Randwick City Council

Kensington and Kingsford Planning Strategy

Stage 2 Transport Modelling Report

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1 Introduction

Randwick City Council appointed Conybeare Morrison International to advise on new planning controls for the Kingsford and Kensington town centres. The new planning controls will comprise a key aspect of a Planning Strategy to guide the coordinated growth and renewal of these town centres into the future.

Arup has provided Stage 1 Traffic and Transport Advice to inform the development of the planning controls and public realm improvements. This Stage 2 report investigates the impacts of the proposed changes in the Planning Strategy through traffic modelling. Specifically accounted for are the proposed dwelling growth and a number of road closures within each of the town centres, along with the addition of the CBD South East Light Rail through the area expected after 2019.

1.1 Proposed Changes and Methodology

As detailed in the Stage 1 Report, a variety of public domain changes are proposed that are likely to impact road network operation. Increases in residential dwellings and commercial floorspace are also proposed by the Planning Strategy, generating vehicle trips to be accommodated by the local road network. In summary, the proposed changes with bearing on traffic matters include:

- The closure of Meeks Street between Anzac Parade and Harbourne Lane;
- The closure of Duke St between Anzac Parade and Boronia Street;
- The closure of Bowral Street at Anzac Parade; and
- The addition of 2772 dwellings and 36,000m^2 commercial floorspace in Kingsford, expected to generate approximately 1022 trips in peak periods; and
- The addition of 1855 dwellings and 18,000m^2 commercial floorpsace in Kensington, expected to generate approximately 609 trips in peak periods.

These changes were imposed onto an appropriate existing future year model, namely the Sydney Light Rail SCATSIM Aimsun model (SLR model). Since the proposed changes are not large in scale, a subnetwork (known as the Kensington / Kingsford Subnetwork) was created within the SLR Aimsun model to more accurately investigate the impacts on the local area. The road network performance under simulation with and without the above changes was then compared to infer the traffic impacts of the changes.

2 Kensington / Kingsford Subnetwork

2.1 Methodology

The Sydney Light Rail SCATSIM Aimsun model, developed by GTA consultants, models the road network from North Sydney through the Sydney CBD to Kingsford under the CBD South East Light Rail (CSELR) and forms the basis of this investigation. The Sydney Light Rail model was itself developed from the Sydney Transit Model (STM), adding mesoscopic dynamic user equilibrium (DUE) simulation of the whole area to the strategic assessment of the CSELR project.

An appropriate subnetwork of the received model has been used to investigate the Kingsford / Kensington area specifically, for a variety of reasons:

- The proposed road closures are minor/ local in nature, and are unlikely to impact on a wider scale. Similarly, the floorspace uplifts are also not large enough to warrant employing the Sydney Light Rail model;
- The size of the Sydney Light Rail model means that large detours are possible and could potentially send vehicles on unrealistically long paths in response to minor changes;

An appropriate subnetwork (pictured in Figure 1) of the Sydney Light Rail model was extracted to investigate Kingsford/Kensington area specifically, ultimately using mesoscopic DUE as a simulation methodology. This process involved:

- A macro-static assignment run in the Sydney Light Rail model, generating a cordon O-D matrix for the subnetwork, containing all trips through the area for the four hour duration;
- A static assignment of the Kensington / Kingsford subnetwork, with the cordon matrix above, outputting static paths;
- A mesoscopic DUE of the Kensington / Kingsford subnetwork, using the static paths output above, was run;

However, the results of the full Sydney Light Rail SCATSIM mesoscopic DUE were received, and the outputs of the Kensington / Kingsford Subnetwork mesoscopic DUE were compared to ensure their validity. Further detail to these processes is offered below, along with comment on the convergence of the three assignments conducted above.

With a suitable future base model in place, the following was undertaken:

- Changes were made to reflect the proposed changes on the road network and a static assignment followed by a mesoscopic DUE were run on the Kensington / Kingsford subnetwork.
- The four-hour subnetwork models were converted to one-hour peak models, using traffic profiling from the original SLR model;
- The results of the unaltered Kensington / Kingsford Subnetwork (Do Nothing case) and the subnetwork with changes (Project case) were compared to infer the traffic impact of the road closures and generated trips.

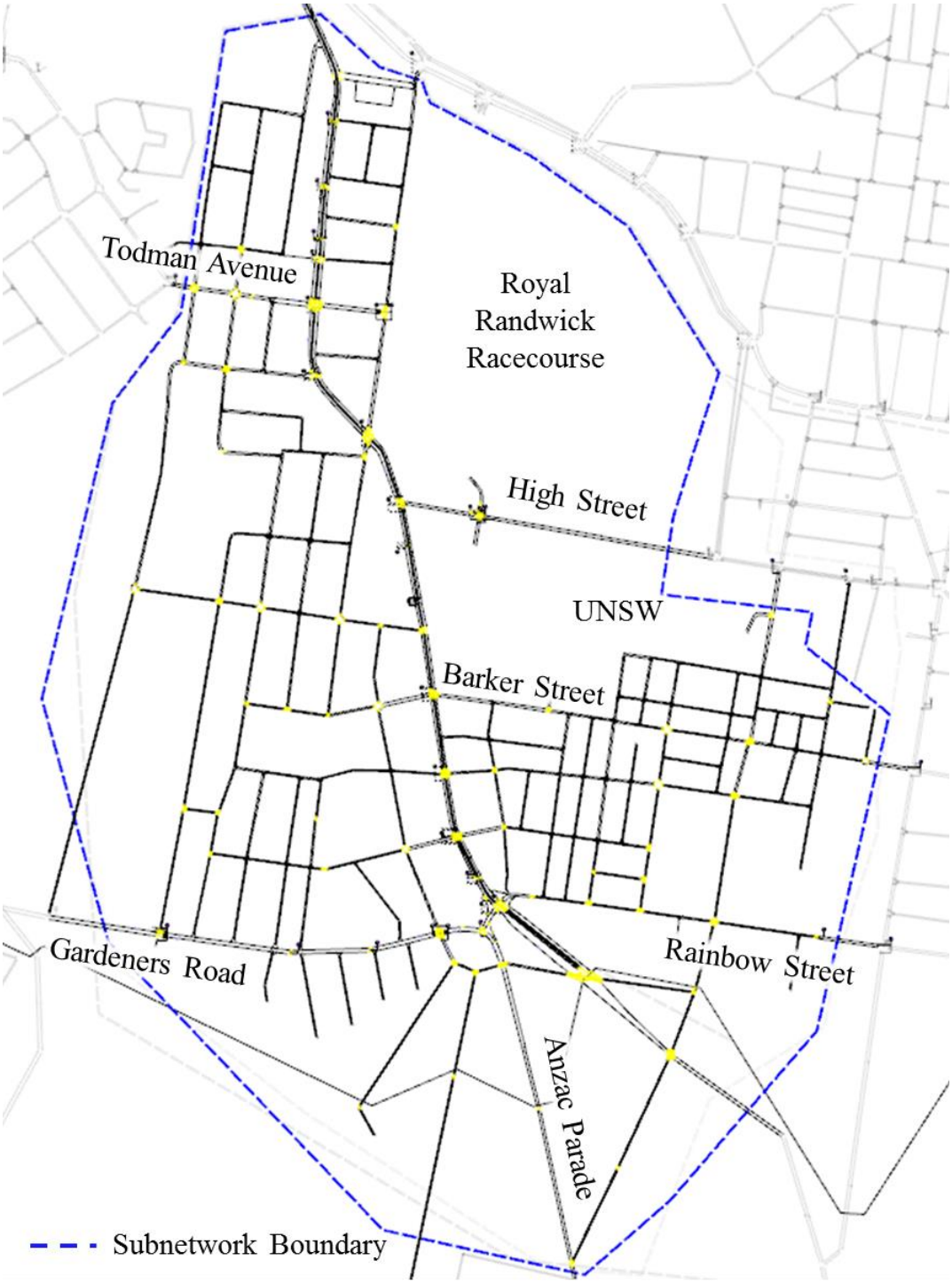

Figure 1: Kingsford / Kensington Subnetwork Extent

2.1.1 CBD Subnetwork: Macroscopic Static Assignment Convergence

The strategic models received were unaltered by Arup Pty Ltd and subsequently assumed to be sufficiently validated previously. Without the real data sets used to validate the original CSELR model, it was not possible to re-validate the results of each assignment run. However, the relative gap between iterations settled to the convergence criteria of 0.100% relative quickly:

- AM Peak: Converged to 0.99073% Relative Gap in 39 iterations;
- PM Peak: Converged to 0.90599% Relative Gap in 53 iterations.

