Final Report

Canberra Brickworks and Environs Options & Evaluation Report Update

17 December 2013 3002363.103

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PREPARATION, REVIEW AND AUTHORISATION

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Canberra Brickworks & Environs Options & Evaluation Report Update

For: Land Development Agency

DECEMBER 17, 2013

EXECUTIVE SUMMARY

ES.1 Introduction

This report details the intersection and local level network impacts, other transport modes and civil engineering issues of and for the proposed development of the Canberra Brickworks and Environs in Yarralumla, ACT. The development involves modifications to the existing road network. The road network includes Adelaide Avenue/Yarra Glen, Cotter Road, Denman Street, Dudley Street, Kintore Crescent, Kent Street and Novar Street. Land use increases expected in the development are an additional population of 2,591, 13,092 m² GFA of additional commercial floor space, contributing 622 new jobs and 500 m² GFA of retail floor space.

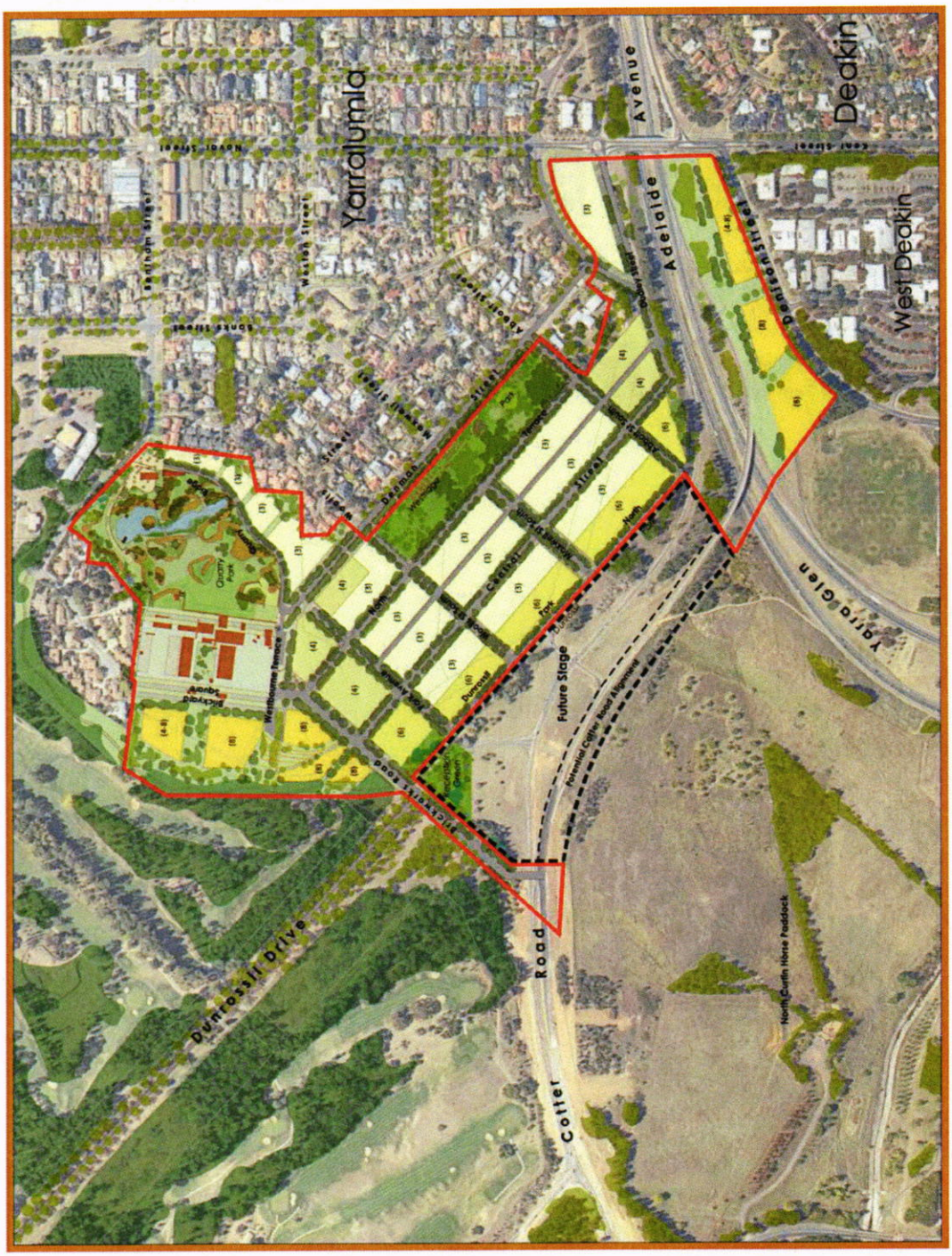

Figure ES.1: CB+E Master Plan Road Network Layout

ES.2 Strategic Transport Modelling Analysis

Strategic transport modelling was conducted for the AM peak period using SMEC's strategic transport model of Canberra, maintained in EMME 4. The strategic transport modelling identified increases in traffic on Cotter Road and Yarra Glen due to land use growth and improvements in network capacity. In particular, the increased traffic on Cotter Road poses issues for the CB+E development, as in the 2031 AM peak period the demand for the eastbound movement from Cotter Road to Adelaide Avenue exceeds the capacity of the on-ramp between these two roads. As a result, a large proportion of this eastbound movement is forced on to Dudley Street. With the CB+E development in place, Dudley Street is removed and this additional traffic is shifted on to Brickworks Road, Central Street and North Terrace, through the development itself, as shown in Figure ES.3.

Three scenarios have been assessed:

- *2011 AM Existing* represents the road network in 2011.
- *2031 AM Do Nothing* represents the 2031 road network, with expected land use and road network developments, but without the CB+E Master Plan
- *2031 AM Master Plan* represents the 2031 road network, with expected land use and road network developments, and the CB+E Master Plan

These results are discussed in detail in Section 3.1 while a summary of the outputs is shown in Table ES.1, for the locations shown in Figure ES.2.

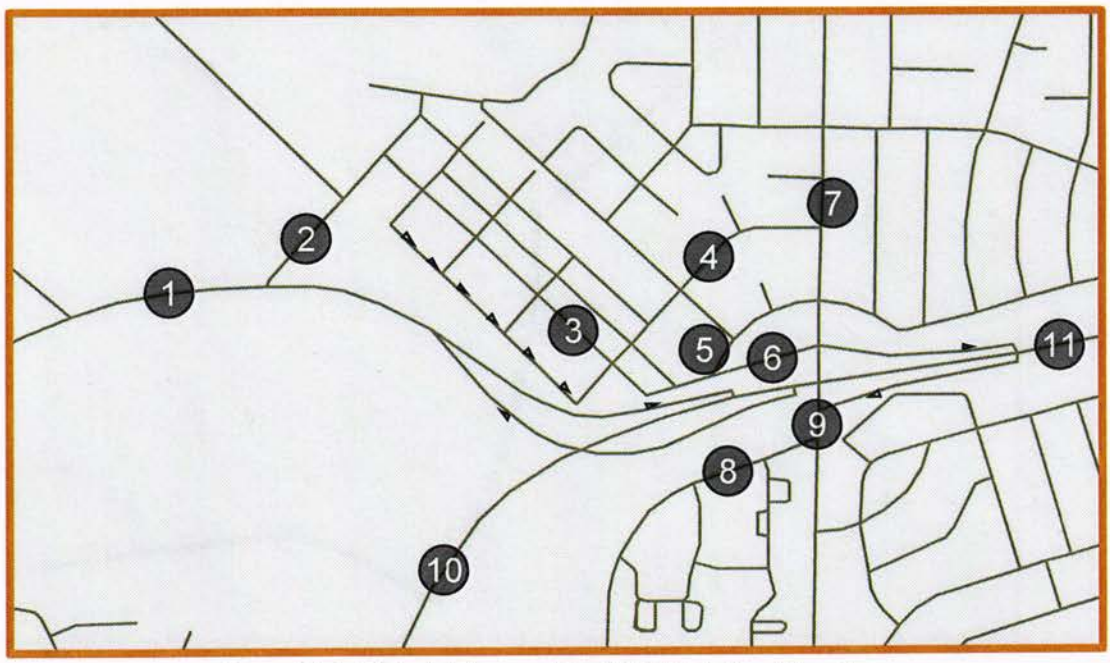

Figure ES.2: Strategic Transport Model Midblock Count Locations

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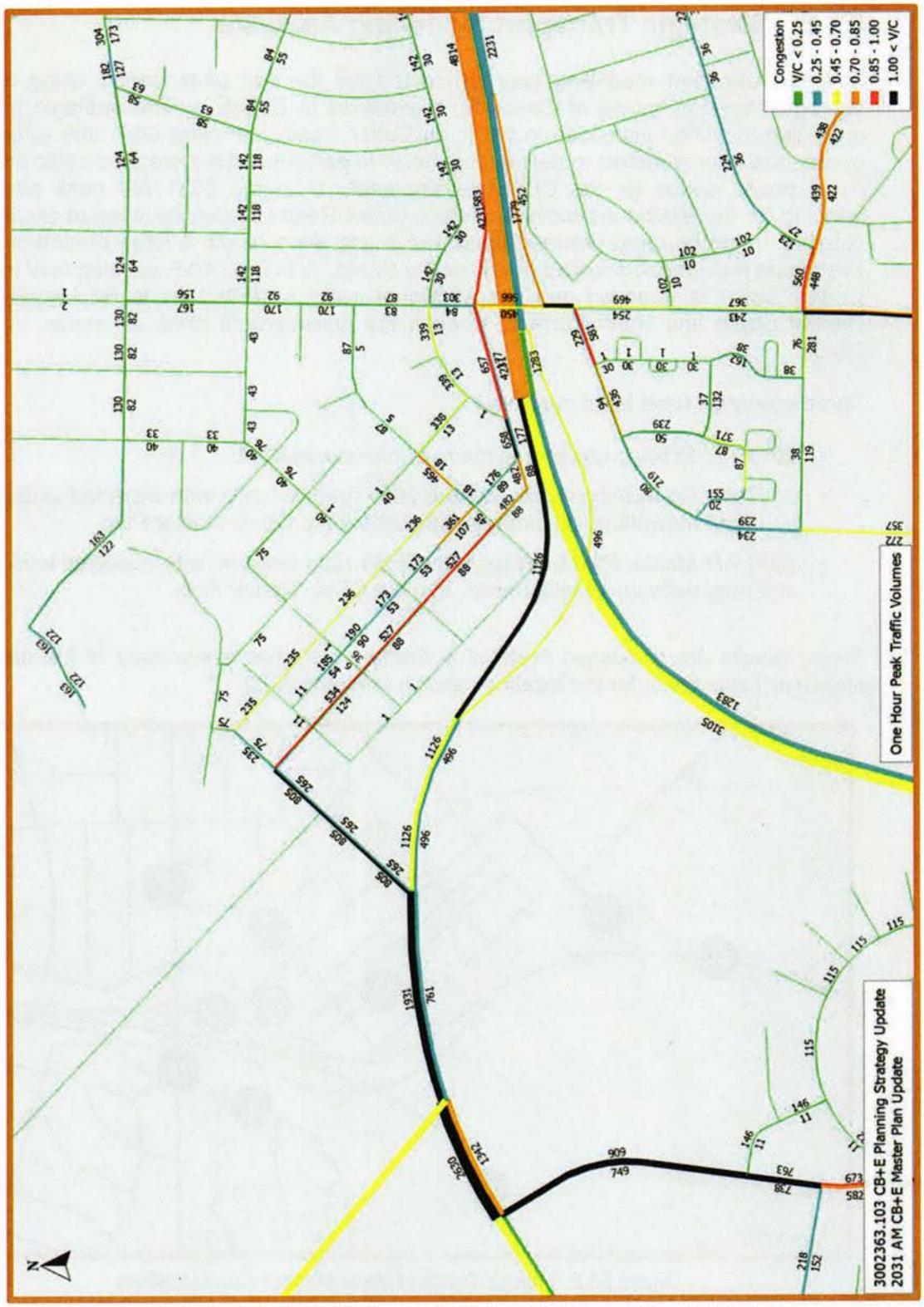

Figure ES.3: 2031 AM Master Plan Strategic Transport Model Output

Table ES.1: 2031 AM Strategic Transport Model Midblock Counts

Location	Road	2011 AM Existing	2031 AM Do Nothing	2031 AM Master Plan
1	Cotter Road (EB/WB)	1,100/440	1,910/710	1,940/760
2	Brickworks Road (NB/SB)	N/A	N/A	810/270
3	Central Street (EB/WB)	N/A	N/A	530/90
4	Abbott Street (NB/SB)	0/0*	0/0*	90/0
5	Kintore Crescent (EB/WB)	0/0*	0/0*	340/10
6	Dudley Street (EB/WB)	270/130	820/210	660/180
7	Novar Street (NB/SB)	190/170	190/150	170/90
8	Denison Street (EB/WB)	80/380	100/460	230/580
9	Kent Street (NB/SB)	380/680	410/860	400/970
10	Yarra Glen (NB/SB)	3,240/1,130	3,180/1,310	3,140/1,310
11	Adelaide Avenue (EB/WB)	4,290/1,840	4,830/2,220	4,860/2,260

Note: Traffic counts are rounded to the nearest 10 vehicles.
* This part of Yarralumla does not receive any traffic without the CB+E development due to the placement of the TAZ connectors.

A breakdown of the traffic using Dudley Street in the *Existing* and *Do Nothing* scenarios, or Brickworks Road in the *Master Plan* scenario, is shown in Table ES.2. The results indicate that there is a large increase in eastbound traffic "rat-running" through the study area to access Adelaide Avenue. This rat-running is due to congestion on the Cotter Road – Adelaide Avenue onramp, and could be alleviated by improvements to the onramp. In addition, a fair proportion of the traffic is generated by Deakin and Yarralumla, for which the only nearby alternative routes are via Carruthers Street or Hopetoun Circuit, both of which would mean a greatly increased travel distance.

Table ES.2: Destinations for Dudley Street/Brickworks Road Traffic (Hourly Trips)

Scenario	Direction	Total	Deakin (Existing)		Yarralumla (Existing)		CB+E Development*		Adelaide Avenue	
2011 AM Existing	To (Eastbound)	274	175	64%	99	36%	0	0%	0	0%
	From (Westbound)	133	71	53%	62	47%	0	0%	0	0%
2031 AM Do Nothing	To (Eastbound)	771	323	42%	106	14%	0	0%	342	44%
	From (Westbound)	238	173	73%	65	27%	0	0%	0	0%
2031 AM Master Plan	To (Eastbound)	801	305	38%	148	18%	101	13%	247	31%
	From (Westbound)	265	70	26%	74	28%	121	46%	0	0%

* Includes additional development in both Yarralumla and West Deakin

ES.3 Micro-simulation Modelling Analysis

Micro-simulation modelling was conducted for the 2031 weekday AM peak period to test localised traffic impacts. The modelling results suggest that traffic that uses Dudley Street in *Do Nothing* and is forced on to Brickworks Road/Central Street in *Master Plan* will experience a substantial increase in delay, while other traffic will be largely unaffected. These results are given in Table ES.3 for the routes shown in Figure ES.4, and discussed in detail in Section 3.2.

Table ES.3: Route Performance Differences Between 2031 AM Do Nothing and 2031 AM Master Plan

ID	Route	Direction	Length	Average Speed	Travel Time
1	Denison Street - Adelaide Avenue	Eastbound	0 m	-7.2 km/h	+0:15
		Westbound	0 m	-9.0 km/h	+0:15
2a	Cotter Road - Adelaide Avenue via Cotter Road	Eastbound	0 m	+0.2 km/h	-0:05
		Westbound	0 m	-9.0 km/h	+0:10
2b	Cotter Road - Adelaide Avenue via Dudley Street	Eastbound	+260 m	-3.4 km/h	+3:10
		Westbound	+210 m	-18.8 km/h	+1:45
3	Denison Street - Cotter Road	Eastbound	+250 m	-3.8 km/h	+3:15
		Westbound	+210 m	-16.9 km/h	+1:40
4	Yarra Glen - Adelaide Avenue	Eastbound	0 m	+3.1 km/h	-0:35
		Westbound	0 m	-1.0 km/h	0:00

Figure ES.4: Paramics Performance Testing Routes (Master Plan)

ES.4 Intersection Analysis

Intersection analysis was conducted with SIDRA Intersection to test the impacts of the network changes, and proposed intersection treatments for mitigation of those impacts. Alternative configurations were tested for some intersections where their future performance was unacceptable. It was established that three of the existing intersections; Novar Street – Dudley Street, Kent Street – Denison Street, and Kent Street – Adelaide Avenue off-ramp; should be converted to signal control to maintain acceptable performance in 2031. The details of these results are discussed in Section 3.3. A summary of the intersection analysis is given in Table ES.4.

The three intersections along Kent and Novar Streets have been assessed in isolation. The signalisation of these three intersections does however present opportunities for signal coordination, which would result in improved performance.

Table ES.4: Intersection Analysis Results Summary

Intersection	Analysis Notes
Cotter Road – Lady Denman Drive	This intersection is currently being upgraded, so the previous roundabout layout no longer applies in the future and has only been analysed for the *Existing* scenario. In both 2031 AM scenarios the intersection is signalised. Despite the total volume almost doubling between 2010 AM and 2031 AM, the upgrade maintains performance at LoS D in all scenarios.
Cotter Road – Dudley Street	This intersection will be removed for the construction of the CB+E development and is therefore only present in *Existing* and *Do Nothing*. Its performance is good in 2010 AM, being LoS A, however the increased volume in 2031 AM causes it to come under considerable stress. An investigation of the intersection modelling outputs indicates that the cause of the stress is the short distance (<100 m) to the downstream merge on the eastbound carriageway, which results in LoS F for the through movement. This can be greatly improved by increasing the distance between the intersection and this downstream merge.
Cotter Road – Brickworks Road	This intersection is part of the CB+E development and therefore is only present in the *Master Plan* scenario. The proposed configuration offers good performance, at LoS C. Due to the high demand for the movement, the length of the left turn from Cotter Road eastbound is critical. The intersection modelling analysis indicates that the left turn lane should be at least 200 m long.
Novar Street – Dudley Street/Adelaide Avenue on-ramp	This intersection operates well in *Existing*, at LoS B. In 2031 AM, the traffic rat-running along Dudley Street causes the performance to deteriorate to LoS F in both *Do Nothing* and *Master Plan*. A signalised option was tested that would improve the performance in 2031 AM to LoS C.
Kent Street – Adelaide Avenue off-ramp	The performance of this intersection is good in *Existing* (LoS A), and decreases slightly to LoS B in *Do Nothing*, however the off-ramp operates at LoS F. In *2031 AM Master Plan* the overall performance deteriorates to LoS F. A signalised option was tested which would improve performance to LoS A in *Do Nothing* and LoS B in *Master Plan*.
Kent Street – Denison Street	This intersection performs well in both *Existing* and *Do Nothing*, however the give-way condition for Denison Street results in high delays for that approach. In *Master Plan* the overall performance deteriorates to LoS E with very high delays on Denison Street. A signalised option was tested which would improve performance to LoS A in both 2031 AM scenarios if slip lanes can be provided for left turns.

ES.5 Other Transport Modes

Chapter 4 includes an assessment of public transport, cyclist and pedestrian access to the development. The current *Strategic Public Transport Network Plan* (SPTNP) recommends a stop on Adelaide Avenue near the Kent Street overpass, which could provide bus access to the area. The development is expected to be medium-high density and mixed-use, which is favourable for increasing public transport mode share in line with the targets set out by *Transport for Canberra*. Connection of the major north-south and east-west roads within the study area to the existing trunk cycleway network will provide sufficient cyclist accessibility for the area. Recommendations for provision of pedestrian and both on-road and off-road bicycle facilities are shown below.

The bus station proposed for construction in the median of Adelaide Avenue to the east of the Cotter Road – Adelaide Avenue interchange is within 750m (required by the *Future Urban Areas Residential Subdivision Development Code 2008*) of all of the residential zones within the CB+E development and also large parts of Yarralumla and Deakin, including the Deakin employment area, as shown below.

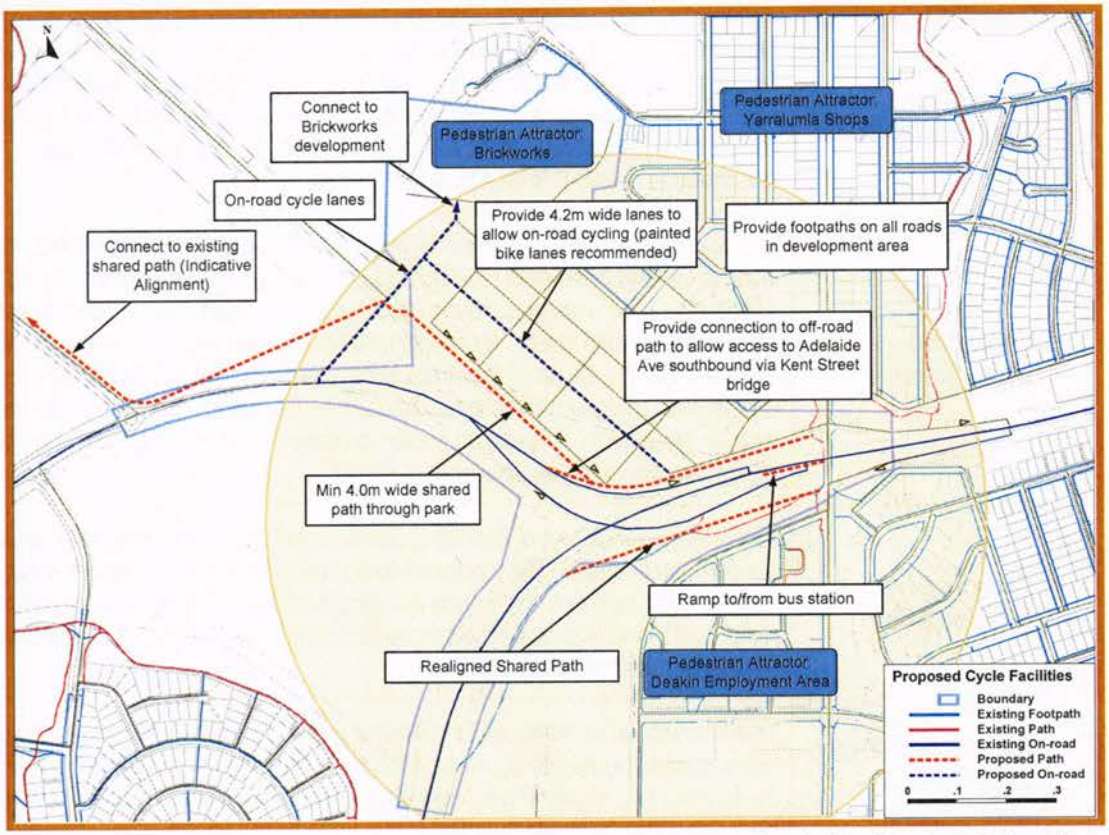

Figure ES.5: Potential Pedestrian and Cycle Facilities and Attractors (Bus Station Catchment Shown)

ES.6 Civil Engineering and Cost Estimates

An assessment of civil engineering issues is included in Chapter 5 along with indicative cost estimates for roadways including service alignment and realignment. The estimated earthworks requirements entail 25,000 m² of cut to fill for the roads, while 25,000 m² of cut to fill are required for block development. At this stage, it is estimated that at least 200,000 m³ earthworks will be necessary to allow appropriate SISD and contain stormwater to within the road system. The design calls for 4,767 m of additional roads with reserve widths between 7.5 m and 30 m. Water detention requirements for the approximately 37.5 ha catchment would be approximately 2,800 m³ for a 50 year storm, however this could be reduced by the use of water sensitive urban design (WSUD) principles. The extent of earthworks and a summary of the cost estimates for each parcel of work (excluding earthworks) are included below.

