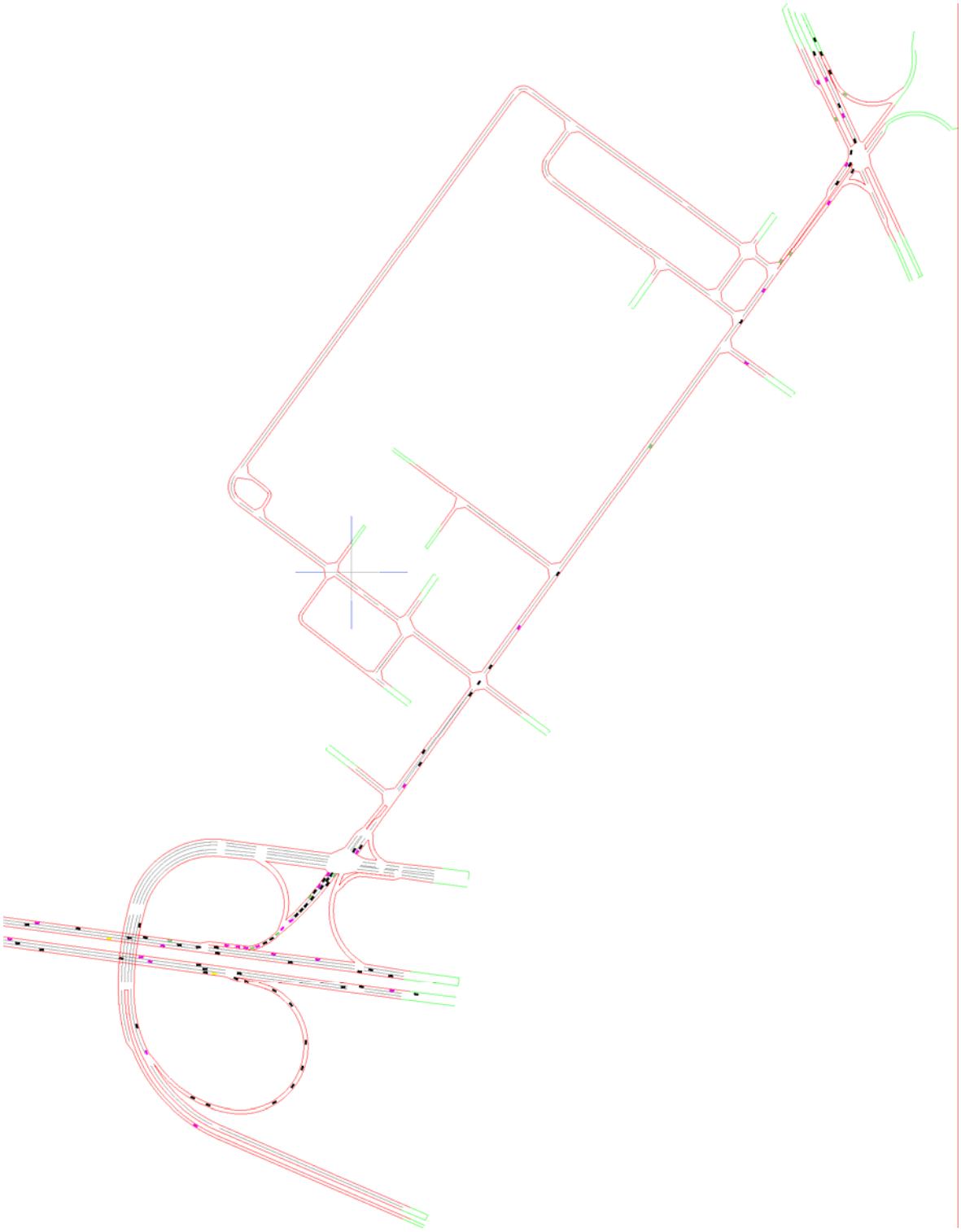


Figure 8: Loaded 2008 AM One-Hour Peak Stage 1 Network (Static Shot)

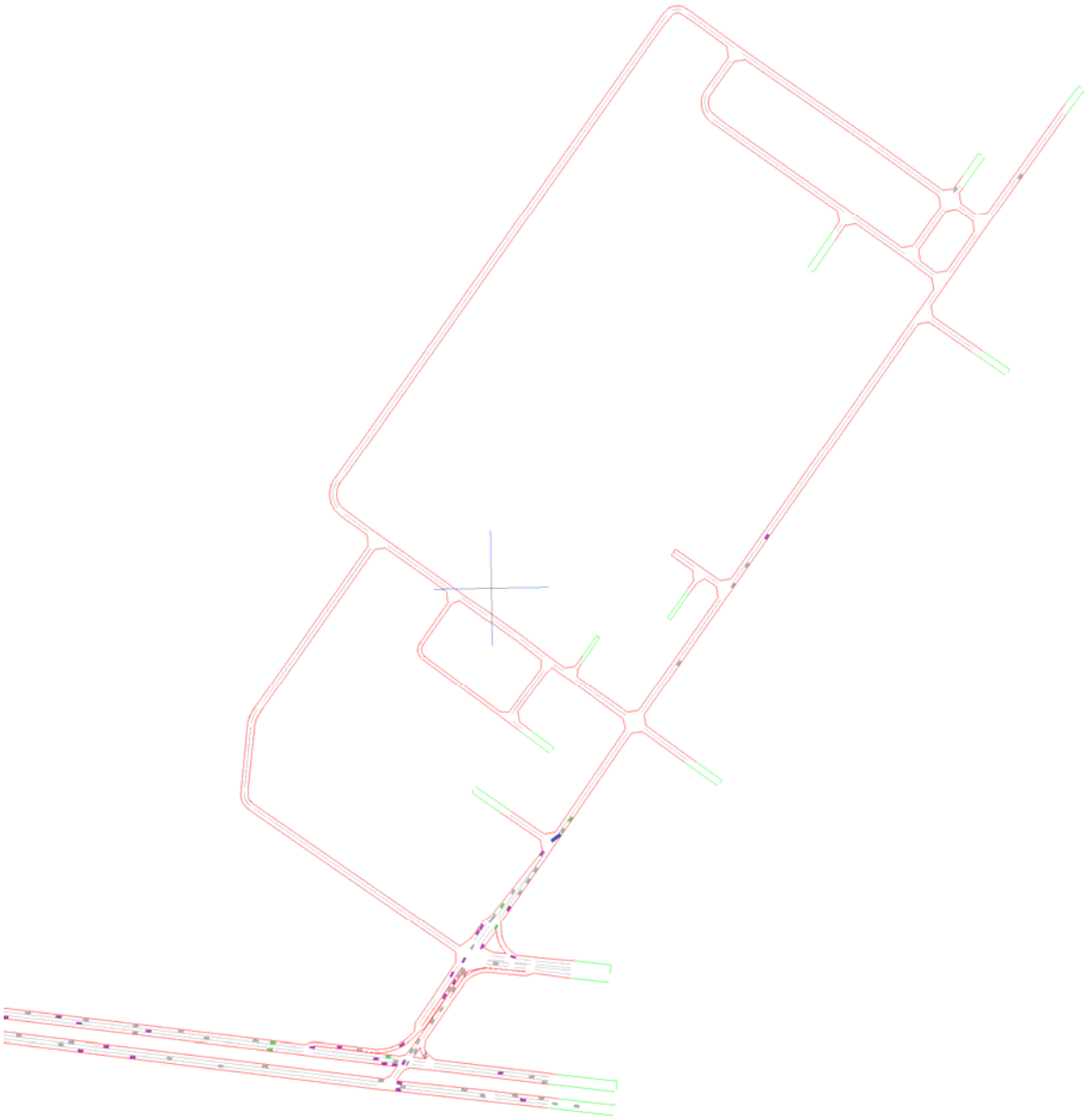


Figure 9: Loaded 2013 AM One-Hour Peak Stage 2 Network (Static Shot)

6 Intersection Modelling and Issue Identification

6.1 Introduction

This step is concerned with conducting Level of Service analysis for the two major intersections in the study area, namely:

- King Edward Terrace/Parkes Place West Intersection
- King Edward Terrace/Mall Road West Intersection

This will be conducted both for the do nothing as well as for Master Plan Stages 1 and 2. Stage 1 is expected to occur by 2008, while Stage 2 is expected by 2013. The micro-simulation modelling is used to derive turn counts for discrete intersection modelling. Modelling and performance analysis for the intersection was conducted using SIDRA Intersection 3.1. All configuration options were used at their default settings. It has to be noted that all synthesised turning flows are AM peak. This is sufficient for identifying any expected intersection issues. Future remedial measures will be considered in light of AM and PM peak analysis.

6.2 Existing King Edward Terrace – Parkes Place West: Configuration, Turning Flows and Performance

The intersection was modelled in the configuration shown in Figure 10 to simulate the lane sharing that occurs close to give way intersections that have sufficient road reserve to fit vehicles side by side when performing different turning movements.

Maximum approach length has been set to the distance between the intersection and the nearest road facility (intersection or driveway) on each approach leg. This distance functions as a limit to the acceptable length of queue formation. The nearest facilities on each approach of the intersection of King Edward Terrace and Parkes Place West and their distances are included below:

Table 2: King Edward Terrace and Parkes Place West Maximum Approach Distances

Approach	Distance to Nearest Facility	Nearest Facility
North	100m	National Library loop road intersection with Parkes Place West
East	130m	Mall Road intersection with King Edward Terrace
South	140m	Newlands Street intersection with Parkes Place West
West	150m	National Library West car park driveway to King Edward Terrace

The layout diagrams shown give a useful visual representation of the intersection layout. However, they are not intended to be an accurate geometric representation of the intersection. The numbers shown together with a widening “turn slot” on some of the approaching lanes indicate that they are short lanes, and refer to the storage length of the lane in metres.

The intersection was modelled in the configuration shown in Figure 10 to simulate the lane sharing that occurs close to give way intersections that have sufficient road reserve to fit vehicles side by side when performing different turning movements. The 15 meters storage length is just indicative to such behaviour.

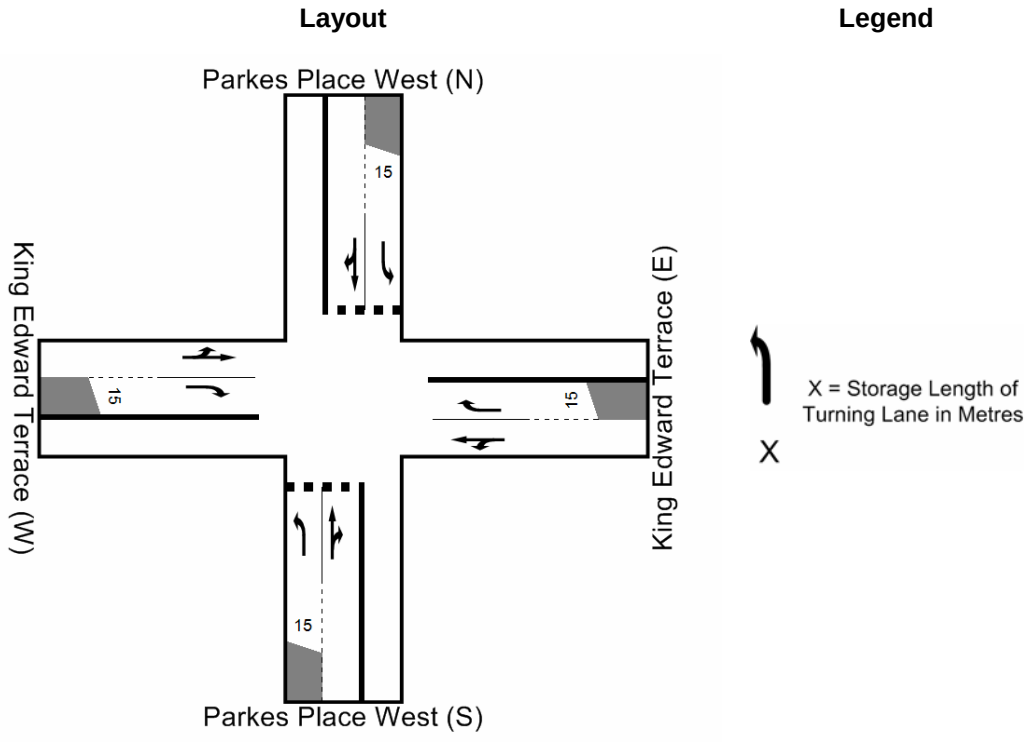


Figure 10: Existing King Edward Terrace – Parkes Place West Intersection Layout

6.2.1 Existing King Edward Terrace – Parkes Place West: Turning Volumes

These detail the turning flows that were used in each case, and include two sets of numbers, the larger being the total turning flow and the smaller being the heavy vehicle turning flow. Turning flows for the 2006 were based on data collected during the AM peak hour of 08:00-09:00.

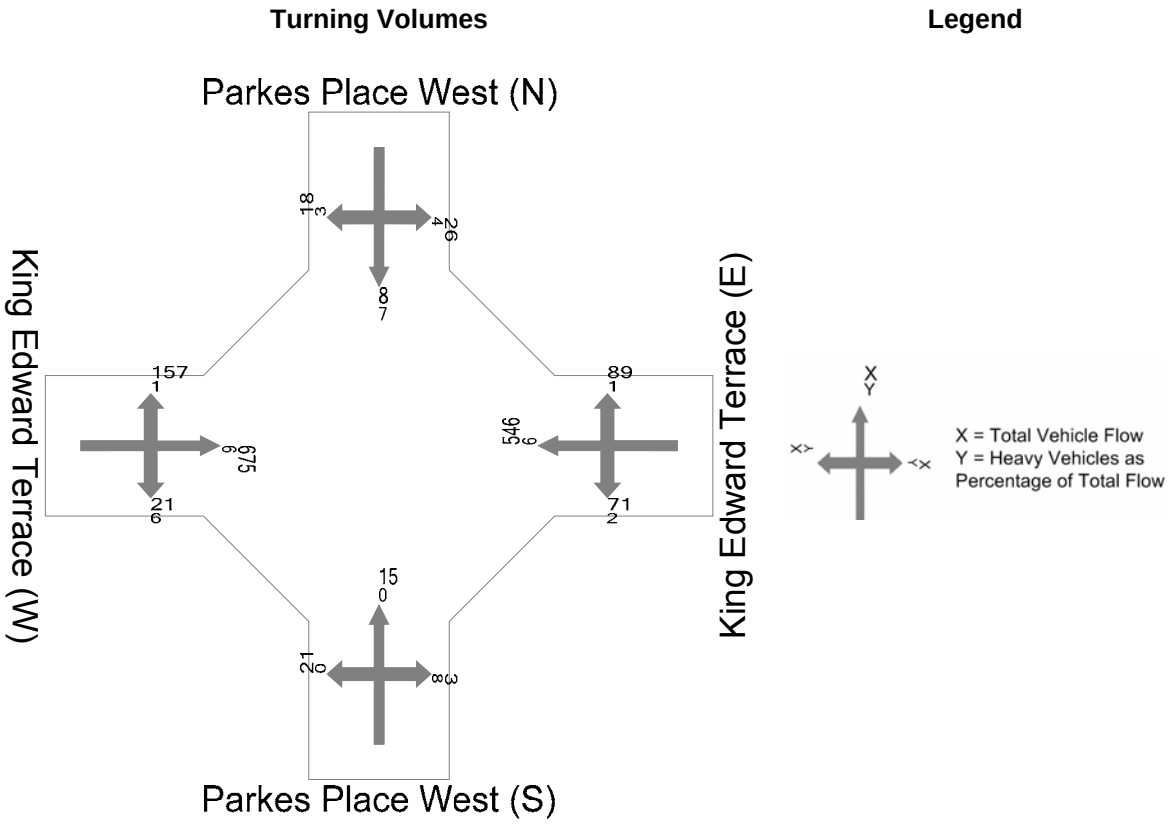


Figure 11: 2006 AM One-Hour (8 – 9) Peak Estimated Turning Volumes (Existing)

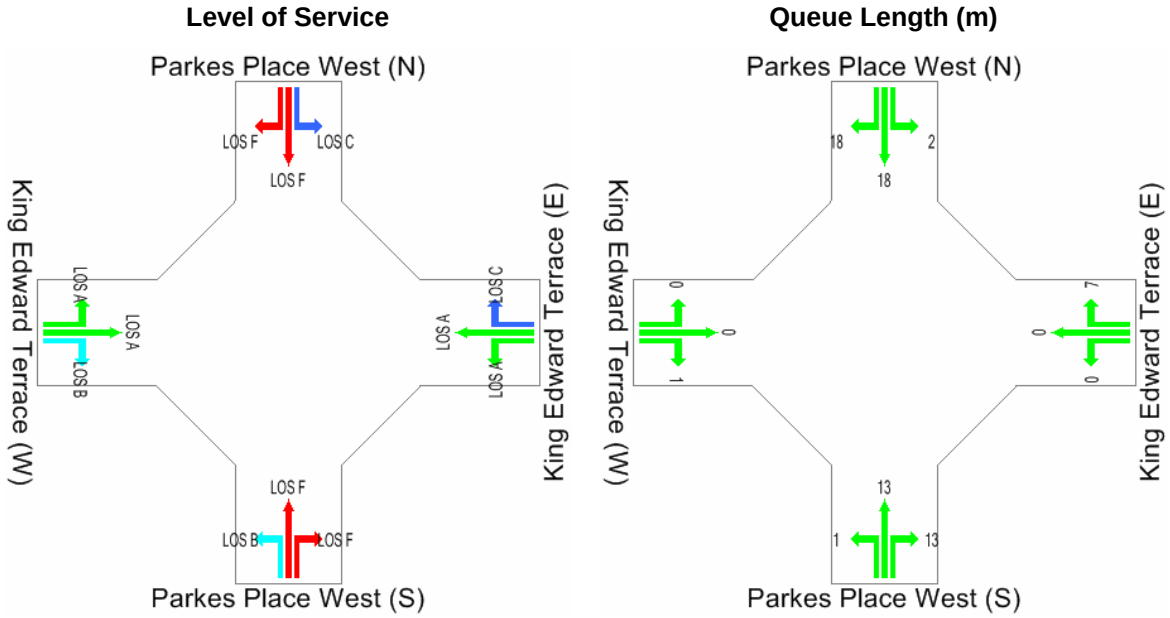
6.2.2 Existing King Edward Terrace – Parkes Place West: Performance

An intersection's performance can be measured using two statistics:

- Queue Length, showing the 95th percentile back of queue distance for the approach in metres, in other words the queue length that could be expected to be reached or exceeded 5% of the time during the simulated period.
- Level of Service (LoS), which is calculated for each movement by SIDRA from vehicle delay using the Highway Capacity Manual (HCM) method. SIDRA is a world renowned intersection analysis software package that is developed and maintained in Australia.