This indicates that the static assignment process converged well and the cordon matrix generation was successful.

2.1.2 Kensington / Kingsford Subnetwork: Macroscopic Static Assignment Convergence

Similarly, the static assignment experiment conducted on theKensington / Kingsford Subnetwork with the traversal matrix converged successfully, specifically:

- AM Peak: Converged at 0.8936% Relative Gap on the 40th iteration;
- PM Peak: Converged at 0.9477% Relative Gap on the 44th iteration.

The paths of the final iterations for each peak were passed to the dynamic user equilibrium experiment as a starting point for that process.

2.1.3 K2K Town Centre Subnetwork: Mesoscopic DUE Simulation Convergence and Validation

The mesoscopic DUE of the subnetwork successfully converged to the following parameters:

- AM Peak: Converged to 5% Relative Gap in 54 iterations, surpassing the 10% relative gap undertaken on the corresponding meso-DUE on the full-scale model;
- PM Peak: Converged to 2% Relative Gap in 100 iterations, surpassing the 10% relative gap undertaken on the corresponding meso-DUE on the full-scale model.

These relative gap throughout the convergence process is shown in Figure 2 and Figure 3.

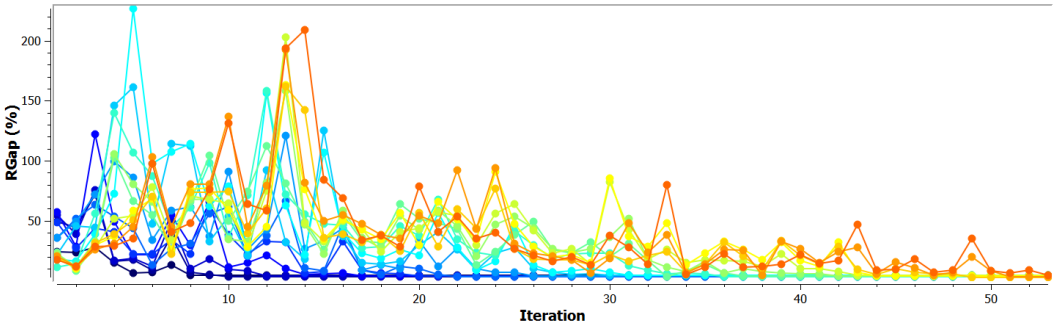

Figure 2: AM Subnetwork Meso-DUE Convergence (Relative Gap per Iteration)

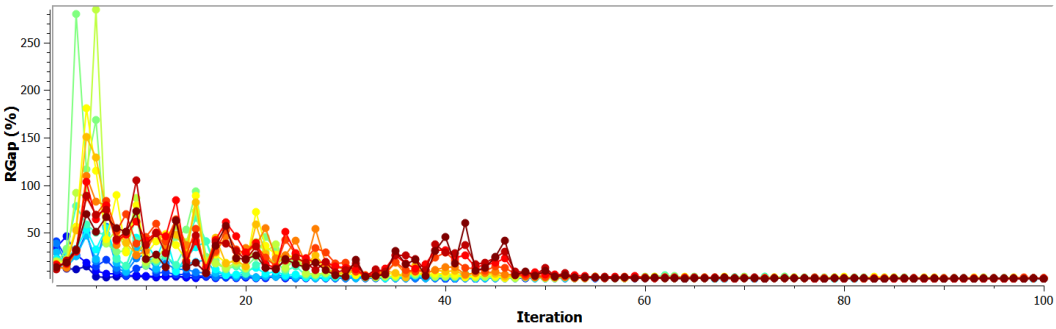

Figure 3: PM Subnetwork Meso-DUE Convergence (Relative Gap per Iteration)

3 Model Flow Comparison

Before modelling changes and drawing inference from the converged simulation, the mesoscopic DUE experiments on the Kensington / Kingsford subnetwork must first be proven to have produced flow results sufficiently similar to the original large model running the same meso-DUE process. The comparison was considered for:

- Average simulated section flows across the subnetwork; and
- Average simulated section flows along Anzac Parade; and

Details of these comparisons are provided below. However, it should also be noted that the simulations run on the subnetwork model consider a much smaller study area; this has allowed the subnetwork to achieve a convergence beyond the larger-scale simulation, but may also produce a variance between their flows.

3.1 Subnetwork Flow Comparison

The results of this comparison across the Kensington / Kingsford subnetwork are shown in Figure 4 and Figure 5 for the AM and PM peaks respectively.