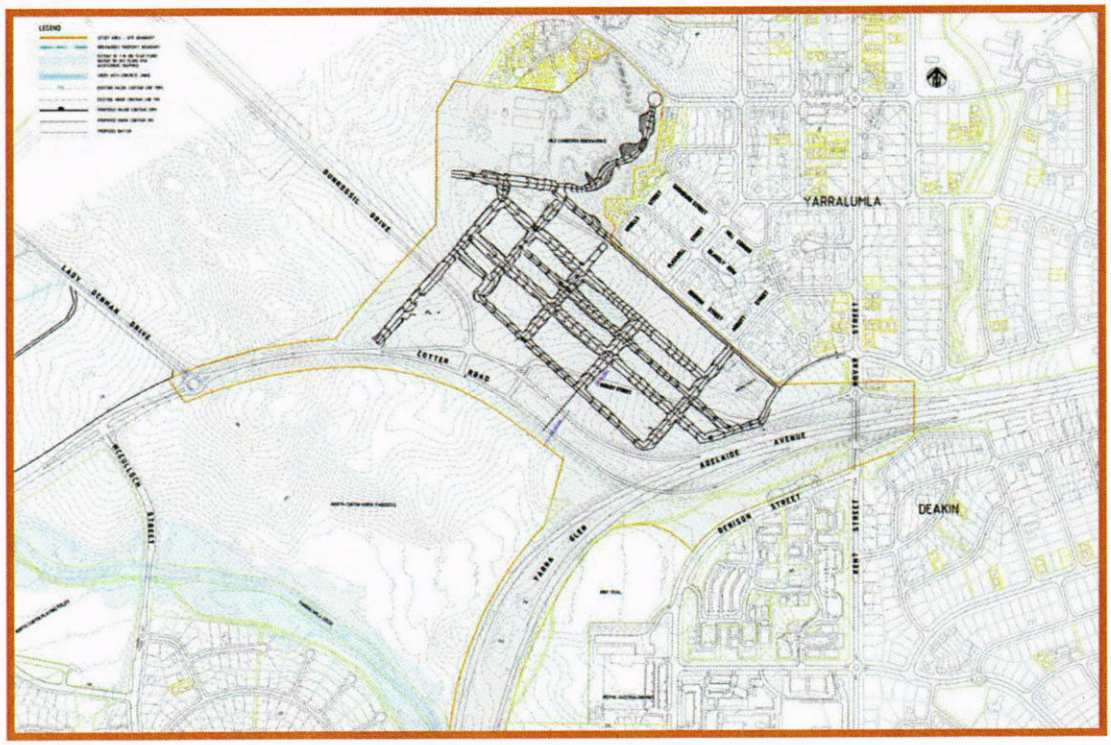

Figure ES.6: Earthworks Requirements

The preliminary construction costs are tabulated for each road type based on calculations for all salient road features resulting in overall construction cost per linear metre of each road type in the Master Plan. Table ES.5 summarises these road costs, taking into account intersection costs, kerbing, footpaths, signage, and services including electricity transmission, water distribution, gas distribution, and telecommunications. Separate items for sanitary sewerage, stormwater drainage, electrical transmission line relocation, high security fibre optic (ICON) relocation, traffic signalisation at the intersection of Cotter Road with Brickworks Road, and relocation of 525 m of 2.5 m wide Shared User Path to make way for the portion of the CB+E development in West Deakin have also been included.

These civil infrastructure costs relate only to the subject development and do not include contingency. An additional item has been included for bulk earthworks, due to site issues identified. This is estimated to be at least 200,000 m³, but requires substantial further analysis.

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Table ES.5: CB+E Master Plan Cost Estimates

Work Parcel	Cost
Road including earthworks and services/utilities (water, electricity, telecoms, gas etc.)	$7,769,437
Road Drainage	$1,760,793
Sewer	$1,923,435
Relocation of High Voltage Electricity (HV-OH) and Icon Services	$3,150,000
Bulk Earthworks (200,000 m²)	$3,560,000
Signalisation of intersection between Brickworks Road and Cotter Road	$210,000
Relocation of Shared User Path (West Deakin)	$100,000
Total Cost	**$18,473,665**

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FIGURES

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACTION	Australian Capital Territory Internal Omnibus Network
CB	Canberra Brickworks
CB+E	Canberra Brickworks and Environs
HCM	Highway Capacity Manual
LoS	Level of Service
OD	Origin-Destination
TAZ	Traffic Analysis Zone
WSUD	Water Sensitive Urban Design

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1 ROAD NETWORK LAYOUT

A single road network layout option, consistent with the urban design alternatives proposed by Hill Thalis, was used in the traffic and transport analysis. The design assumes no changes to the existing arterial road network. The Master Plan assumes partial development of the Canberra Brickworks and Environs (CB+E) area, given the retention of the existing Cotter Road and Cotter Road – Adelaide Avenue on-ramp alignments.

The current Master Plan road layout is shown in Figure 1. This has changed since the previous *CB+E Options and Evaluation Report* (SMEC 2011). A notable element of the Master Plan is the introduction of a new road at the western side of the development that intersects Cotter Road and is expected to serve as the main access road to the CB site, as well as replacing the existing functionality of Dudley Street in providing access between Cotter Road and Deakin and Yarralumla.

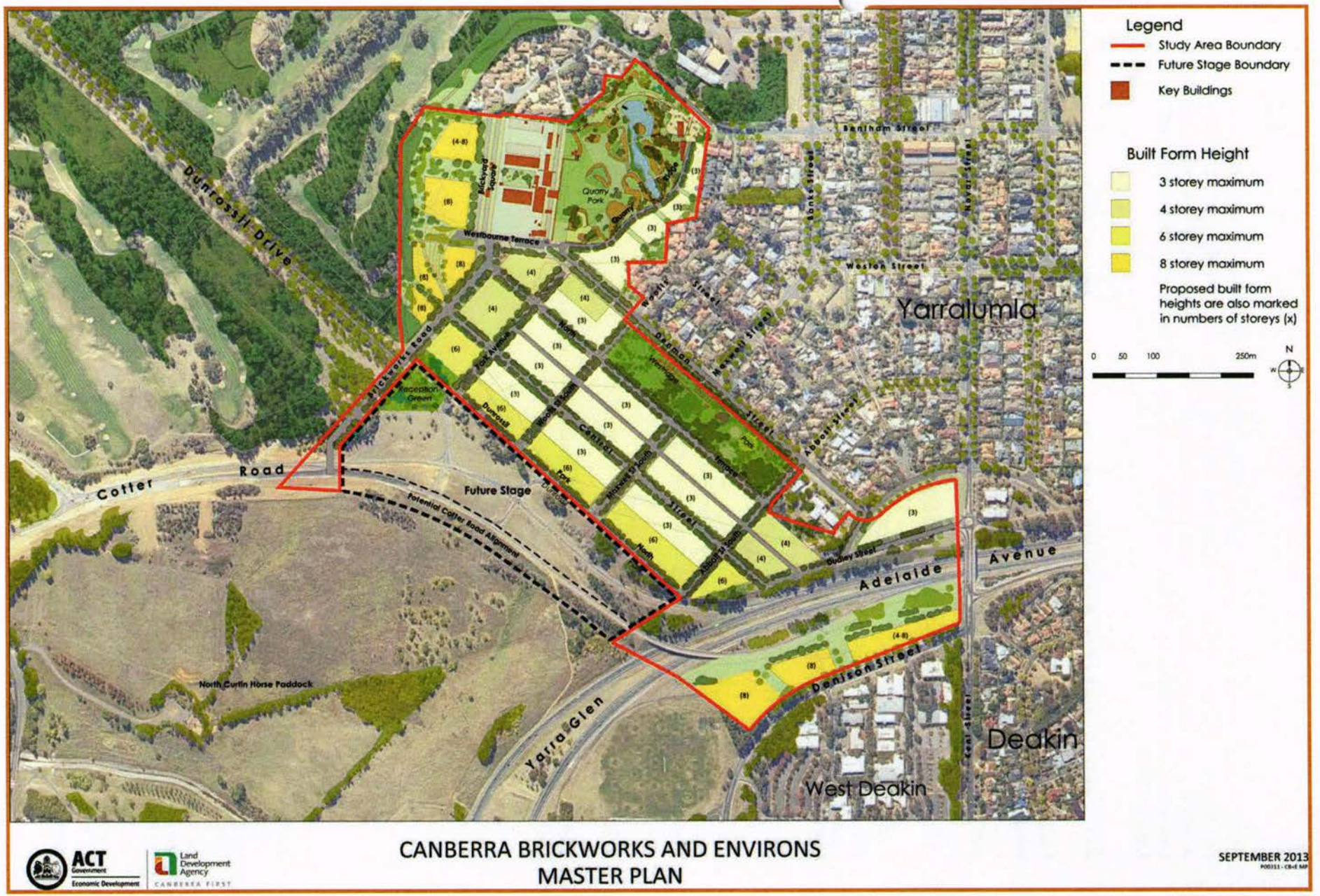

Figure 1: CB+E Master Plan Road Network Layout and Precinct Plan

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2 TRAFFIC MODELLING AND ANALYSIS

SMEC was provided with the final layout of the Master Plan design by Hill Thalis on 11 September 2013, which was used as the basis of the traffic modelling and analysis. In addition, a *Do Nothing* scenario was modelled to allow comparison and illustration of the differences in network flow and operations between the existing configuration and the Master Plan.

2.1 Existing Traffic Volumes

Manual, classified traffic counts were performed for all major intersections in the study area for the weekday AM peak period on Thursday 11 February 2010. The total count volumes are shown in Figure 2. As such, the base year micro-simulation and intersection models are referred to as *2010 AM Existing*.

2.2 Strategic Transport Modelling

Strategic transport modelling was initially undertaken to provide preliminary indications of the network flow changes that can be expected in each future scenario. The long term planning horizon (2031) was used to assess the network's operational performance under the heaviest demand forecast available.

SMEC's EMME strategic transport model of the ACT was used to estimate traffic projections along the links within the designated study area. The model includes all planned land use changes and road infrastructure upgrades that are expected to be in place by 2031, based on information obtained from ESDD. The base year in the strategic transport model is 2011, so the base year strategic transport models and results are referred to as *2011 AM Existing*.

2.2.1 Land Use Inputs

The strategic transport model is divided into traffic analysis zones (TAZs), which contain the following land use information:

- Population
- Employment
- Retail Space
- School Enrolment
- Tertiary Enrolment

Updated ACT land use projections for 2031 were provided by ESDD on 4 March 2013. An illustration of the TAZs within and around the study area is shown in Figure 3, while Table 1 details the corresponding land use data for TAZs surrounding the study area. The table also includes the estimated additions to the land use figures due to the CB+E development under the Master Plan designed by Hill Thalis. The population figure is based on the dwelling yield suggested by Hill Thalis (1,579) and dwelling size distribution, and the average occupancy for equivalent medium-high density dwelling types in Curtin, Deakin and Yarralumla of 1.64/dwelling, derived from the ABS *2011 Census of Population and Housing*. The employment figure is based on the commercial floor space yield suggested by Hill Thalis (13,092 m² GFA) and the average employment density of 0.0475/m², given in the RTA *Guide to Traffic Generating Developments* for commercial floor space. The total retail floor space was specified by LDA.

Figure 2: Manual Traffic Count Movement Totals (2010)

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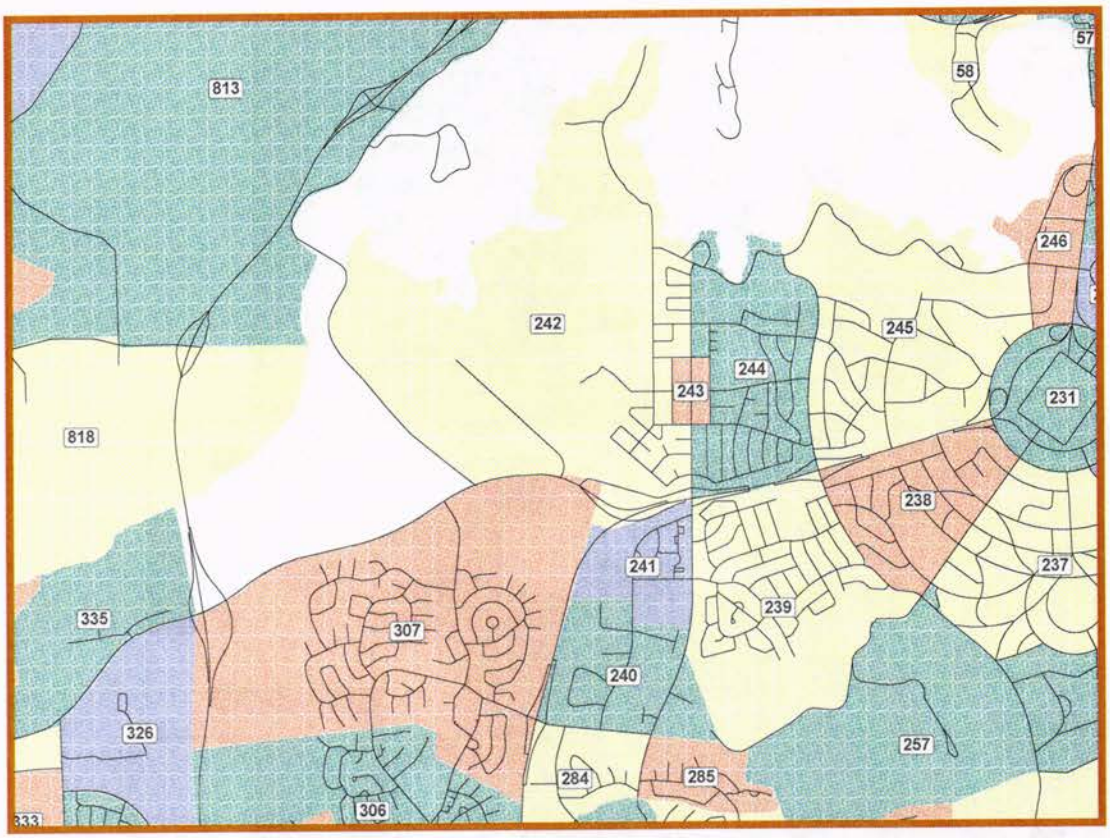

Figure 3: Traffic Analysis Zone (TAZ) Layout in the Study Area

Table 1: Land Use Information for TAZs Within and Around the Study Area (2031)

Zone	Description	Population	Employment	Retail Space [m² GFA]	School Enrolments	Tertiary Enrolments
239	Deakin (Shops & Stonehaven Cr)	1,900	550	12,500	0	0
240	Deakin West (south of Strickland Cr)	0	2,600	4,500	200	0
241	Deakin West (north of Strickland Cr)	100	1,600	0	785	0
242	Yarralumla	635	270	0	0	0
243	Yarralumla	559	355	5,212	0	0
244	Yarralumla	915	200	0	250	0
307	Curtin (north)	3,860	730	13,841	270	0
Canberra Brickworks Development						
CB+E	Master Plan	2,591	622	500	0	0

2.3 Micro-Simulation Modelling

Traffic micro-simulation was conducted to evaluate finer operational parameters that cannot be determined to a reasonable level of detail using a strategic transport model. Micro-simulation allows the investigation and assessment of traffic impacts caused by potential land use changes in a given study area. Outputs produced by strategic transport modelling packages are macroscopic and are generally not considered to provide sufficient microscopic detail for analysing operational issues like vehicle queues, weaving sections and intersection performance. For instance, a micro-simulation model simulates the interaction and conflict between the vehicles in the network and the network itself, while a strategic transport model is based on empirical formulae linking travel cost to volume and capacity.

Detailed information on the impacts of small changes in the network can also be obtained by micro-simulation, providing analysts and decision-makers with insight in to the effectiveness of proposed intervention measures and network system improvements. It is thus a useful tool for comparing traffic operations between design alternatives that do not have large-scale differences.

The Paramics networks models are shown in Figure 4 for *2010 AM Existing* and *2031 AM Do Nothing*, and Figure 5 for *2031 AM Master Plan*.

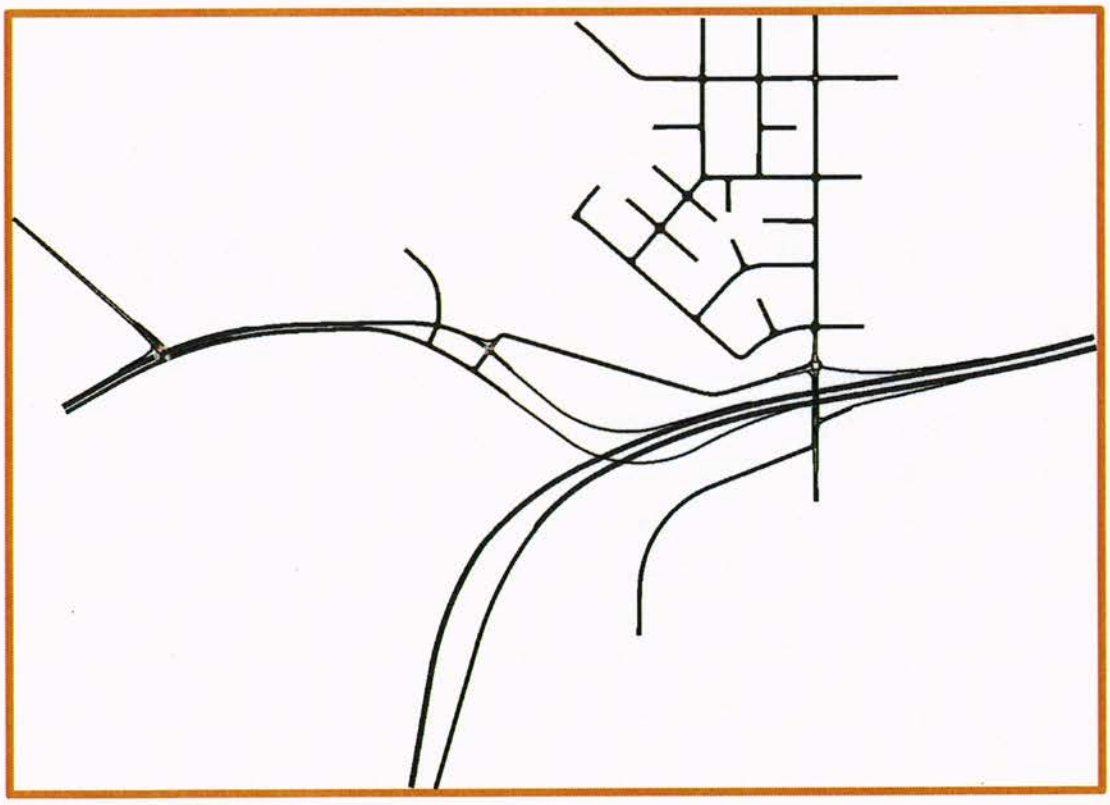

Figure 4: 2010 AM Existing/2031 AM Do Nothing Paramics Model

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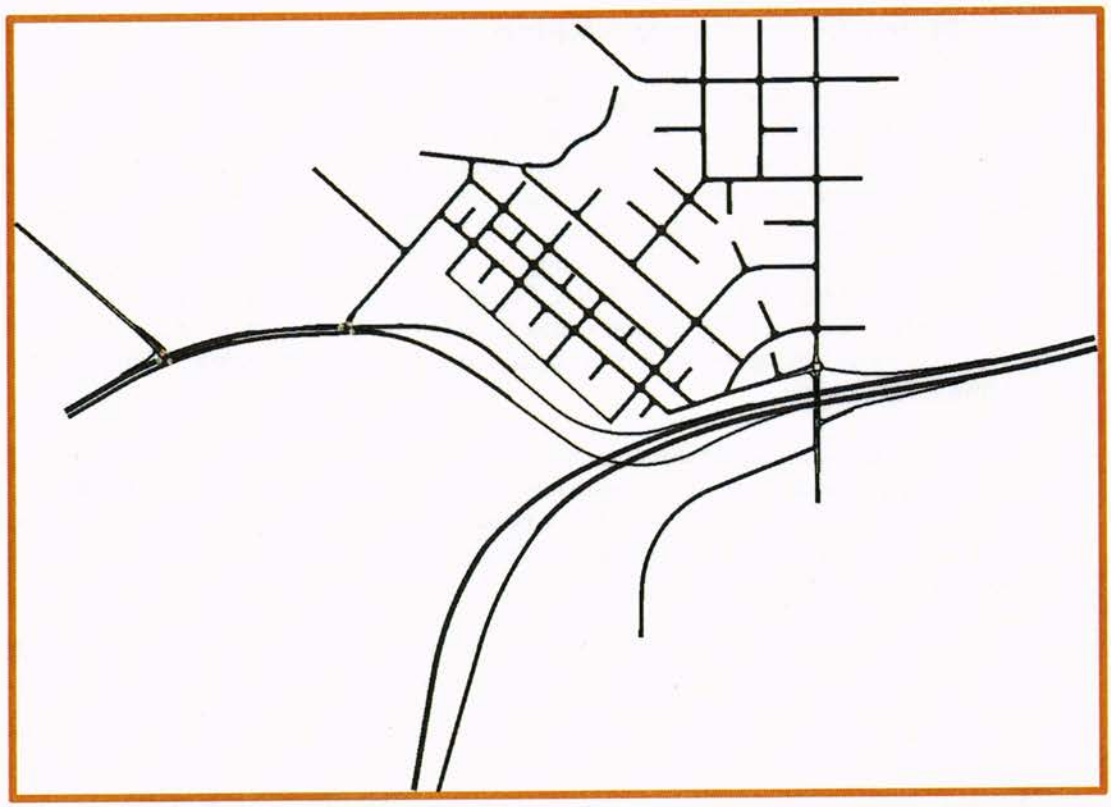

Figure 5: 2031 AM Master Plan Paramics Model

2.3.1 Input Data

The model was estimated using the manual intersection turning movement counts and midblock counts collected on Thursday 11 February 2010 for the following intersections, also shown in Figure 6:

1. Cotter Road – Lady Denman Drive
2. Cotter Road – Dunrossil Drive
3. Cotter Road – Dudley Street
4. Dudley Street – Novar Street
5. Kent Street – Adelaide Avenue off-ramp
6. Kent Street – Denison Street
7. Adelaide Avenue at Kent Street bridge
8. Yarra Glen west of Cotter Road ramps

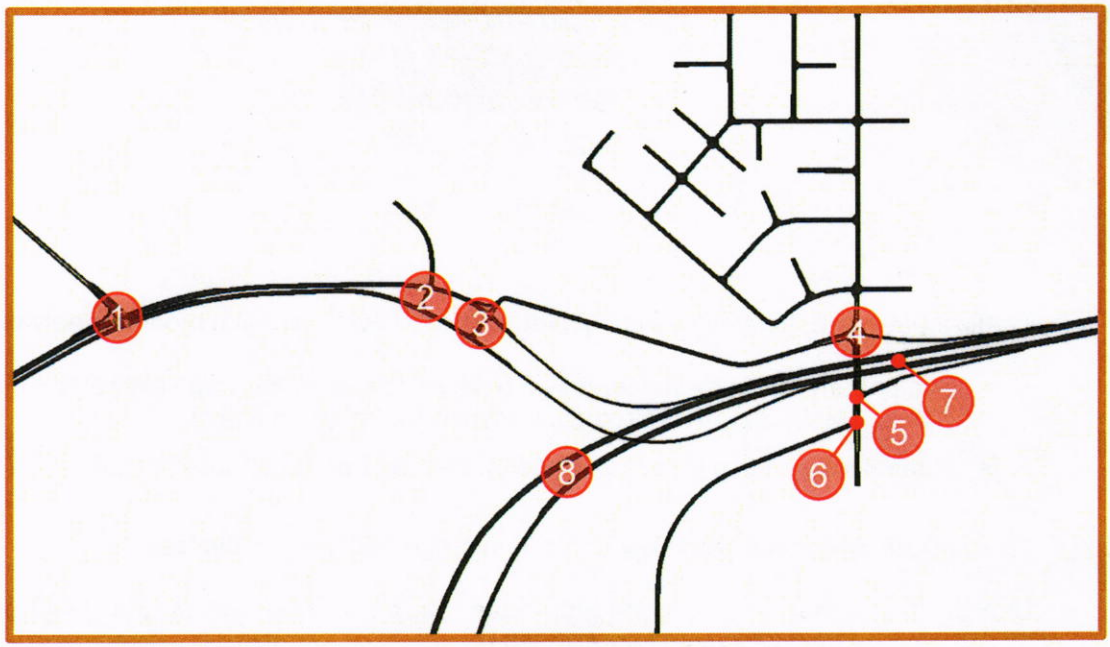

Figure 6: Intersection and Midblock Count Locations for Estimation

2.3.2 OD Matrix Estimation and Calibration

Micro-simulation demand estimation was performed using Paramics Estimator. This software uses an incremental method to attempt to generate an Origin-Destination (OD) matrix that matches the provided turn, midblock and cordon count data. It runs a simulation of the model and records the traffic at each location for which traffic count data has been provided, comparing the simulated volumes to the provided real world counts to determine their accuracy. As it knows the origin and destination of each vehicle recorded at a count location, it can make incremental change to the contents of the OD matrix and repeat the process, eventually converging on a minimised average GEH statistic for all of the input data, in this case turning movement counts.