Generalised definitions of the different Level of Service ratings and the HCM delay criteria by which they are derived can be found in Appendix A. Generally, LoS A and B represent very good performance, C and D represent good to acceptable performance, and E and F represent performance levels that are not acceptable and should be avoided.

The following figures show the queue length measured in meters and the levels of service for all turning movements at Kings Edward Terrace/Parkes Place intersection. The figures show these performance indicators for the existing 2006 condition.



Average LoS: A

Figure 12: 2006 AM One-Hour (8 -9) Peak Performance (Existing Give-Way Intersection)

6.2.3 2008 King Edward Terrace – Parkes Place West: Turning Volumes

Turn flows for the 2008 were synthesised from the Paramics simulation runs. These are shown below both for the future 2008 do nothing scenario as well as the future 2008 Master Plan Stage 1.

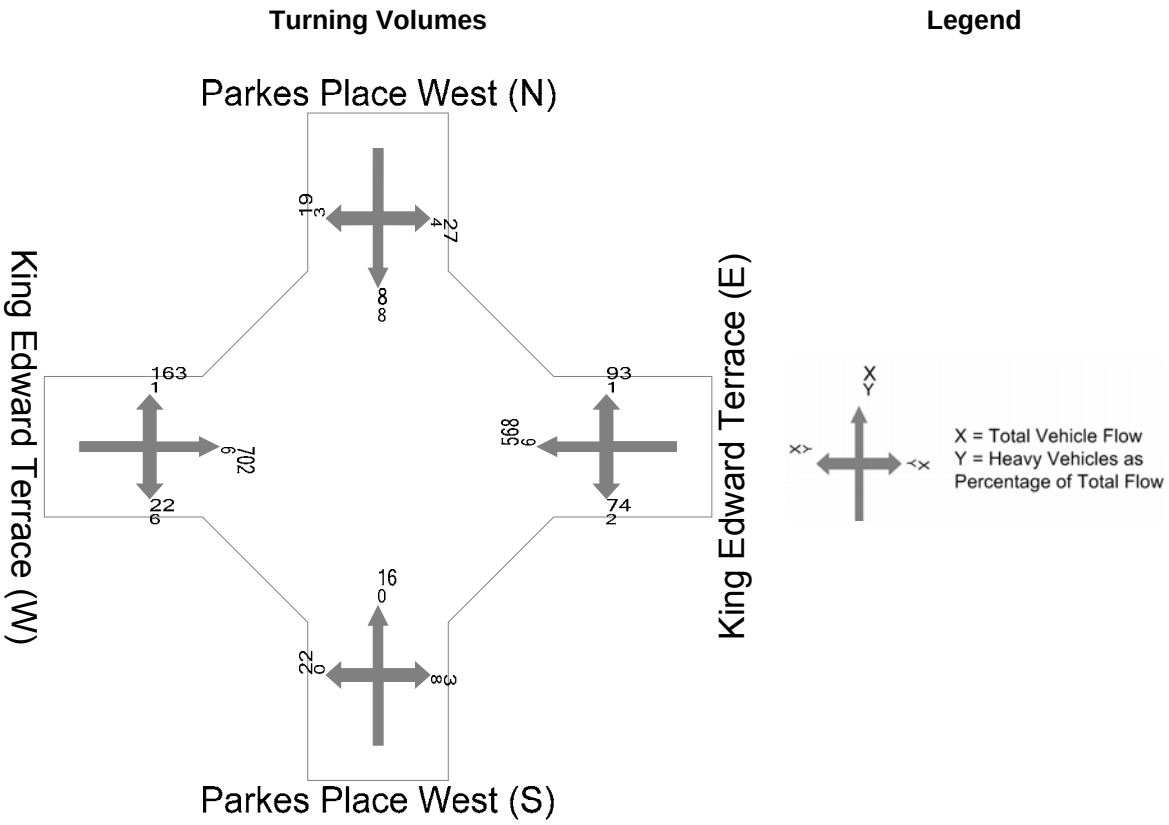


Figure 13: 2008 AM One-Hour (8 -9) Peak Estimated Turning Volumes (Do Nothing)

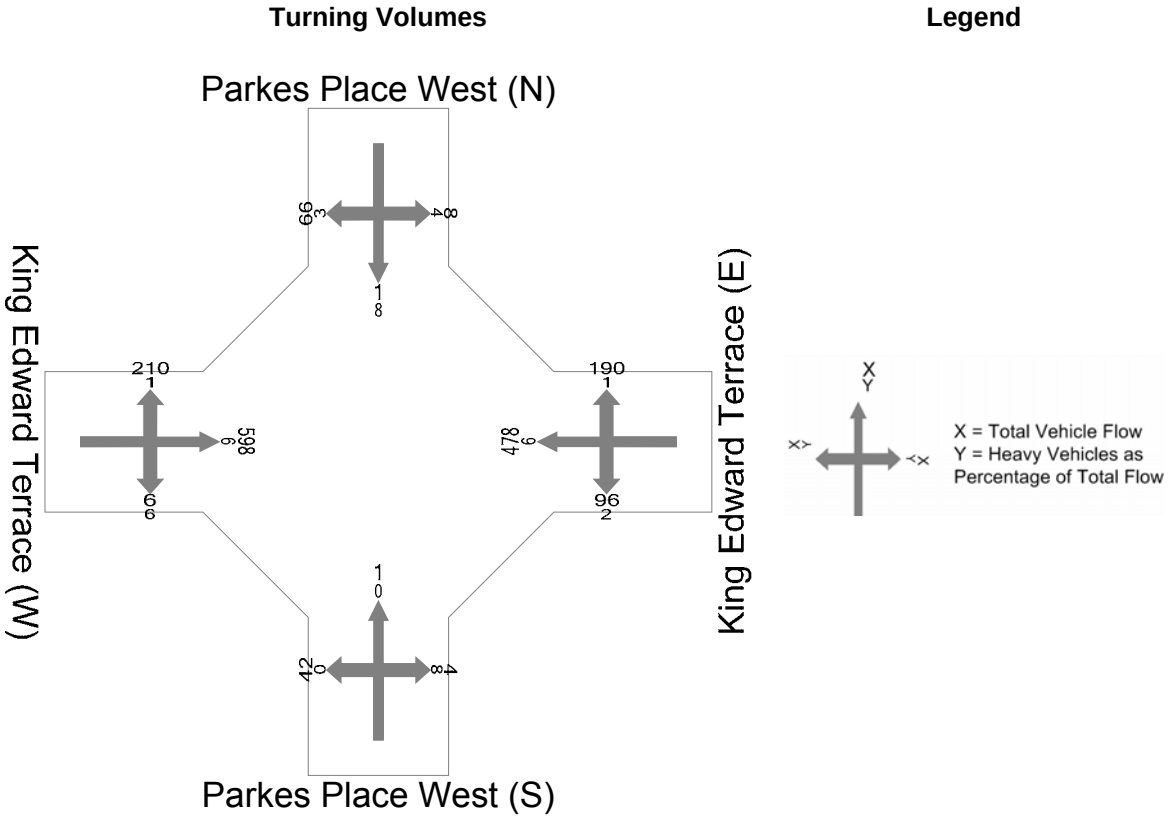
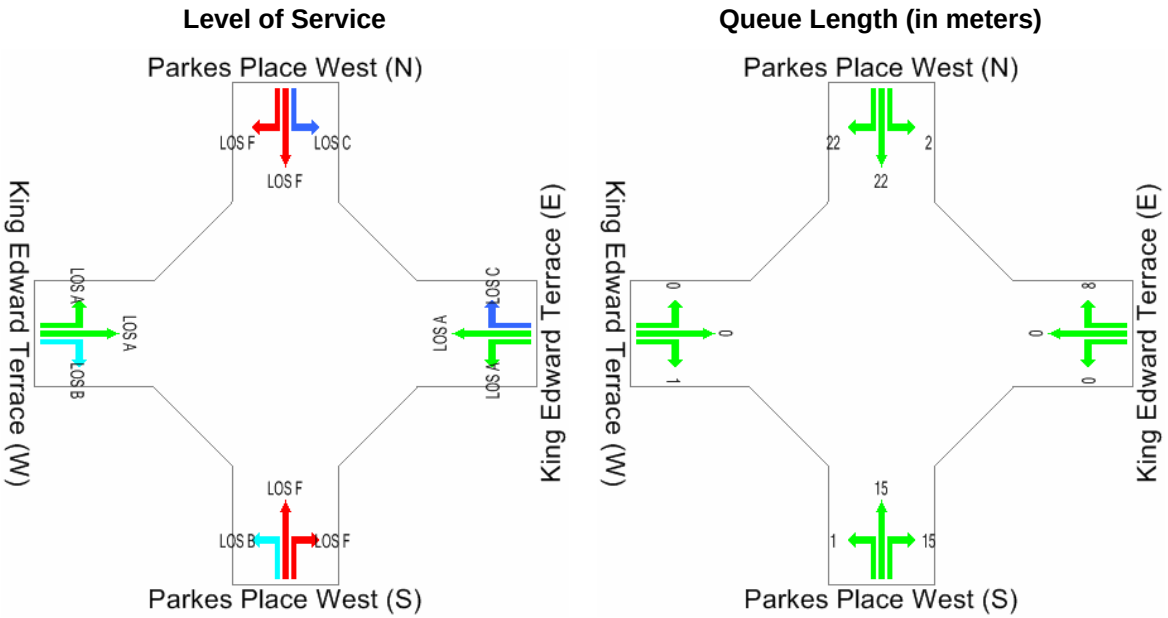


Figure 14: 2008 AM One-Hour (8 – 9) Peak Stage 1 Estimated Turning Volumes

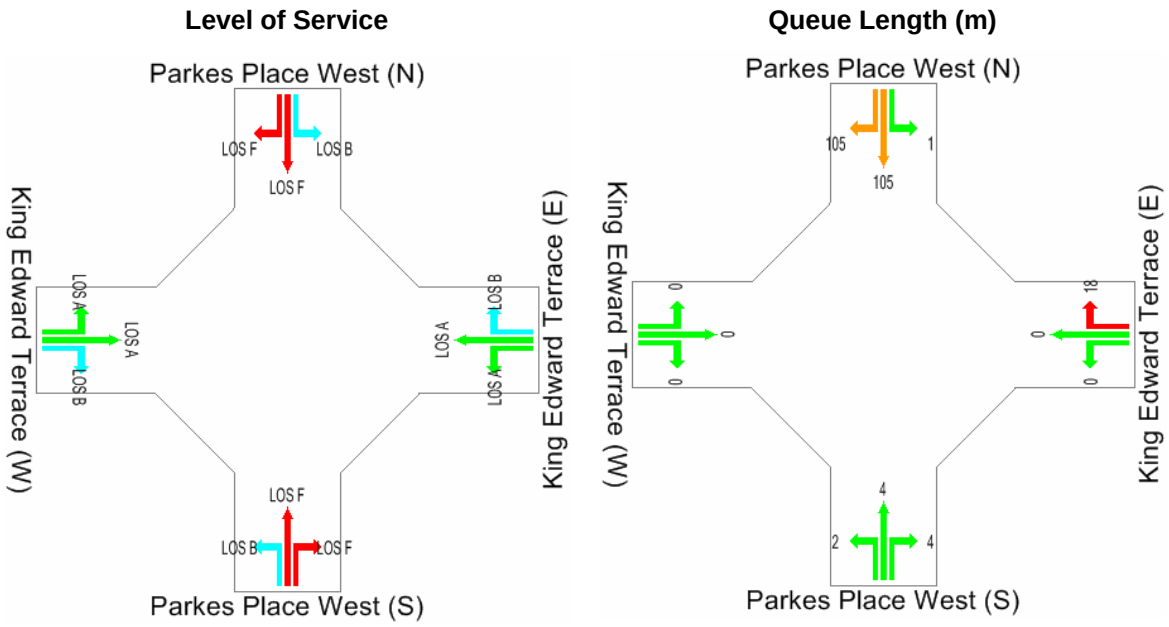
6.2.4 2008 King Edward Terrace – Parkes Place West: Performance

It can be seen that the effect of Master Plan Stage 1 on the traffic flow along traffic flow through the intersection is not significant. The overall average intersection LoS (as distinct from the individual movement LoS) for the Do Nothing scenario is A and for the Master Plan Stage 1 is B. This is considered as good performance, however as shown in the below figures, the through and right turning movements from Parkes Place West are operating at LoS F which is considered to be unacceptable performance. This can be attributed to the opposing volumes travelling through King Edward Terrace. It is of vital importance to improve the operability of the through and right turning movements from Parkes Place West so as to discharge possible queues that might lead to blockage of other entry and exit point along Parkes Place west. Thus, improving performance of these two movements is required. This can be potentially achieved with a different control method.



Average LoS: A

Figure 15: 2008 AM One-Hour (8-9) Peak Do Nothing Future Performance (Give-Way Intersection)



Average LoS: B

Figure 16: 2008 AM One-Hour (8 – 9) Peak Stage 1 Future Performance (Give-Way Intersection)

6.2.5 2013 King Edward Terrace – Parkes Place West: Turning Volumes

Turn flows for the 2013 were synthesised from the Paramics simulation runs. These are shown below for both the 2013 Do Nothing and the future 2013 Master Plan Stage 2.