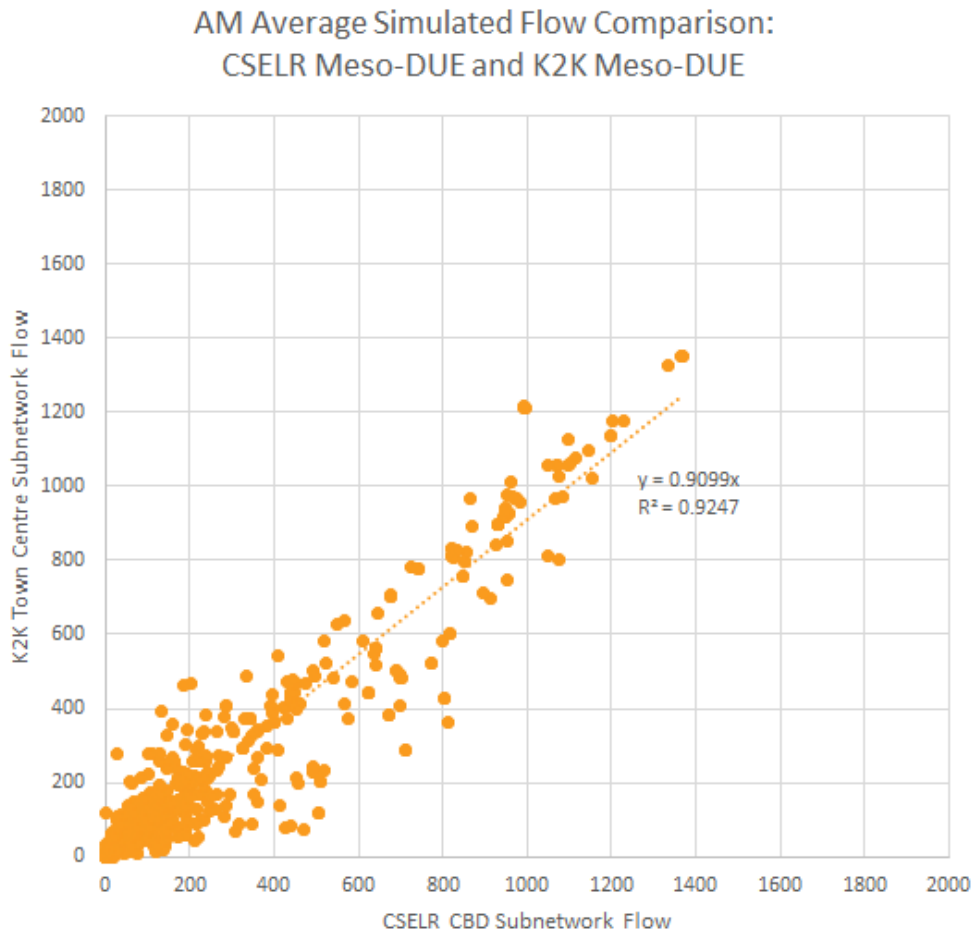

Figure 4: AM Simulated Flow Comparison: All of Subnetwork

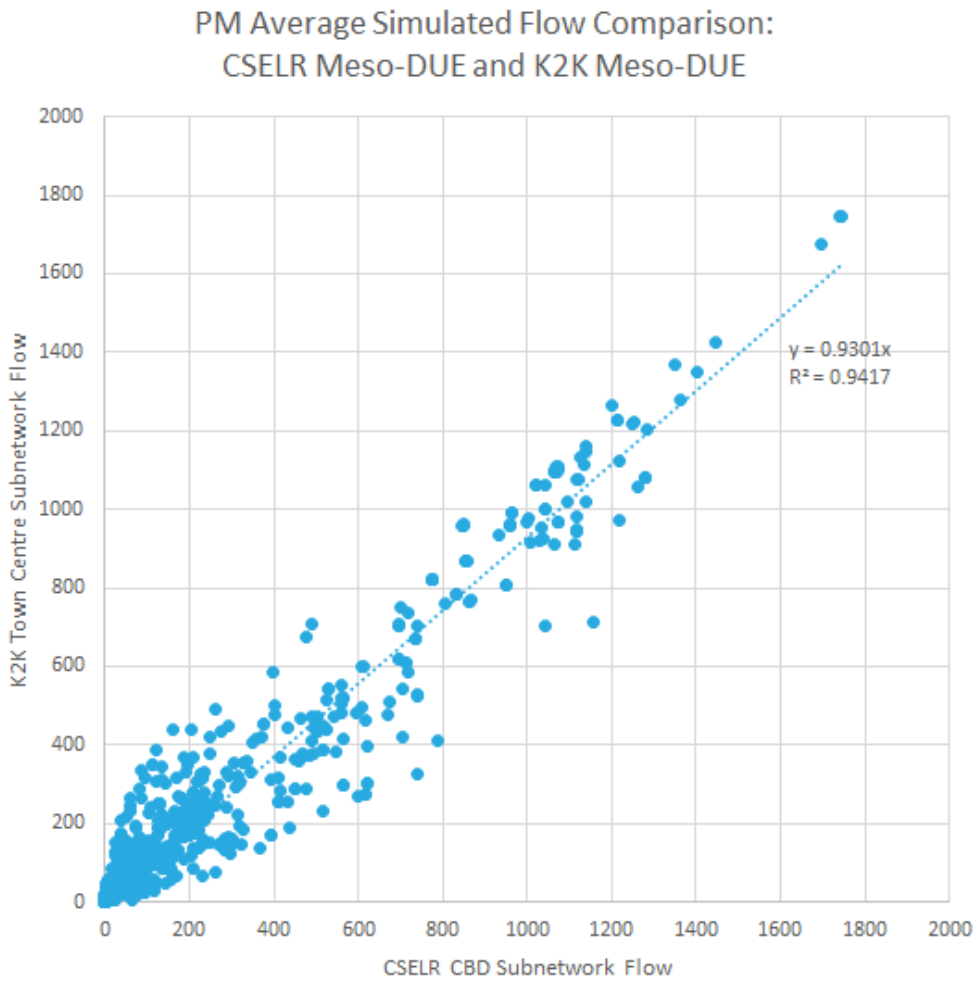

Figure 5: PM Simulated Flow Comparison: All of Subnetwork

As evidenced by the above graphs, specifically noting the R^2 of both peaks exceeds 0.9, and considering the looseness of the original CSELR simulation over such a large area, the flows simulated under a much smaller study area are considered to sufficiently resemble the flows estimated by the DUE over the larger area.

3.2 Anzac Parade Flow Comparison

Anzac Parade has been identified as of particular importance inferring to the validity of the modelling undertaken; it is the major arterial through the town centres and is directly adjacent to the proposed road closures. As a result, link flows along Anzac Parade were interrogated with further rigour, using the Geoffrey E. Havers Statistic (GEH) in conjunction with calibration criteria from the *RMS Modelling Guidelines*, namely:

- 100% of volumes to be below GEH 10; and
- 85% of volumes to be low GEH 5.

The GEH Statistic is essentially a measure of how different the observed and modelled flows are. However, it scales this difference based on the size of the

observed count allowing a comparison of "inaccuracy" between turning movements of different sizes. It is expressed as:

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

Where M is the modelled volume and C is the observed volume. The R^2 value is also an important measure for comparison between two sets and has been provided alongside the GEH comparison. The performance of each peak in relation to these GEH and R^2 criteria are shown in Table 1 and Table 2.

Table 1: Anzac Parade AM Flow Comparison Statistics

AM	**Northbound**	**Southbound**
GEH < 10	100%	100%
GEH < 5	95%	96%
Average GEH	1.5	1.7
R^2	0.602	0.93
Total turns	20	24

Table 2: Anzac Parade PM Flow Comparison Statistics

PM	**Northbound**	**Southbound**
GEH < 10	100%	100%
GEH < 5	95%	96%
Average GEH	2.83	2.38
R^2	0.77	0.7
Total turns	20	24

As evidenced by the above tables, the Anzac Parade corridor through the Kensington / Kingsford Subnetwork model calibrates well at a link volume level against the modelled volumes in the Sydney Light Rail SCATSIM model in 2021.

3.3 Comparison Summary

Overall, the Kensington / Kingsford Subnetwork appears to sufficiently resemble the flow patterns of the larger Sydney Light Rail it was derived from, and specifically can be considered to calibrate along Anzac Parade. The subnetwork is consequently considered to be fit for purpose, in light of the previously calibrated and validated Sydney Light Rail model and the lack of alterations made to the subnetwork. Beyond that, the subnetwork constrains the possibility of long detours as a reaction to relatively minor local road closures, while modelling in the full Sydney Light Rail model would still allow such unrealistic re-routing behaviour.

3.4 Peak Modelling Period Selection

Due to the likely traffic generation period of the new floorspaces, it was decided to model the subnetwork for only the peak hour instead of the full four hour duration of the Sydney Light Rail. Peak times and a factor to scale down the four-hour cordon matrix were drawn from hourly profiles within the Sydney Light Rail model, shown in Figure 6 and Figure 7.

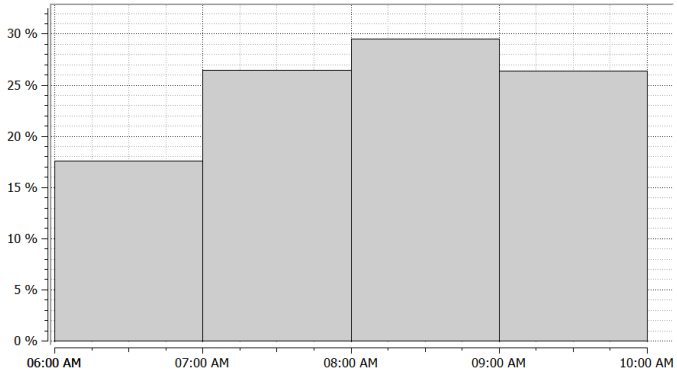

Figure 6: AM Hourly Traffic Profile in the Sydney Light Rail Model

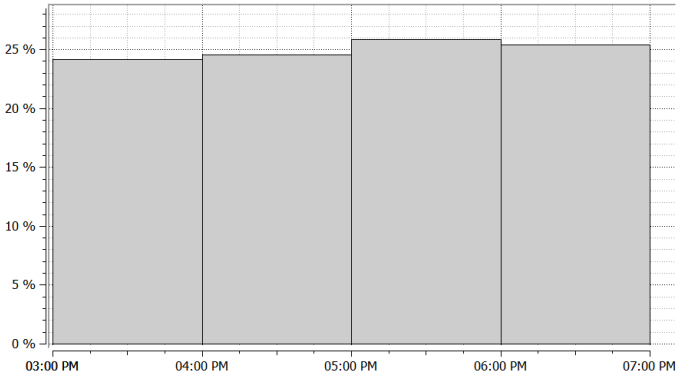

Figure 7: PM Hourly Traffic Profile in the Sydney Light Rail Model.

From this, the following peak times and factors were selected:

- AM Peak: 08:00 to 09:00, applying 29.54% of the 4-Hour O-D matrix; and
- PM Peak: 17:00 to 18:00, applying 25.88% of the 4-Hour O-D matrix.

These profiles represent the background traffic patterns, but are also likely to coincide with the peak generation time for the new floorspace. As a result, the modelled peak estimates the worst-case scenario.

4 Proposal Modelling

With a fit for purpose model as a basis, the proposed local road closures and floorspace uplifts were added to the model to test their impact. This involved a number of steps:

- Removal of the local roads to be closed and addition of new zones to generate new trips;
- Distribution of the traffic generated by new development (as in the Stage 1 Transport Assessment) based on Journey to Work 2011, on top of the future background traffic through the area as in the full Sydney Light Rail model;
- Running a static assignment on the Kensington / Kingsford subnetwork to anticipate changes in traffic patterns with these new trips and changes to the local road network. This generates initial paths to pass to the mesoscopic DUE simulation;
- Running the mesoscopic DUE simulation of the Kensington / Kingsford subnetwork to identify resultant traffic conditions; and
- Comparison the results of the mesoscopic DUE simulation to the unaltered Kensington / Kinsford 2021 Base model.