The GEH statistic, which is simply named after the transport planner who devised it (Geoffrey E. Havers), is an empirical formula that was adopted by the UK Highway Agency for use as an acceptance criterion for comparison and evaluation of modelled traffic volumes against real-world traffic counts. It is used as a reference to measure the general accuracy of a transport model according to the following equation:

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

Where:

- M is the traffic volume estimated by the model; and
- C is the observed real-world traffic count.

The ideal GEH-based calibration criteria for micro-simulation modelling according to the UK Highways Agency Design Manual for Roads and Bridges are shown in Table 2.

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Table 2: Ideal GEH Calibration Thresholds

GEH Value	Proportion
GEH < 5	≥85%
GEH < 10	100%

Traffic input into Estimator was comprised of the following for each modelled network:

- The pattern matrix for the 2010 AM peak period estimation was extracted from the SMEC EMME 2011 AM strategic transport model of Canberra.
- Manual intersection counts were conducted by Counters Plus Pty. Ltd.

The estimation was run iteratively until the average GEH was minimised.

Due to the absence of meaningful route choice in the model the All-Or-Nothing assignment method was used for estimation.

The resulting average GEH statistic achieved at the end of the demand estimation process was 0.47 for the 2010 AM peak period. The GEH values from the calibration of the base network model are given in Table 3.

Table 3: GEH Statistics of the Base Micro-Simulation Model Calibration

GEH Value	Proportion
GEH < 5	100%
GEH < 10	100%

2.3.3 Future Demand

2031 AM OD matrix for the *Do Nothing* and *Master Plan* scenarios was developed using the estimated 2010 AM OD matrix as a baseline, with growth rates extracted from the EMME strategic transport modelling results. The process involves a number of steps:

1. Productions and attractions (trip ends) for each zone are extracted for the study area in 2011 and 2031 using the EMME strategic transport model.
2. Growth rates from 2011 to 2031 for the trip ends at each zone of this sub-area OD matrix are calculated, and applied to the estimated 2010 AM OD matrix trip ends to derive 2031 AM trip ends.
3. The 2031 AM trip ends are balanced, so that the total productions and attractions are equal (the next step would not otherwise converge).
4. The grown trip ends are then used to estimate the future OD trip matrix using the Frater method. This is a process that alternately and iteratively scales the rows (productions) and columns (attractions) of the 2010 AM OD matrix to match the 2031 AM trip ends. This results in a 2031 AM OD matrix containing the total number of trips expected from the calculated 2031 AM trip ends, and a trip pattern resembling the estimated 2010 AM OD matrix.

2.3.4 Demand Profile

The traffic volumes from the intersection turning movement counts were provided for 15 minute intervals, and the AM peak hour was identified as 08:00-09:00. The model consists of a one-hour warm-up period followed by a one-hour peak simulation period. The demand profile is shown in Table 4.

Table 4: AM Peak Traffic Demand Profile

Warm-up Period		AM Peak Period	
Period	Proportion	Period	Proportion
07:00 – 07:15	7%	08:00 – 08:15	23%
07:15 – 07:30	10%	08:15 – 08:30	26%
07:30 – 07:45	16%	08:30 – 08:45	26%
07:45 – 08:00	20%	08:45 – 09:00	25%
Total	**53%**	**Total**	**100%**

2.4 Intersection Analysis

A number of major intersections within the study area have been identified for analysis and these are the following (some of these intersections are not in all scenarios):

1. Cotter Road – Lady Denman Drive
2. Cotter Road – Dudley Street
3. Cotter Road – Brickworks Road
4. Kent Street – Denison Street
5. Kent Street – Adelaide Avenue off-ramp
6. Dudley Street – Novar Street

The intersection modelling analysis was conducted using SIDRA Intersection. Level of Service (calculated from average delay) and queue length at the specified key intersections within, and surrounding, Yarralumla and the brickworks will provide information on how the planned developments across the three planning horizons can affect the performance of major junctions.

Turning volumes for the intersection models were extracted from the Paramics micro-simulation models.

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3 TRAFFIC OPERATIONS ASSESSMENT

The modelling outputs were used in the operations assessment process, which essentially established traffic operational conditions in the future years, assuming only the planned road networks will be implemented ("base" cases). The performance measures that were evaluated are the following:

- Peak Volume
- Volume to Capacity Ratio (V/C)
- Route Travel Time
- Average Travel Speed
- Intersection Average Delay and Level of Service

The succeeding sections discuss the results obtained from the operations assessments, as well as some professional and industry standards that were used for evaluation.

3.1 Peak Volume and V/C Assessment

A selection of midblock volumes has been extracted from the strategic transport model, and listed in Table 5 for comparison. The location of each of these midblock counts is shown in Figure 7.

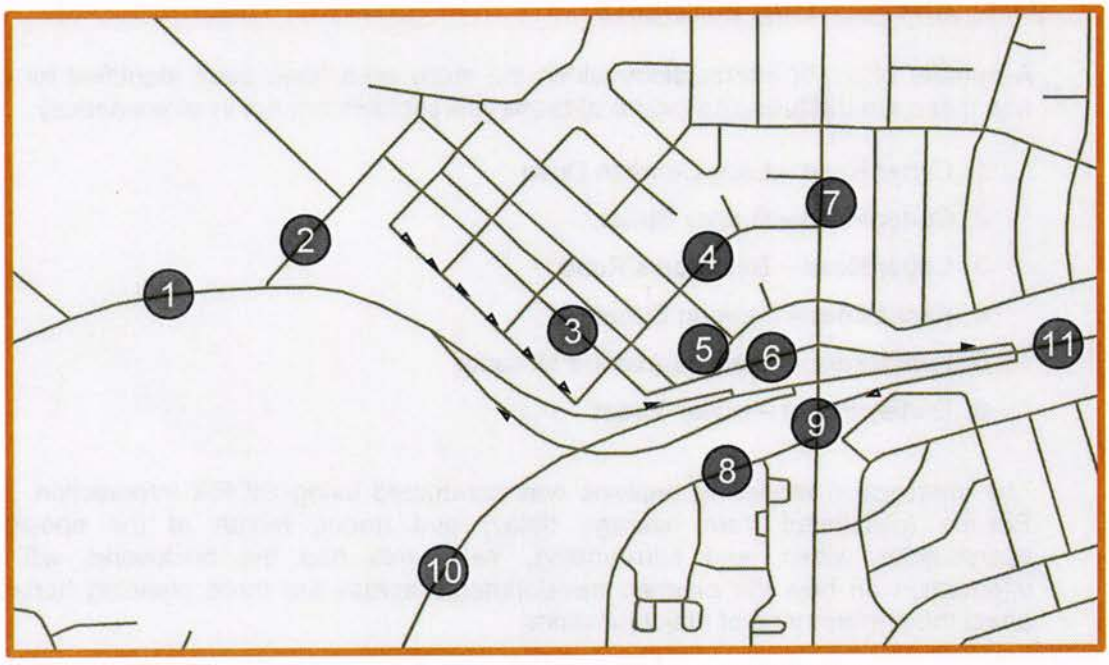

Figure 7: Strategic Transport Model Midblock Count Locations

Table 5: 2031 AM Strategic Transport Model Midblock Counts

Location	Road	2011 AM Existing	2031 AM Do Nothing	2031 AM Master Plan
1	Cotter Road (EB/WB)	1,100/440	1,910/710	1,940/760
2	Brickworks Road (NB/SB)	N/A	N/A	810/270
3	Central Street (EB/WB)	N/A	N/A	530/90
4	Abbott Street (NB/SB)	0/0*	0/0*	90/0
5	Kintore Crescent (EB/WB)	0/0*	0/0*	340/10
6	Dudley Street (EB/WB)	270/130	820/210	660/180
7	Novar Street (NB/SB)	190/170	190/150	170/90
8	Denison Street (EB/WB)	80/380	100/460	230/580
9	Kent Street (NB/SB)	380/680	410/860	400/970
10	Yarra Glen (NB/SB)	3,240/1,130	3,180/1,310	3,140/1,310
11	Adelaide Avenue (EB/WB)	4,290/1,840	4,830/2,220	4,860/2,260

Note: Traffic counts are rounded to the nearest 10 vehicles.
* This part of Yarralumla does not receive any traffic without the CB+E development due to the placement of the TAZ connectors.

The traffic demand on Cotter Road increases considerably between *Existing* and *Do Nothing* due to the complete duplication of Cotter Road to the west, which is expected to occur in the interim. In *Master Plan* there is no significant further traffic increase on Cotter Road eastbound, since its capacity is the limiting factor, and it is over capacity in all three scenarios.

On Dudley Street, the demand in *Existing* is mostly local traffic, since the Cotter Road – Adelaide Avenue on-ramp still has spare capacity. In *Do Nothing* however, the on-ramp from Cotter Road is over capacity. This, combined with the additional eastbound traffic on Cotter Road allowed by its duplication, results in a substantial proportion of the east-west traffic diverting to Dudley Street, and accessing Adelaide Avenue via the on-ramp from Novar Street. This change in traffic conditions will cause major issues for the *Master Plan*, as the traffic will already be heavy in the area even if the CB+E development does not go ahead. The peak volume on Brickworks Road in *Master Plan* (810 veh/h) does not differ significantly from the peak volume on Dudley Street in *Do Nothing* (820 veh/h) because both roads are over capacity. Kintore Crescent also picks up some overflowing traffic movements in *Master Plan* that can be considered unlikely without the CB+E development in place.

Denison Street shows a substantial traffic increase in *Master Plan* compared to *Do Nothing*, due to the additional commercial floor space and employment along its northern edge. This additional traffic also puts further stress on Kent Street, as it is already over capacity southbound in *Do Nothing*.

To elaborate on the origins or destinations of the traffic using Dudley Street (in *Existing* and *Do Nothing*) or Brickworks Road (in *Master Plan*), the volumes have been broken down proportionally as shown in Table 6. It shows clearly that 44% of the eastbound Dudley Street traffic is actually destined for Adelaide Avenue in *Do Nothing*. This through

volume decreases in *Master Plan*, most likely due to the increased distance and reduced speed of travel through the area. In addition, a fair proportion of the traffic is generated by Deakin and Yarralumla, for which the only nearby alternative routes are via Carruthers Street or Hopetoun Circuit, both of which would mean a greatly increased travel distance.

Table 6: Destinations for Dudley Street/Brickworks Road Traffic (Hourly Trips)

Scenario	Direction	Total	Deakin (Existing)		Yarralumla (Existing)		CB+E Development*		Adelaide Avenue	
2011 AM Existing	To (Eastbound)	274	175	64%	99	36%	0	0%	0	0%
	From (Westbound)	133	71	53%	62	47%	0	0%	0	0%
2031 AM Do Nothing	To (Eastbound)	771	323	42%	106	14%	0	0%	342	44%
	From (Westbound)	238	173	73%	65	27%	0	0%	0	0%
2031 AM Master Plan	To (Eastbound)	801	305	38%	148	18%	101	13%	247	31%
	From (Westbound)	265	70	26%	74	28%	121	46%	0	0%

* Includes additional development in both Yarralumla and West Deakin

The one-hour peak traffic flow diagrams from the strategic transport modelling, from which the values in Table 5 were extracted, are shown in Figure 8 for *2011 AM Existing*, Figure 9 for *2031 AM Do Nothing* and Figure 10 for *2031 AM Master Plan*. These diagrams illustrate the AM peak hour vehicle volumes (both enumerated, and as proportional link thicknesses), and the congestion level in terms of the ratio of hourly *Volume* to hourly *Capacity* (or V/C), across the entire network surrounding the CB+E development area. The congestion levels that are shown have been developed to give a general overview of the road network implications as described in Table 7.

Table 7: Strategic Transport Model Congestion Levels

Congestion Level	Range
Free Flow	V/C < 0.25
Not Congested	0.25 ≤ V/C < 0.45
Mildly Congested	0.45 ≤ V/C < 0.7
Congested	0.70 ≤ V/C < 0.85
Seriously Congested	0.85 ≤ V/C < 1
Above Capacity	V/C ≥ 1.00

The travel time on any link in the model is a function of the V/C. The volume-delay functions used in strategic transport modelling generally have the effect of doubling travel time when V/C = 1 compared to when V/C = 0, and the travel increases very steeply as V/C increases past that point. This prevents the volumes from greatly exceeding the specified capacity of a road, and results in rerouting of traffic that indicates where "rat-running" might be expected to occur.

In the 2011 AM *Existing* scenario, Cotter Road eastbound is over capacity, while the Cotter Road – Adelaide Avenue on-ramp has a small amount of spare capacity and remains the preferred route for eastbound traffic not heading for Deakin or Yarralumla.

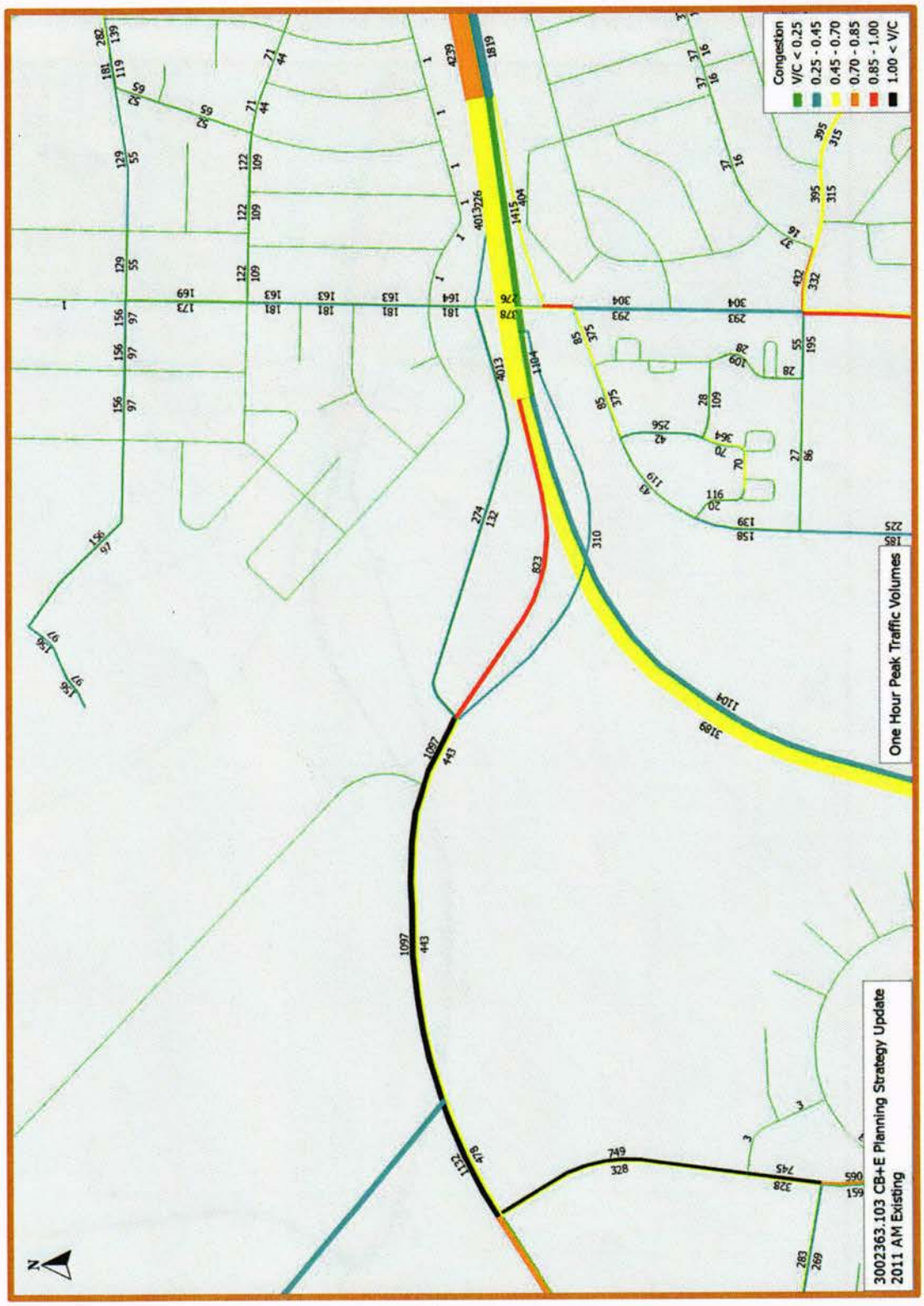

Figure 8: 2011 AM Existing Strategic Transport Model Output

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In the 2031 AM *Do Nothing* scenario, the Cotter Road – Adelaide Avenue on-ramp is over capacity in the eastbound direction, as the duplication of Cotter Road that has occurred between 2011 and 2031 doubles the potential volume entering the area. As a result of the congestion on the on-ramp, significant traffic diverts onto Dudley Street to access Adelaide Avenue via Novar Street. This causes Dudley Street to also exceed its capacity.

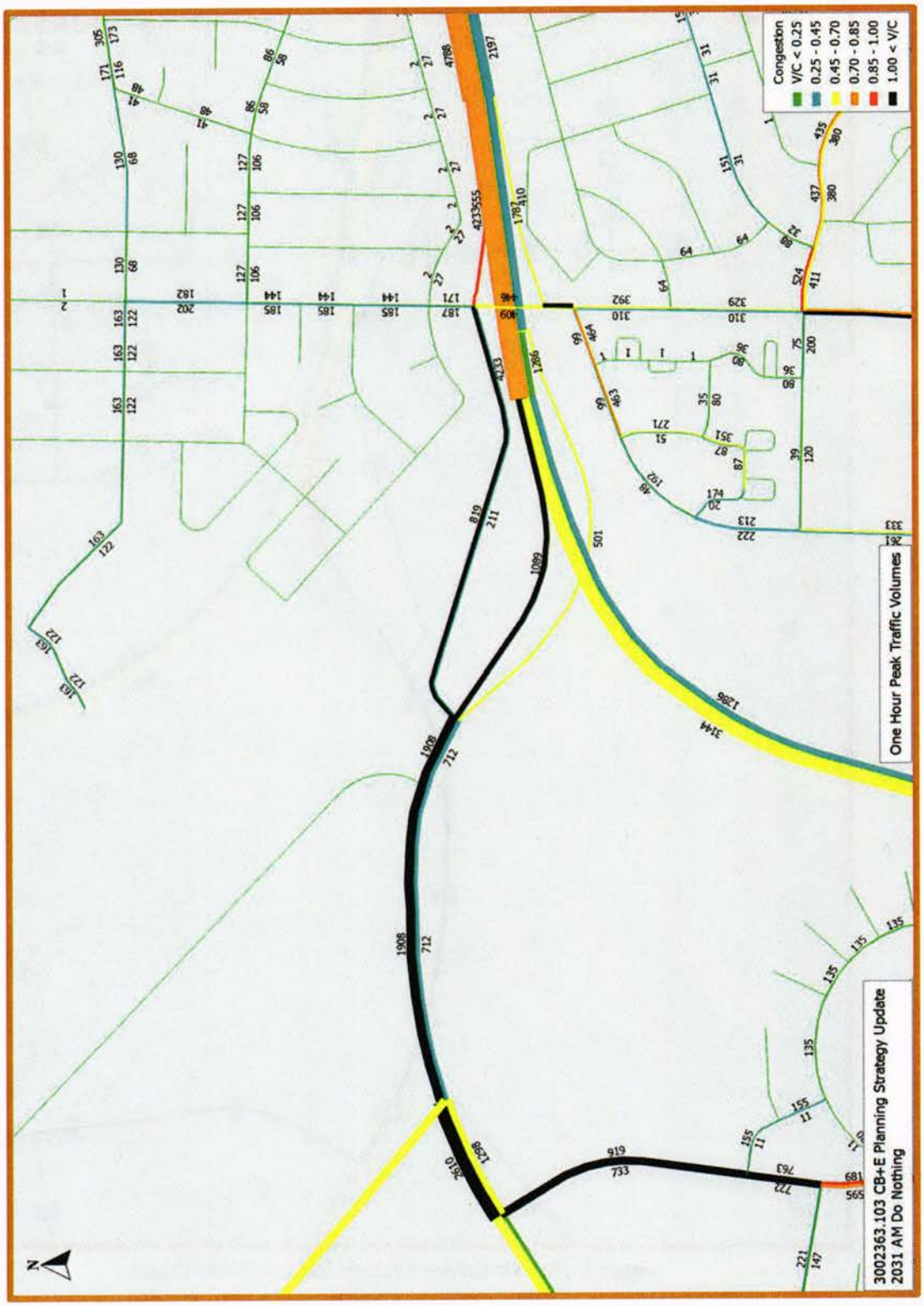

Figure 9: 2031 AM Do Nothing Strategic Transport Model Output

In the 2031 AM *Master Plan* scenario, the removal of Dudley Street and the congestion on the Cotter Road – Adelaide Avenue on-ramp causes a substantial amount of traffic to "rat-run" through the CB+E development. Brickworks Road is over capacity, and Central Street is near capacity, causing some eastbound traffic to use North Terrace and existing roads, such as Dudley Street and Kintore Crescent, to access Novar Street and Adelaide Avenue.

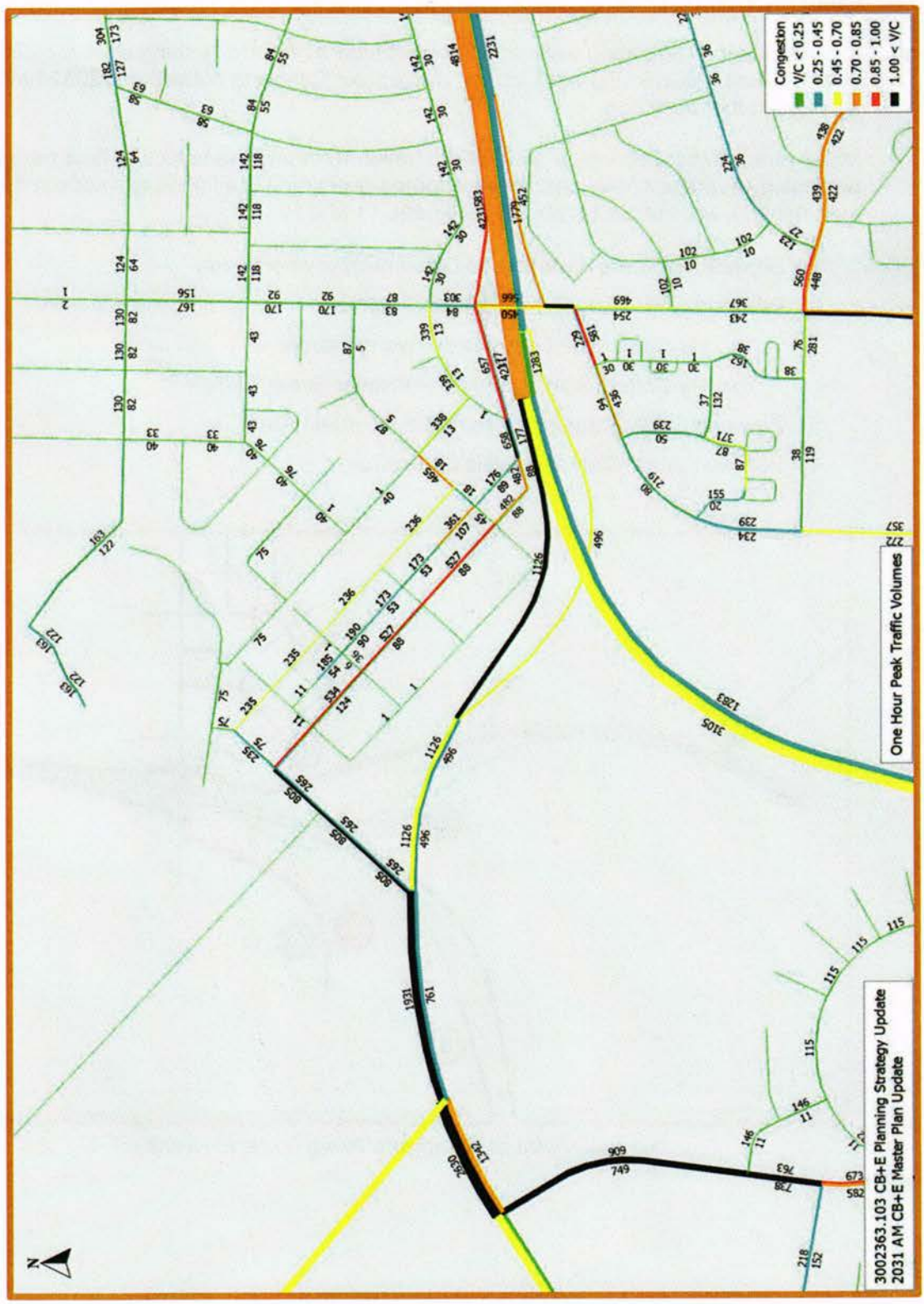

Figure 10: 2031 AM Master Plan Strategic Transport Model Output

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3.2 Route Travel Time and Average Travel Speed

The Paramics Do Nothing models were used in the analysis of route travel times and average speeds, as these typically provide a more accurate depiction of operations than strategic transport models. Specific routes within the study area were selected and analysed to give an indication of traffic operational changes from the base year to the future planning horizons.