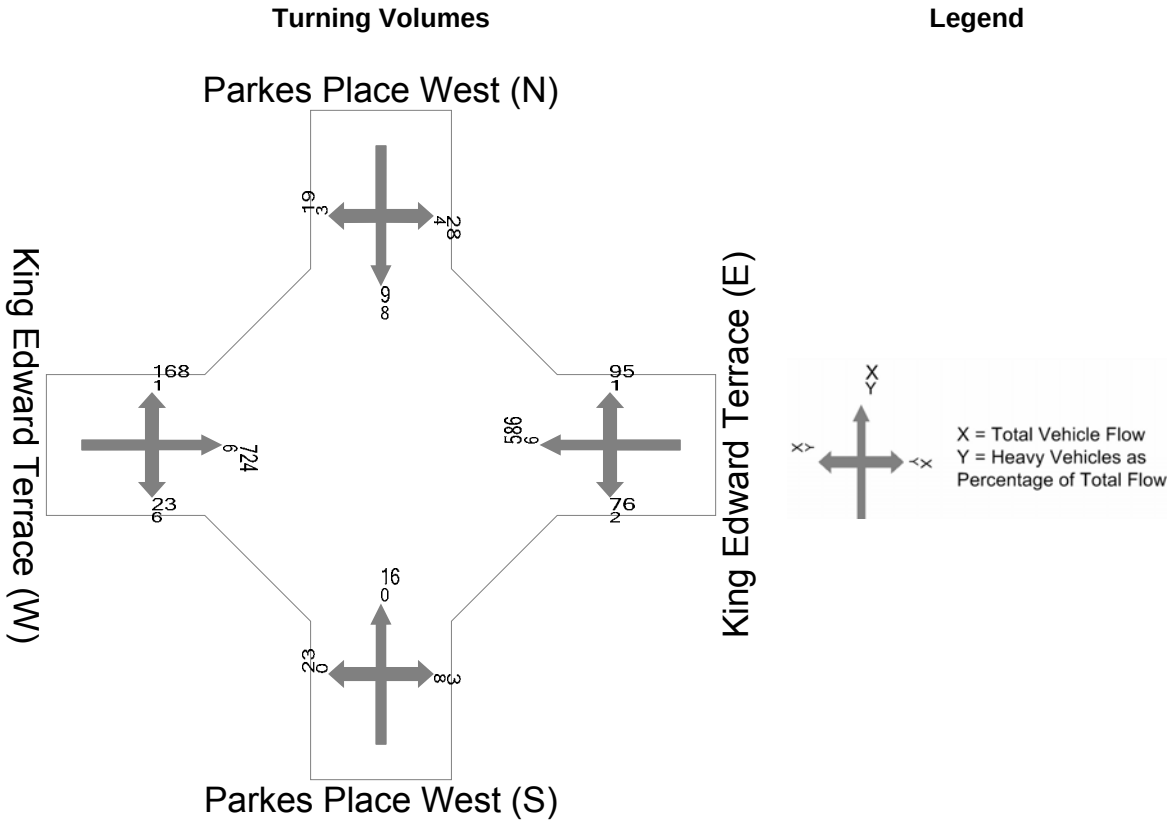


Figure 17: 2013 AM One-Hour (8 -9) Peak Estimated Turning Volumes (Do Nothing)

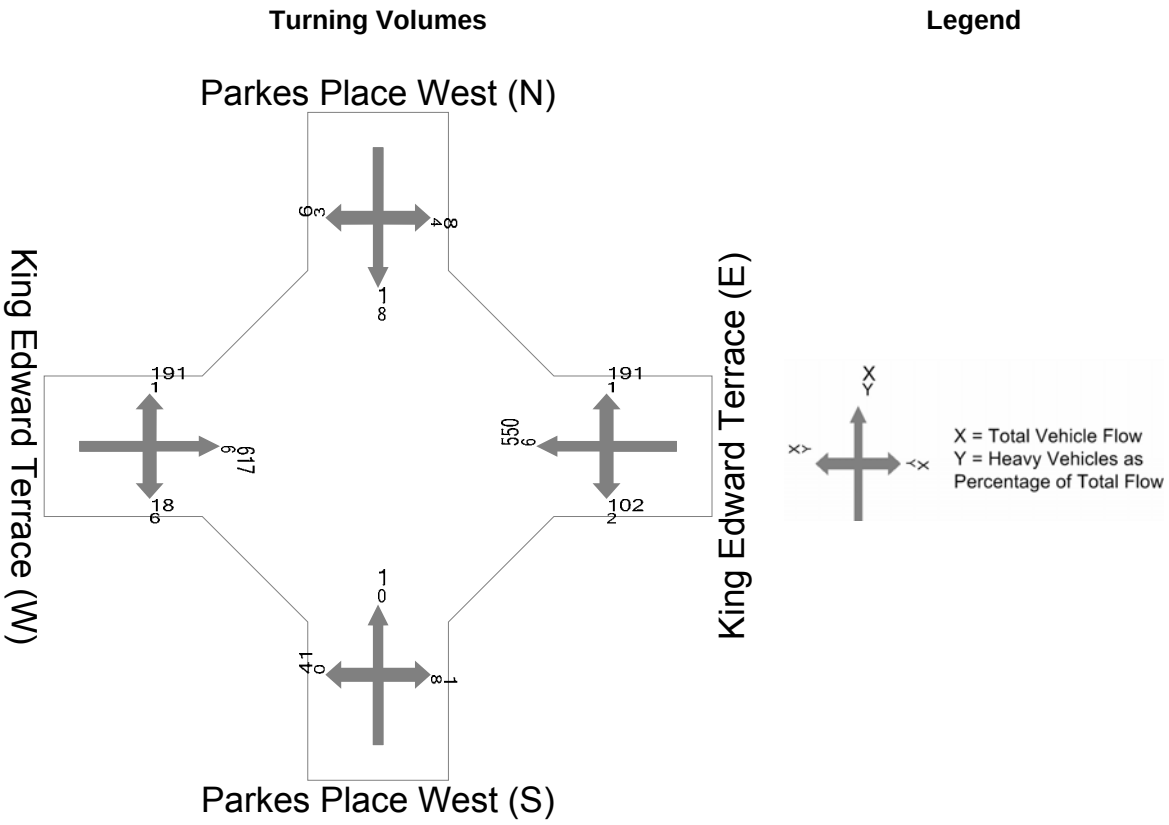
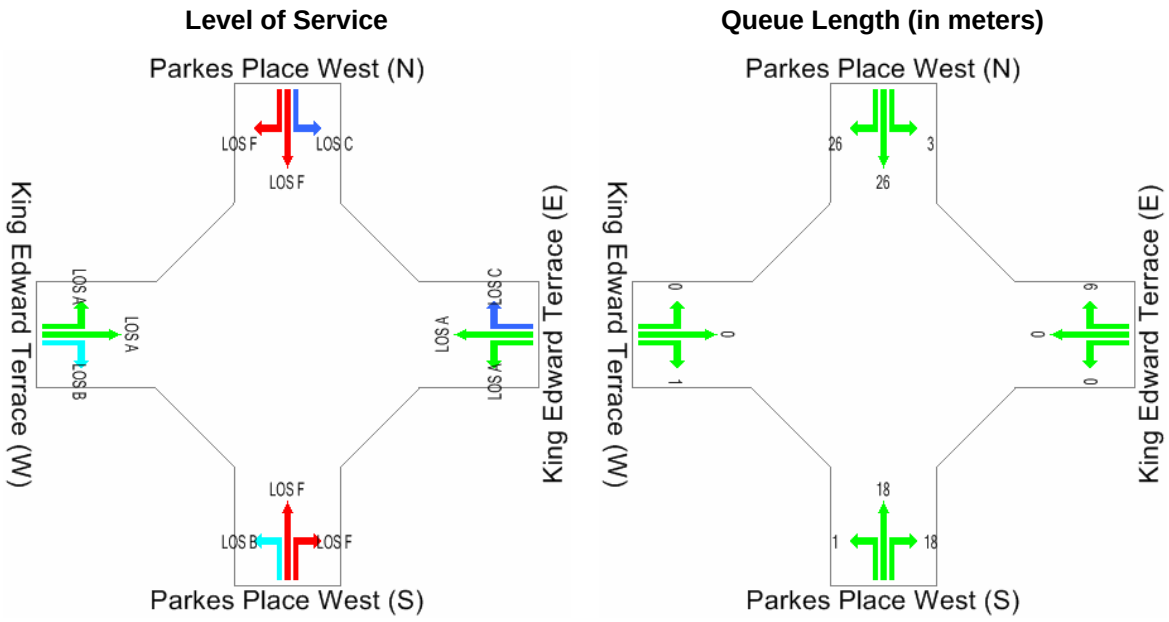


Figure 18: 2013 AM One-Hour (8 – 9) Peak Stage 2 Estimated Turning Volumes

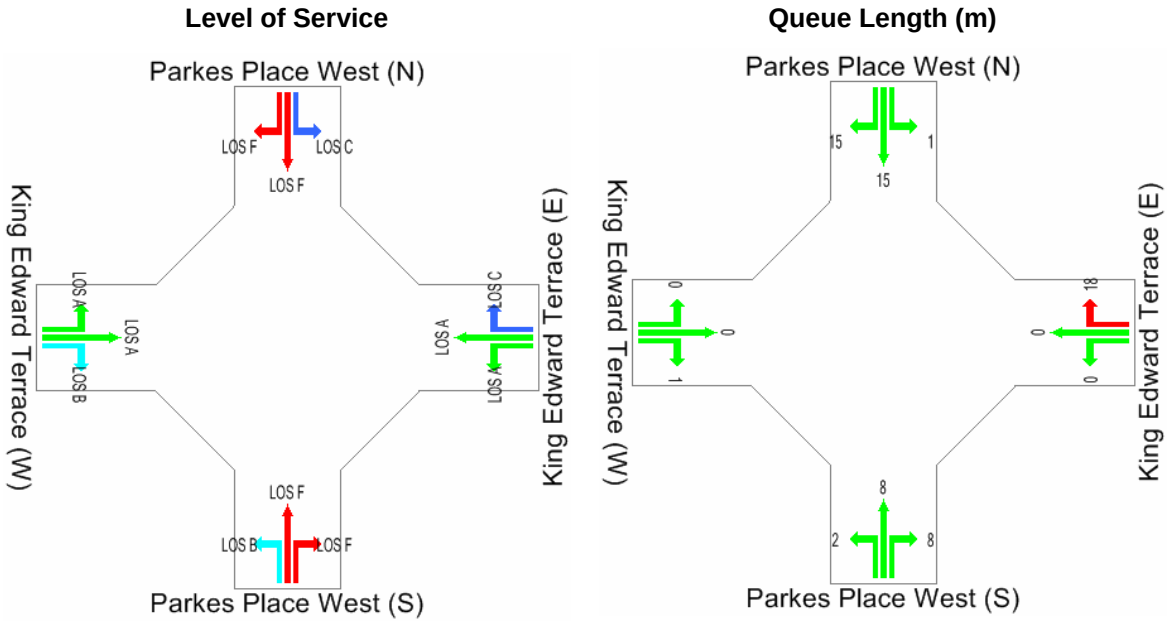
6.2.6 2013 King Edward Terrace – Parkes Place West: Performance

It can be seen that the effect of Master Plan Stage 2 on the traffic flow along traffic flow through the intersection is not significant. The overall average intersection LoS (as distinct from the individual movement LoS) for the Do Nothing scenario is A and for the Master Plan Stage 2 is B. This is considered as good performance, however as shown in the below figures, the through and right turning movements from Parkes Place West are operating at LoS F which is considered to be unacceptable performance. This can be attributed to the opposing volumes travelling through King Edward Terrace. It is of vital importance to improve the operability of the through and right turning movements from Parkes Place West so as to discharge possible queues that might lead to blockage of other entry and exit point along Parkes Place west. Thus, improving performance of these two movements is required. This can be potentially achieved with a different control method.



Average LoS: A

Figure 19: 2013 AM One-Hour (8 -9) Peak Do Nothing Future Performance (Give-Way Intersection)



Average LoS: B

Figure 20: 2013 AM One-Hour (8 – 9) Peak Stage 2 Future Performance (Give-Way Intersection)

6.3 Existing King Edward Terrace – Mall Road West: Configuration and Turning Flows

The intersection was modelled in the configuration shown in Figure 21 to simulate the lane sharing that occurs close to give way intersections that have sufficient road reserve to fit vehicles side by side when performing different turning movements. The 15 meters storage length is just indicative to such behaviour.

The layout diagrams shown give a useful visual representation of the intersection layout. However, they are not intended to be an accurate geometric representation of the intersection. The numbers shown together with a widening “turn slot” on some of the approaching lanes indicate that they are short lanes, and refer to the storage length of the lane in metres.

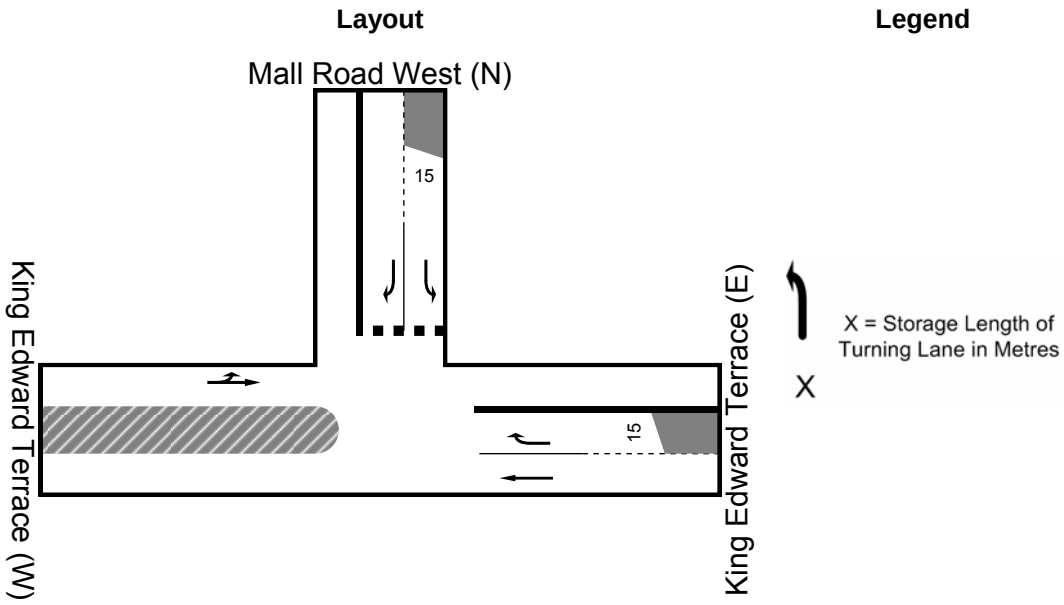


Figure 21: Existing King Edward Terrace – Parkes Place West Intersection Layout

6.3.1 Existing King Edward Terrace – Mall Road West: Turning Volumes

These detail the turning flows that were used in each case, and include two sets of numbers, the larger being the total turning flow and the smaller being the heavy vehicle turning flow. Turning flows for the 2006 were based on data collected during the AM peak hour of 08:00-09:00.

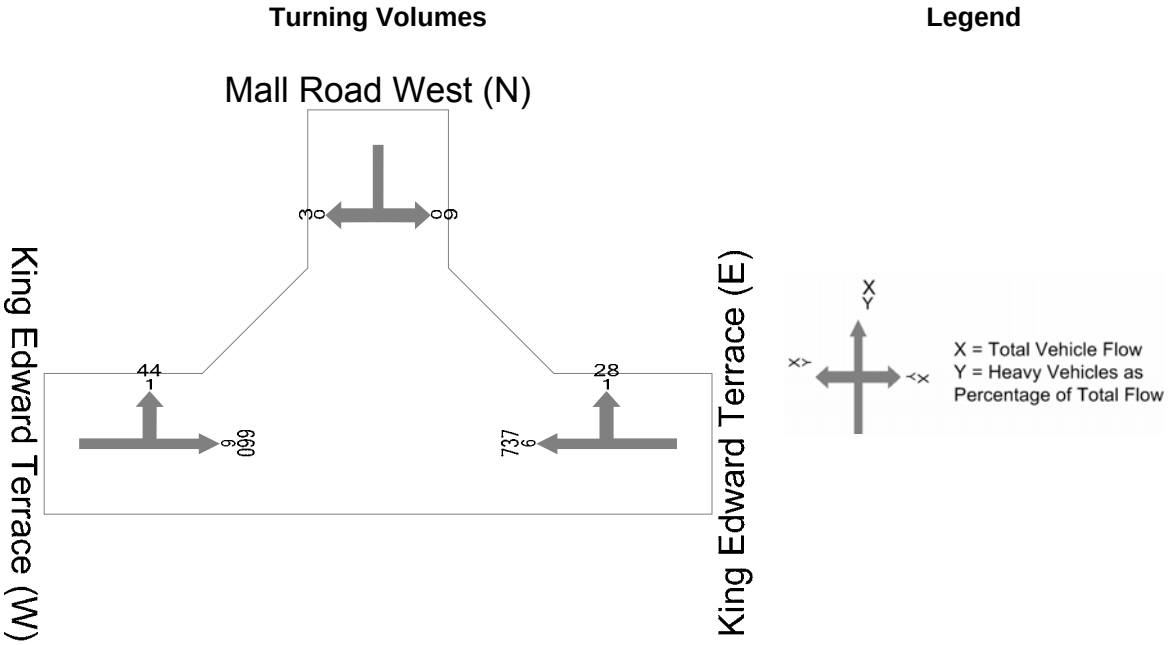


Figure 22: 2006 AM One-Hour (8 -9) Peak Estimated Turning Volumes (Existing)

6.3.2 Existing King Edward Terrace – Mall Road West: Performance

An intersection's performance can be measured using two statistics:

- Queue Length, showing the 95th percentile back of queue distance for the approach in metres, in other words the queue length that could be expected to be reached or exceeded 5% of the time during the simulated period.