These processes are detailed below.

4.1 Proposed Road Network Changes

In order to factor in the proposed road closures, which would limit/eliminate access to and from Anzac Parade, three streets were removed from the project model. As above, these were:

- Meeks Street;
- Duke Street; and
- Bowral Street.

These changes are illustrated in Figure 8 and Figure 9.

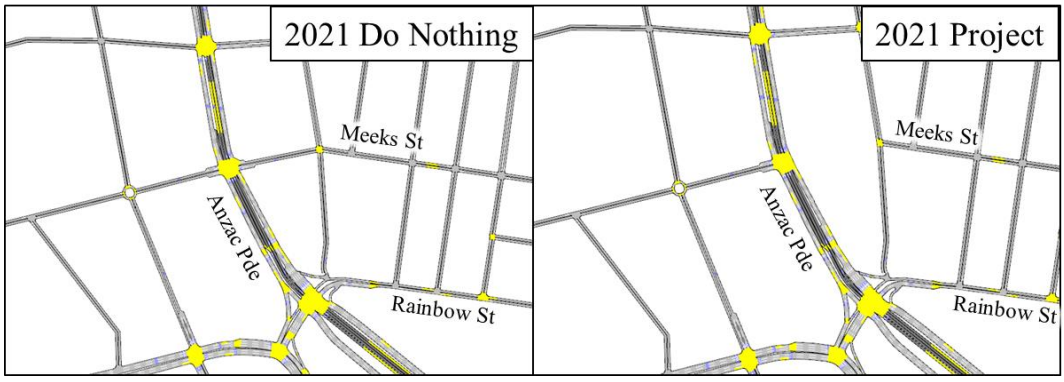

Figure 8: Meeks Street modelled road closure.

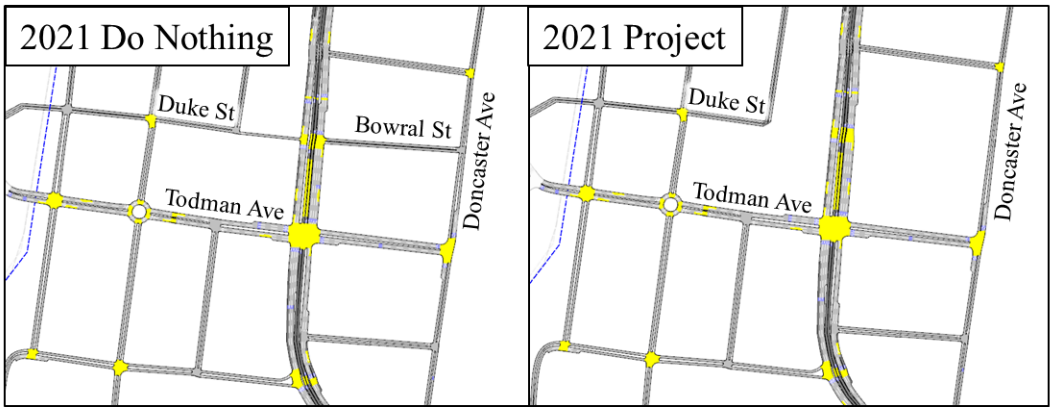

Figure 9: Bowral Street and Duke Street modelled road closure.

The proposed road closures do not actually involve the full removal of the road. The roads are proposed to remain intact for local access, while works would be undertaken to limit access to and from Anzac Parade. However, the overall Sydney Light Rail model releases vehicles onto nodes, not links, so removing the link in the Aimsun model is a valid way of modelling the reduced route choice. This modelling approach does not affect "local access" or the number of vehicles coming from the closed streets in the model.

4.2 Floorspace Uplifts

The additional dwellings and commercial floorspace afforded by the proposed Planning Strategy were applied as per the traffic generation levels and distribution undertaken in the Stage 1 Transport Assessment. Their trips were distributed to six major road routes from their expected origin based on the *Journey to Work 2011* (JTW 2011) and expected routing to-and-from the S3 Statistical Area listed in the *JTW*. The Place of Work and Place of Residence distributions are shown in Table 3 and Table 4.

Table 3: Place of Work of people living in Randwick – Kensington S3 Statistical Area. *Source: Journey to Work Survey, 2011.*

S3 Statistical Area	Trips	%
Eastern Suburbs – South	1207	58%
Botany	226	11%
Sydney Inner City	177	8%
Kogarah - Rockdale	116	6%
Eastern Suburbs – North	104	5%
Hurstville	80	4%
Canterbury	63	3%
Strathfield – Burwood – Ashfield	46	2%
Sutherland – Menai – Heathcote	39	2%
North Sydney – Mosman	33	2%

Major Route	%
Anzac Parade North	22.2%
Anzac Parade South	19.2%
High Street	6.1%
Rainbow Street	6.1%
Gardeners Road	21.9%
Bunnerong Road	24.6%

Table 4: Place of Residence of people working in Randwick – Kensington S3 Statistical Area. *Source: Journey to Work Survey, 2011.*

S3 Statistical Area	Trips	%
Sydney Inner	2338	43%
Eastern Suburbs – South	1574	29%
Eastern Suburbs – North	481	9%
Botany	465	9%
North Sydney – Mosman	204	4%
Chatswood – Lane Cove	143	3%
Ryde – Hunters Hill	94	2%
Marrickville – Sydenham – Petersham	62	1%
Strathfield – Burwood – Ashfield	62	1%

Major Route	%
Anzac Parade North	55.7%
Anzac Parade South	14.0%
High Street	2.2%
Rainbow Street	2.2%
Gardeners Road	16.2%
Bunnerong Road	9.7%

Using these two distributions from the Journey to Work, the trip distributions associated with the new floorspace and dwellings can be inferred. Specifically:

- **The Place of Work** relates to the **residential traffic distribution**. It tells us where people who live in this area are driving to and from for work. It informs the **AM destinations** and **PM origins** related to the **new residential dwellings**.
- **The Place of Residence** related to the commercial traffic distribution. It tells us where people who work in this area are driving from and to from home. It informs the **AM origins** and **PM destinations** related to the **new commercial floorspace**.

In addition to this assumed pattern from the *Journey to Work*, the following In and Out splits were assumed for each peak and land use:

- Trips generated by new commercial floorspace are assumed to attract 90% of trips in during the AM Peak, with 10% out, and vice-versa in the PM Peak.
- Trips generated by new residential dwellings are assumed to attract 20% of trips in during the AM Peak, with 80% out, and vice-versa in the PM Peak.

This produced the additional distributed trips to add into the O-D matrix. These trips are aggregated into Town Centre and to Major Route in Table 5 and Table 6 respectively.

Table 5: Total Trips Generated by Floorspace and Dwelling uplift – by Town Centre.

Town Centre	AM		PM	
	IN	OUT	IN	OUT
Kingsford	516	505	505	516
Kensington	281	335	335	281
Total	**796**	**839**	**839**	**796**

Table 6: Total Trips Generated by Floorspace and Dwelling uplift - by Major Route

Major Route	AM		PM	
	IN	OUT	IN	OUT
Anzac Pde North	241	445	445	241
Anzac Pde South	143	121	121	160
High St	41	21	21	43
Rainbow St	41	21	21	43
Gardeners Rd	163	140	140	183
Bunnerong Rd	167	91	91	179

4.3 Re-determining O-D Matrices and Paths

With the new trips in place and an altered road network, the previous static assignment of the subnetwork was not a valid starting point for the project meso-DUE simulation. A static assignment was run on the new project model to generate a valid set of static paths, which converged successfully:

- To 0.065% in 34 iterations for the AM Peak; and
- To 0.099% in 27 iterations for the PM Peak.

With the paths from this static assignment as a starting point, the meso-DUE was run on the project subnetwork model, converging to:

- 5% in 100 iterations for the AM Peak; and
- 2% in 100 iterations for the PM Peak.

5 Modelling Results

Following the establishment of both models and their convergence, the results of the Do Nothing and Project subnetworks were compared from the mesoscopic DUE simulation. The comparison is largely undertaken through:

- The simulated flows on links around the Anzac Parade Corridor;
- Similarly, the simulated delay time on links;
- The approach Level of Service (LoS) at selected intersections; and
- The overall intersection LoS of selected intersections.