It is important to note that, while this is considered as the Do Nothing case for CB+E, the planned road network upgrades across the greater Canberra network for 2031 have been included in the modelling.

Major routes within the study area were chosen to determine vehicular flow parameters, particularly average speed and average route travel time. The following routes in the study area network were selected, shown in Figures 11 and 12:

1. Between Adelaide Avenue and Deakin Employment Area
2. Between Cotter Road and Adelaide Avenue
    a. via Cotter Road – Adelaide Avenue ramps
    b. via Cotter Road – Kent Street/Novar Street Ramps
3. Between Cotter Road and Deakin Employment Area
4. Between Yarra Glen and Adelaide Avenue

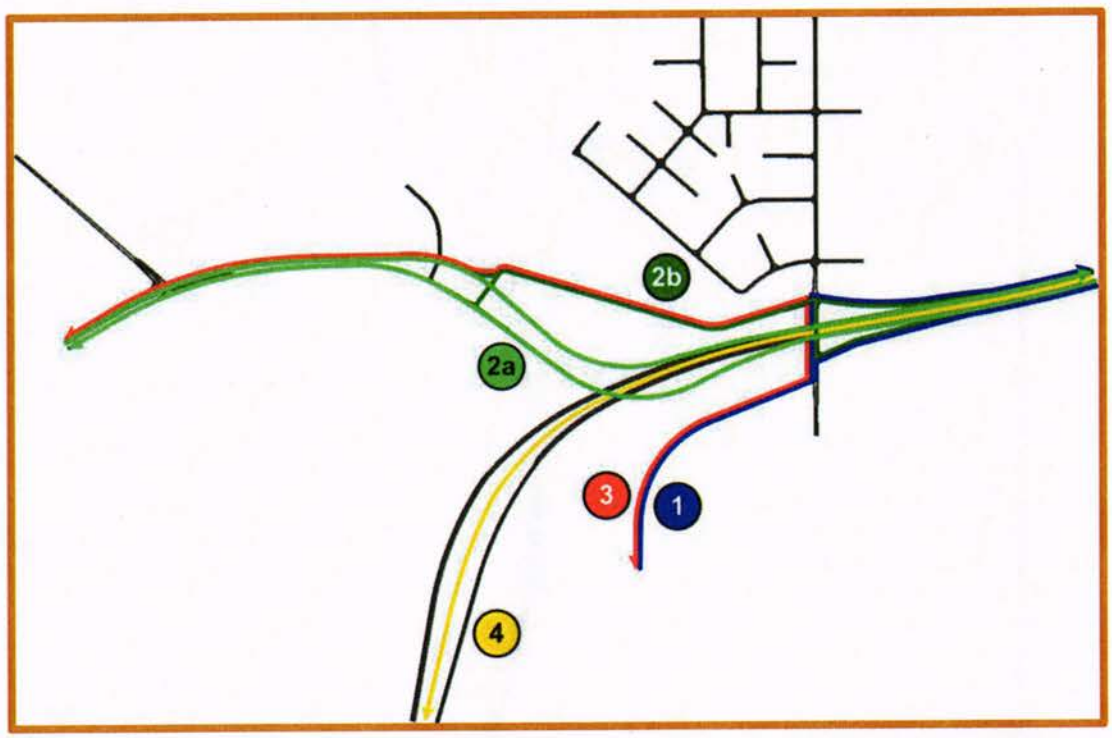

Figure 11: Paramics Performance Testing Routes (Do Nothing)

Figure 12: Paramics Performance Testing Routes (Master Plan)

The Master Plan contains numerous road network changes, additional intersections, almost 1,600 additional dwellings housing a population of almost 2,600, more than 13,000 m² GFA of additional commercial floor space contributing more than 600 jobs, and 500 m² GFA of retail floor space. Overall the micro-simulation modelling results indicate that a decrease in average speed can be expected for most of the routes surveyed.

Table 8 illustrates the performance impacts of the *Master Plan* scenario in the AM peak period. In general, the routes that travel along Dudley Street in *Do Nothing*, and therefore necessarily along Brickworks Road and Central Street in *Master Plan* (routes 2b and 3), experience a substantial reduction in average speed. Routes that use Denison Street (1 and 3) are also affected somewhat by the increased traffic due to the additional commercial floor space along that street. Routes 2a and 4 are not directly influenced by the CB+E development's land use or road network, and are largely unaffected.

The micro-simulation modelling results are outlined in Table 8 for the 2031 weekday AM peak period.

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Table 8: Comparison of 2031 AM Peak Average Speed and Travel Time on Selected Routes

Performance Measure	Scenario	1: Denison-Adelaide		2a: Cotter-Adelaide via Interchange		2b: Cotter-Adelaide via Dudley St		3: Cotter-Denison		4: Yarra Glen-Adelaide	
		EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
Route Length [m]	2010 AM Existing	1,210	1,180	2,040	2,260	2,100	2,330	2,420	2,410	1,840	1,780
	2031 AM Do Nothing	1,210	1,180	2,030	2,250	2,090	2,320	2,420	2,400	1,840	1,780
	2031 AM CB+E Master Plan	1,210	1,180	2,030	2,250	2,350	2,530	2,670	2,610	1,840	1,780
	2031 AM Difference	0	0	0	0	+260	+210	+250	+210	0	0
Average Speed [km/h]	2010 AM Existing	56.3	56.2	38.3	78.1	35.8	54.4	36.0	53.9	81.3	86.4
	2031 AM Do Nothing	49.5	55.5	19.0	78.9	16.4	53.9	17.8	51.5	23.4	81.5
	2031 AM CB+E Master Plan	42.2	46.5	19.2	69.9	13.0	35.1	14.0	34.6	26.6	80.5
	2031 AM Difference	-7.2	-9.0	+0.2	-9.0	-3.4	-18.8	-3.8	-16.9	+3.1	-1.0
Average Travel Time [min:sec]	2010 AM Existing	1:15	1:15	3:10	1:45	3:30	2:35	4:00	2:40	1:20	1:15
	2031 AM Do Nothing	1:30	1:15	6:25	1:45	7:40	2:35	8:10	2:50	4:45	1:20
	2031 AM CB+E Master Plan	1:45	1:30	6:20	1:55	10:50	4:20	11:25	4:30	4:10	1:20
	2031 AM Difference	+0:15	+0:15	-0:05	+0:10	+3:10	+1:45	+3:15	+1:40	-0:35	0:00

Note: Travel times are rounded to the nearest five seconds, traffic counts are rounded to the nearest 10 vehicles.

Demand on the road sections shown in Figure 7 has also been extracted from the micro-simulation model, and is shown in Table 9. The model was run with a demand factor of 75%, for the same reasons as described in Section 2.4 for the intersection turn counts; to strike a balance between congestion and demand. The volumes in Table 9 are therefore a closer representation of the hourly demand than if the demand factor was 100%. In contrast, the strategic transport model output is entirely constrained by capacity, and is therefore not a complete representation of the real demand on those roads or routes.

Table 9: Micro-simulation Model Midblock Demand

Location	Road	2010 AM Existing	2031 AM Do Nothing	2031 AM Master Plan
1	Cotter Road (EB/WB)	1,840/490	2,930/950	2,960/1,020
2	Brickworks Road (NB/SB)	N/A	N/A	1,510/470
3	Central Street (EB/WB)	N/A	N/A	1,560/350
4	Abbott Street (NB/SB)	0/0*	0/0*	150/10
5	Kintore Crescent (EB/WB)	10/0*	30/0*	130/30
6	Dudley Street (EB/WB)	750/150	1,270/320	1,280/350
7	Novar Street (NB/SB)	420/260	420/270	320/200
8	Denison Street (EB/WB)	160/630	190/650	280/820
9	Kent Street (NB/SB)	690/1,040	750/1,120	770/1,350
10	Yarra Glen (NB/SB)	3,490/1,420	3,250/1,510	3,370/1,600
11	Adelaide Avenue (EB/WB)	5,090/2,230	5,440/2,510	5,470/2,650

Note: Traffic counts are rounded to the nearest 10 vehicles.
* This part of Yarralumla receives little or no traffic without the CB+E development due to the placement of the zone connectors.

The difference between the recorded micro-simulation midblock volumes and the strategic transport model volumes in Table 5 is due mostly to the differences in the initial volumes. For example, there are large differences on Cotter Road and Adelaide Avenue between Existing in Table 5 (strategic) and Table 9 (micro-simulation). Through the estimation process detailed in Section 2.3.1, the 2010 AM micro-simulation volumes are a much closer match to the observed intersection counts than the 2011 AM strategic transport model volumes. This carries through to differences between the two modelling techniques in the future volumes.

Between 2010 and 2031, the total (bidirectional) AM peak traffic demand on Dudley Street increases from 900 veh/h to 1,590 veh/h. With the addition of the CB+E development, this traffic, plus the additional development traffic, results in total AM peak volumes of 1,980 veh/h on Brickworks Road and 1,910 veh/h on Central Street. This is partly due to the congestion on the Cotter Road – Adelaide Avenue on-ramp causing vehicles to seek alternative routes, i.e. Brickworks Road and Central Street/North Terrace. Without other road network connectivity improvements, such as a full interchange connecting Cotter Road, Adelaide Avenue and Deakin to provide more favourable route options, these volumes are unsustainable for an undivided, two lane urban street. A lane-add at the end

of the Cotter Road – Adelaide Avenue on-ramp rather than the existing merge is another potential improvement option, however this has not been tested.

3.3 Intersection Analysis

The turning flows at each of the analysed intersections were taken from the micro-simulation modelling outputs and used as input to SIDRA Intersection for the assessment of service levels.

Alternative configurations were tested for some intersections where the future performance was unacceptable. The locations of each of these intersections are shown in Figure 13 for *2010 AM Existing* and *2031 AM Do Nothing,* and Figure 14 for *2031 AM Master Plan*.

Summarised intersection analysis results:

1. Cotter Road – Lady Denman Drive
   This intersection is currently being upgraded, so the previous roundabout layout (Figure 15) no longer applies in the future and has only been analysed for the *Existing* scenario. In both 2031 AM scenarios the intersection is signalised (Figure 16). Despite the total volume almost doubling between 2010 AM and 2031 AM, the upgrade maintains performance at LoS D in all scenarios.
2. Cotter Road – Dudley Street (*Existing*/*Do Nothing* only)
   This intersection will be removed for the construction of the CB+E development and is therefore only present in *Existing* and *Do Nothing*. The northern side is shown in Figure 17 and the southern side in Figure 18. Its performance is good in 2010 AM, being LoS A, however the increased volume in 2031 AM causes it to come under considerable stress. An investigation of the intersection modelling outputs indicates that the cause of the stress is the short distance (<100 m) to the downstream merge on the eastbound carriageway, which results in LoS F for the through movement. This can be greatly improved by increasing the distance between the intersection and this downstream merge.
3. Cotter Road – Brickworks Road (*Master Plan* only)
   This intersection is part of the CB+E development and therefore is only present in the *Master Plan* scenario. The proposed configuration shown in Figure 19 offers good performance, at LoS C. Due to the high demand for the movement, the length of the left turn from Cotter Road eastbound is critical. The intersection modelling analysis indicates that the left turn lane should be at least 200 m long.
4. Dudley Street – Novar Street
   This intersection (Figure 20) operates well in *Existing*, at LoS B. In 2031 AM, the traffic rat-running along Dudley Street causes the performance to deteriorate to LoS F in both *Do Nothing* and *Master Plan*. A signalised option (Figure 21) was tested that would improve the performance in 2031 AM to LoS C.
5. Kent Street – Adelaide Avenue off-ramp
   The performance of this intersection (Figure 22) is good in *Existing* (LoS A), and decreases slightly to LoS B in *Do Nothing*, however the off-ramp operates at LoS F. In *2031 AM Master Plan* the overall performance deteriorates to LoS F. A signalised option (Figure 23) was tested which would improve performance to LoS A in *Do Nothing* and LoS B in *Master Plan*.
6. Kent Street – Denison Street
   This intersection (Figure 24) performs well in both *Existing* and *Do Nothing*, however the give-way condition for Denison Street results in high delays for that approach. In *Master Plan* the overall performance deteriorates to LoS E with very high delays on Denison Street. A signalised option (Figure 25) was tested which would improve performance to LoS C in both 2031 AM scenarios if slip lanes can be provided for left turns.

The future volumes are based on the calibrated 2010 AM Existing Paramics model, with traffic growth derived from the 2011 and 2031 EMME models. These EMME models generate traffic using the ESDD's land use forecasts. The intersections are simply breaking down because the expected growth in area traffic by 2031 is too much for them to handle. That they fail in 2031 AM Do Nothing indicates that the CB+E development is not the cause of the failure.

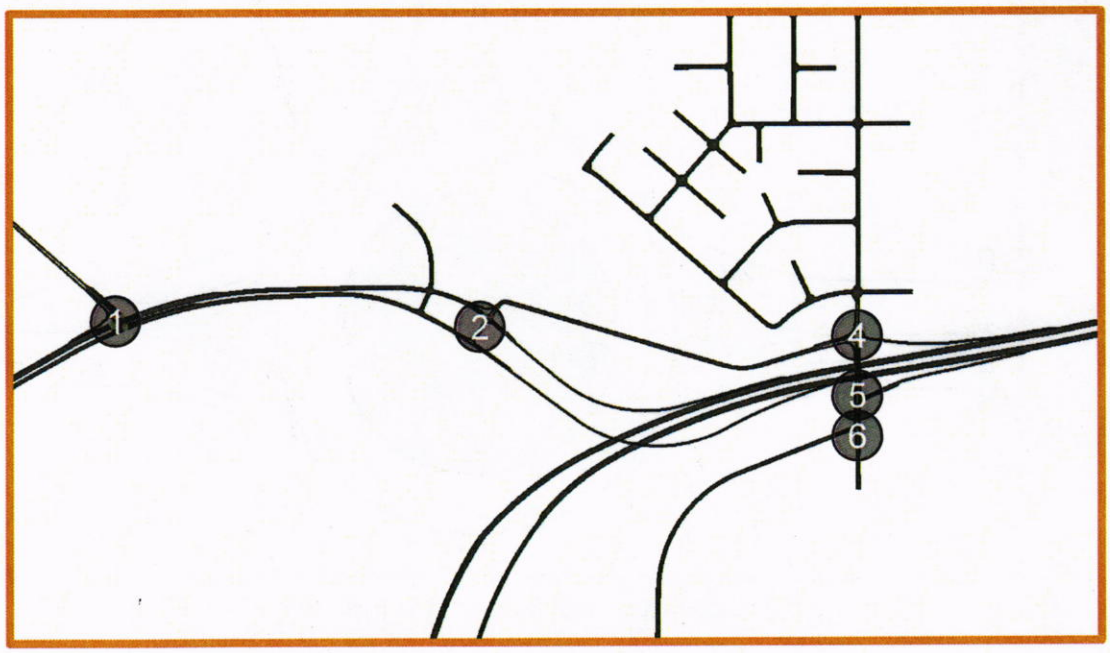

Figure 13: 2031 AM Do Nothing Intersections Analysed

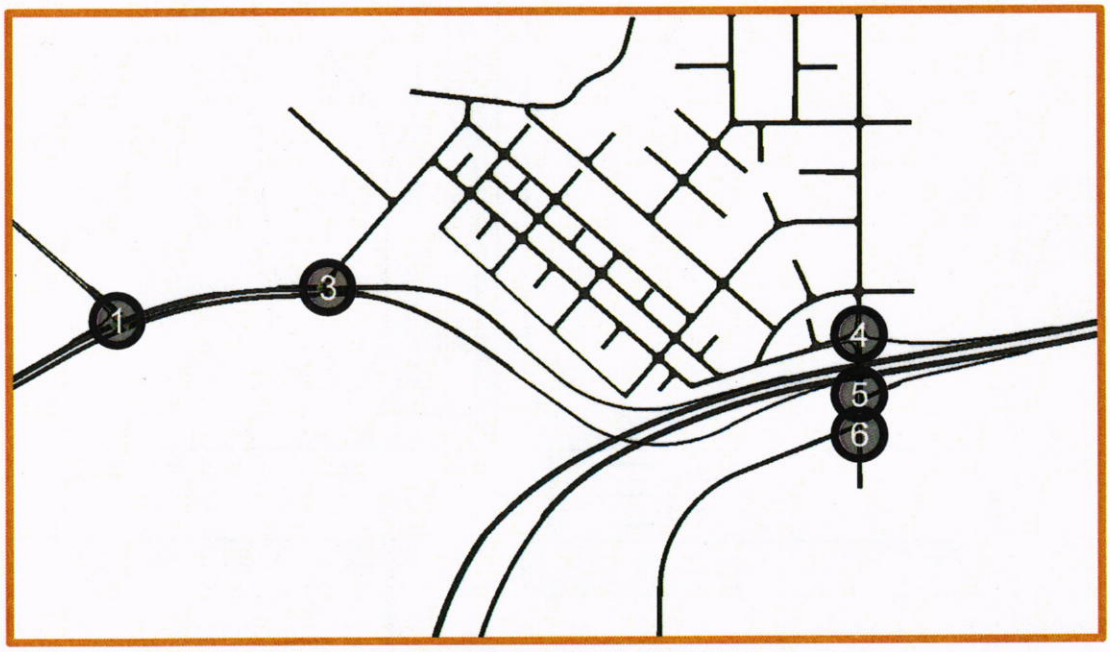

Figure 14: 2031 AM Master Plan Intersections Analysed

Intersection layouts as modelled in SIDRA Intersection are included in Figures 15 through 24.

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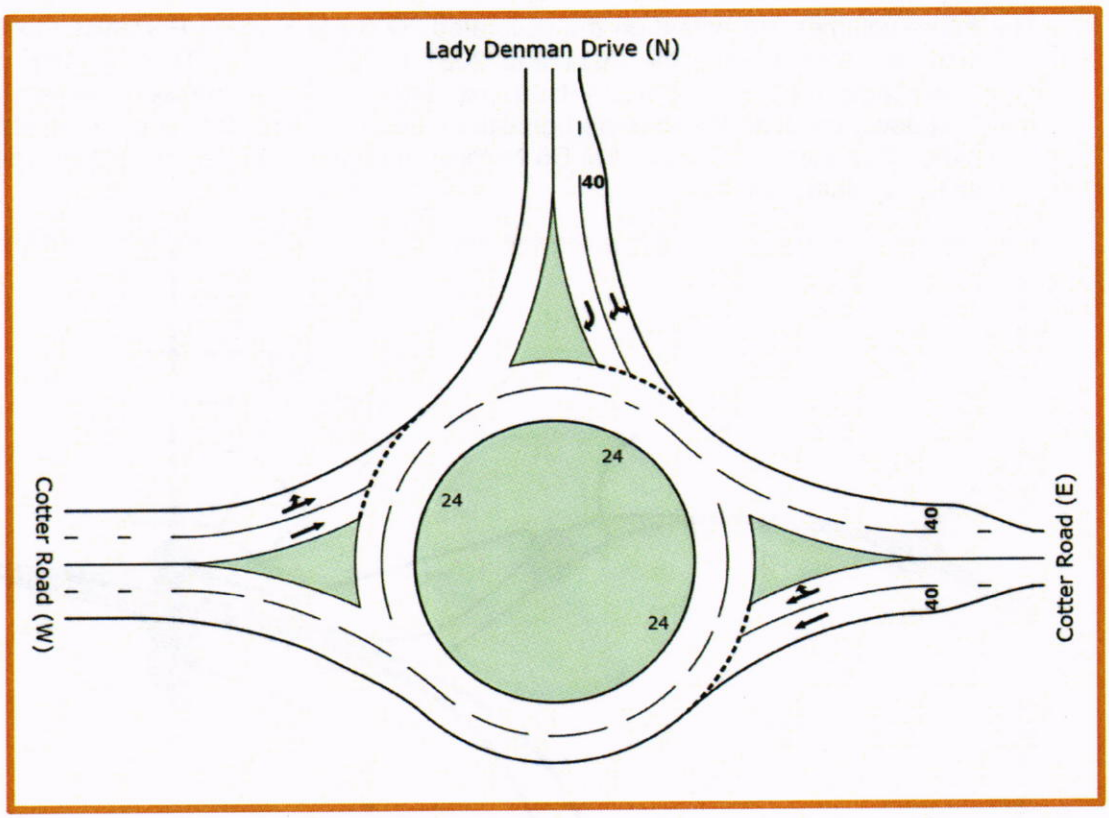

Figure 15: Cotter Road – Lady Denman Drive (Roundabout, 2010 AM only)

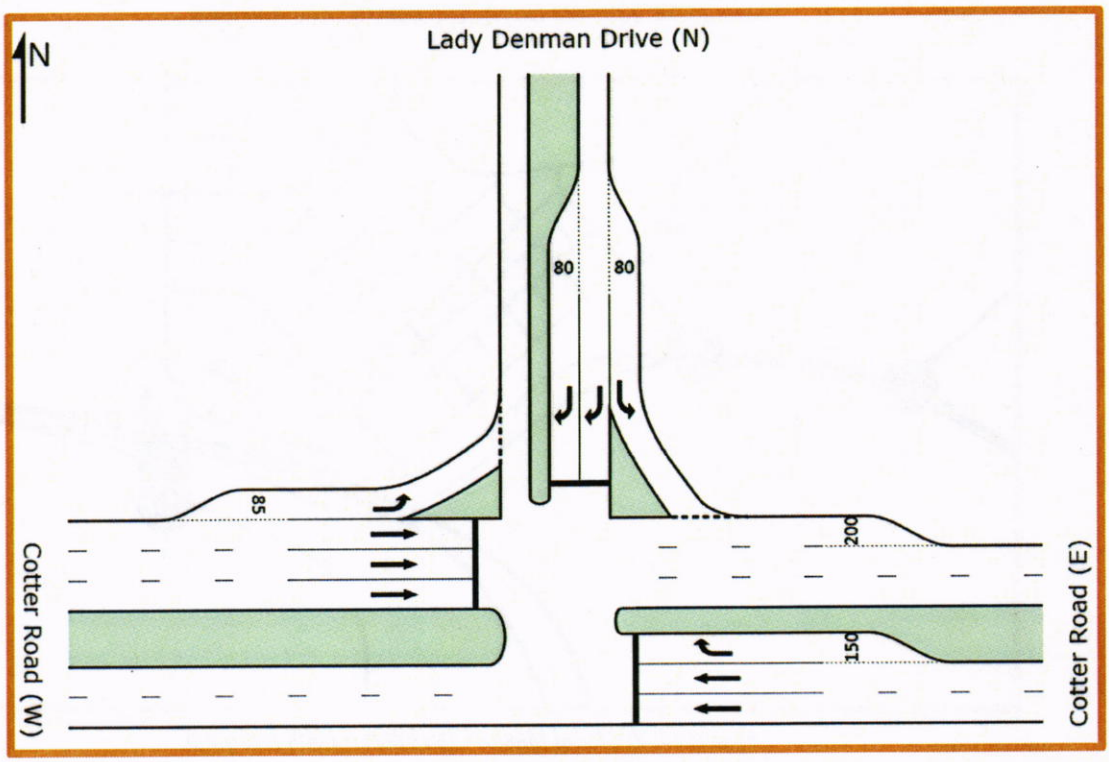

Figure 16: Cotter Road – Lady Denman Drive (Signals, 2031 AM only)