- Level of Service (LoS), which is calculated for each movement by SIDRA from vehicle delay using the Highway Capacity Manual (HCM) method.

Generalised definitions of the different Level of Service ratings and the HCM delay criteria by which they are derived can be found in Appendix A. Generally, LoS A and B represent very good performance, C and D represent good to acceptable performance, and E and F represent performance levels that are not acceptable and should be avoided.

The following figures show the queue length measured in meters and the levels of service for all turning movements at Kings Edward Terrace/Mall Road West intersection. The figures show these performance indicators for the existing 2006 condition.

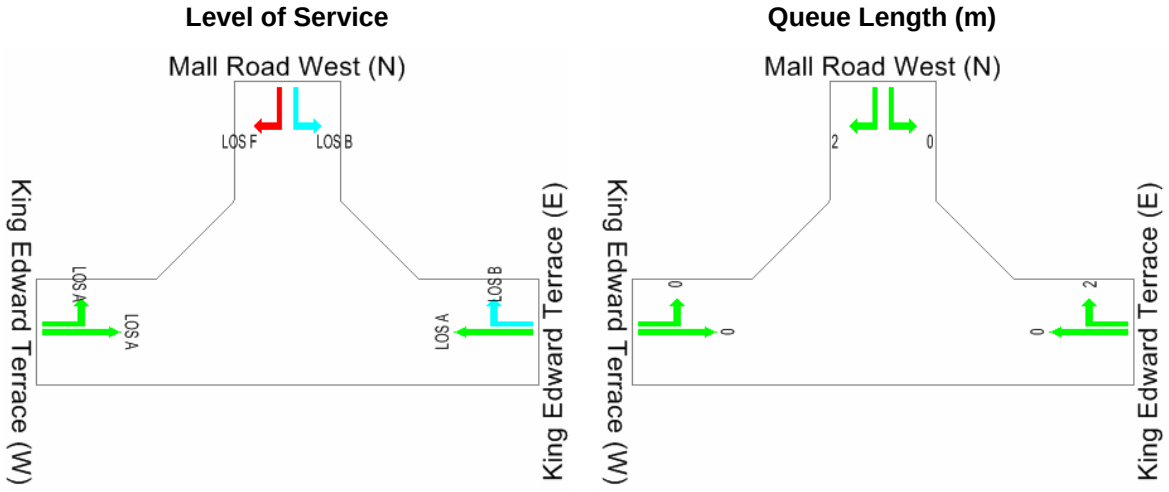


Figure 23: 2006 AM One-Hour (8 – 9) Peak Performance (Existing Give-Way Intersection)

6.3.3 2008 King Edward Terrace – Mall Road West: Turning Volumes

Turn flows for 2008 were synthesised from the Paramics simulation runs. These are shown below both for the future 2008 do nothing scenario. .

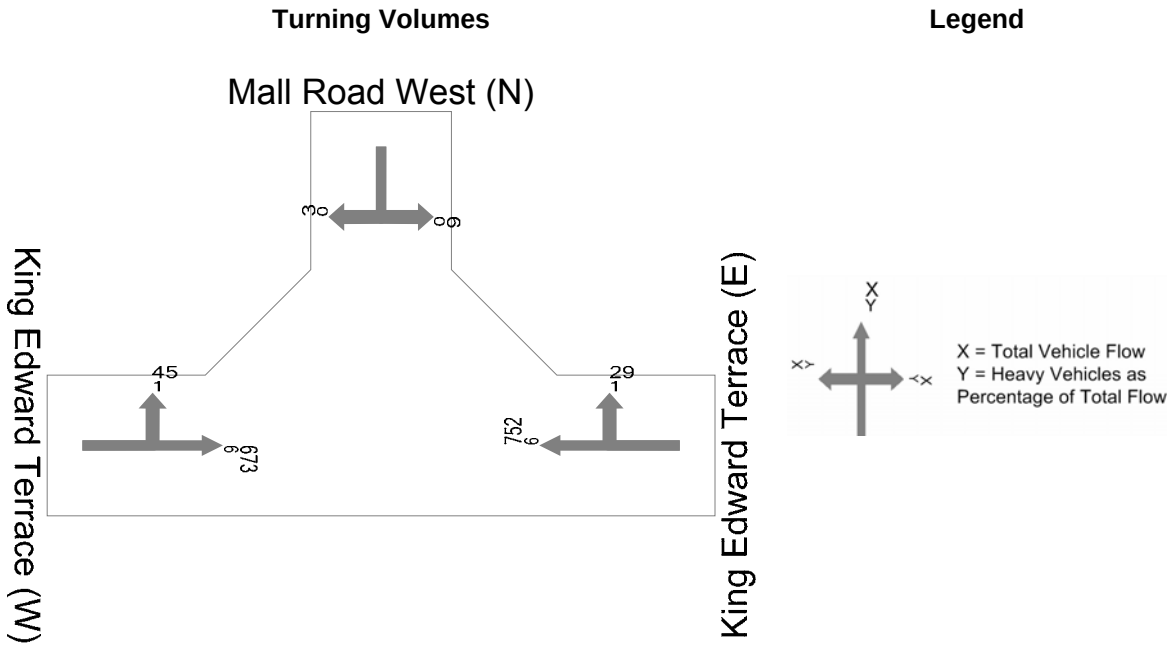
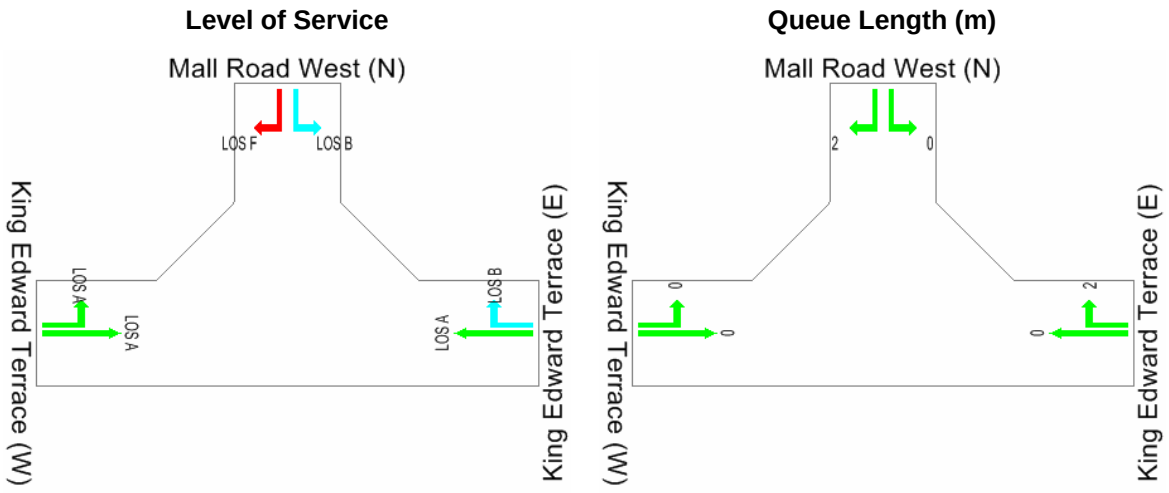


Figure 24: 2008 AM One-Hour (8 – 9) Peak Estimated Turning Volumes (Do Nothing)

6.3.4 2008 King Edward Terrace – Mall Road West: Performance

The following figures show the queue length measured in meters and the levels of service for all turning movements at Kings Edward Terrace/Mall Road West intersection. The figures shows these performance indicators for the future 2008 do nothing scenario. The overall average intersection LoS (as distinct from the individual movement LoS) for the Do Nothing scenario is A. This is considered as good performance, however as shown in the below figures, the right turning movement from Mall Road West is operating at LoS F which is considered to be unacceptable performance. This can be attributed to the opposing volumes travelling through King Edward Terrace



Average LoS: A

Figure 25: 2008 AM One-Hour (8 -9) Peak Do Nothing Future Performance (Give-Way Intersection)

For Master plan stage 1 Mall Road West is to be used as a Coach dedicated service road only. The Coach travel demand pattern is not expected to coincide with King Edward Terrace AM and PM peak traffic. In this context, the current giveway configuration is expected to operate at an A LoS as minimum interruption is expected for the through traffic along KET at the Mall Road West intersection

6.3.5 2013 King Edward Terrace – Mall Road West: Turning Volumes

Turn flows for the 2013 were synthesised from the Paramics simulation runs. These are shown below for both the 2013 Do Nothing and the future 2013 Master Plan Stage 2.

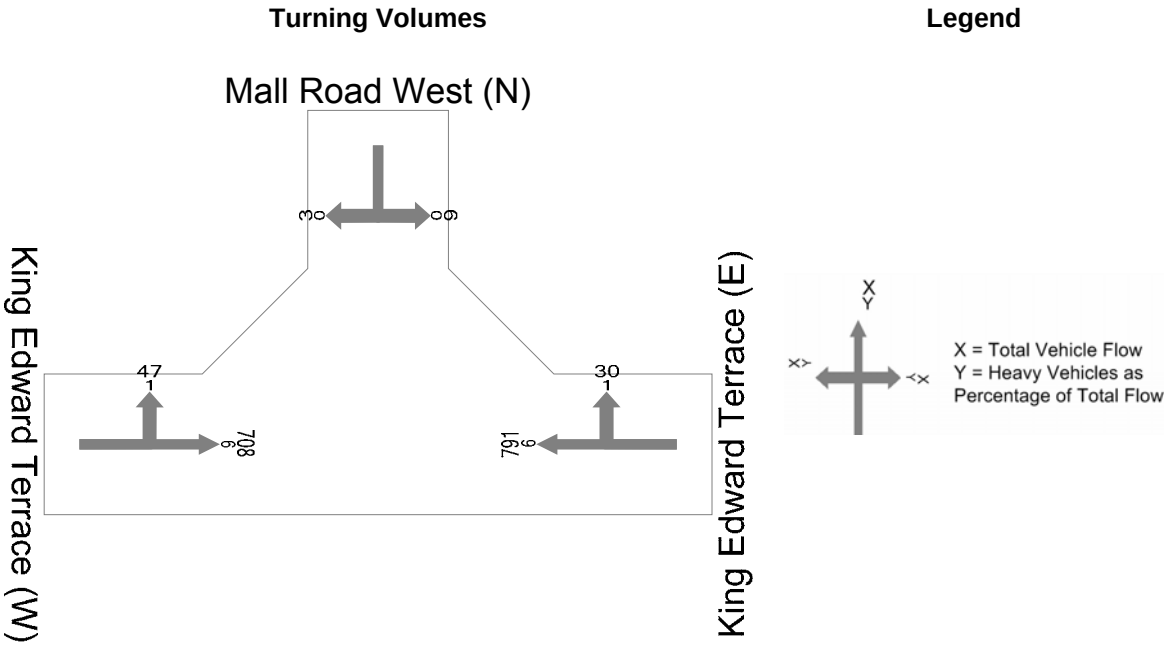


Figure 26: 2013 AM One-Hour (8 -9) Peak Estimated Turning Volumes (Do Nothing)

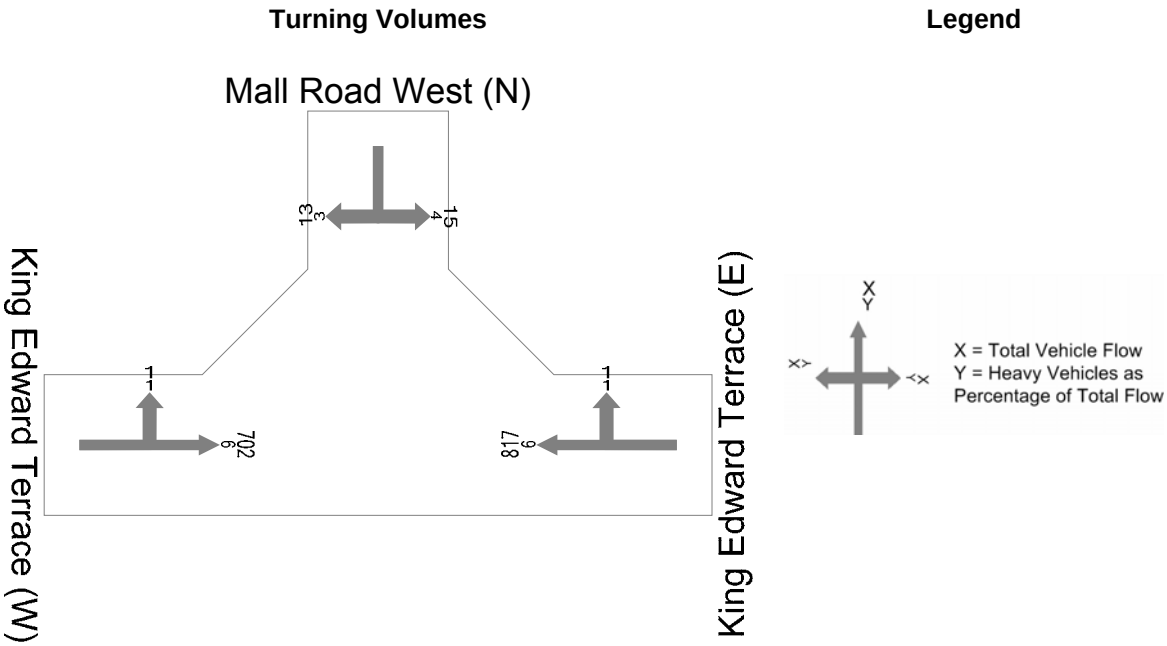
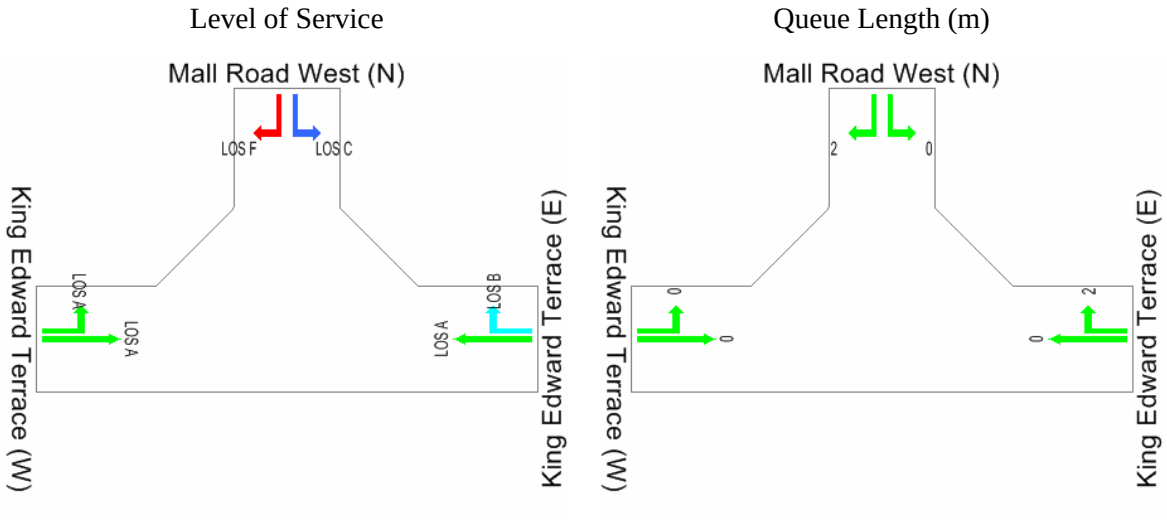


Figure 27: 2013 AM One-Hour (8 -9) Peak Stage 2 Estimated Turning Volumes

6.3.6 2013 King Edward Terrace – Mall Road West: Performance

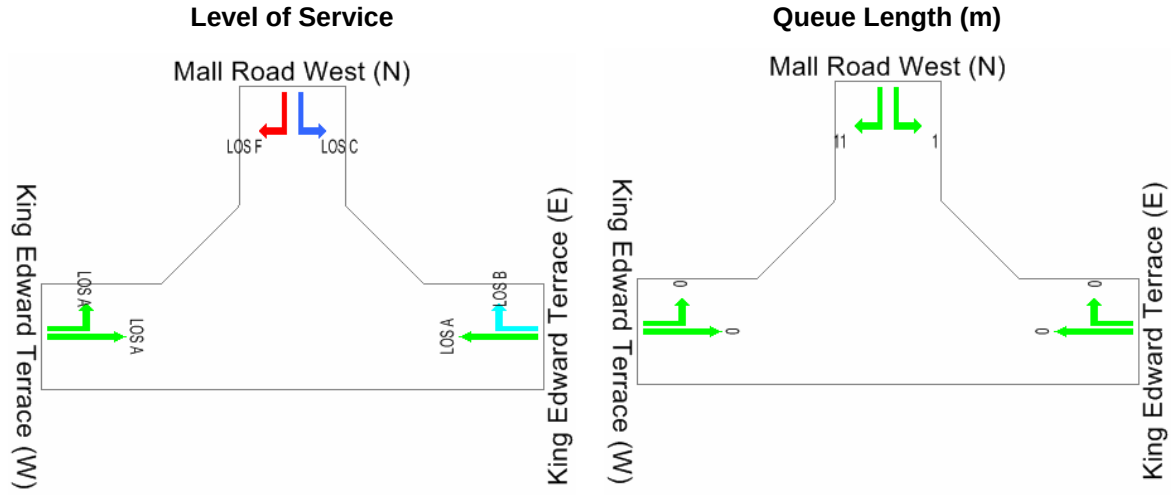
The following figures show the queue length measured in meters and the levels of service for all turning movements at Kings Edward Terrace/Mall Road West intersection. The figures shows these performance indicators for the future 2013 do nothing scenario as well as the future 2013 master plan stage 2 option. It can be seen that the effect of Master Plan Stage 2 on the traffic flow within the intersection is not significant. The overall average intersection LoS (as distinct from the individual movement LoS) for the Do Nothing scenario is A and for the Master Plan Stage 2 is A. This is considered as good performance, however as shown in the below figures, the right turning movement from Mall Road West is operating at LoS F which is considered to be unacceptable

performance. This can be attributed to the opposing volumes travelling through King Edward Terrace. It is of vital importance to improve the operability of the right turning movement from Mall Road West so as to discharge possible queues that might lead to blockage of Questacon Car parking exit point along Mall Road west. Thus, improving performance of this movement is required. This can be potentially achieved with a different control method.