To investigate the first two, screenshots of the Aimsun model showing flow and delay time within Kensington and Kingsford Town Centres are presented in Figure 10 through Figure 17, with commentary. Approach Level of Service and Intersection Level of Service were investigated for the following intersections within the Kensington:

- Anzac Parade / Boronia Street;
- Anzac Parade / Bowral Street / Duke Street;
- Anzac Parade / Todman Avenue;
- Anzac Parade / Addison Road; and
- Anzac Parade / Doncaster Avenue.

While the following intersections were investigated in the Kingsford Area:

- Anzac Parade / Barker Street;
- Anzac Parade / Middle Street / Strachan Street;
- Anzac Parade / Meeks Street / Borrodale Road; and
- Anzac Parade / Gardeners Road / Rainbow Street.

These levels of service are determined by the average delay time as shown in Table 7 (as per the *RMS Modelling Guidelines 2013, Table 14.3)*. The intersection Level of Service from the model is summarised in Table 8 with further detail in Appendix A and commentary below.

In short, looking at the intersection levels of service, it appears that the proposal generally has a small impact on intersection performance at this high level. Levels of service are mostly maintained while average delays worsen marginally, with the exception of:

- Anzac Parade / Todman Avenue during the AM Peak where it worsens from LoS E to LoS F, although the average delay difference is a matter of 11.2s;
- Anzac Parade / Barker Street during the AM Peak, where performance worsens from LoS C to LoS D, with an average delay difference of 9s.
- Anzac Parade / Meeks St / Borrodale St during the AM Peak, where it worsens from LoS B to LoS C, with an average delay difference of 4s.

Small deviations (whether they worsen or improve performance) at both the intersection level and the approach level are likely due to model variability and some traffic rerouting during the dynamic user equilibrium.

Table 7: Level of Service thresholds
Source: RMS Modelling Guidelines (2013), Table 14.3 pg. 199.

Level of Service	Average Delay Threshold
A	<14 seconds
B	<28 seconds
C	< 42 seconds
D	< 56 seconds
E	< 72 seconds
F	> 72 seconds

Table 8: Intersection Performance Summary (Level of Service)

Intersection	AM				PM			
	Do Nothing		Project		Do Nothing		Project	
Anzac Pde / Boronia St	0.7	A	1.2	A	0.9	A	1.2	A
Anzac Pde / Goodwood St	0.6	A	0.9	A	0.7	A	0.8	A
Anzac Pde / Ascot St	0.3	A	0.1	A	0.2	A	0.3	A
Anzac Pde / Bowral St	3.8	A	3.7	A	4.0	A	4.2	A
Anzac Pde / Todman Ave	65.8	E	77.0	F	45.5	D	47.4	D
Anzac Pde / Addison Rd	4.6	A	4.1	A	5.0	A	4.5	A
Anzac Pde / Doncaster Ave	14.1	B	15.3	B	14.1	B	15.4	B
Anzac Pde / Barker St	38.2	C	47.2	D	30.7	C	32.4	C
Anzac Pde / Middle St	22.0	B	24.9	B	16.9	B	20.5	B
Anzac Pde / Meeks St / Borrodale Rd	24.5	B	28.5	C	25.7	B	20.5	B
Anzac Pde / Gardeners Rd	15.2	B	14.2	B	15.3	B	14.2	B

5.1 Kingsford Town Centre Results Comparison

Kingsford: AM Peak

Figure 10: AM Flow Comparison, Kingsford Town Centre

The closure of Meeks Street causes rerouting away from Meeks Street and Borrodale Road, mostly onto Rainbow Street and Barker Street. Backstreets within Kingsford (such as Forsyth Street and Willis Street) also experience growth due to this, but their volumes remain low. Some rerouting occurs in the northeastern corner of Figure 10, although this is not substantial. The addition of 1020 vehicles from the proposed commercial floorspace and residential dwellings can also be seen in a marginal overall increase in flows.

Figure 11: AM Simulated Delay by Approach Comparison (Kingsford Town Centre)

There appears to be marginal impacts on delay time throughout the local Kingsford network, excepting:

- A worsening of delay time on the western Approach of Anzac Parade / Barker Street, moving the delay time from 56 seconds to 173.7 seconds and the approach Level of Service from LoS D to Los F;
- The eastern approach of Anzac Parade / Barker Street, moving from an average delay of 79.8 seconds (LoS F) to 115 seconds (LoS F);
- The western approach of Anzac Parade / Middle Street (Strachan Street), where delay has worsened from 78.2 seconds (LoS F) remaining LoS F at 79.4 seconds;
- The eastern approach of Anzac Parade / Middle Street, where delay has worsened from 37.3 seconds (LoS C) to 74.2 seconds (LoS F)
- The western approach of Anzac Parade / Meeks Street from 80.1 seconds (LoS F) to 109.1 seconds (LoS F),.

The majority of the Kingsford local road network at least one block back from Anzac Parade experiences minimal delay times, while delays along Anzac Parade remain satisfactory. The impacts of the rerouting and development under this analysis are experienced on the minor approaches onto Anzac Parade, likely due to the unchanged signals; there may be room in reality and in another analysis for more time to be afforded to these minor roads to improve their performance. The overall level of service for these intersections indicate that there may be a little rebalancing towards the minor roads available. Outside of signal adaptation, this congestion may also self-mitigate via drivers re-routing,or (desirably) mode-switching to the new light rail along the corridor.

Kingsford: PM Peak

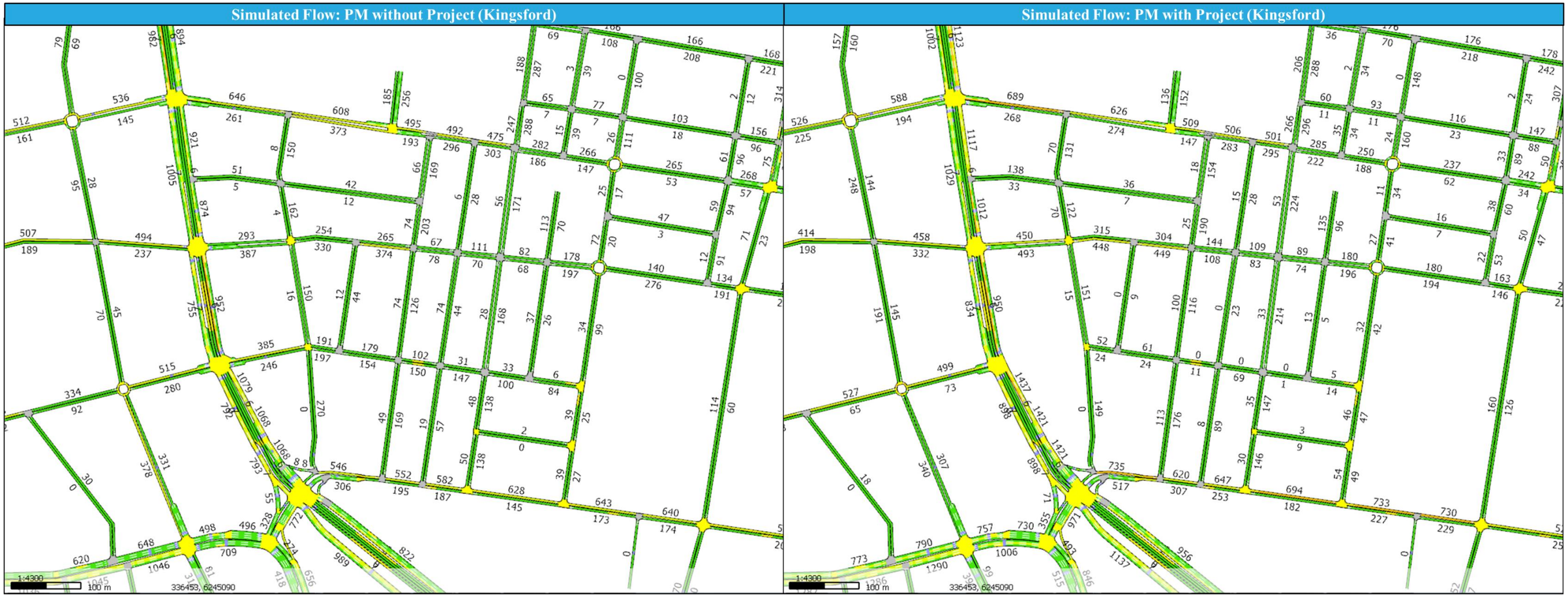

Figure 12: AM Simulation Flow Comparison (Kingsford Town Centre)

As in the AM Peak, flows on the remainder of Meeks Street drop (although Borrodale Road's volumes are almost maintained), while vehicles reroute to Barker Street, Middle Street, Strachan Street and Rainbow Street. Volumes change on Forsyth Street, Willis Street and in the northeastern corner of Figure 12, but remain small. Traffic from new floorspace is perceptible in some overall volume growth.