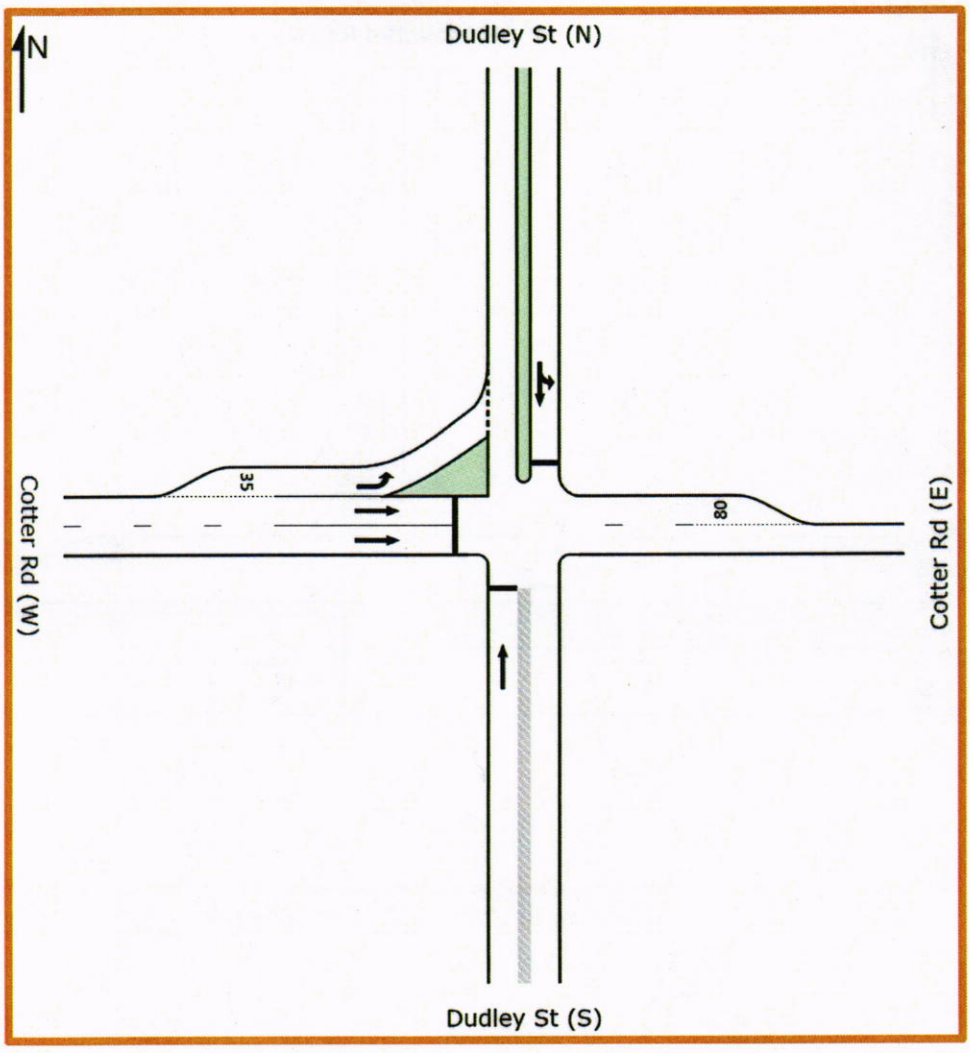

Figure 17: Cotter Road – Dudley Street (North)

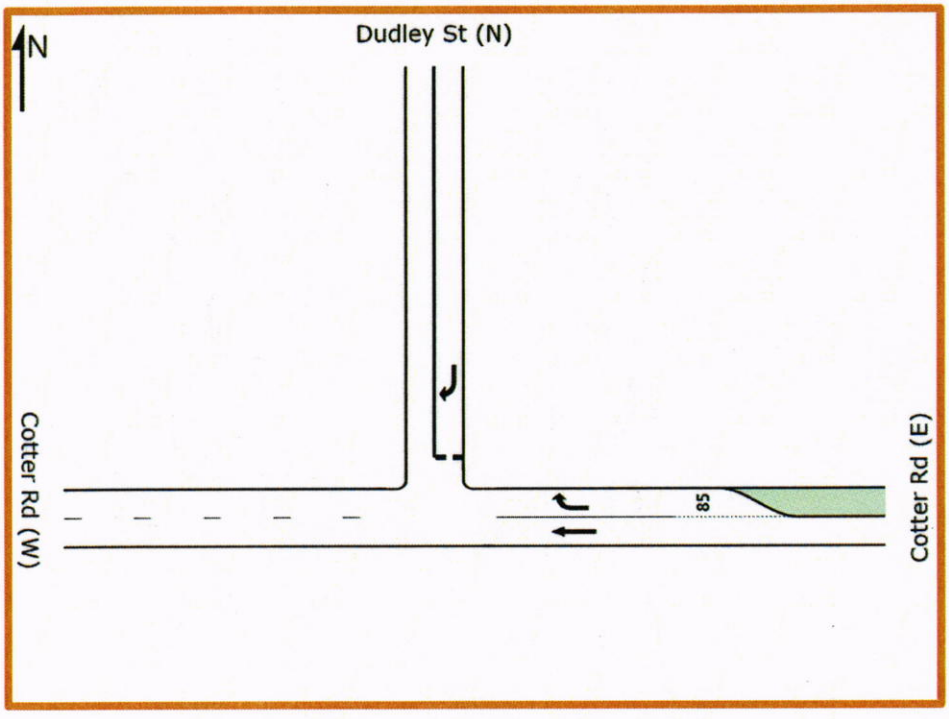

Figure 18: Cotter Road – Dudley Street (South)

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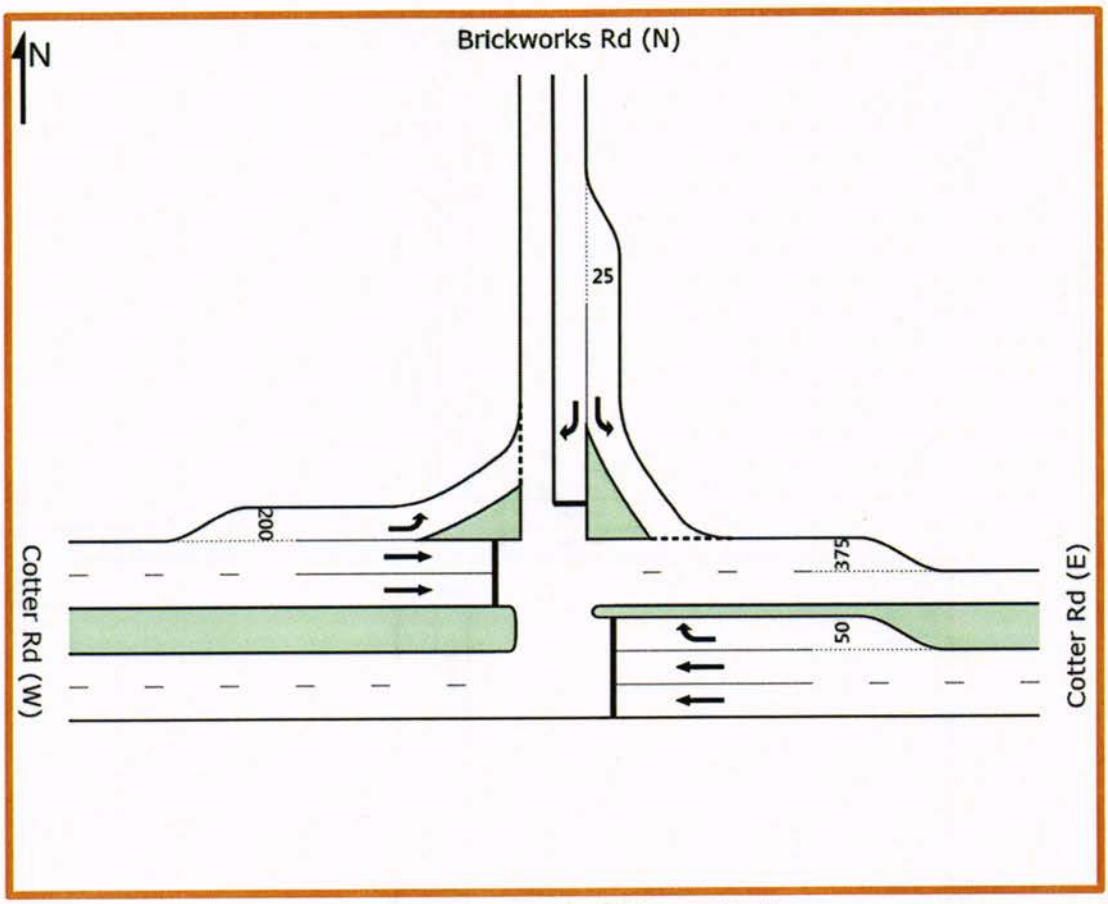

Figure 19: Cotter Road – Brickworks Road

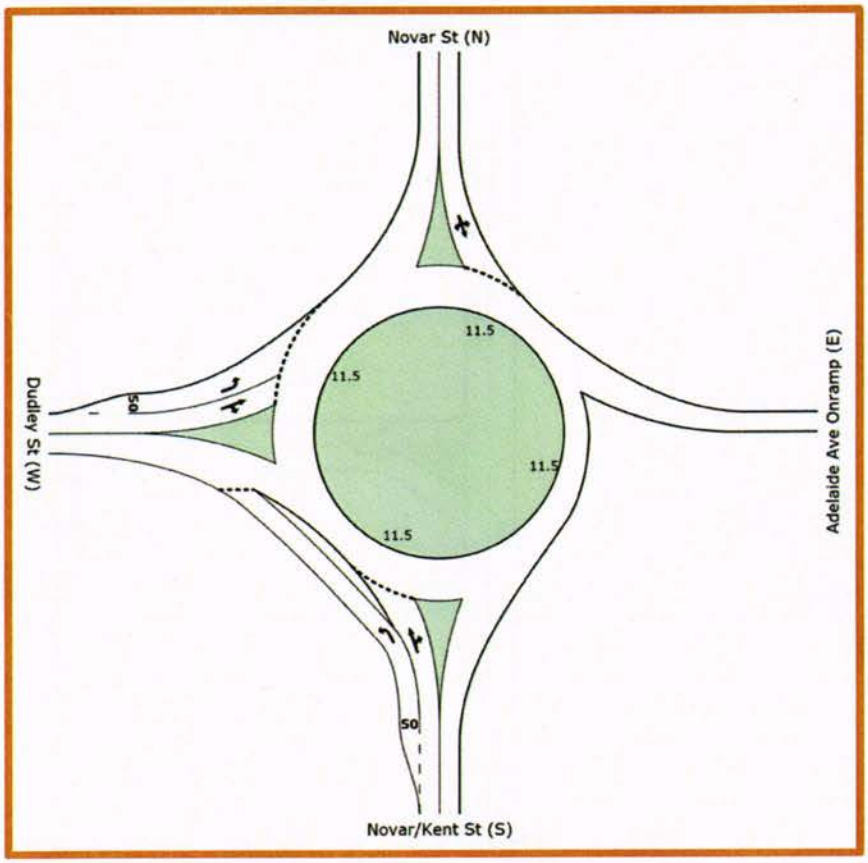

Figure 20: Novar Street – Dudley Street/Adelaide Avenue On-ramp (Roundabout)

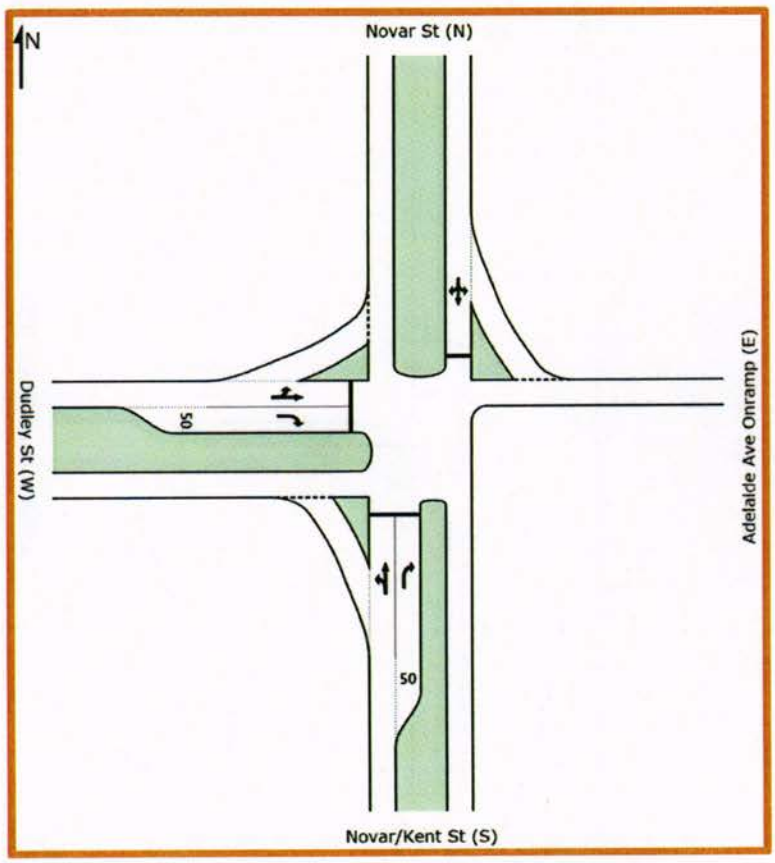

Figure 21: Novar Street – Dudley Street/Adelaide Avenue On-ramp (Signals)

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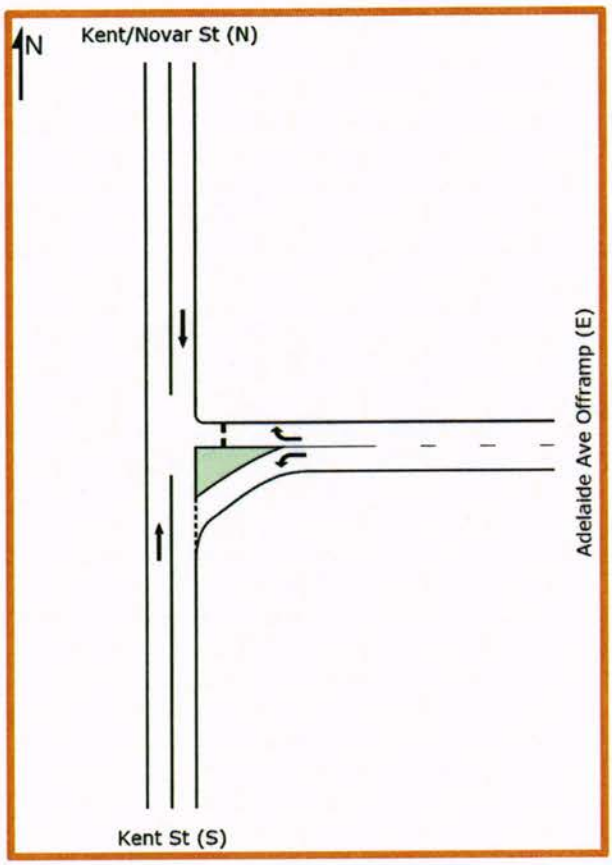

Figure 22: Kent Street – Adelaide Avenue Off-ramp (Give-way)

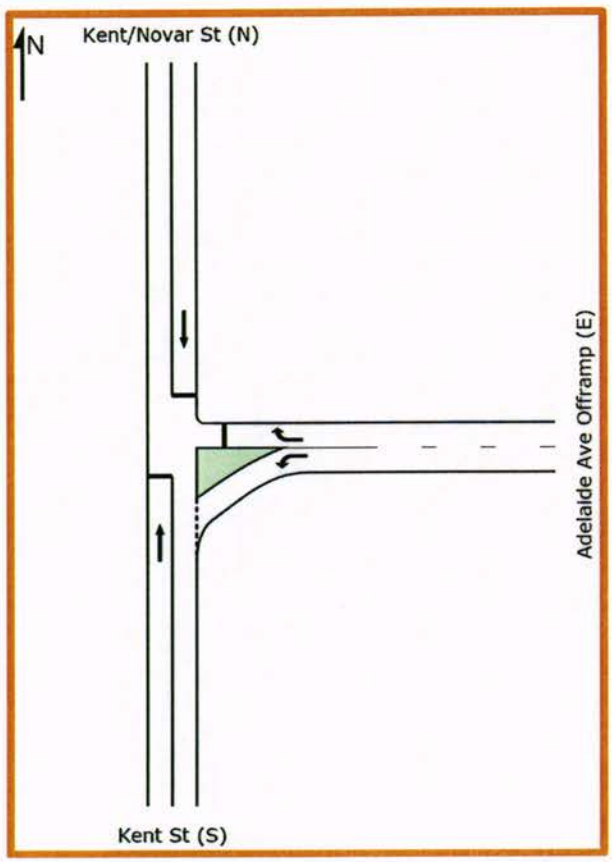

Figure 23: Kent Street – Adelaide Avenue Off-ramp (Signals)

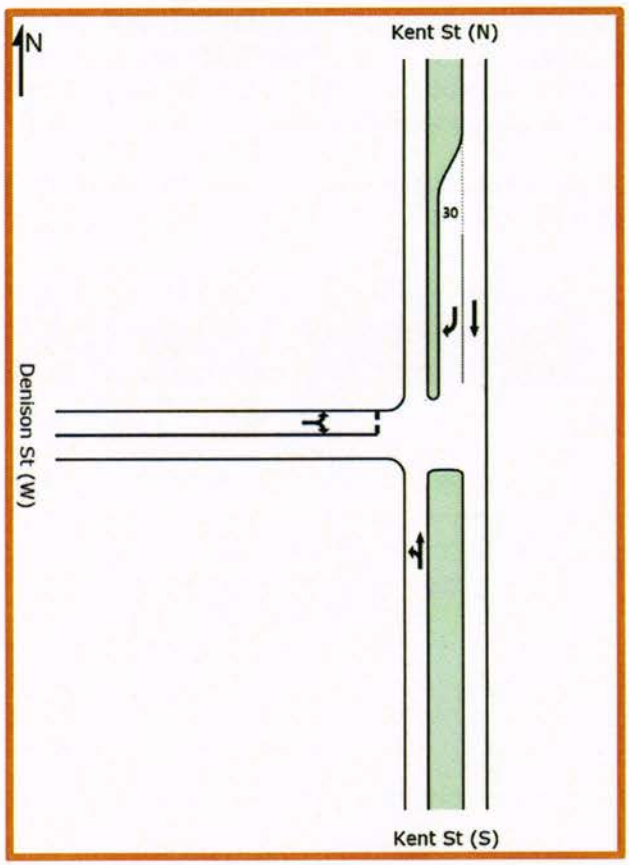

Figure 24: Kent Street – Denison Street (Give-way)

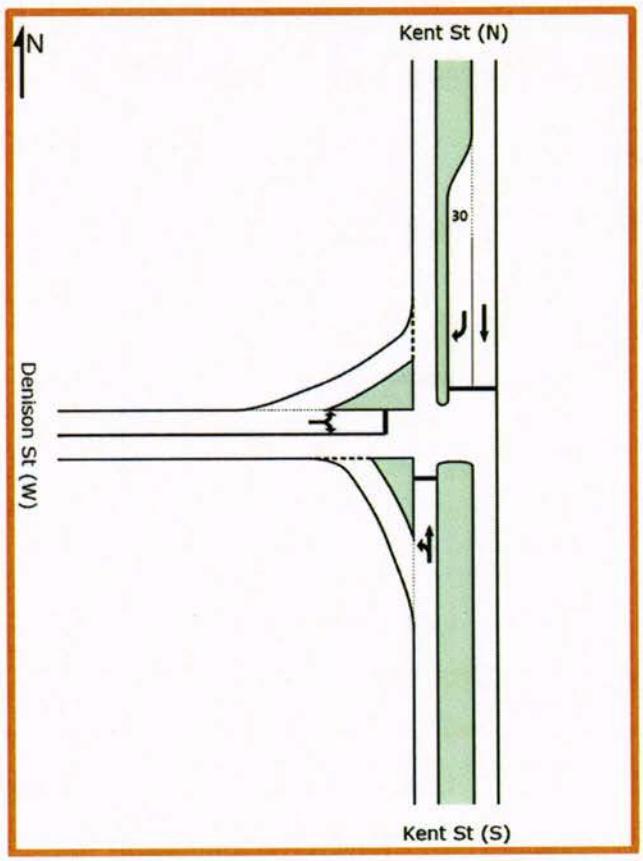

Figure 25: Kent Street – Denison Street (Signals)

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The 2031 AM peak intersection assessment results are outlined in Table 11. The analysis shows that the roundabout at Cotter Road and Lady Denman Drive is well over capacity by 2031. The configuration of the Cotter Road – Adelaide Avenue interchange operates at a good level of service in all tested periods.

The HCM2010 Level of Service criteria by which the intersection performance is assessed are given in Table 10.

Table 10: HCM Level of Service Criteria (Average Delay D in Seconds)

Level of Service	Signals	Give-Way/Roundabout
A	$D < 10$ s	$D < 10$ s
B	10 s ≤ D < 20 s	10 s ≤ D < 15 s
C	20 s ≤ D < 35 s	15 s ≤ D < 25 s
D	35 s ≤ D < 55 s	25 s ≤ D < 35 s
E	55 s ≤ D < 80 s	35 s ≤ D < 50 s
F	$D \geq 80$ s or V/C > 1	$D \geq 50$ s or V/C > 1

Source: Highway Capacity Manual 2010, Exhibits 18-4 (p.18-6), 19-1 (p.19-2) and 21-1 (p.21-1)

Table 11: Comparison of AM Peak Intersection Analysis Results

ID	Intersection	2010 AM Existing			2031 AM Do Nothing			2031 AM Master Plan		
		Count	Delay	LoS	Count	Delay	LoS	Count	Delay	LoS
1	Cotter Road – Lady Denman Drive	2,783	45.8 s	D	5,240	49.5 s	D	5,293	50.2 s	D
2	Cotter Road – Dudley Street	2,323	9.4 s	A	3,791	60.7 s	E	-	-	-
3	Cotter Road – Brickworks Road	-	-	-	-	-	-	3,996	29.4 s	C
4	Novar Street – Dudley Street/Adelaide Avenue on-ramp	1,829	15.4 s	B	2,407	148.5 s	F	2,443	124.1 s	F
	Signalised	-	-	-		30.0 s	C		29.7 s	C
5	Kent Street – Adelaide Avenue off-ramp*	1,824	8.9 s	A (D)	1,943	12.5 s	B (F)	2,187	116.6 s	F (F)
	Signalised	-	-	-		7.6 s	A		11.4 s	B
6	Kent Street – Denison Street*	1,772	10.8 s	B (E)	1,896	10.9 s	B (D)	2,096	47.2 s	E (F)
	Signalised	-	-	-		29.5 s	C		24.9 s	C

* SIDRA Intersection does not report overall intersection delays for give way or stop intersections because of the minimal delay typically experienced by major road movements; the Level of Service shown has been determined manually using Table 10.

The three intersections on Kent and Novar Streets (intersections 4, 5 and 6) have been assessed in isolation when signalised. Signal control at these three intersections does however present opportunities for signal coordination, which would result in further improvements to their performance. A summary of the recommended intersection treatments is shown in Table 12.

Table 12: Summary of Recommended Intersection Treatments

ID	Intersection	Recommended Treatment
1	Cotter Road – Lady Denman Drive	With the duplication of Cotter Road, this intersection will already be upgraded to signals and no further intervention is required.
2	Cotter Road – Dudley Street	This intersection will be removed with the development of the CB+E Master Plan. In the *2031 AM Do Nothing* scenario its Level of Service is poor. The eastbound movement on Cotter Road operates at LoS F because of the distance to the downstream merge, approaching the Adelaide Avenue on-ramp. Increasing the distance to this downstream merge would be recommended in this scenario.
3	Cotter Road – Brickworks Road	This intersection should be signalised. A single protected turning lane from each direction of Cotter Road to Brickworks Road is sufficient. The intersection modelling suggests that the left turning slip lane from must be at least 200 m long to limit the effect of queues spilling into the through lanes.
4	Novar Street – Dudley Street/Adelaide Avenue on-ramp	The existing roundabout will operate poorly in the future. An upgrade to signals using the existing lane disciplines, with slip lanes for left turns, is sufficient.
5	Kent Street – Adelaide Avenue off-ramp	To better control this intersection in the future, and ensure better balance of delays, signals are recommended.
6	Kent Street – Denison Street	Similar to the Novar Street – Dudley Street/Adelaide Avenue on-ramp intersection, signals with slip lanes for left turns are recommended.

3.3.1 Intersection Life Analysis

A brief analysis of the effective operating life of selected intersections has been conducted, specifically Novar Street – Dudley Street and Kent Street – Adelaide Avenue off-ramp. This was achieved by exponentially interpolating the volumes for each turning movement between 2010/11 and 2031. As such the results are approximate; a more formal investigation into the effective operating life of the intersections would require the interim years to be modelled using EMME and Paramics as well. The results are shown in Table 13. The results for these two intersections indicates that their performance is expected to deteriorate to unacceptable levels in the 2031 AM peak period whether or not the CB+E Master Plan development goes ahead.