Average LoS: A

Figure 28: 2013 AM One-Hour (8 -9) Peak Do Nothing Future Performance (Give-Way Intersection)



Average LoS: A

Figure 29: 2013 AM One-Hour (8 -9) Peak Stage 2 Future Performance (Give-Way Intersection)

7 Master Plan Stage 1 – 2008

7.1 Remedial Measure 1: King Edward Terrace – Parkes Place West, Two-Phase Signalised

Traffic signals allow priority to be applied to each approach at an intersection in a more balanced way than a simple give-way intersection. The intersection design below, see Figure 30 would as a minimum require the full width of the road reserve at the intersection. Turning volumes are the same as those used in Section 6.2. No slip lanes are allowed and a storage length of 25 meters was considered as acceptable and within the maximum approach distances as specified in Table 2.

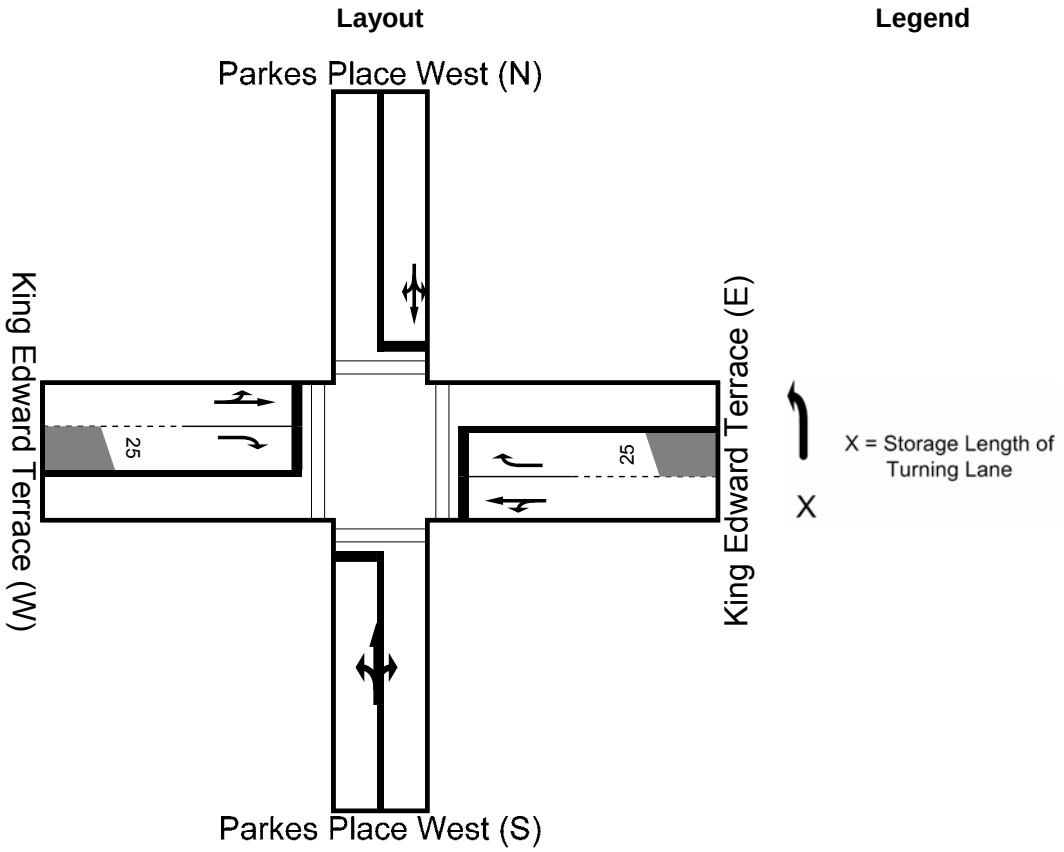


Figure 30: Two Phase Signalised King Edward Terrace – Parkes Place West Intersection Layout

PM peak flows are obtained by reversing the AM peak flows, see Figure 31.

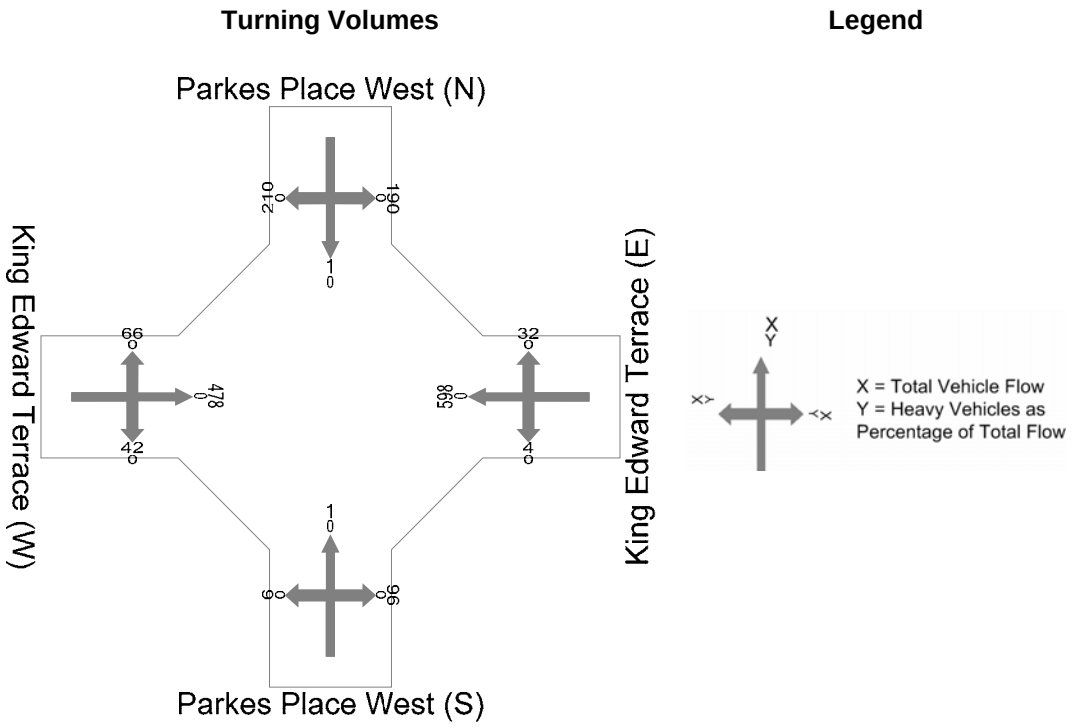


Figure 31: 2008 PM One Hour Peak Turning Volumes Stage 1

7.1.1 Signal Phasing

The proposed intersection design operates using a two-phase signal arrangement, which has filtered right turns on all approaches. This phasing operation requires right turning vehicles to exploit gaps in the opposing through traffic stream, which can pose safety issues with large movements. The Austroads *Guide to Traffic Engineering Practice* outlines potential crash risk factors for the evaluation of filtered intersections. These suggest that filtered turns should have adequate sight distance; should not have more than one lane of turning traffic; should not expose parallel pedestrian movements to high volumes of turning traffic; and that the 85th percentile speed of the opposing traffic should be no greater than 70km/hr. This intersection conforms to each of the potential crash risk factors. The phasing method is illustrated below in Figure 32:

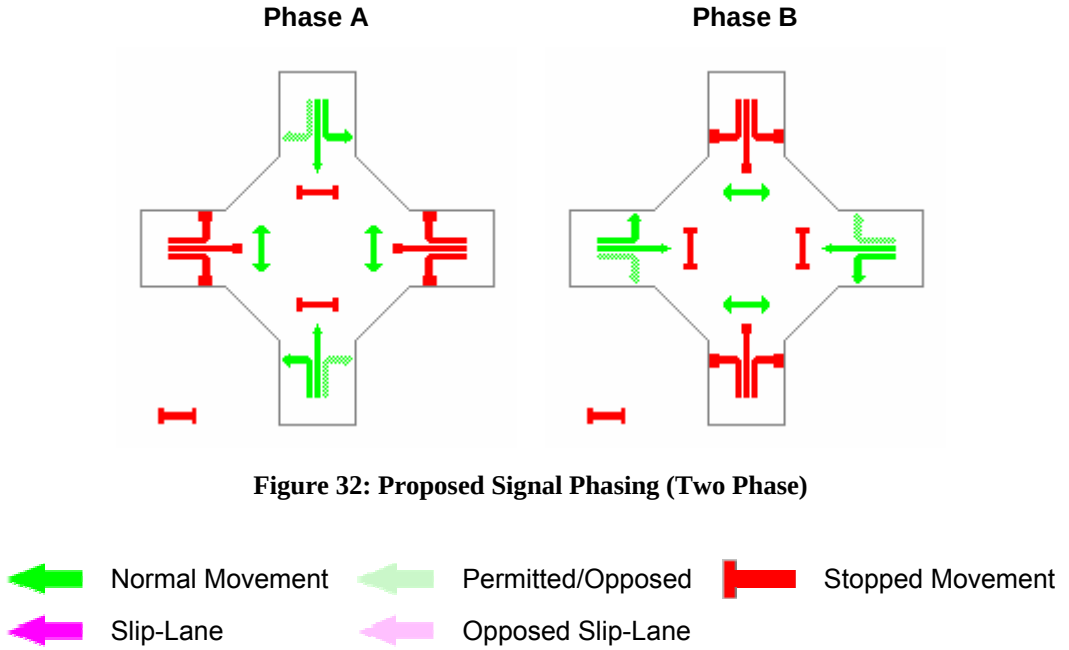
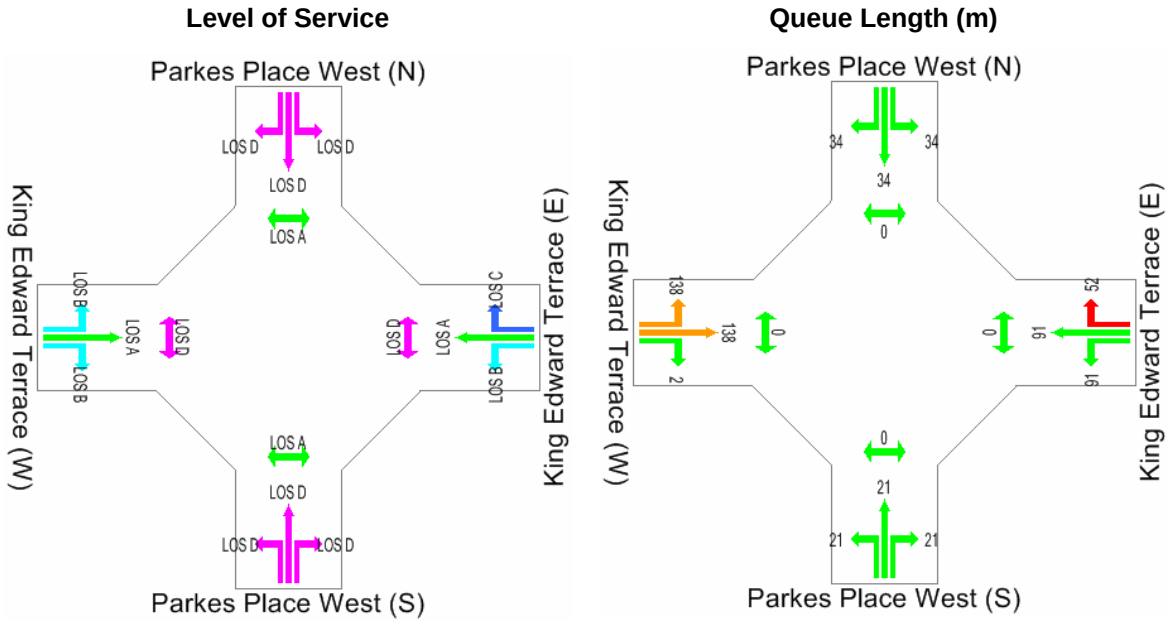


Figure 32: Proposed Signal Phasing (Two Phase)

7.1.2 Performance of King Edward Terrace/Parkes Place West as Signalised Two Phase Intersection

The two-phase signal layout offers very good levels of service – A for the AM peak and B for the PM peak, see Figures 33 and 34 respectively. The intersection analysis shows that 95th percentile of the expected queues do not exceed the available storage distance on any approaches, see below figures. Introducing a signalised intersection along KET is also expected to discourage through traffic from using KET. In this context, it can be looked upon as an advantage. However safety issues are expected to arise due to the potential conflict between the through movements on King Edward Terrace and the opposing right turning movements. The current direction of the Parliamentary Zone planning and particularly with regards to King Edward Terrace is to have a more sustainable road network in terms of reduction in speed, more vehicle safety, and better pedestrian amenity. In this context, this study will consider other remedial measures for the King Edward Terrace Parkes Place intersection.



Average LoS: A

Figure 33: 2008 AM One-Hour (8 -9) Peak Stage 1 Future Performance (Two Phase Signalised)

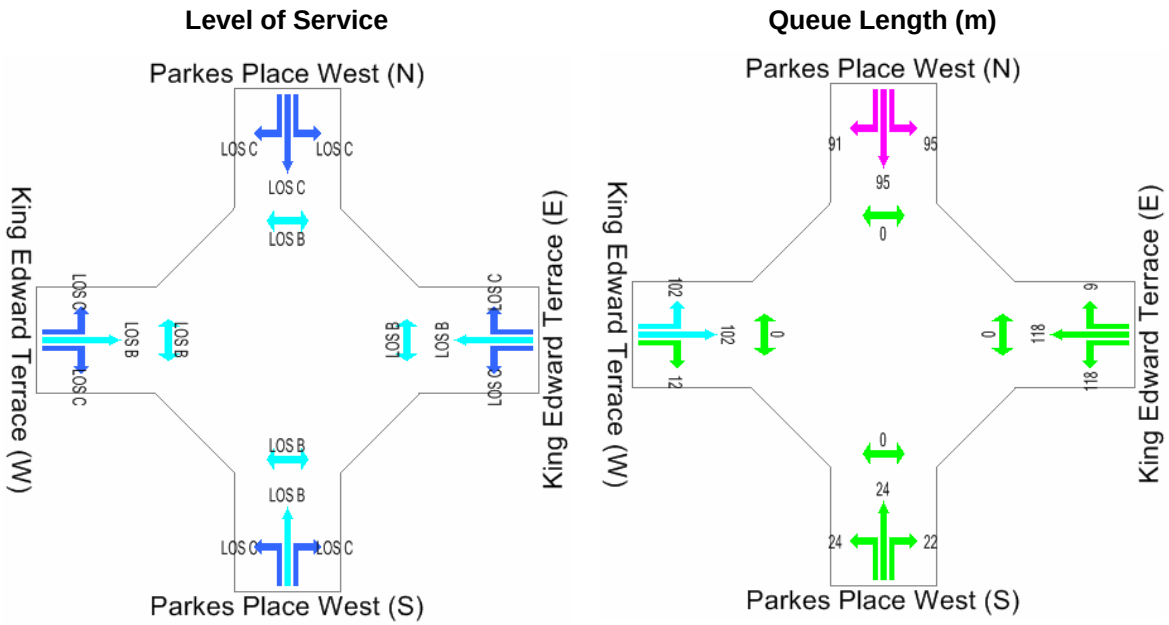


Figure 34: 2008 PM One-Hour (5 -6) Peak Stage 1 Future Performance (Two Phase Signalised)

7.2 Remedial Measure 2: King Edward Terrace – Parkes Place West, Four-Phase Signalised

The layout is the same as that used in Section 7. This intersection differs in its signal phasing, offering a safer design than the two-phase signals as it eliminates conflict between the through movements and opposing right turning movements on King Edward Terrace. Turning volumes are the same as those used in Section 6.2.