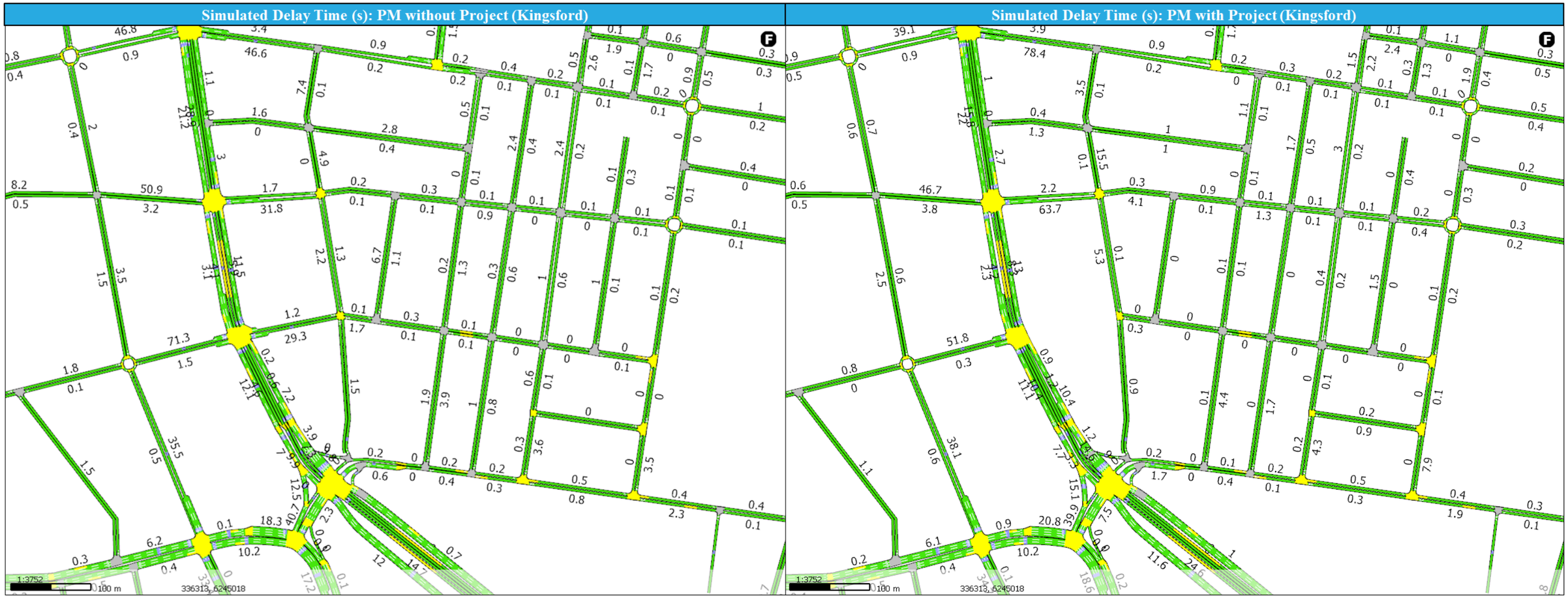

Figure 13: PM Simulated Delay Time Comparison (Kingsford Town Centre)

The PM model performs slightly better than the AM model in this area overall and at key locations. As in the AM, the road network performance is largely maintained, with some notable impacts:

- The eastern approach of Barker Street worsens from 46.6 seconds average delay (LoS C) to 78.4 seconds (LoS F);
- Middle Street eastern approach worsens from 31.8 seconds (LoS C) to 63.7 seconds (LoS E);
- Borrodale Road western approach improves from an average delay of 71.3 seconds (LoS E, almost F) to 51.8 seconds (LoS C, almost D).

Again, the local road network not immediately on Anzac Parade largely experiences little delay, with the levels of service along Anzac Parade maintained at satisfactory levels.

The projected large delays mean that congestion is expected on minor approaches to Anzac Parade, while travel along the corridor is not substantially impeded. This is likely due to the lack of change in signal timings and, as mentioned in the AM Peak assessment of Kingsford Town Centre, may be ameliorated by changed signal timings. This congestion may also self-mitigate via drivers re-routing on a larger scale, or (desirably) mode-switching to the new light rail along the corridor.

5.2 Kensington Town Centre Results Comparison

Kensington: AM Peak

With the closure of the Duke Street and Bowral Street at Anzac Parade, a small amount of re-routing occurs. However, Duke Street is a left-in one-way street, and Bowral Street is particularly minor, so detours are relatively small; according to the modelling, the volumes on Bowral Street relocate to Todman Avenue, Ascot Street and Goodwood Street.

The addition of 609 trips from the proposed commercial floorspace and residential dwellings (mostly onto Boronia Street, Doncaster Street and Addison Road) in conjunction with the small rerouting, produces notable flow increases at:

- The eastern approach of Anzac Parade / Todman Avenue;
- Doncaster Avenue, south of Todman Avenue;
- Kensington Road, either side of Todman Avenue;
- Certain sections of Roma Avenue and Cottenham Avenue; and
- Anzac Parade in general.

The other local roads maintain relatively low flows.

Figure 14: AM Simulated Flow Comparison (Kensington Town Centre)

In light of the above flow increases, the following notable changes or issues in performance are projected in the AM Peak:

- Anzac Parade / Todman Avenue overall performs at LoS E in the existing case, moving to LoS F under project conditions. Detailed changes in the approaches include:
  - The western approach changes little, maintaining poor performance well into LoS F;
  - The southern approach of Anzac worsens from Los E (64.9 seconds average delay) to LoS F (92.4 seconds)
  - The eastern approach of Todman Avenue worsens from 29.6 seconds (LoS C) to 38.8 seconds (Los C)
  - The northern approach worsens from 49.9 seconds (LoS D) to 57.9 seconds (LosS D)
- Not visible in Figure 15, but the Southern approach (Doncaster Avenue) of Anzac Parade / Doncaster Avenue worsens from 39.37 seconds (Los C) to 45.6 seconds (LoS D), although the intersection maintains Los B overall.

Most other changes in delay are negligible, or remain well within acceptable delays. Notably, most of Anzac Parade and local streets not directly adjacent continue to experience low delays. This includes the northern end of Doncaster Avenue, which experiences a small amount of overall growth.

Figure 15: AM Simulated Delay Time Comparison (Kensington Town Centre)

Kensington: PM Peak

Flow growth patterns in the PM Peak are similar to those in the AM Peak, that is growth is projected on:

- The eastern approach of Anzac Parade / Todman Avenue;
- Doncaster Avenue, south of Todman Avenue;
- Kensington Road, either side of Todman Avenue;
- Certain sections of Roma Avenue and Cottenham Avenue; and
- Anzac Parade in general.

The increases on Doncaster Avenue and Anzac Parade are larger than in the AM Peak, however, the intersection remains at LoS B.

Figure 16: PM Simulated Flow Comparison (Kensington Town Centre)

The PM model performs slightly better than the AM Peak in the Do Nothing case, and delays projected by that case are quite reliably maintained or slightly worsened in the Project case. Although performance may not be ideal in the Do Nothing case (with various Los D approaches), it is to be expected on an urban corridor such as Anzac Parade. The impact of rerouting and development related traffic growth in the project case is considered minimal, as no approach worsens perceptibly and no approach reaches Los E or Los F. As previously, the local road network experiences little induced delay outside of Anzac Parade and Todman Avenue.