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Table 13: AM Peak Do Nothing Levels of Service in Interim Years (Overall/Worst)

ID	Intersection	2010	2016	2021	2026	2031
4	Novar Street – Dudley Street/Adelaide Avenue on-ramp	B/C	B/D	C/F	E/**F**	**F**/**F**
5	Kent Street – Adelaide Avenue off-ramp*	A/D	A/E	A/E	B/E	B/**F**

In the Do Nothing scenario, the intersection of Novar Street and Dudley Street is expected to reach an overall LoS F between 2026 and 2031, with the worst movement (Novar Street north) reaching LoS F between 2021 and 2026. The Adelaide Avenue off-ramp at Kent Street reaches LoS F between 2026 and 2031.

3.4 Summary of Operational Assessment Findings

The strategic transport and micro-simulation modelling results indicate that some parts of the road network surrounding the CB+E development area are already over capacity in the 2010/11 AM peak period, particularly Cotter Road eastbound. The strategic transport modelling suggests that the ongoing duplication of Cotter Road will not serve to relieve this congestion; rather it will allow even more traffic to enter the area. With the duplication of Cotter Road, the provision of alternative routes for east-west traffic, and improved access between Cotter Road and Adelaide Avenue, become more important.

The intersection modelling suggests that, due to the large volume of traffic, the new intersection connecting Brickworks Road to Cotter Road requires signal control, and a long left turning lane from Cotter Road eastbound. The unsignalised intersections in the study area should all be converted to signal control.

3.4.1 Impacts

In comparison to previous work conducted for the CB+E development, this version of the Master Plan omits the full interchange connecting Cotter Road to Adelaide Avenue and Denison Street. As a result, including the limited capacity of the existing on-ramp from Cotter Road to Adelaide Avenue, the travel patterns are noticeably different in this version of the CB+E Master Plan.

In the future, the strategic transport modelling indicates that the traffic demand will overwhelm the existing on-ramp from Cotter Road to Adelaide Avenue, which results in substantially more traffic using Dudley Street as an alternative. In contrast, the removal of Dudley Street as an access road between Cotter Road and Deakin/Yarralumla in the CB+E Master Plan appears likely to result in this large volume of through traffic using the roads within the CB+E development instead.

In comparison to the background traffic growth that is already expected to occur between 2010 and 2031, the increased land use in the CB+E Master Plan has only a small impact on the road network. It does increase traffic demand on the unsignalised intersections along Kent and Novar Streets, although these intersections would greatly benefit from upgrades regardless of the CB+E development. The development has minimal impact on Cotter Road itself.

3.4.2 Proposed Solutions

The strategic transport and intersection modelling results suggest that the increased future traffic overloads the roads in the development area, and necessitates an upgrade to the access arrangement between Cotter Road, Adelaide Avenue and the surrounding suburbs. Without an interchange, or similar solution, any development in the CB+E area will be affected by this additional traffic. Ultimately, the construction of the Cotter Road – Adelaide Avenue interchange should be considered to be necessary to support the viability of the CB+E development, by diverting through traffic away from the local streets.

To better accommodate the expected future traffic, whether or not the CB+E development goes ahead, strong consideration should be given to upgrading the intersections of Novar Street – Dudley Street/Adelaide Avenue on-ramp, Kent Street – Adelaide Avenue off-ramp and Kent Street – Denison Street to signal control. This will provide better control over the heavy movements, more opportunities for the minor movements, and allow for signal coordination of the three intersections to further improve performance.

In addition, the rat-running that was noted on Dudley Street in *2031 AM Do Nothing*, and Brickworks Road in *2031 AM Master Plan*, suggests that improvements to the capacity of the Cotter Road – Adelaide Avenue on-ramp will be necessary in the future. The rat-run occurs in the strategic transport model because the capacity of the on-ramp is constrained by the fact that it merges with Adelaide Avenue; thus it goes over capacity, and some of the eastbound through traffic gets forced to find an alternative route, being Dudley Street and/or Brickworks Road. Widening Adelaide Avenue eastbound by a lane, which would allow for the on-ramp to join as an added lane rather than the existing merge, would effectively double the capacity of the on-ramp and would likely eliminate this rat-running movement. However, the feasibility of this upgrade should be investigated further, taking into account engineering and safety constraints.

4 OTHER TRANSPORT MODES

While private car is the primary transport mode in Canberra, the ACT Government made a commitment to increasing sustainable transport with the *Sustainable Transport Plan* (ACTPLA, 2004) and has updated that commitment in *Transport for Canberra* (ESDD, 2012). The government hopes to increase the share of sustainable modes, including public transport, cycling and walking, from 15.4% of work trips in 2006 to 30% in 2026. Consideration has therefore been given in this report as to how to contribute to meeting these goals.

4.1 Mode Split (Existing + Target)

Mode share data from the 2011 ABS Census of Population and Housing Census indicates the mode share for journey to work trips as shown in Table 14. Journey to work trip data have been examined specifically since this information is readily available from the ABS. The table indicates that the current sustainable transport share (walking, cycling and public transport) for Curtin, Yarralumla and Deakin ranges from 12% (Deakin) to 19% (Curtin) with Yarralumla currently at 16%.

Table 14: Current Journey to Work Mode Split for Suburbs Surrounding the Study Area

Mode	Curtin		Deakin		Yarralumla	
	Trips	Mode Share	Trips	Mode Share	Trips	Mode Share
Car/Motorcycle	1,837	81.4%	943	85.6%	1,038	86.1%
Public Transport	242	10.7%	68	6.2%	76	6.3%
Cycling	94	4.2%	45	4.1%	47	3.9%
Walking	83	3.7%	46	4.2%	44	3.7%
Total	2,256		1,102		1,205	

Source: ABS Census, 2011

Transport for Canberra lists the mode share targets outlined in Table 15.

Table 15: Journey to Work Mode Share Targets

Mode	2011 actual	2011 target	2016 target	2026 target
Public Transport	8.5%	9%	10.5%	16%
Cycling	4.1%	5%	6%	7%
Walking	3.8%	6%	6.5%	7%
Total	16.3%	20%	23%	30%

Source: Transport for Canberra, ABS Census 2011

The suburbs around the study area are close to meeting the sustainable transport plan targets and any new developments in the study area should encourage sustainable transport in line with the targets specified by the ACT Government.

The higher-density, mixed-use developments that are proposed are expected to encourage more sustainable transport options. However, the development must be supported by good access to public transport and pedestrian/cycle facilities as well.

4.2 Public Transport

Figure 26 shows the proposed strategic bus network for 2031 (*ACT Strategic Public Transport Network Plan*, MRC). This network proposed increased coverage for the study area by introducing a bus route along Cotter Road.

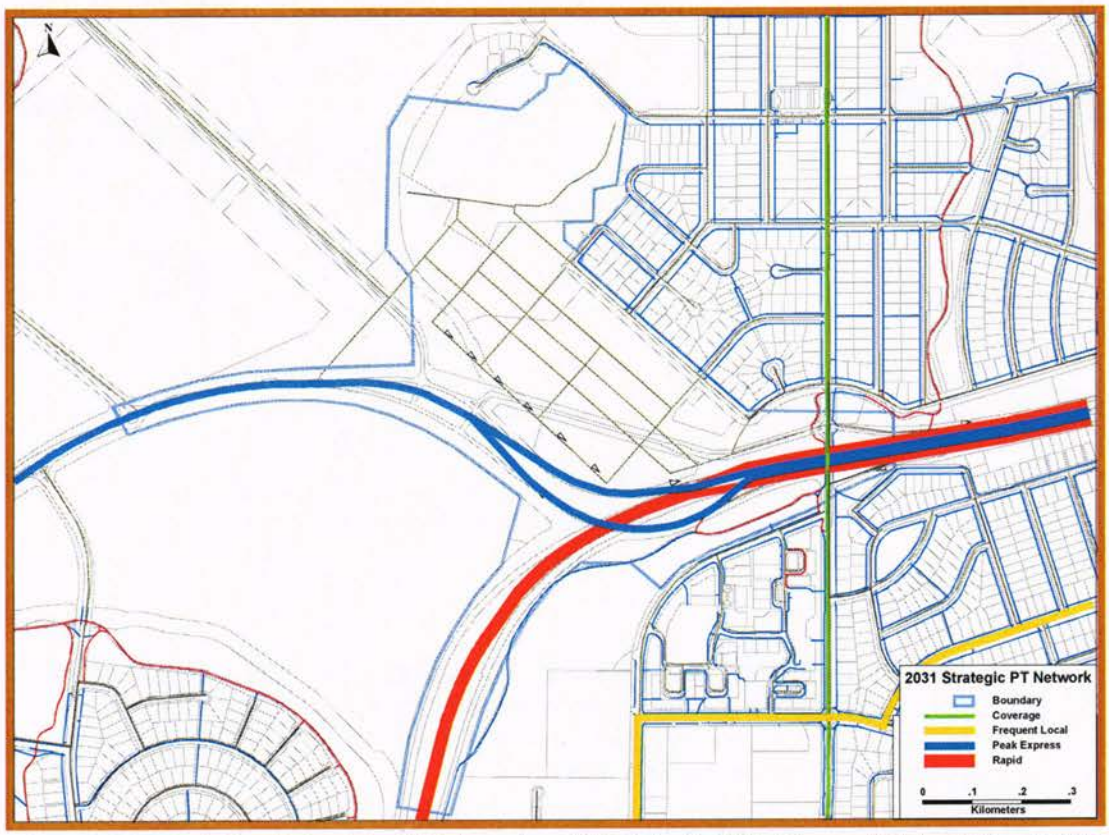

Figure 26: Strategic Bus Network for 2031 (based on ACT Strategic Public Transport Network Plan, MRC)

The *Strategic Public Transport Network Plan* does not currently include any provision for bus stops close to the study area along Cotter Road, but does include a bus station in the median of Adelaide Avenue that would service not only the new development but the Deakin employment area as well.

The *Adelaide Avenue Bus Stops Feasibility Study* (SMEC, 2013) recommends a median bus stop on Adelaide Avenue on the western side of the Kent Street bridge. This stop would be serviced by a number of the Rapid buses that currently run along Adelaide Avenue without stopping. This stop would not be accessible by the proposed Peak Express route along Cotter Road due to the location of the Cotter Road to Adelaide Avenue ramps.

Current planning for ACTION indicates that the maximum walking distance to a bus stop should be 500 metres. However, the *Future Urban Areas Residential Subdivision Development Code 2008* states that a walk distance of up to 750 metres is acceptable for high frequency services, such as the Rapid route on Adelaide Avenue. The proposed location of a median bus station on Adelaide Avenue provides coverage of the new development as well as the Deakin employment area and is expected to increase public transport usage for these areas. The coverage area is shown in Figure 27.

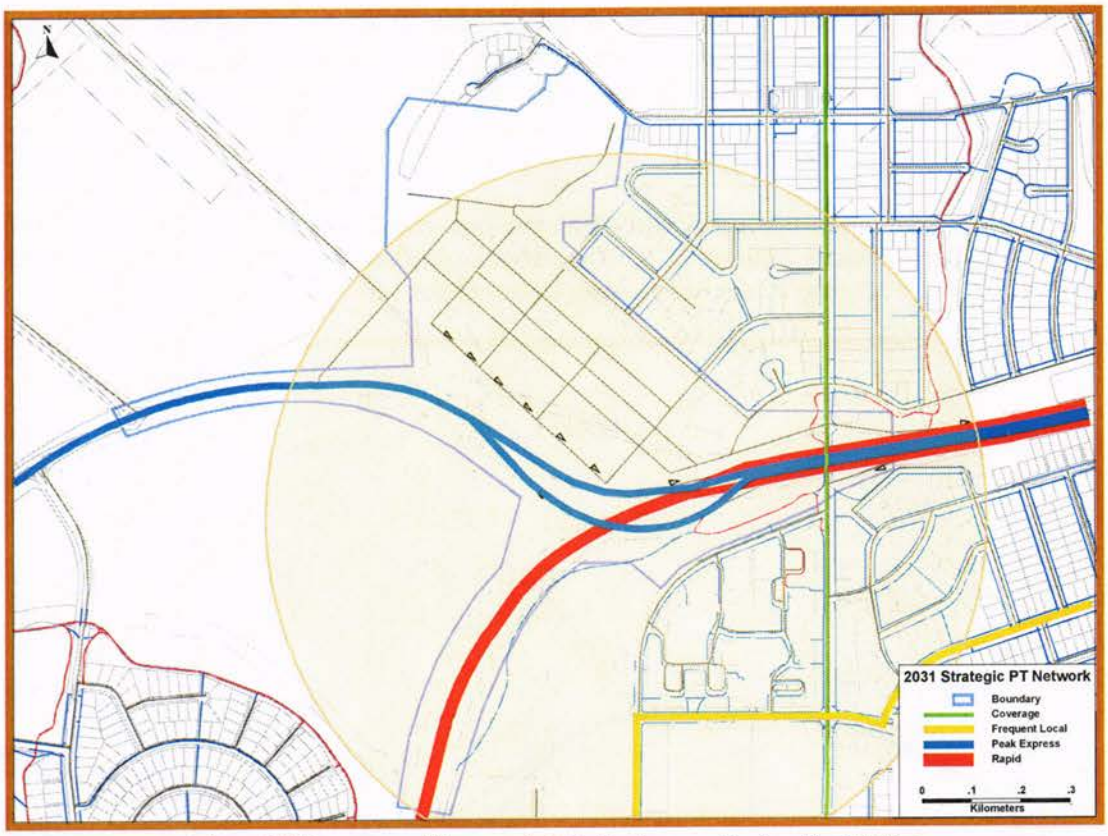

Figure 27: Coverage of Proposed Adelaide Avenue Median Bus Station

4.3 Cycling

The current coverage of facilities for use by cyclists in the study area is shown in Figure 28. This figure shows that while there are a number of existing facilities, these facilities tend to be outside of the study area. However, the existing facilities offer opportunities for connections into and through the study area.

Of particular note is the fact that the existing off-road cycle path is grade separated at its crossings of Lady Denman Drive, Cotter Road, Dunstan Street, Adelaide Avenue and McCulloch Street, making it easier and safer for cyclists to pass through the area.

The ACT *Design Standards for Urban Infrastructure Part 13 – Pedestrian and Cycle Facilities* (DS13) (TAMS, 2007) present the requirements for the provision of pedestrian and cycle facilities. Of particular note is the requirement for provision of facilities for different types of cyclists from school children to commuters and athletes. School children and recreational cyclists typically prefer off-road paths while commuters and athletes prefer higher speed, direct routes on-road.

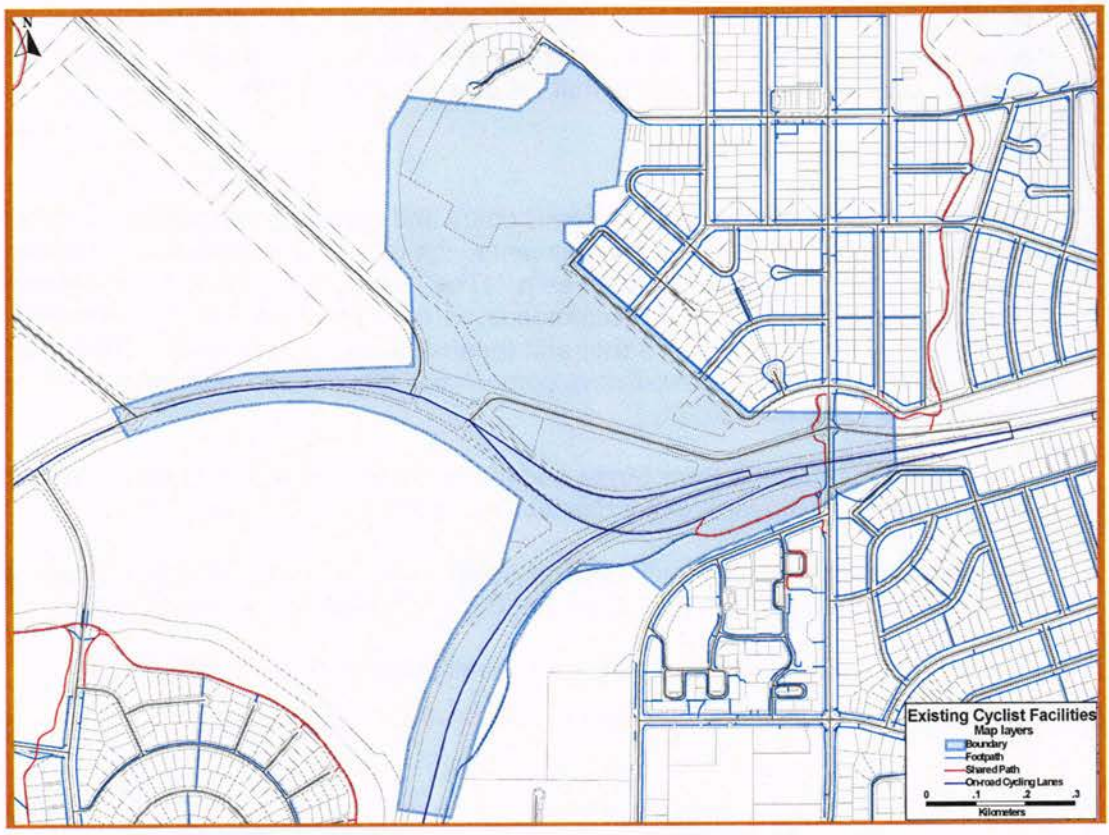

Figure 28: Existing Cycling Facilities (Information Obtained from TAMS)

4.3.1 On-Road Cycling

The main on-road network, as shown in Figure 28, provides high-speed, continuous access for cyclists along the main arterial roads in the area. Appropriate connections to this network from the proposed development need to be made.

With the exception of Brickworks Road, the roads in the new development are not considered appropriate for formal bicycle lane marking as traffic speeds and volumes are expected to be low enough to allow safe cycling. Provision of on-road bicycle lanes along Brickworks Road is recommended to allow cyclist access between Cotter Road and the new development. The major east-west road through the development, connecting Brickworks Road to Dudley Street, should provide wider than normal traffic lanes to allow safe on-road cycling.

Access to the proposed median bus station should provide for cyclist as well as pedestrian movements via ramps from the Kent Street bridge. The eastbound on-road cycle path on Cotter Road should connect to the northbound lane on Adelaide Avenue. However, there is no direct connection to Deakin or the southbound on-road lane on Adelaide Avenue. Connection and signage should be made to the off-road path so these movements can be made via the Kent Street bridge.

The interchange between Cotter Road and Adelaide Avenue provides no pedestrian and cyclist connectivity between the new development and the employment area in Deakin. A grade separated pedestrian and cyclist crossing may provide this connection, which should encourage walking and cycling trips to work. If a cycle and pedestrian bridge is not provided, all walk and cycle trips must use the Kent Street bridge. The *Sustainable Transport Plan* and *Transport for Canberra* suggest that the maximum cycle trip to work is ten kilometres. The provision of good cycling links between the development and Deakin employment area is expected to encourage cycling to work. Also, the connection of the development to the on-road network will allow access to Civic, Russell, Woden and the

Parliamentary Zone, all of which are less than approximately six kilometres from the development and are the major employment areas in Canberra. Figure 29 shows potential facilities and connections that will encourage use of the cycling mode.

4.3.2 Off-Road Cycling

Off-road cycling is appropriate for slower riders and riders who do not feel confident riding adjacent to traffic. The linear park adjacent to the proposed development provides a good opportunity for an off-road shared path. The *Cycling and Pedestrian Network* report (Cardno Eppell Olsen, 2010) recommends an off-road cycle path from Dunrossil Drive along Dudley Street to Novar Street and then south along Kent Street. This alignment is not feasible with the proposed development but the off-road path shown in Figure 29 provides the same connectivity.

The shared path on the Kent Street bridge should be connected to the off-road paths at either end to allow travel in either direction along Adelaide Avenue.

The shared path on the southern side of Adelaide Avenue, west of Novar Street, will need to be realigned prior to commencement of CB+E development in West Deakin.

The recommended cycle facilities for the development are shown in Figure 29.

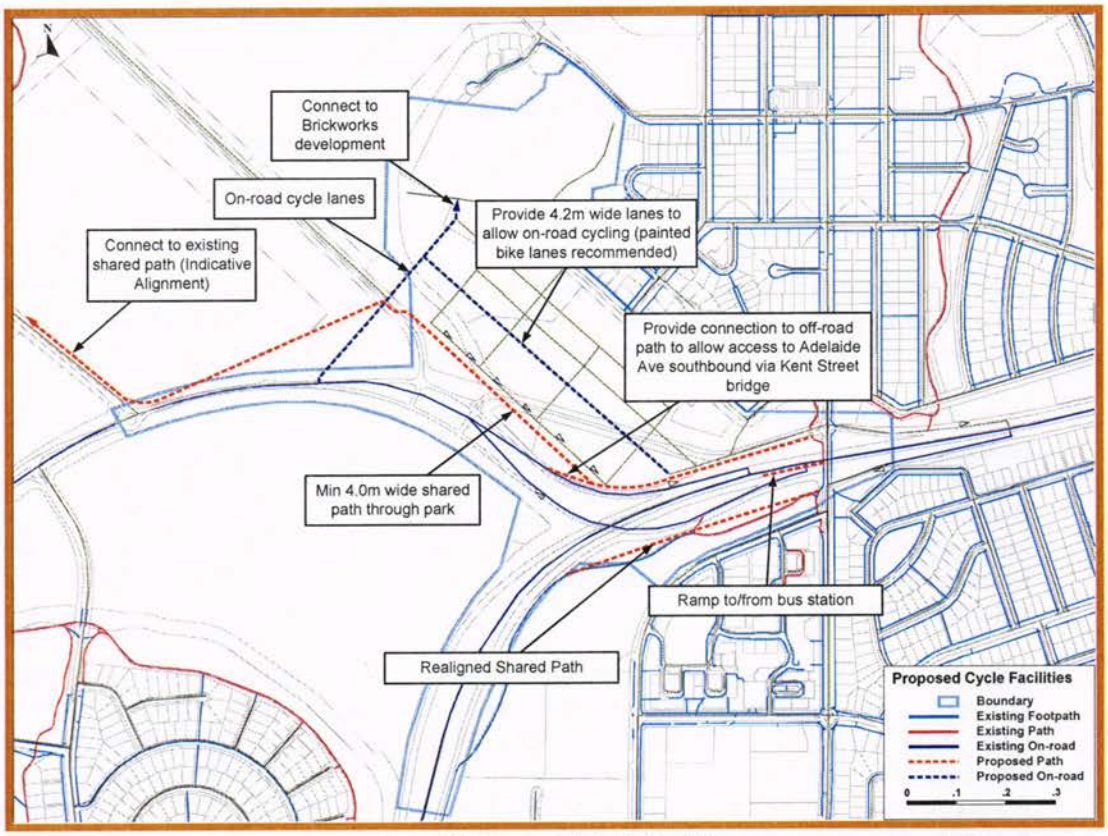

Figure 29: Proposed Cycle Facilities

4.4 Pedestrians

There are currently no pedestrian facilities inside the development area. However, the off-road path on the south side of Adelaide Avenue is part of the trunk cycling and pedestrian network and is expected to be heavily utilised. Figure 30 shows the existing pedestrian facilities.