7.2.1 Signal Phasing

The proposed intersection design operates using a four-phase signal arrangement, which has a filtered right turn on the Parkes Place West approaches (Phase A; allowing right-turning vehicles to exploit gaps in the opposing through traffic stream) and a lead-lag right turn arrangement on the King Edward Terrace approaches (Phases B-D.) This method was chosen as leading right turns on King Edward Terrace would be less efficient given the unbalanced right turning flows; in the 2008 AM Stage 1 case, this is 190 vehicles from the East and only 6 from the West. The chosen phasing method is illustrated below in Figure 35:

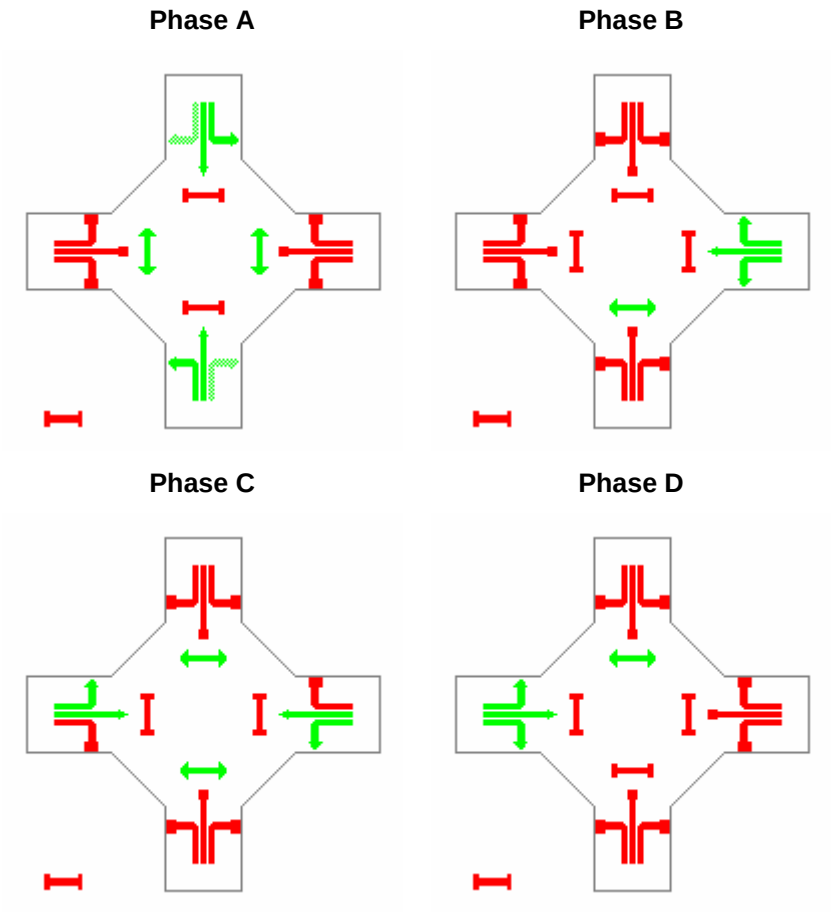
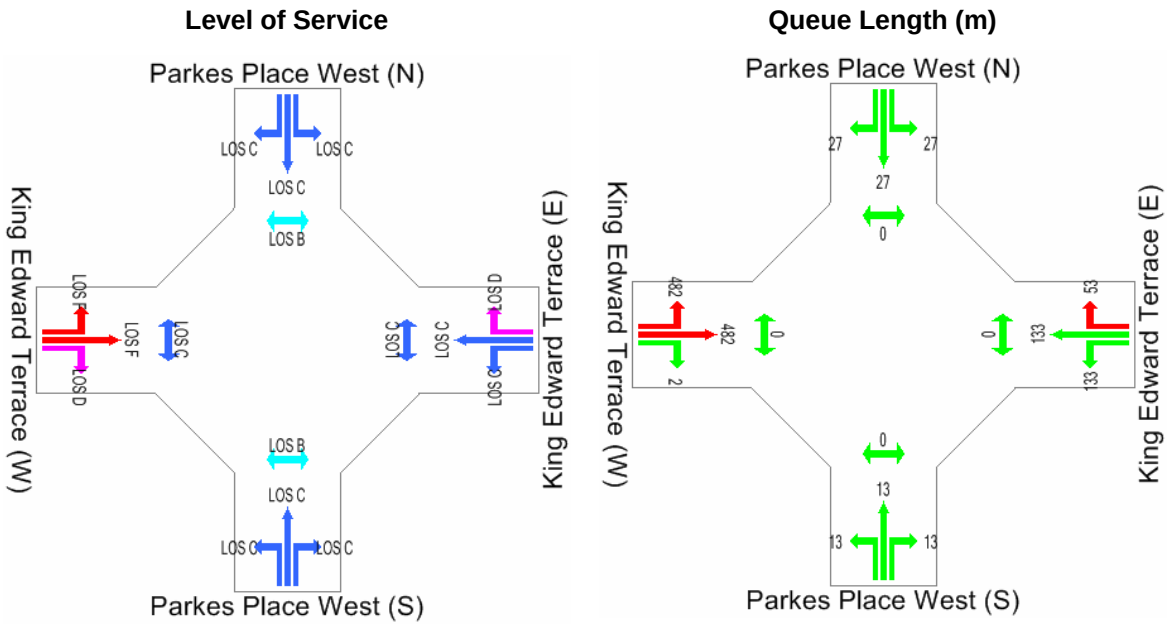


Figure 35: Proposed Signal Phasing (Four Phase)

7.2.2 Performance of King Edward Terrace Parkes Place as Signalised Four Phase Intersection

The four phase signalised intersection improves the Levels of Service of the through and right turning movements from Parkes Place West to acceptable levels compared to the existing give-way control, see below figures. However the queue length exceeds the available storage on the West approach and would on occasion block the National Library West car park driveway. It was felt unnecessary to conduct intersection analysis for the PM peak as it is clear from the AM results that the two phase signalised intersection provides a better performance.



Average LoS: C

Figure 36: 2008 AM One-Hour (8 -9) Peak Stage 1 Future Performance (Four Phase Signalised)

7.3 Remedial Measure 3: King Edward Terrace – Parkes Place West, Roundabout

The width of the road reserve on both King Edward Terrace and Parkes Place West (~10m), and the large corner radii (~15m) allows the possibility of a small roundabout being used for traffic control. This road area would allow a roundabout with a standard 5m circulating width and an island diameter of 15m. The roundabout would also serve as a full-time traffic calming measure. Turning volumes are the same as those used in Section 6.2

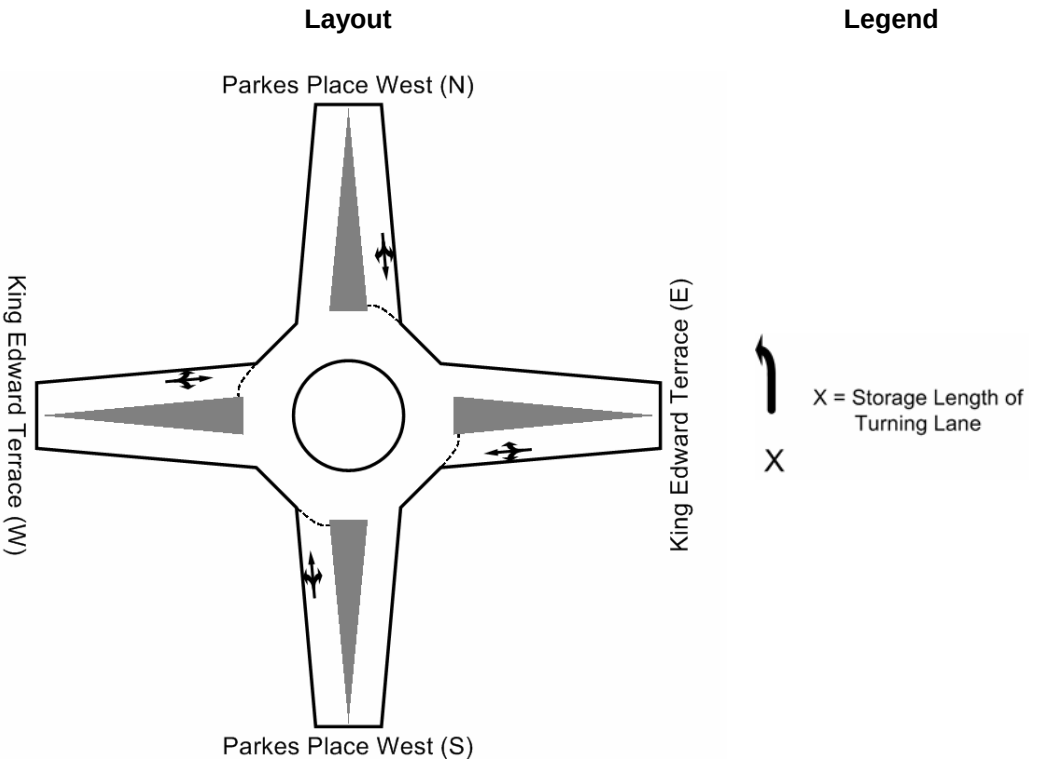
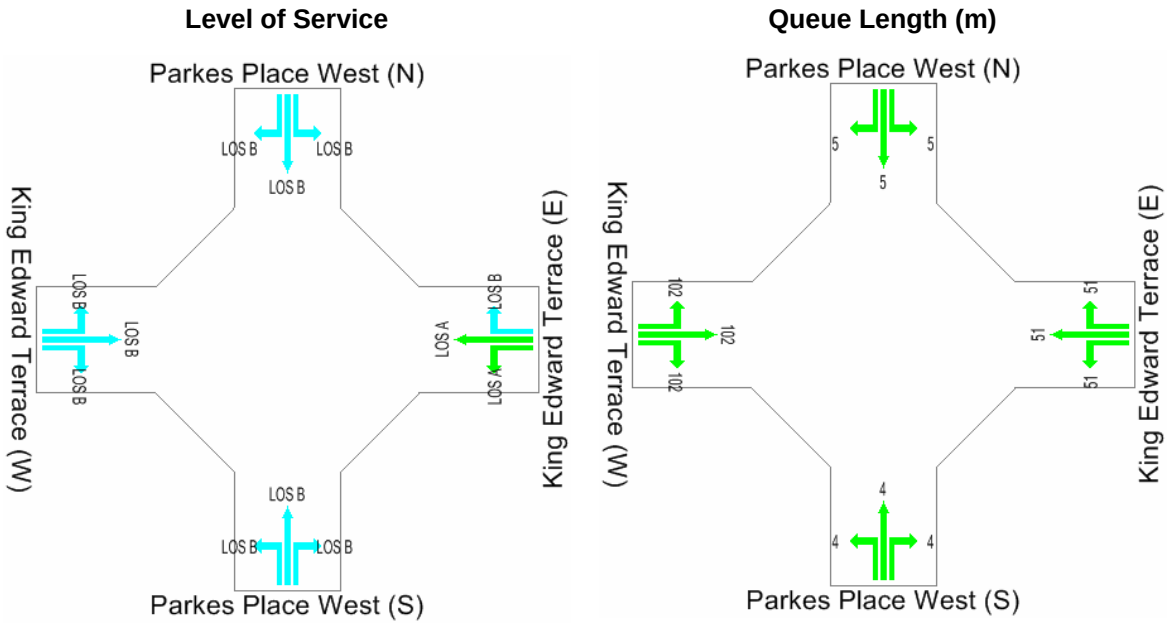


Figure 37: Roundabout King Edward Terrace – Parkes Place West Intersection Layout

7.3.1 Performance of King Edward Terrace Parkes Place as Roundabout

The roundabout configuration operates with excellent Levels of Service, i.e. an overall of A and all turning movements either A or B. Queues are expected to be within the available storage length on all approaches, see below figures. The excellent Levels of Service imply that there is low average delay for vehicles using the intersection, which indicates that the average speed is close to the signposted speed limit. It was felt unnecessary to conduct intersection analysis for the PM peak as SMEC was instructed that such configuration is not acceptable because of its limitations for pedestrians crossing and cycling.



Average LoS: B

Figure 38: 2008 AM One-Hour (8 -9) Peak Stage 1 Future Performance (Roundabout)

8 Master Plan Stage 2 – 2013

The only options investigated in this section for the two intersections are 2-phase signalised. This is likely to give the best performance with the minimum disruption to traffic at these intersections.

8.1 Remedial Measure 1: King Edward Terrace – Parkes Place West, Two-Phase Signalised

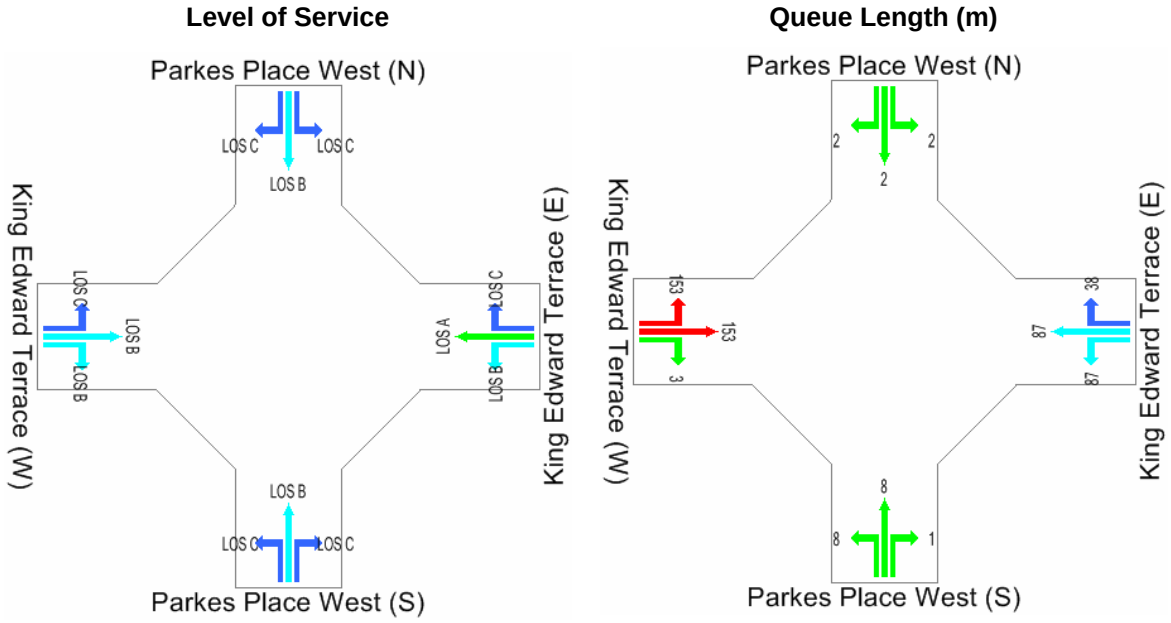
This intersection will have the same layout as presented in Figure 30.