Figure 17: PM Simulated Delay Time Comparison (Kensington Town Centre)

5.3 Further Intersection Upgrades

Following the initial modelling, two intersection upgrades were considered, namely:

- At Anzac Parade / Todman Avenue: adding a short right turn lane to the western approach, allowing a dedicated through lane on that approach; and
- At Anzac Parade / Barker Street: adding a short through-and-left lane to the eastern approach, allowing a dedicated through lane on that approach.

The additional lanes and altered lane discipline of these approaches are shown in Figure 18 and Figure 19.

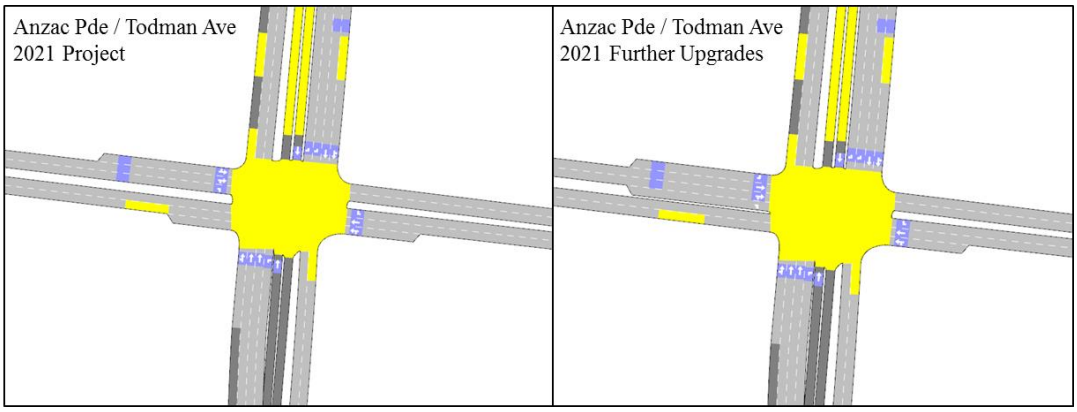

Figure 18: Anzac Parade / Todman Avenue Intersection Upgrade

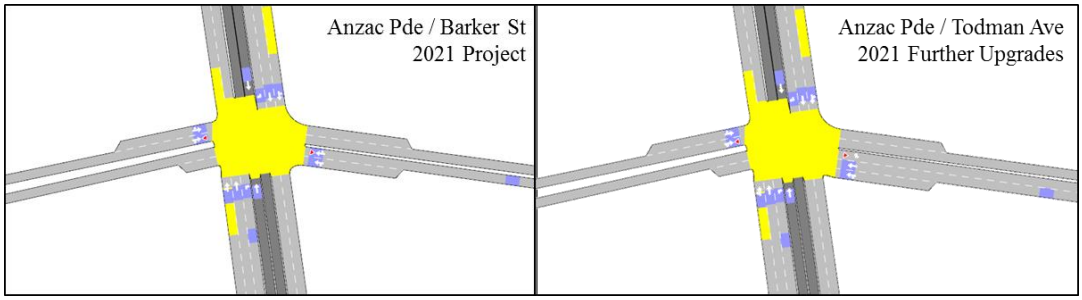

Figure 19: Anzac Parade / Barker Street Intersection Upgrade

These upgrades were modelled mesoscopically within the established subnetwork for comparison with the previous analysis, noting the following:

- Signal times were unchanged between the Project case and Further Upgrades;
- The static assignment was re-run for the Further Upgrades case, accounting for the expected change in route choice induced by the upgraded capacity.
    - This caused some re-routing between Barker Street and Middle Street; the performance of Anzac Pde / Middle St is also shown
    - Apparent “inconsistencies” in volumes between the two cases are likely due to the revised route choice.
- Short Lane lengths were assumed in light of existing short lane length and a minimised land-take:

  - The proposed right-turn bay at Anzac Parade / Todman Avenue was assumed to be the same length as the existing left turn bay there; and
  - The proposed left turn-bay at Anzac Parade / Barker Street is the same length as the existing left-turn bay.
- The mesoscopic simulaton has limitations in evaluating detailed geometry, especially in relation to queue stacking. As a result, the results do not infer on the required length of turn bays, or any other detailed geometry. These results are only intended to infer the benefit of added lanes and changed lane discipline.

Results of this comparison for the altered intersections are shown in Table 9.

Table 9: Further Intersection Upgrades Intersection Performance comparison.

Intersection	AM				PM			
	Project		Further Upgrades		Project		Further Upgrades	
	Delay (secs)	LoS	Delay (secs)	LoS	Delay (secs)	LoS	Delay (secs)	LoS
Anzac Pde / Todman Ave	77.0	F	67.3	E	47.4	D	45.7	D
Anzac Pde / Barker St	47.2	D	45.9	D	32.4	C	30.4	C
Anzac Pde / Middle St	24.9	B	23.3	B	20.5	B	17.4	B

At the overall intersection level, there are some decreases in average delay indicating marginally increased efficiency with the upgrades. The results presented for each approach are shown in Appendix B. The notable performance improvements in the AM include:

- The changes at Todman Avenue drop the average delay on the western and southern approaches from 92.4s and 94.6s to 73.3s and 78.2s respectively
- The western approach of Todman Avenue services an extra 200 vehicles (~800 vehicles in the project, ~1000 vehicles with further upgrade);
- The average delay on the other approaches of Todman Avenue remain approximately similar;
- The changes at Barker Street drop the average delay of the eastern approach from 173.7s to 104.5s. Although this remains LoS F, the performance;
- The average delay on the other approaches of Barker Street remain approximately similar.

In the PM the notable performance improvements include:

- The changes at Todman Avenue maginally drop the average delay on the western and southern approaches from 50.9s and 47.2s to 49s and 43.1s, respectively;
- The average delay on the other approaches of Todman Avenue remain approximately similar;
- The changes at Barker Street drop the average delay of the eastern approach from 78.4s (LoS F) to 44.4s (LoS D)
- The average delay on the other approaches of Barker Street remain approximately similar.

In both peak hours, the proposed further upgrades appear to improve the major movements on the western approach of Todman Avenue and eastern approach of Barker Street. This includes a reduction in average delay for those approaches and in some cases an increase in serviced traffic volumes. The end effect of those upgrades is slightly improved ease of access onto Anzac Parade along with a marginal gain in overall intersection efficiency.

6 Conclusion

The impact of the proposed road closures and new floorspace has been assessed and generally found to be acceptable at an intersection level, as the difference between Do Nothing and Project case is not large. The PM model generally presents acceptable results in both existing and project, with the exception of some side road approaches in Kingsford projected to experience LoS F and LoS E in the project case.

Existing performance in the AM model is substantially poorer than the PM, with various existing approaches experiencing LoS F and LoS E. This worsens marginally in the project case, with Anzac Parade / Todman Avenue and Anzac Parade / Barker Street moving to Los F and LoS D, respectively. More generally, the model indicates that some minor approaches at Anzac Parade intersections within Kingsford will operate poorly at LoS F, and gaining access to Anzac Parade may be difficult. The real response to this potential difficulty is (a desirable) mode-switch away to public transport including the new Light Rail running through the precinct, or more inventive re-routing through the precinct. Both of these outcomes might ameliorate the projected failures into “congested, but functional” territory.

Further assessment of two potential geometric upgrades at Anzac Parade / Todman Avenue and Anzac Parade / Barker Street indicated that some slight efficiencies could be gained at these two intersections overall. The benefits to individual minor approaches to Anzac Parade were more substantial, but continued to operate poorly.

There are various limitations to the assessment of the corridor under the current modelling methodology. No changes to signal phasing were incorporated in the project model; the overall intersection performance in most cases indicates that signal optimisation with the future intersection layouts (as currently planned and modelled in the SLR model) may be possible. It may be possible to more evenly balance signal timing between the co-ordination of the Anzac Parade corridor with the minor approaches, making the corridor more accessible from side-streets.