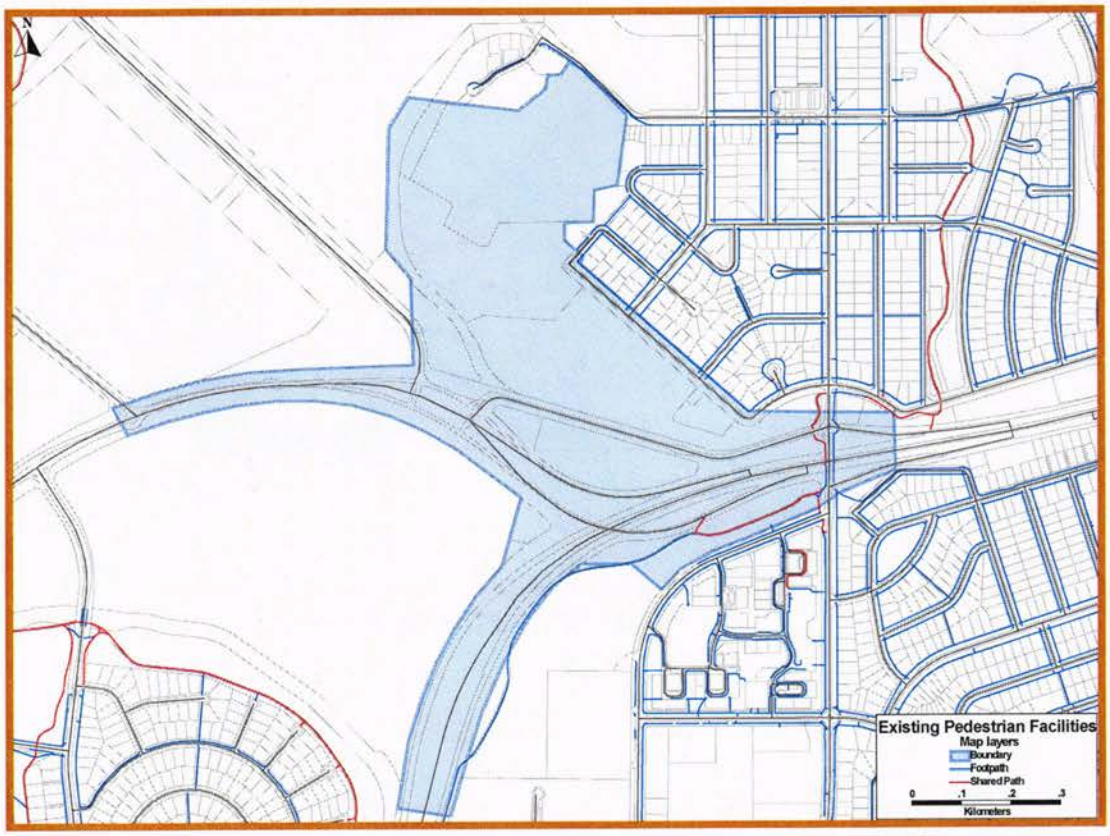

Figure 30: Existing Pedestrian Facilities (Information obtained from TAMS)

The ACT *Design Standards for Urban Infrastructure Part 13 – Pedestrian and Cycle Facilities* (DS13) (TAMS, 2007) state that paths are required on streets where traffic volumes exceed 200 vehicles per day, which is the majority of streets in the proposed development. DS13 also states that paths should generally be provided on all streets in new developments. Paths should be provided on both sides of the street in areas of higher density, higher pedestrian traffic or near commercial centres.

Based on these requirements, it is recommended that paths be provided on both sides of the street on all streets in the development.

Figure 31 shows the main pedestrian attractors in the area along with the proposed pedestrian facilities. It is expected that any retail or commercial areas in the new development will also attract pedestrians and should have adequate footpath connectivity.

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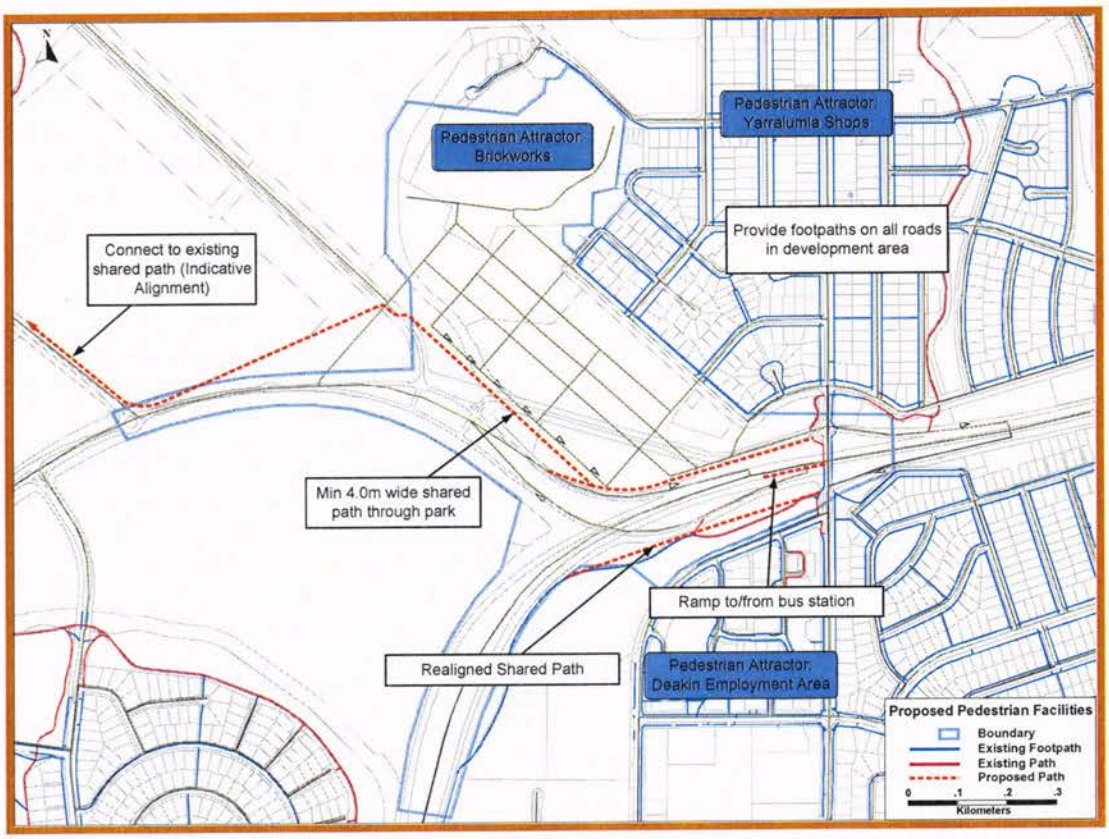

Figure 31: Proposed Pedestrian Facilities

5 ROADWAYS AND CIVIL INFRASTRUCTURE

SMEC engineers have completed a preliminary assessment of the site area as relating to civil infrastructure, including road construction and the provision of utility services. The construction costs anticipated for the CB+E Master Plan are based on recent ACT infrastructure data compiled from a number of local construction projects with certain similarities.

5.1 Site Assessment for Road Layout and Stormwater Runoff

An analysis of the Master Plan road layout has been completed with regard to the required earthworks and stormwater management facilities. The earthwork required for the proposed layout, to confine drainage to the road network and allow for adequate sight distance at intersections, is likely to be extensive because of the conflict between the road layout and the landform. The stormwater management requirements were considered for the entire site area.

5.1.1 Road Layout

The layout provided by Hill Thalis was superimposed onto topographic data to verify the feasibility of the grid-system alignment proposed. The study area is shown on the earthworks plan in Figure 32. The vertical alignment of the major roads was considered in relation to a typical cross section of an urban street. The various road hierarchy typical sections proposed by Hill Thalis have been included in the model, giving a conceptual design which has yielded a reasonable understanding of the earthworks required and final design issues to be considered. Preliminary longitudinal sections have been prepared with consideration to necessary stopping sight distance (SSD) at all crests and low points in the roads. Safe intersection sight distance (SISD) has also been considered, and the design will achieve appropriate sight lines to all intersections once detailed design makes allowance for bulk earthworks, batter slopes and possible retaining walls at road verges.

The earthworks required for the roads are estimated to be in the order of 25,000 m^3 cut to fill, inclusive of pavement boxing requirements. This is exclusive of earthworks required for the site development of each individual block, which is in the order of a further 25,000 m^3 cut to fill. The plan in Figure 32 shows the minimum areas of cut and fill required. More detailed investigation will be required to accurately estimate the bulk earthworks requirements. At this stage, it is estimated that at least 200,000 m^3 of bulk earthworks will be necessary to allow appropriate SISD and contain stormwater within the road system.

For the mixed-use development in West Deakin, along the northern edge of Denison Street, major earthworks will most likely not be required. The Master Plan shows that the proposed development will be set back from the embankments along the edge of the Adelaide Avenue off-ramp. Improvements to Denison Street are not expected to be required. Any earthworks that might be required to prepare the site – including relocation of the shared user path – are estimated to be on the order of 1,000 m^3, and are thus included in the bulk earthworks estimate.

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Road design concerns:

- The grid-system layout is generally at odds with the existing landform, and subsequently the earthworks required are higher than would be the case with a more sympathetic layout. The grid system also provides little scope for directing stormwater into appropriate flow paths away from potential building pad areas without extensive earthworks. The design can be considered acceptable provided that good solar access principles and energy efficient designs can be incorporated into the buildings within the blocks.
- The roads at the southern edge of the site are very close to the existing alignments of Cotter Road and Adelaide Avenue. Further attention will need to be given to minimising earthworks in these areas to avoid impinging on the existing roads.

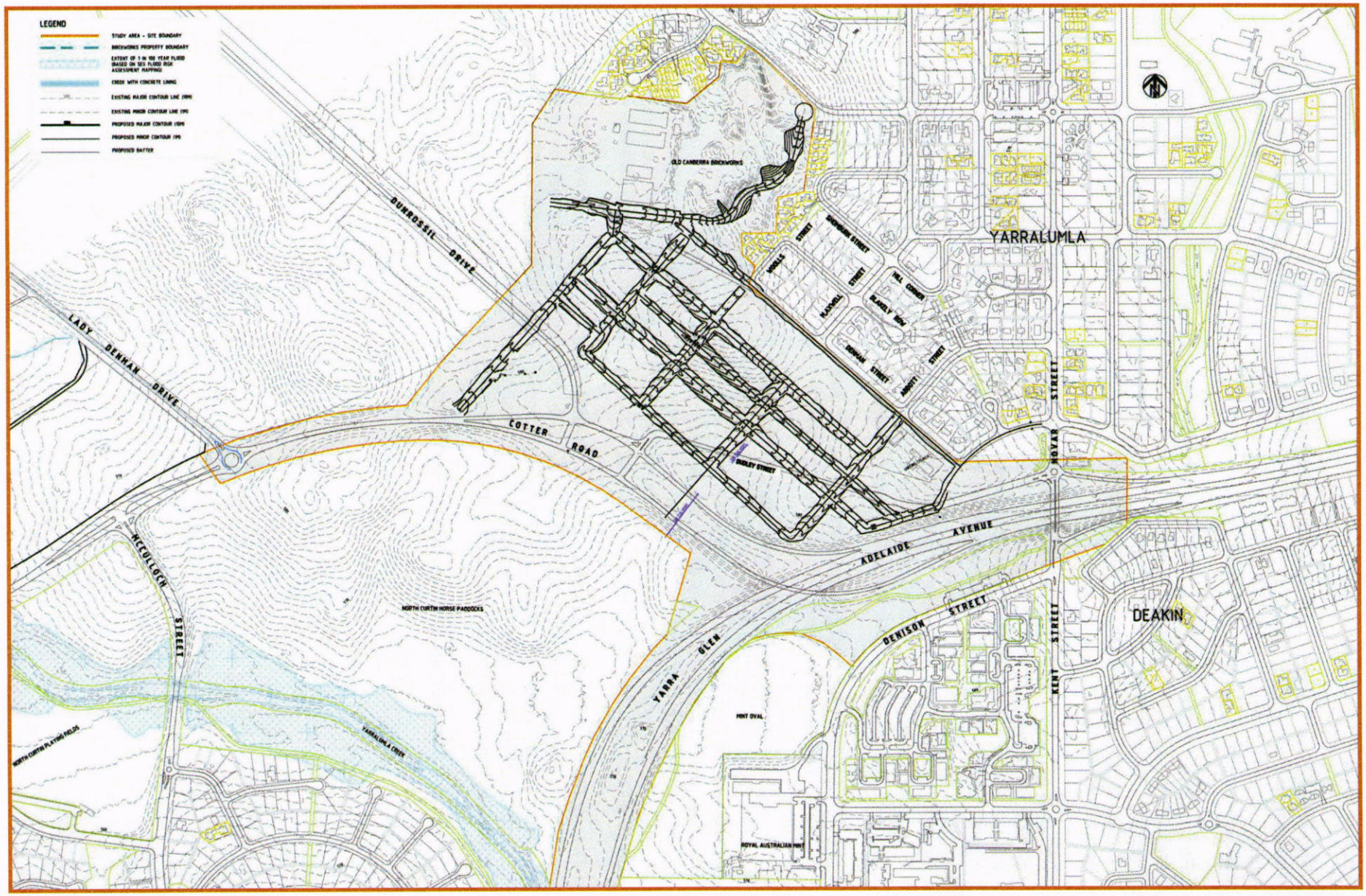

Figure 32: Earthworks and Roadworks

5.1.2 Stormwater Detention

The development of the study area will require post-development stormwater discharges to be less than or equal to the pre-development conditions. Best practice water-sensitive urban design (WSUD) and stormwater harvesting can reduce the required stormwater detention volumes to a significant degree.

Because the site is situated at the lower end of the total Yarralumla Creek catchment area, there may be some argument for reducing or eliminating the throttling effect of detention basins so that, in a critical storm event, the flow from this development will have drained to Yarralumla Creek and the Molonglo River before being joined by flows from the upper catchment.

It should be noted, however, that detention ponds provide more than the effective calming of peak stormwater flows. They generally start life as sediment basins during construction and can be developed to enhance the aesthetic appeal of the neighbourhood, and provide wildlife habitat and ongoing pollution controls once the development is complete.

Given the catchment's location, flooding from upstream catchments is unlikely to occur. Extensive site re-grading will be required to ensure that overland flows are directed along roads and/or dedicated stormwater easements rather than existing gullies within the site.

The site is located on high ground with no runoff or watercourses draining toward the site. Figure 33 illustrates the five small catchments comprising the entire site are.

The opportunity exists for the provision of stormwater detention basins within green spaces proposed for the development. Basins could be located on either side of the extensions of Dunrossil Drive to the west of the development, making use of existing culverts under Cotter Road. Detention could be provided as a surface pond or alternately as an underground storage in the form of Atlantis cells or other underground storage method. In addition, the areas around Dunrossil Drive to the west of the development could also support infiltration zones, bioretention zones, filtration zones and swales.

The commercial area proposed for the Deakin side of Adelaide Avenue could accommodate a precinct wide WSUD strategy. Site topography indicates that water would be able to collected and stored in underground tanks, similar to the option available for Dunrossil Drive, and used as irrigation for surrounding sporting fields. If this option proves unviable, collected stormwater could be used to irrigate green spaces within the precinct.

In West Deakin, overland flow drains towards the Mint Oval.

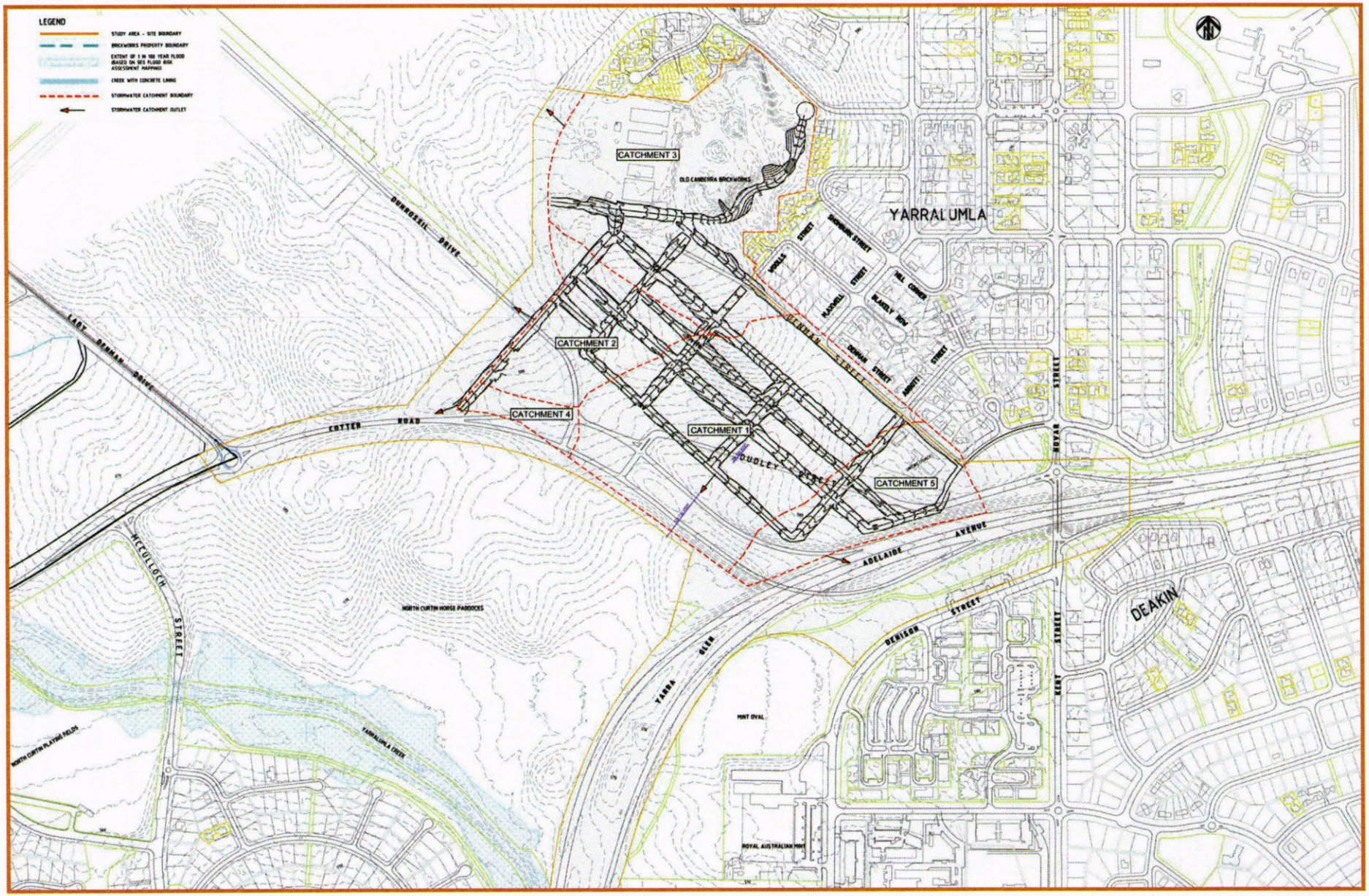

Figure 33: Catchment Areas and Roadworks

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5.1.3 Stormwater Catchments

The catchments have been considered on the basis of minimal earthworks. These catchments should be reviewed once the design has been developed further.

5.1.3.1 Catchment No. 1

This catchment located in the southern section of the site is approximately 14 ha, with stormwater flowing in generally a south-westerly direction gathering at the existing 675 mm diameter pipe culvert under Dudley Street, and then to the existing 900 mm diameter pipe under Cotter Road.

For a design storm with a 2% probability of occurring in any given year (i.e. a 50 year recurrence interval storm) the peak runoff discharge leading to the new alignment of Cotter Road would be expected to be in the order of 1.0 m^3/s with the existing undeveloped conditions. If we conservatively assume no rainwater harvesting and no detention effects of WSUD facilities the post-development runoff would be expected to increase to approximately 1.8 m^3/s for the same 50 year return period. The required detention volume would then be estimated to be approximately 2800 m^3. This could be accommodated by a basin of about 35 m × 75 m assuming an average design depth of 1.0 m. This basin could be sited in a green buffer near Cotter Road or in a number of basins located near the downstream end of the development. Again, the size of the ponding required can be significantly reduced by the use of WSUD principles during final design.

5.1.3.2 Catchment No. 2

This is a 5 ha catchment at the western end of the site draining to catch drains beside Dunrossil Drive in the existing conditions. It is considered that the post-development conditions would result in this catchment draining into and becoming a part of Catchment No. 3

5.1.3.3 Catchment No. 3

This catchment is mainly contained within the existing Brickworks site and was measured at approximately 13 ha. The ultimate discharge point for this catchment is toward the Royal Canberra Golf Club, as indicated by the contours in Figure 33. The heritage buildings comprising the old Brickworks operations have an old underground drainage system that is anticipated to be renovated and perhaps augmented with respect to its hydraulic capacity. Final design proceedings will most likely result in the need for additional detention basin volume in a green belt area to be located in the northern extremity of the site. The old clay excavation areas in this catchment are earmarked for parkland with presumably some significant ponding of the rainfall runoff. The pre-development runoff discharge is estimated at 0.7 m^3/s for the design 50 year storm, and the post-development runoff and downstream detention pond volume will be very much contingent on the amount of ponding and WSUD facilities incorporated into the final design. The downstream basin would be expected to be less than 1000 m^3.

5.1.3.4 Catchment No. 4

This is a small (0.5 ha) catchment at the south-western end of the site draining to catch drains beside Adelaide Avenue in the existing conditions. It is considered that the post-development conditions would result in this catchment continuing to drain to this area.

5.1.3.5 Catchment No. 5

This catchment of approximately 4 ha is located at the eastern end of the site and currently drains to catch drains along the edge of the existing Cotter Road entry ramp to Adelaide Avenue. It is considered that the post-development conditions would result in this catchment draining southwest beside Adelaide Avenue.

5.2 Constructability and Safety Assessment

5.2.1 Construction Issues

The site is undulating with ridges and depressions running at varying directions to the proposed road grid layout. The site will require a substantial earthworks re-grade to suit the proposed layout, ensure the intersections have safe approaches for drivers and that the overland stormwater flow paths are located generally along the road corridors. The natural surface grades for the roads are generally between 4% and 6% with a maximum grade of 8.7%. The grades may have to be reduced to suit the proposed large building developments in order to provide reasonable pedestrian access vehicle access to basement parking and access to building service areas. An initial bulk earthworks design will be required to balance the earthworks for the site and include existing services relocation works. For cost estimation an assumption of at least 200,000 m^3 bulk earthworks has been included.

5.2.2 Safety Issues

The roads will require substantial re-grading from the existing natural surface to ensure safe approaches to the intersections. Local re-grading in the intersections should result in 2% vertical approach grades to ensure the maximum grade break across the road crown is 4% or less to provide riding comfort for vehicles.

The grid layout generally provides right angle crossing of intersecting roads, although there are some intersections that have intersection angles of less than 70°. Drivers will be required to look over their shoulder in order to see approaching vehicles. This movement is difficult for drivers with minor physical and mobility issues.

The vertical alignment should consider accessible grades to allow full pedestrian access to the proposed residential buildings.

Dunrossil Park North appears to be a one way road turning at 90° into Abbott St South which is a two way road. The design will have to provide a U-turn area or restrict access to building sites only for Abbott Street south between Central Street and Dunrossil Park North.

5.3 Road Facilities and Cost Estimates

The road facilities will vary from narrow one-way one lane access alleyways with 7.5 m wide road reserves to major four-lane collector roads with 30.0 m wide road reserves. Pavements are assumed to be flexible (i.e. asphalt overlaying granular base material) ranging from 300 mm depth for the 7.5 m road reserves to 500 mm depth for the 30.0 m road reserves.

The preliminary construction costs are tabulated for each road type based on calculations for all salient road features resulting in overall construction cost per linear metre of each road type in the Master Plan. Table 16 summarises these road costs, taking into account intersection costs, kerbing, footpaths, signage, and services including electricity transmission, water distribution, gas distribution, and telecommunications. Separate items for sanitary sewerage, stormwater drainage, electrical transmission line relocation, high security fibre optic (ICON) relocation, traffic signalisation at the intersection of Cotter Road with Brickworks Road, and relocation of 525 m of 2.5 m wide Shared User Path to make way for the portion of the CB+E development in West Deakin have also been included.

Table 16: CB+E Master Plan Cost Estimates

1	**Road including earthworks and services/utilities (water, electricity, telecoms, gas etc.)**				
	Road Hierarchy	Reserve Width (m)	Length (m)	Rate per metre	Total Cost
	1	7.5	566	$1,071.43	$606,428
	2	12	772	$1,353.50	$1,044,898
	3	18	851	$1,533.68	$1,305,157
	4	20	1,381	$1,584.08	$2,187,618
	5	30	1,197	$2,193.26	$2,625,335
	Total		**4,767**		**$7,769,437**
2	**Road Drainage**				**$1,760,793**
3	**Sewer**				**$1,923,435**
4	**Relocation of Services**				**$3,150,000**
5	**Bulk Earthworks (200,000 m³)**				**$3,560,000**
6	**Signalisation of intersection between Cotter Road and Brickworks Road**				**$210,000**
7	**Relocation of Shared User Path (West Deakin)**				**$100,000**
Total Cost					**$18,473,665**

These civil infrastructure costs relate only to the subject development and do not include contingency. An additional item has been included for bulk earthworks, due to the site issues identified in Sections 5.1 and 5.2. This is estimated to be at least 200,000 m³, but requires substantial further analysis.

5.3.1 Intersection Upgrades Required in Do Nothing

The intersection modelling identified issues with some intersections that can be expected to require upgrade in future even in the Do Nothing scenario, i.e. even if the CB+E Master Plan development does not go ahead. Some brief cost estimates have been developed for these intersections and are detailed in Table 17.