8.1.1 Signal Phasing

The signal phasing for this intersection will be as presented in Figure 32

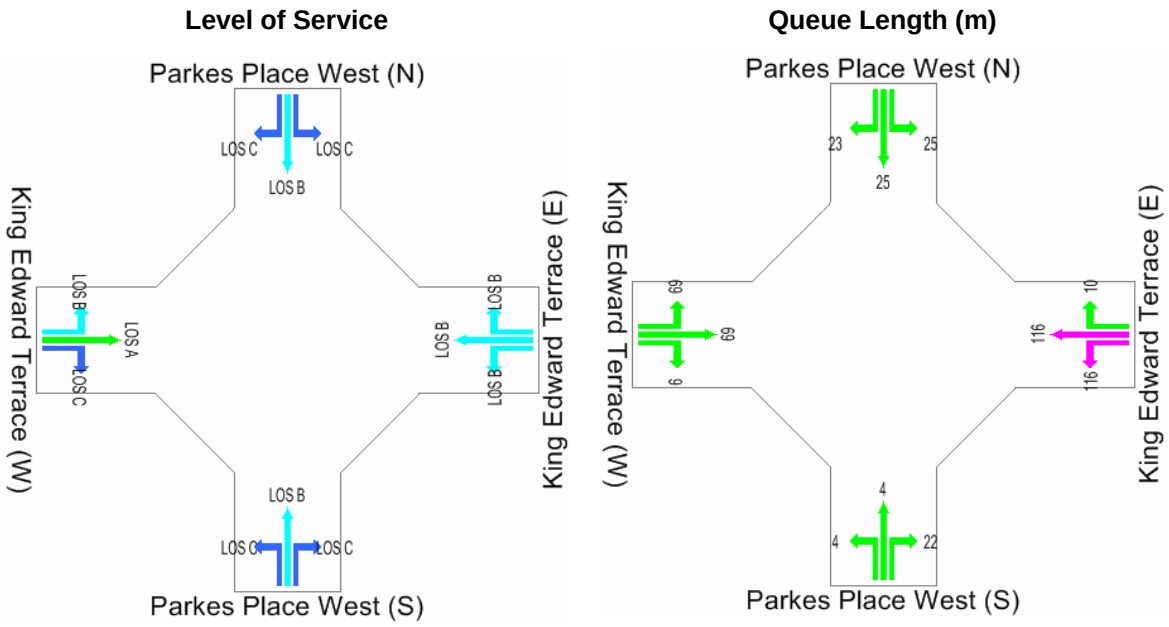
8.1.2 Performance of King Edward Terrace – Parkes Place as Signalised Two Phase Intersection

The two-phase signal layout offers very good levels of service – B for both the AM and PM peaks. The intersection analysis shows that 95th percentile of the expected queues do not exceed the available storage distance on any approaches, see below figures. This is also expected to discourage through traffic from using KET. In this context, it can be looked upon as an advantage. However safety issues are expected to arise due to the potential conflict between the through movements on King Edward Terrace and the opposing right turning movements.



Average LoS: B

Figure 39: 2013 AM One-Hour (8 -9) Peak Stage 2 Performance (2 Phase Signalised)



Average LoS: B

Figure 40: 2013 PM One-Hour (8 -9) Peak Stage 2 Performance (2 Phase Signalised)

8.2 Remedial Measure 1: King Edward Terrace – Mall Road West, Two-Phase Signalised

In case of structured car park with an exit point to Mall road west, Mall roadwest/KET intersection can be treated as a two-phase signalised intersection. This intersection will have the same layout as presented in Figure 40

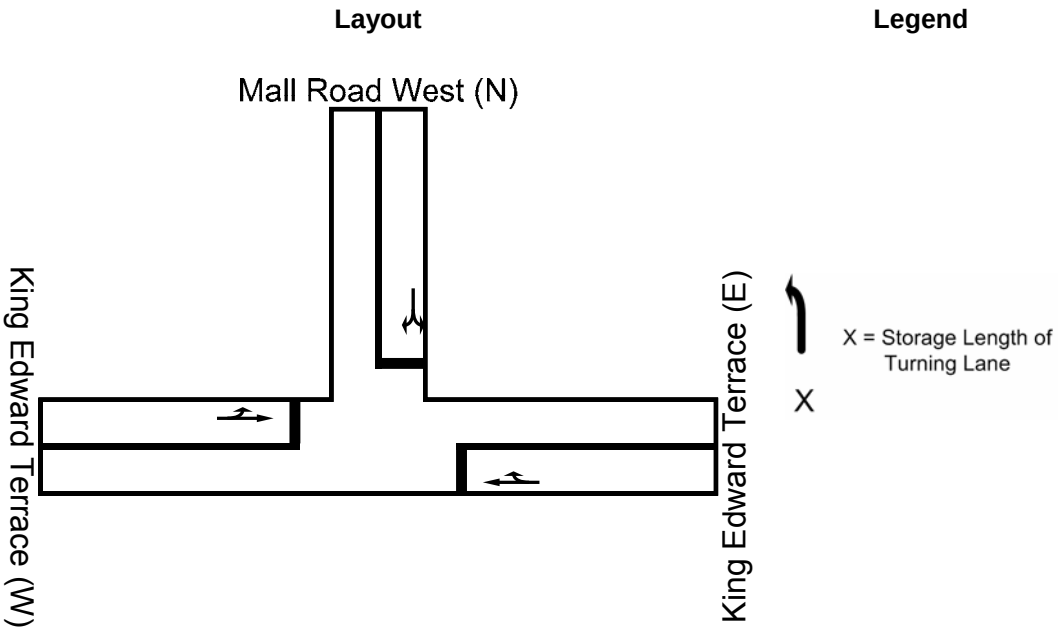


Figure 41: Two Phase Signalised King Edward Terrace – Mall Road West Intersection Layout

8.2.1 Signal Phasing

The signal phasing for this intersection will be as presented in Figure 41

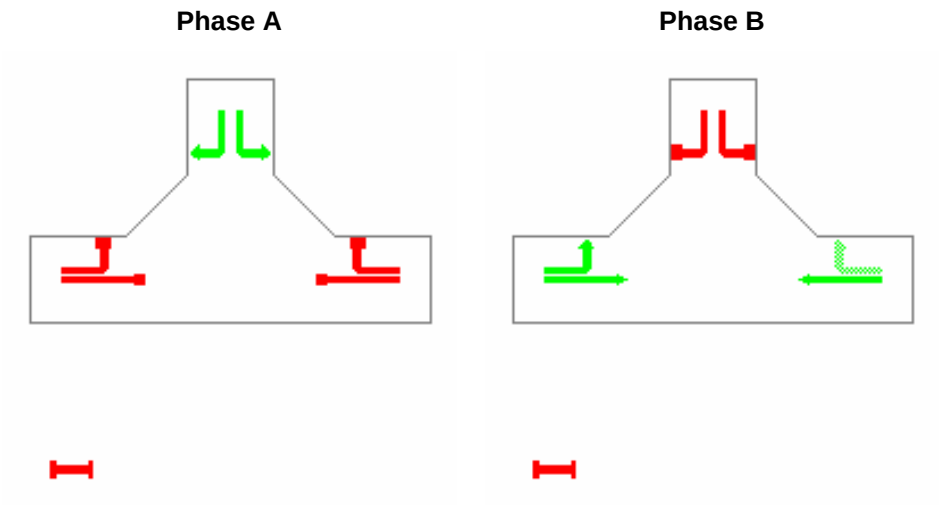


Figure 42: Proposed Signal Phasing (Two Phase)

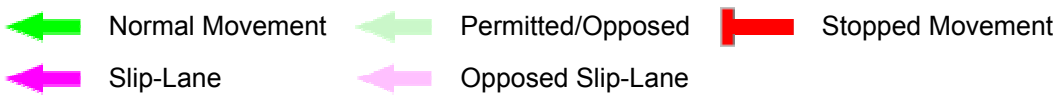
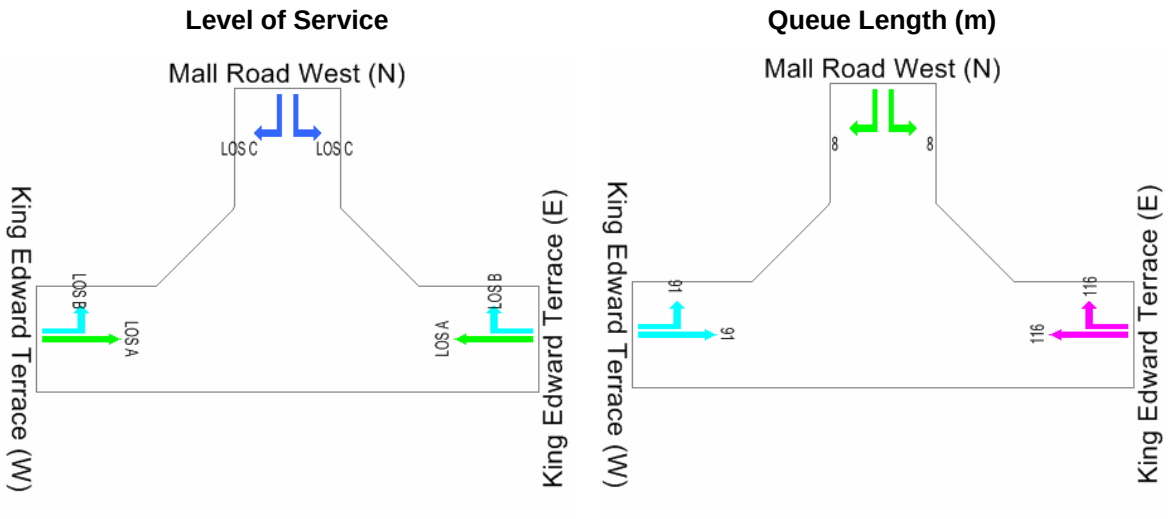


Figure 43: Two Phase Signalised King Edward Terrace – Mall Road West Intersection Proposed Phasing

8.2.2 Performance of King Edward Terrace – Mall Road West as Signalised Two Phase Intersection

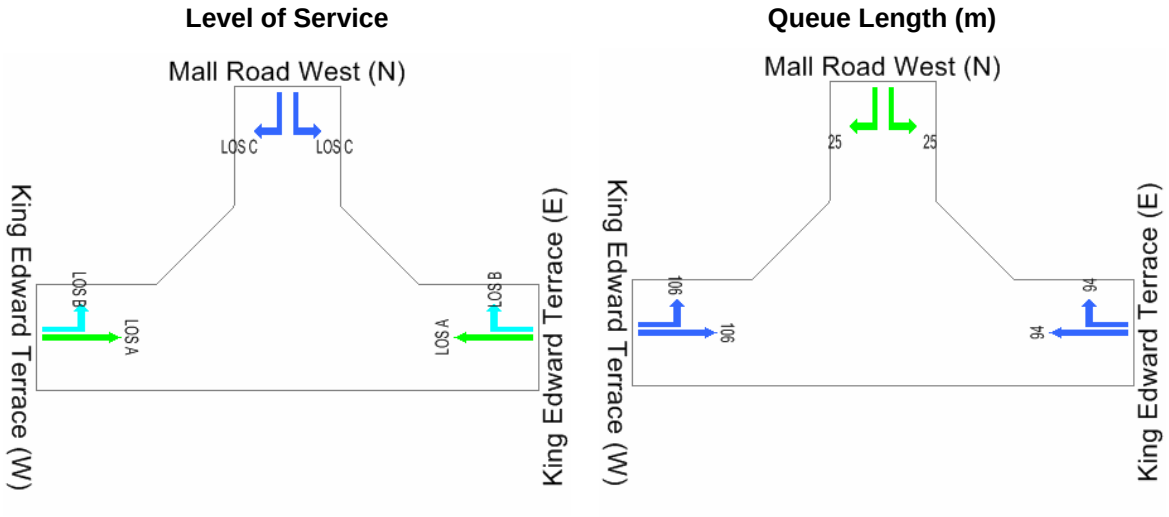
The two phase signalised layout offers very good levels of service (B) and 95th percentile queues that do not exceed the available storage distance on any approaches, see below figures. However, as shown in section 6 the current giveway configuration offers a better overall LOS of A. The advantage of the two phase signalisation is that it allows the discharge of the left turn queues in a better way resulting into a LOS C for this movement rather than the F for the giveway.

Based on the above discussion, SMEC recommends sustaining the current giveway configuration so as to have an overall LOS of A. This is also based on the conclusion that PM queues along Mall Road west for the giveway configuration are expected to be within the available queuing distance and not blocking the exit from the Questacon multistorey car park exit intended in stage 2.



Average LoS: B

Figure 44: 2013 AM One-Hour Peak Stage 2 Future Performance (Two Phase Signalised)



Average LoS: B

Figure 45: 2013 PM One-Hour Peak Stage 2 Future Performance (Two Phase Signalised)

9 Summary and Conclusions

This study examined the traffic impacts of the proposed master plan staging for the Humanities & Science Campus. The report identified any traffic, circulation or safety issues that may arise from the suggested Master Plan Stages and reviews the efficacy of remedial measures for these issues.

SMEC developed a micro simulation model to be used to examine network changes and their impact on traffic flows. This model was utilised to examine future traffic flows for the year 2008 as the year when Stage 1 is expected to be completed and 2013 as the year when Stage 2 is expected to be completed. The outcome of the analysis remains valid if the implementation of stages occurs earlier.

Future traffic forecasts were used to synthesise the expected AM and PM turning volumes both for the King Edward Terrace(KET)/Parkes Place West (PPW)Intersection as well as for the KET/Mall Road West (MRW) Intersection.

The intersection analysis was based on AM figures. Two comparisons were conducted. The first was a comparison of the Do Nothing future 2008 scenario versus the Stage 1 master plan scenario. The second was a comparison of the do nothing future 2013 scenario versus the Stage 2 master plan scenario.

An intersection's performance can be measured using two statistics:

- Queue Length that could be expected to be reached or exceeded 5% of the time during the simulated period.
- Level of Service (LoS) which ranges from A to F, where LoS A-B = Good and Acceptable LOS C = Acceptable Los D = Undesirable and warrant intervention LOS E-F = Unacceptable

The following represents a summary of the outcome results and recommendations.

9.1 King Edward Terrace/Parkes Place West

The existing give way configuration of King Edward Terrace/Parkes Place west intersection provides good performance to King Edward Terrace through traffic, where queues for all movements along King Edward Terrace are within acceptable limit. However, the give-way arrangement results in poor unacceptable Levels of Service (LOS F) on both of the Parkes Place West approaches. This can be attributed to the opposing high volumes travelling through King Edward Terrace. Such operation is expected to further deteriorate into the future. It is of vital importance to improve the operability of the through and right turning movements from Parkes Place West so as to discharge possible queues that might lead to blockage of other entry and exit points along Parkes Place west. This is expected to be more critical during the PM peak as traffic volumes on Parkes Place West increase due to departing commuter traffic. Thus, improving performance of these two movements is required. This can be potentially achieved with a different control method.

9.1.1 Recommendation: King Edward Terrace/Parkes Place West (2 Phase Signalised Intersection)

This study explored a number of remedial measures for this intersection including two phase signalisation, four phase signalisation as well as roundabout configuration. These were tested for both the AM and PM peaks for Stage 1 (2008) master plan as well as for Stage 2 (2013) master plan. Levels of Service improved by the two phase signalisation as did the dissipation of queues along Parkes Place West Approaches. This is also expected to discourage through traffic from using KET. In this context, it can be looked upon as an advantage. The only limitation of two phase signalisation is the potential conflict between the through movements on King Edward Terrace and the opposing right turning movements.

9.2 King Edward Terrace/Mall Road West

The existing give way configuration of King Edward Terrace/Mall west intersection provides good performance to King Edward Terrace through traffic, where queues for all movements along King Edward Terrace are within acceptable limits. For Master plan Stage 1, Mall Road West is to be used as a Coach dedicated service road only. The Coach travel demand pattern is not expected to coincide with King Edward Terrace AM and PM peak traffic. In this context, the current giveway configuration is expected to operate at an A LoS as minimum interruption is expected for the through traffic along KET at the Mall Road West intersection

In Stage 2, and in the case of a structured car park, the give-way arrangement is expected to result into poor unacceptable Levels of Service (LOS F) on the Mall West approach. This can be attributed to the opposing high volumes travelling through King Edward Terrace. It is of vital importance to improve the operability of the right turning movements from Mall West during PM peak so as to discharge possible queues that might lead to blockage of Questacon structured car park exit point along Mall Road West. This is expected to be more critical during the PM peak. Mall roadwest/KET intersection can be treated as a two-phase signalised intersection.

Thus, improving the performance of this exit can be potentially achieved by providing another exit point from Questacon Car park and into Parkes Place West, thus splitting the expected exiting traffic during the PM peak between Mall Road West and Parkes Place West.

9.2.1 Recommendation: King Edward Terrace/Mall Road West (Remain as Giveway)

The remedial works proposed for the intersection of King Edward Terrace and Parkes Place West will improve the conditions for the intersection of King Edward Terrace and Mall Road West to the extent that SMEC recommends retaining the current giveway configuration. This would still provide the intersection with an overall LOS of A.