Appendix A

Modelling results for base + project cases

A1 AM Peak Base and Project Performance Comparison by Approach

Intersection Performance Comparison: AM													
Intersection	Approach	2021 Base						2021 Project					
		Volume	Delay Time	LoS	∑ Volume	Delay Time	LoS	Volume	Delay Time	Los	∑ Volume	Delay Time	LoS
Anzac Parade / Boronia St	N	892	0.3	A	2278	0.7	A	1167	0.6	A	2969	1.8	A
	SE	1022	0.3	A				1226	0.3	A			
	S	364	3.1	A				576	7.4	A			
	W	-	-					-	-				
Anzac Parade / Goodwood St	N	900	1.2	A	1994	0.6	A	1222	1.6	A	2551	0.9	A
	E	71	2.7	A				103	3.6	A			
	S	1023	0	A				1226	0.0	A			
	W												
Anzac Parade / Ascot St	N	897	0.3	A	1938	0.3	A	1194	0.2	A	2468	0.1	A
	E	18	0.9	A				48	0.3	A			
	S	1023	0.2	A				1226	0.0	A			
	W												
Anzac Parade / Bowral St / Duke St	N	855	4.9	A	2122	3.8	A	1172	5.1	A	2398	3.7	A
	E	169	0.4	A				-	-				
	S	1098	3.5	A				1226	2.4	A			
	W	-	-					-	-				
Anzac Parade / Todman Avenue	N	956	49.9	D	3064	65.8	E	1180	57.9	E	3497	77.0	F
	E	122	29.6	C				276	38.8	C			
	S	1165	64.9	E				1230	92.4	F			
	W	821	91	F				811	94.6	F			
Anzac Parade / Addison Road	N	1060	4.5	A	2562	4.6	A	1348	3.6	A	2900	4.1	A
	E	-	-					-	-				
	S	1378	5.1	A				1469	4.8	A			
	W	124	0.7	A				83	0.7	A			
Anzac Parade / Doncaster Avenue	N	104	26.2	B	2954	14.1	B	165	28.0	C	3520	15.3	B
	E	1311	16.1	B				1484	16.8	B			
	S	328	39.37	C				383	45.6	D			
	W	1211	4	A				1488	4.5	A			
Anzac Parade / Barker Street	N	594	25.6	B	2514	38.2	C	848	23.0	B	3086	47.2	D
	E	102	56	E				89	173.7	F			
	S	1291	25.6	B				1610	30.3	C			
	W	527	79.6	F				539	115.0	F			
Anzac Parade / Middle St	N	577	2.6	A	2497	22.0	B	798	2.7	A	3003	24.9	B
	E	187	37.3	C				348	74.8	F			
	S	1205	4.2	A				1324	3.3	A			
	W	528	78.2	F				533	79.4	F			
Anzac Parade / Meeks St	N	666	7.5	A	2413	24.5	B	749	10.2	A	2538	28.5	C
	E	171	29.4	C				-	-				
	S	1167	14	B				1359	13.1	A			
	W	409	80.1	F				430	109.1	F			
Anzac Parade / Gardeners Road	N	862	9.358399	A	2857	15.2	B	1164	6.9	A	3572	14.2	B
	E	182	27.8111	B				307	24.7	B			
	S	1447	13.3	A				1697	14.0	B			
	W	366	29.82721	C				404	28.4	C			

A2 PM Peak Base and Project Performance Comparison by Approach

Intersection Performance Comparison: PM													
Intersection	2021 Base							2021 Project					
	Approach	Volume	Delay Time	Los	∑ Volume	Delay Time	LoS	Volume	Delay Time	Los	∑ Volume	Delay Time	LoS
Anzac Parade / Boronia St	N	1269	0.8	A	2309	0.9	A	1727	1.2	A	3007	1.2	A
	SE	771	0.2	A				943	0.3	A			
	S	269	3.1	A				337	3.7	A			
	W	-	-					-	-				
Anzac Parade / Goodwood St	N	1079	1.2	A	1904	0.7	A	1446	1.3	A	2449	0.8	A
	E	54	1.1	A				60	3.2	A			
	S	771	0	A				943	0	A			
	W												
Anzac Parade / Ascot St	N	995	0.2	A	1766	0.2	A	1222	0.3	A	2190	0.3	A
	E	0	0	A				25	0.1	A			
	S	771	0.2	A				943	0.2	A			
	W												
Anzac Parade / Bowral St / Duke St	N	950	5.4	A	1962	4.0	A	1176	5.7	A	2119	4.2	A
	E	127	0.2	A				-	-				
	S	885	3	A				943	2.4	A			
	W	-	-					-	-				
Anzac Parade / Todman Avenue	N	1003	41.7	C	2024	45.5	D	1116	46.8	D	2380	47.4	D
	E	167	32.6	C				291	39	C			
	S	854	49.5	D				973	50.9	D			
	W	809	48.6	D				777	47.2	D			
Anzac Parade / Addison Road	N	1148	3.9	A	2558	5.0	A	1360	3.37	A	2768	4.5	A
	E	-	-					-	-				
	S	1410	6	A				1408	5.8	A			
	W	49	0.4	A				71	0.7	A			
Anzac Parade / Doncaster Avenue	N	210	31.2	C	1834	14.1	B	381	34.1	C	2093	15.4	B
	SE	1451	16.8	B				1438	17.4	B			
	S	173	37.08	C				274	30.16	C			
	NW	1249	5	A				1478	5.8	A			
Anzac Parade / Barker Street	N	894	27.2	B	2160	30.7	C	1123	27.5	B	2420	32.4	C
	E	261	46.6	D				268	78.4	F			
	S	1005	21.2	B				1029	22	B			
	W	536	46.8	D				588	39.1	C			
Anzac Parade / Middle St	N	874	3	A	2016	16.9	B	1012	2.7	A	2339	20.5	B
	E	387	31.8	C				493	63.7	E			
	S	755	3.1	A				834	2.3	A			
	W	494	50.9	D				458	46.7	D			
Anzac Parade / Meeks St	N	952	11.5	A	1990	25.7	B	950	13	A	1848	20.5	B
	E	246	29.3	C				-	-				
	S	792	12.1	A				898	11.1	A			
	W	515	71.3	F				499	51.8	D			
Anzac Parade / Gardeners Road	N	1068	9.441086	A	2362	15.3	B	1421	7.278213	A	3071	14.2	B
	E	305	31.72967	C				513	29.23345	C			
	S	989	12	A				1137	11.6	A			
	W	324	28.9638	C				351	28.28632	C			

Appendix B

Modelling results for further road upgrades

B1 AM Peak Project and Further Upgrades Performance Comparison by Approach

Intersection Performance Comparison: AM													
Intersection	Approach	2021 Project						2021 Project + Further Upgrades					
		Volume	Delay Time	Los	∑ Volume	Delay Time	LoS	Volume	Delay Time	Los	∑ Volume	Delay Time	LoS
Anzac Parade / Todman Avenue	N	1180	57.9	E	3497	77.0	F	1195	58.8	E	3612	67.3	E
	E	276	38.8	C				261	37.5	C			
	S	1230	92.4	F				1151	73.3	F			
	W	811	94.6	F				1005	78.2	F			
Anzac Parade / Barker Street	N	848	23.0	B	3086	47.2	D	849	23.0	B	3085	45.9	D
	E	89	173.7	F				247	104.5	F			
	S	1610	30.3	C				1477	29.2	C			
	W	539	115.0	F				512	103.8	F			
Anzac Parade / Middle St	N	798	2.7	A	3003	24.9	B	776	2.4	A	2900	23.3	B
	E	348	74.8	F				255	50.9	D			
	S	1324	3.3	A				1316	3.7	A			
	W	533	79.4	F				553	86.6	F			

B2 PM Peak Project and Further Upgrades Performance Comparison by Approach

Intersection Performance Comparison: PM													
Intersection	2021 Base	2021 Project						2021 Project + Council Upgrades					
	Approach	Volume	Delay Time	Los	∑ Volume	Delay Time	LoS	Volume	Delay Time	Los	∑ Volume	Delay Time	LoS
Anzac Parade / Todman Avenue	N	1116	46.8	D	2380	47.4	D	1155	46.8	D	2418	45.7	D
	E	291	39	C				296	38.9	C			
	S	973	50.9	D				967	49	D			
	W	777	47.2	D				882	43.1	D			
Anzac Parade / Barker Street	N	1123	27.5	B	2420	32.4	C	1148	27.7	B	2650	30.4	C
	E	268	78.4	F				435	44.4	D			
	S	1029	22	B				1067	21.4	B			
	W	588	39.1	C				497	44	D			
Anzac Parade / Middle St	N	1012	2.7	A	2339	20.5	B	1011	2.7	A	2263	17.4	B
	E	493	63.7	E				405	51.5	D			
	S	834	2.3	A				847	2.4	A			
	W	458	46.7	D				532	43.1	D			