9.3 Introduction of 50 Km/Hr Speed Zone

The introduction of 50 km/hr speed limit is expected to deter traffic using KET as a short cut to and from Wentworth Avenue. In this context the intersection performances will be even better. However, it is difficult to determine the amount of traffic reduction that will be caused by such measure and hence its potential impact on the selection of an intersection control type. Without the introduction of a 50 km/hr speed limit, the above measures are expected to accommodate the changes introduced in master plan Stages 1 and 2.

9.4 Conclusions

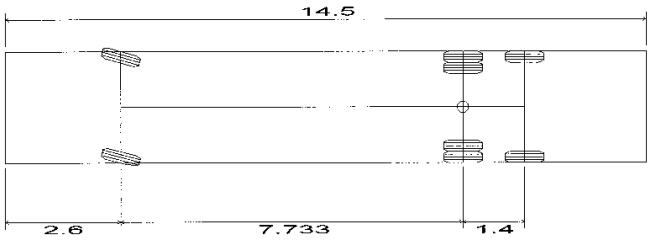
In conclusion, it can be seen from the intersection modelling that while the Master Plan Stages might be expected to draw some more traffic to the area (given the improved and additional amenities provided by the Campus), this traffic can be handled by introducing two phase signalisation for the intersection of King Edward Terrace and Parkes Place West and retaining the giveway for the intersection of King Edward Terrace and Mall Road West. The introduction of a 50 km/hr speed limit to King Edward Terrace with the two intersections can assist in discouraging through traffic from using KET. However, the levels of service presented in this report do not depend on the introduction of 50 km/hr speed limit.

Appendix A Examination of Coach Manoeuvres Along Mall Road West

AutoTrack v7.50 - Australian Design Vehicles

AutoTrack Vehicle Details **Ref: 100016**

Vehicle Name:	**Long Rigid Bus (14.5m) (Desirable min radius)**
Type:	Bus
Category:	Savoy
Classification:	Savoy
Source:	AUSTROADS
Description:	Restricted access vehicle
Notes:	
Unit 1 Name:	Long Rigid Bus (14.5m) (Desirable min radius)



Long Rigid Bus (14.5m) (Desirable min radius)	
Overall Length	14.500m
Overall Width	2.500m
Overall Body Height	3.102m
Min Body Ground Clearance	0.337m
Track Width	2.500m
Lock to Lock Time	6.00sec
Curb to Curb Turning Radius	15.000m

Every Effort Has Been Made To Ensure The Accuracy Of This Information
Please Check Data From Your Own Sources

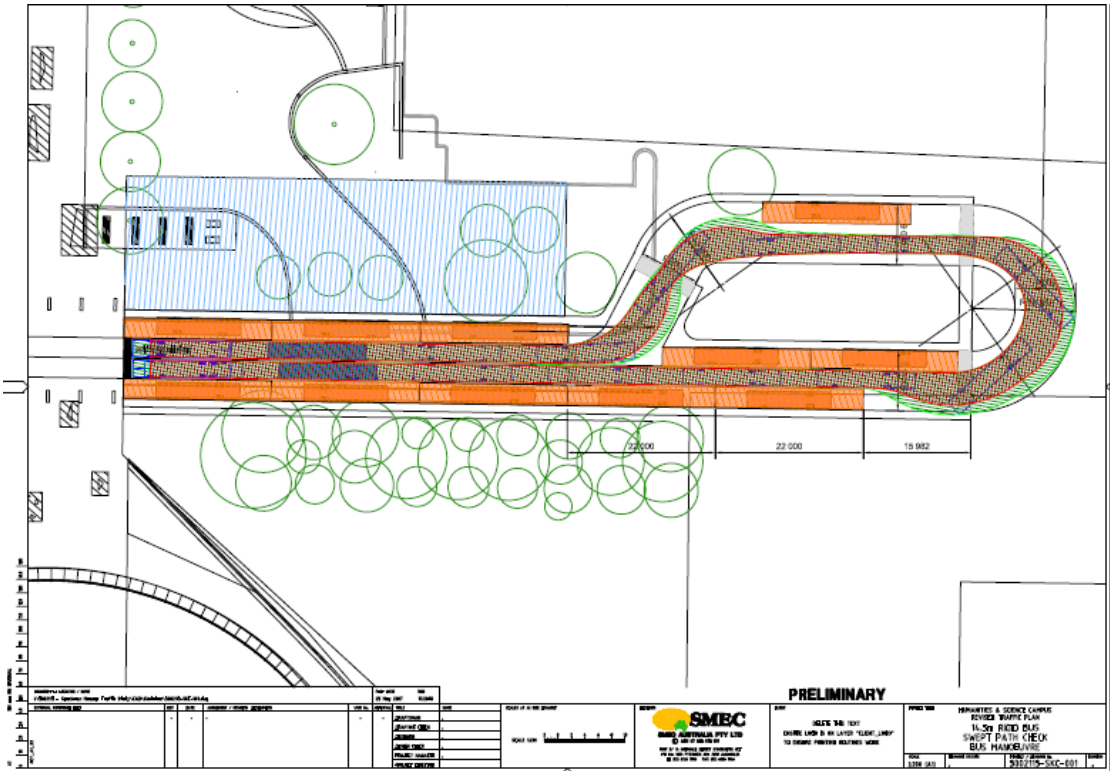
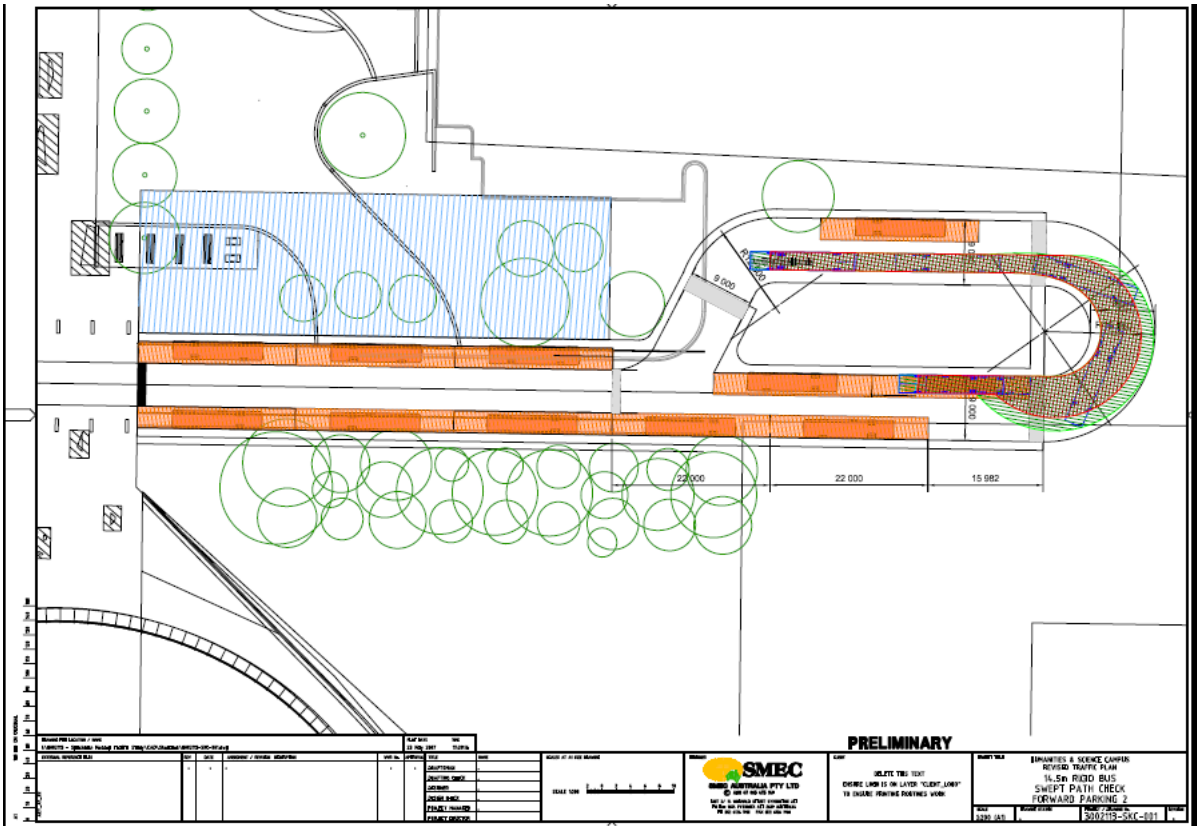


Figure A-1: 14.5 m Rigid Bus Swept Path Check Manoeuvre



FigureA-2: 14.5 m Rigid Bus Swept Path Check Forward Parking directly after manoeuvring turning loop

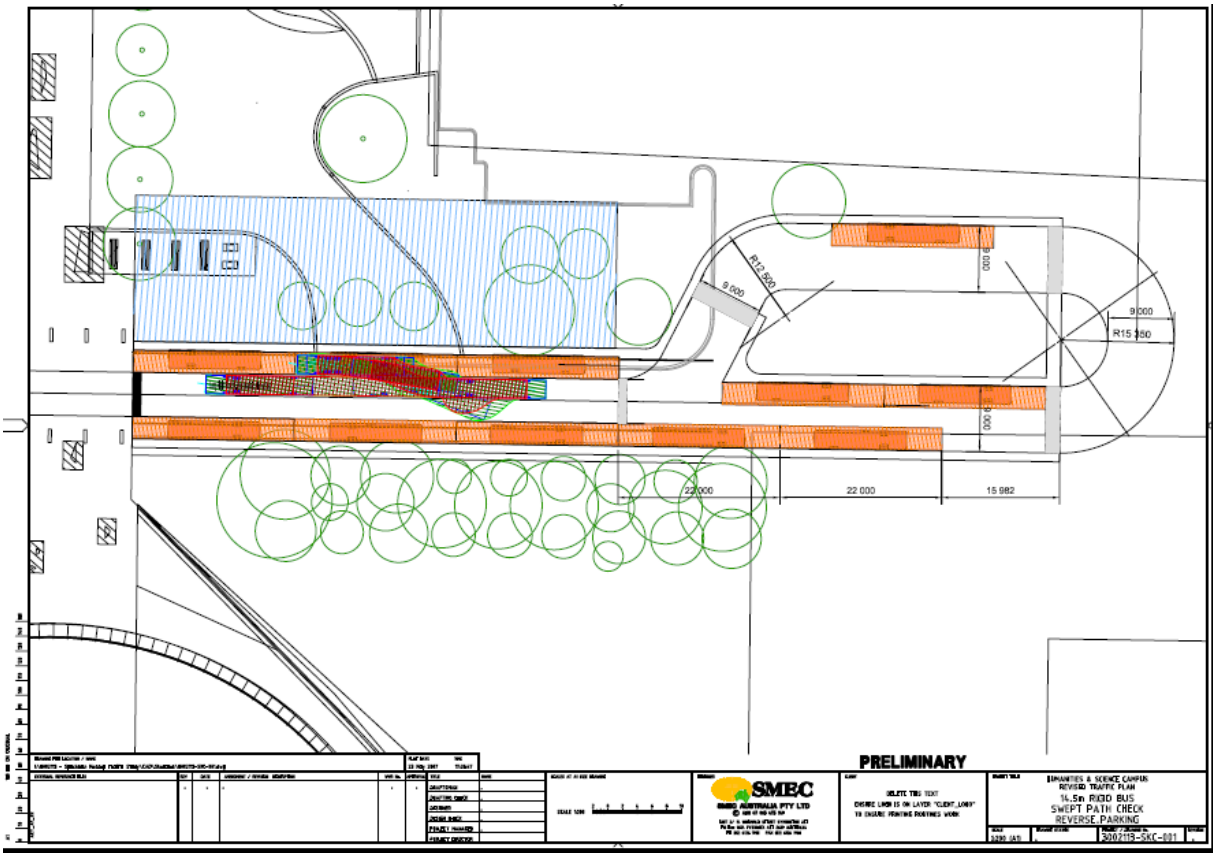


Figure A-3: 14.5 m Rigid Bus Swept Path Check Reverse Parking obstructed by buses parked in all directions front, rear and side.

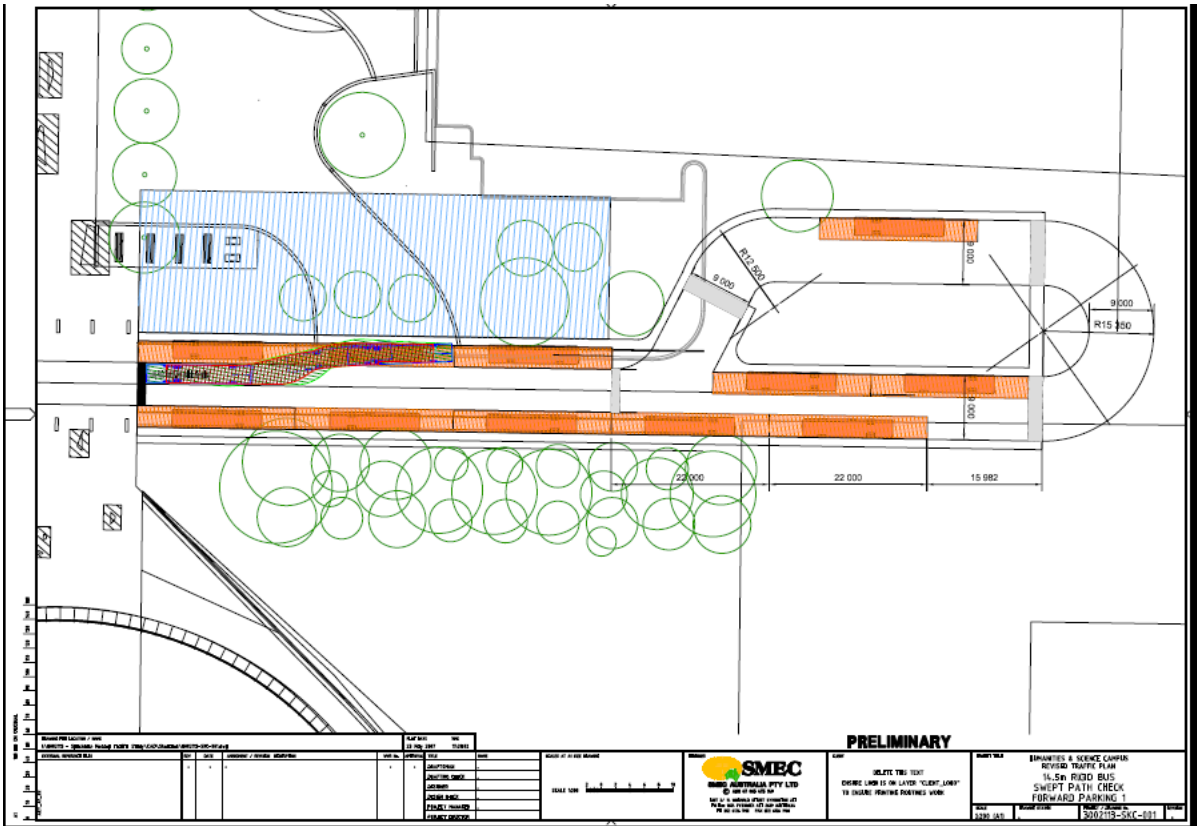


Figure A-4: 14.5 m Rigid Bus Swept Path Check Front Parking obstructed by buses parked in all directions front, rear and side

Appendix B Level of Service Criteria

According to aaSidra and the Highway Capacity Manual, LOS criteria for traffic signals are stated in terms of the average control delay per vehicle, typically for a 15-min analysis period. Definitions of Level of Service by Austroads for a general case are included below.

LOS A describes operations with very low control delay, up to 10 sec per vehicle. This level of service occurs when progression is extremely favourable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes operations with control delay greater than 10 and up to 20 sec per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

LOS C describes operations with control delay greater than 20 and up to 35 sec per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes operations with control delay greater than 35 and up to 55 sec per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavourable progression, long cycle lengths, or high *v/c* ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes operations with control delay greater than 55 and up to 80 sec per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high *v/c* ratios. Individual cycle failures are frequent occurrences.

LOS F describes operations with control delay in excess of 80 sec per vehicle. This level, considered to be unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing factors to such delay levels.

Level of Service	Control Delay (d) per Vehicle in Seconds	
	Signals and Roundabouts	Stop and Give-Way
A	d ≤ 10	d ≤ 10
B	10 < d ≤ 20	10 < d ≤ 15
C	20 < d ≤ 35	15 < d ≤ 25
D	35 < d ≤ 55	25 < d ≤ 35
E	55 < d ≤ 80	35 < d ≤ 50
F	80 < d	50 < d