Table 17: Intersection Upgrades Required in Do Nothing

ID	Intersection	Required Works	Cost Estimate
4	Novar Street – Dudley Street/Adelaide Avenue on-ramp	Complete pavement reconstruction to alter grades, from those appropriate to the existing roundabout, to those appropriate for signals.	$800k-$1m + contingency
5	Kent Street – Adelaide Avenue off-ramp	Retrofit of the existing give-way intersection with traffic signal hardware.	$200k + contingency
6	Kent Street – Denison Street	Retrofit of the existing give-way intersection with traffic signal hardware.	$260k + contingency

5.4 Utility Services

5.4.1.1 Existing Utility Services

The study area is located in a very developable topography, mostly free of obstructions with the exception of some existing utility services that will require relocation. The owners and agents of the various services have been cooperative in providing responses to an initial "Dial-Before-You-Dig" request and in subsequent telephone conversations. Refer to the accompanying existing services conditions plan in Figure 34 for a graphic representation of the existing utility services in the area.

In the Old Canberra Brickworks site, there are existing tie-ins to water distribution, sewer reticulation, power distribution and telecommunications. It is expected that the adaptive reuse development in this area will make use of these facilities or require the relocation and/or augmentation of these essential facilities. The remainder of the study area comprises undeveloped land and road reserves areas. The undeveloped land has some significant ICON (high security telecommunications) fibre optic cabling crossing the site. These cables are in shared trenching with some telecommunications lines and these are estimated to be only about a metre in depth. Therefore, the ultimate development is expected to require the relocation of much of these services to the perimeter of the study area. Additionally, there are high voltage overhead lines crossing through the undeveloped area which will similarly require some relocation.

The road reserves within the study area (Cotter Road, Yarra Glen, Adelaide Avenue, McCulloch Street and Dudley Street) have street lighting and other miscellaneous service facilities leading to the nearby residential areas, which will require relocation accordingly.

The initial account of the services is summarised in Table 18. Existing services are shown in Figure 34.

Table 18: Summary of Existing Services

Utility Service	Old Canberra Brickworks	Remainder of the Study Area
ICON	No facilities in area.	▪ 1,078 m of fibre optic cabling runs from Yarralumla Creek to Denman St. ▪ Another 1,301 m of fibre optic cabling is located in a shared trench with AAPT (as stated again in the AAPT row and TransACT row of this table).
ActewAGL Sewer	▪ An 87 m long sewer connection line crosses the brickworks property boundary in its northwest corner.	No facilities in area.
ActewAGL Electricity	▪ Approximately 200 m of high voltage overhead powerlines feed electricity to the brickworks (southern-most buildings only) originating from the corner of Woolls St and Denman St. ▪ 13 m of abandoned underground high voltage power cabling runs between two of the southern-most buildings in the brickworks.	▪ Approximately 3,161 m of high voltage overhead powerlines are located within the undeveloped project area. Most of this is found along road edges, however there is a 560 m length which runs from north to south through the horse paddocks, and there is a 289 m section which runs between Dudley St and Denman St. ▪ Approximately 270 m of underground low voltage cabling is located in Cotter Rd, between Lady Denman Dr and McCulloch St. ▪ There is over 8 km of underground streetlight power supply cabling which is located along road edges only. There is an additional 850 m of abandoned streetlight power cabling located along various road edges.
ActewAGL Water	▪ 651 m of reticulation line with a diameter of 100 mm delivers water to the brickworks buildings originating from the corner of Woolls St and Denman St.	▪ 1,749 m of reticulation lines with diameters of 100-225 mm are located in the project area. 1,135 m of this piping is located along road edges. The remaining 614 m is located in open areas. ▪ A bulk distribution line (450 mm) follows the bridge over Adelaide Av, along Kent St and Novar St.
Telstra	▪ 317 m of Telstra cabling is located within the brickworks property, although it is not in close proximity to any buildings. ▪ 229 m of this cabling is located just within the property boundary (less than 10 m). ▪ The remaining 88 m extends into the brickworks block.	▪ 3,011 m of Telstra cabling is located within the project area (not including brickworks). Most of this cabling is located along road edges (Cotter Rd, Dunrossil Dr, Dudley St, Novar St). ▪ There is approximately 600 m of cabling just below the southeast corner of the Uniting Church. This cabling is not along a road edge.

Utility Service	Old Canberra Brickworks	Remainder of the Study Area
Optus	No facilities in area.	▪ Optus has one length of cabling which is within the project area. This is a 230 m length of cabling which runs across the bridge over Adelaide Av and continues north and south along Novar St and Kent St respectively.
TransACT	No facilities in area.	▪ A 230 m length of cabling runs across the bridge over Adelaide Av and continues north and south along Novar St (where it becomes underground cabling) and Kent St respectively. ▪ TransACT also shares a trench with ICON and AAPT for 1,301 m (as stated again in the ICON row and AAPT row of this table).
AAPT	No facilities in area.	▪ Approximately 1,301 m of cabling is located within the project area, primarily running along the southern edge of the project. All of this cabling is shared with ICON and TransACT (as stated again in the ICON row and TransACT row of this table).
Jemena Gas	No facilities in area.	▪ 849 m of 63 mm gas lines and 256 m of 110 mm gas lines are located within the project area. All of this piping is located along road edges, running along Novar St, Dudley St, and Lady Denman Dr.

5.4.1.2 Proposed Utility Services

Gas utilities currently service surrounding areas, and gas supply should be relatively simple to provide. However, some upgrades may be required subject to Jemena requirements and availability. Gas reticulation services would be provided from within street verges as per ACT standard practice.

Water mains currently cross the development site, and would need to be relocated as part of the works. Water connections to the wider network are possible at Dunrossil Drive, Cotter Road, Dudley Street and from within existing streets in Yarralumla. The existing water distribution network is expected to be adequate to accommodate the proposed development. The limits of the development are very close to the water zone boundary of the Scan655 (South Canberra) Zone and the Wodlow640 (Woden/Lowe) Zone. The zone valve along Dunrossil Drive will need to be relocated to enable connection to the 150 mm diameter line located in the Dudley Street reserve. Additional connection will be possible at the 150 mm diameter line just north of the Brickworks site and other connections to the 100 mm diameter line in the adjacent residential subdivision of Yarralumla. There is approximately 60 m of static head available at the site's highest elevation.

The existing sewerage facilities in the surrounding area are also understood to be adequate to accommodate the development, with infrastructure existing to the north-east within Yarralumla and to the south on the southern side of Yarralumla Creek. Sewer reticulation would be provided within street verges as per ACT standard practice.

Telecommunications utilities will be provided by TransACT, with the National Broadband Network (NBN) possibly also provided subject to timeframes of the development and the NBN. Telecommunications utilities would be provided from within street verges as per ACT standard practice.

Electricity would be provided by ActewAGL. Further investigations will be required to ascertain the energy requirements of the development and if network upgrades are required. The transmission of electricity for the development would also be accommodated by the nearby existing transmission lines. An overhead high voltage line is currently crossing the site area from the north end of Dudley Street to the Yarralumla residential areas. This line will require relocation to an underground trench within one of the proposed road reserves.

There is one underground streetlight cable serving the carpark that is currently situated in the eastern end of block 4, section 65 Deakin, along Denison Street. The carpark will be removed during the West Deakin development works and the streetlight cable does not need to be realigned or replaced prior to release of the site.

Major reticulation routes and possible connection locations for services are shown in Figure 35.

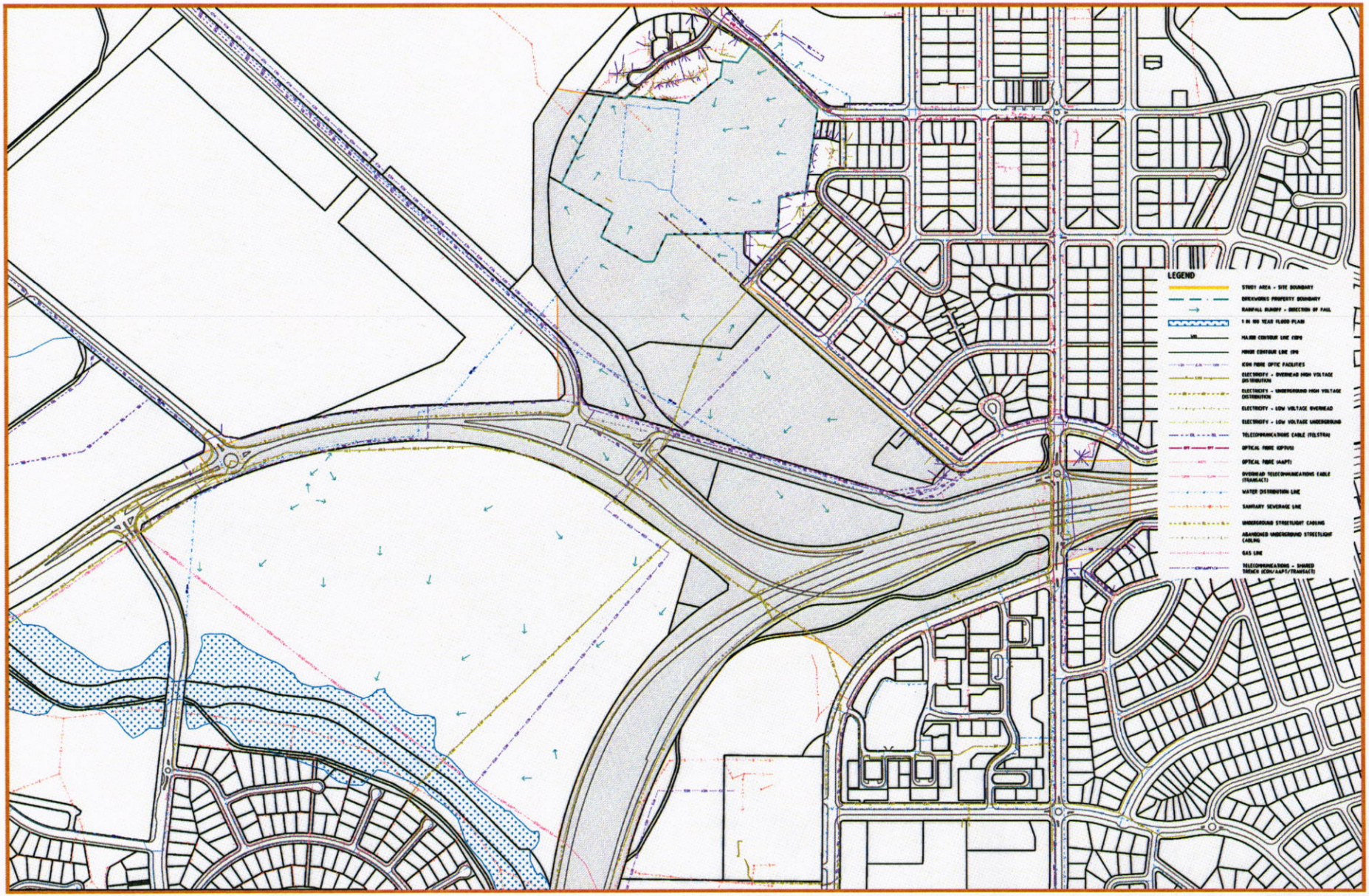

Figure 34: Existing Services Conditions

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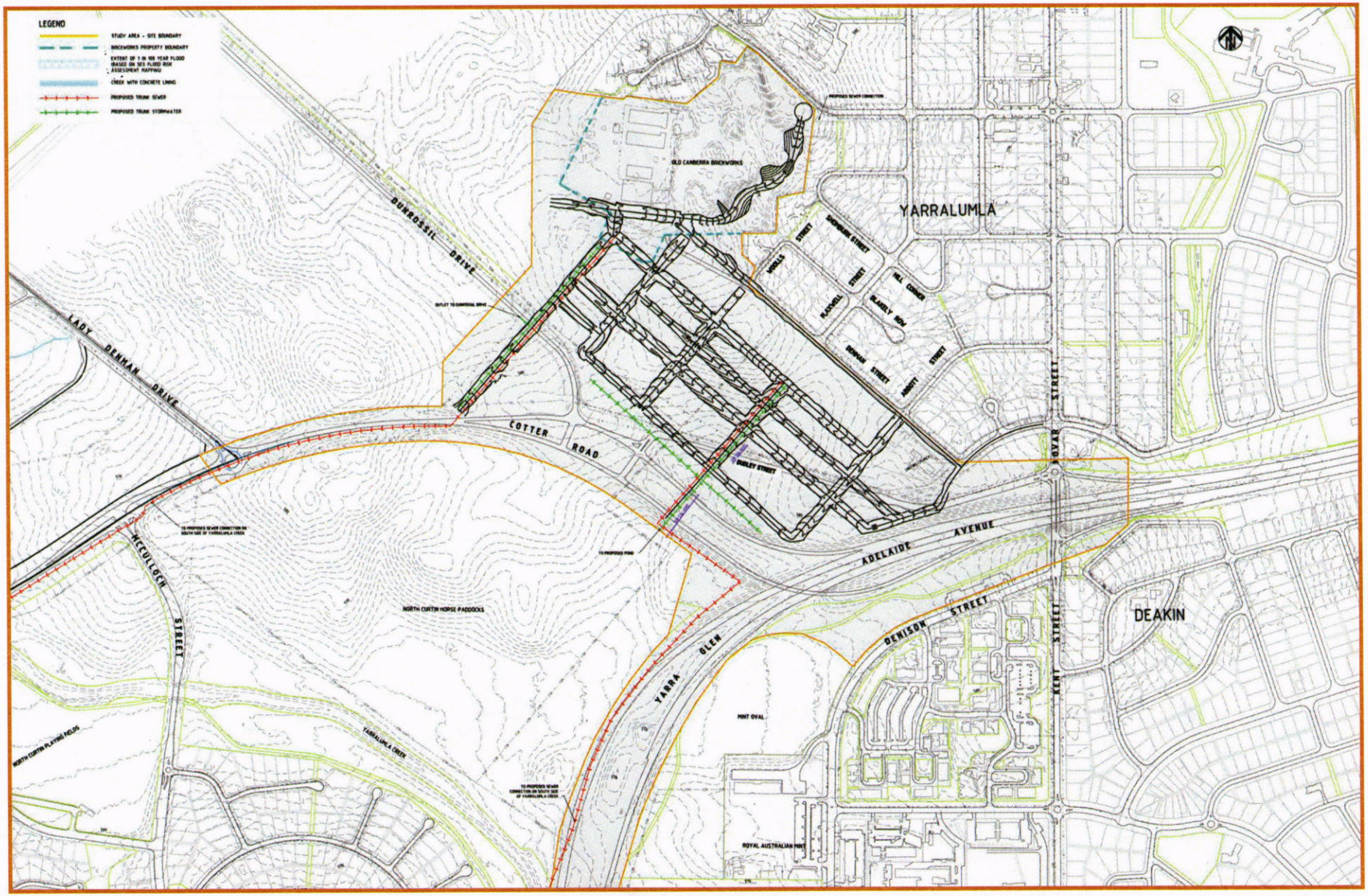

Figure 35: Proposed Service Connections

6 CONCLUSIONS

6.1 Traffic Operation

A number of key findings were made during the AM peak traffic analysis:

- The assumed level of traffic growth by 2031 AM will cause Cotter Road eastbound to operate at its capacity, and overload the surrounding roads (Cotter Road – Adelaide Avenue on-ramp, Dudley Street).
- The Cotter Road – Adelaide Avenue on-ramp operates over capacity in its current configuration. The removal of the proposed roundabout interchange between Cotter Road and Adelaide Avenue, from the CB+E Master Plan design, reduces the available route options and misses the opportunity to improve capacity for eastbound traffic.
- Due to the increased traffic demand for alternative access routes to Adelaide Avenue, the CB+E development will have a large amount of through traffic flowing through it in 2031 AM. Traffic travelling through the development will experience substantially increased travel times.

6.2 Other Transport Modes

The provision for public transport, bicycle and pedestrian traffic must consider the goals of *Transport for Canberra*. Within this context, recommendations have been made to accommodate these alternative transport modes within and around the development area.

- Lower hierarchy streets will operate at speeds that accommodate on-road bicycle use without dedicated bicycle lanes.
- Dedicated on-road bicycle lanes have been recommended for the major streets through the development, with connection to the existing on-road bicycle lanes and off-road bicycle paths.
- The Strategic Public Transport Network Plan recommends a number of bus routes of various hierarchies near the area, which can directly service the area, via the proposed bus stop in the median of Adelaide Avenue.
- Good pedestrian connectivity to surrounding attractors is recommended.

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6.3 Roadways and Civil Infrastructure

A preliminary engineering assessment of the development site has concluded the following:

- The existing water distribution network is expected to be adequate, with some minor relocation of water services to accommodate the required connections.
- The existing sewerage facilities are understood to be adequate.
- The nearby electrical transmission lines can be used to supply the site. The existing overhead high voltage line should be relocated underground.
- The high security ICON cable will require relocation.
- Existing natural gas lines are expected to be available for connection to the site.
- Earthworks to accommodate stopping and safe intersection site distances were considered. A total of 25,000 m^3 of cut to fill is required for the roadways and a further 25,000 m^3 of cut to fill is required for levelling blocks.
- It is estimated that at least 200,000 m^3 earthworks will be necessary to allow appropriate SISD and contain stormwater to within the road system.
- The alignment of the grid layout is considered acceptable for solar access but limits scope for directing stormwater around or away from building pad areas.
- The site is on high ground and is not expected to collect runoff. Peak 50 year stormwater flows are expected to be able to be accommodated by no more than 2,800 m^3 worth of detention pond volume.

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ID	LDA Comment	SMEC Response/Action
1	There is an error in the cost summary table in the Executive Summary. The total should be $18.373m, not the $16.373m shown.	This has been corrected. The cost has also been increased to $18.473m due to the addition of a $100k item. Note that the cost estimates do not include contingency.
2	At the front of the report, add a location plan and precinct plan showing all the current and proposed streets (refer to the draft master plan for names of proposed streets).	Updated Figure ES.1 and Figure 1 with the provided diagram.
3	SMEC verbally advised Stuart Oxborrow (LDA) that the bulk of the rat-running traffic through the Brickworks site is actually traffic which is coming from Cotter Road and is heading to Deakin, not Adelaide Ave. This is not apparent from the report. If so, the report should be updated to reflect this. Also, what proportion of the rat-runners through the Brickworks Development are travelling from Cotter Road to Deakin and what proportion are going to Adelaide Ave.	Added a table with a breakdown of destinations, and discussion to sections ES.2 and 3.1.
	- The report needs to include discussion of the breakdown of volumes by destination (Cotter Road to one of the following: Adelaide Avenue; West Deakin; Yarralumla) of through traffic within the estate. Note the amount of traffic generated by the estate. For instance, Section 3.2 (last paragraph) states that the congestion on the Cotter Road / Adelaide Ave on ramp will cause vehicles to seek alternative routes through the brickworks site. Are there any measures on Adelaide Ave, such as a third lane on Adelaide Ave from this on-ramp, or any other measures, which could reduce this problem. If so, would this alleviate the rat-running through the Brickworks site.	A breakdown and discussion of this traffic has been added to section 3.1 and the potential Adelaide Avenue third lane solution has been included in the discussion in section 3.4.2.
	- What proportion of land use elements (Table 1) from the brickworks development has been allocated to West Deakin in the model? The large proportion of residential population is proposed to be near Adelaide Avenue (1000 dwellings) with taller buildings in West Deakin (8 storeys). Could a comment be included on school/tertiary enrolment estimates in table 1 be provided for the brickworks development. [LDA could be asked how 'zone 240' in Table 1 can generate 200 school enrolments with a zero population.] The report (parts 4.3, 4.4 and costs?) needs to acknowledge changes to the pedestrian / cycle paths in West Deakin due to the proposed development.	West Deakin holds all 500m² of the additional retail floor space, all 622 additional jobs and 583 (23% of the total) additional residents according to the calculations we performed, based on average occupancies from the 2011 Census for the area and the provided floor space and dwelling yield tables from Hill Thalis. All of the additional CB+E land use has been placed in new zones that were added to the EMME model - the existing zones have not been changed. The "school enrolments" land use indicates the presence of one or more schools in that zone. It generates traffic to and from those schools and is not tied to population in the same zone. Sections 4.3 and 4.4 of the report have been updated to account for the required changes in West Deakin. The additional cost for relocating the shared user path has been included in the costs table in the Executive Summary and section 5.3.
4	Is there any merit in providing and edge road from Brickworks Road, around the Brickworks development, to Novar Street, to take rat-running vehicles around, rather than through the brickworks site (down Central Street)? One option would be to include a road reserve (which could accommodate two-lane each way, wide central median and street large trees) in the alignment of Dunrossil Drive. The report would need to comment on staging of this road works.	This was originally to be evaluated during Stage 2 of the original scope of works of the earlier CB+E traffic evaluation, however we were later asked not to continue past Stage 1. The remaining budget for Stage 2 was then absorbed into this project (i.e. CB+E Report Update). As such we haven't modelled this alternative. With that said, providing an edge road would at least remove most of the through traffic from Central Street. It's worth noting that in the current model, Central Street is very close to capacity and therefore some of the through traffic uses North Terrace instead. Some of the through traffic would therefore probably still use Brickworks Road. An edge road however will not alleviate the issues at the intersections on Kent/Novar Street.
5	A comparison of costs from May 2011, to Sept 2013 – noting that earthworks appear to be omitted in 2011 – why are the costs actually more for comparatively less infrastructure? Cross-referencing the line items doesn't seem to make sense – can SMEC give some commentary around this?	As requested, the per-metre rates from the 2011 report were re-used as a basis for the updated costing. They were then indexed to 2013 values based on rate schedules that were provided by LDA from similar projects during that period. The addition of the bulk earthworks costs is based on a more thorough analysis of the site, and is a reflection of the complexity of the site, as discussed in chapter 5 of the report.
6	The analysis/commentary needs to clarify the results of two scenarios: do nothing and development. For instance, Table 10 states that the Novar/Dudley and Kent/Adelaide off-ramp intersections will be LOS F in 2013 under the do-nothing scenario. What is causing the deterioration in LOS at this intersection under the do-nothing scenario? In what year (approximately) will these intersections need upgrading to signalised under the do-nothing scenario. This discussion is required to assist a discussion of what works can be considered estate related and what works are capital associated works.	The future volumes are based on the calibrated 2010 AM Existing Paramics model, with traffic growth derived from the 2011 and 2031 EMME models. These EMME models generate traffic using the ESDD's land use forecasts. The intersections are simply breaking down because the expected growth in area traffic by 2031 is too much for them to handle. That they fail in 2031 AM Do Nothing indicates that the CB+E development is not the cause of the failure. To test this quickly, we ran some extra SIDRA models for 2016, 2021 and 2026. The turning movement counts for these were simply interpolated between the 2010 AM Existing and 2031 AM Do Nothing SIDRA models. They are therefore only approximate results; if more detailed results are required then we would recommend additional EMME and Paramics models for the intervening years, which is not covered by the current project scope and would be a variation. The results of this brief test are: The Kent St/Novar St - Dudley St/Adelaide Ave Onramp intersection goes to an overall LoS F between 2026 and 2031, however the Novar St north approach goes to LoS F between 2016 and 2021. The Kent St - Adelaide Ave Offramp Intersection goes to an overall LoS F between 2026 and 2031.
7	What is the cost estimate for the three signalised intersections on Kent and Novar Sts. Are there any costs associated with road improvements in Denison Street that the modelling demonstrates as necessary. Noting the deliverables (perhaps by including a reference figure showing the location of upgrade/new works) associated with the costing of works in Table 14 would be useful.	If Kent St - Adelaide Ave Offramp only requires retrofitting the existing give-way intersection with signal hardware, it would cost around $200k+contingency. If Kent St - Denison St only requires retrofitting with signal hardware, with the addition of two small slip lanes it would cost around $260k+contingency. Kent St/Novar St - Dudley St/Adelaide Ave Onramp will require complete reconstruction of the pavement to change the grades from those appropriate for the existing roundabout to those appropriate for signals, and could be on the order of $800k-$1m+contingency. The items covered by the cost estimates are discussed in section 5.3. It should be noted that these estimates are indicative only and very high level at this stage. A more detailed and accurate estimate should be considered as part of the next stages of the project - feasibility study and detailed design.
8	As a possible variation (confirm this work would be done at hourly rates) provide comment/analysis to enable clear identification of the costs for roadworks in stage 2 of the estate.	This version of the report was requested by LDA to investigate Stage 1 only, and was based on a previous report that looked at the complete development. Updating again assuming that Cotter Road is realigned and CB+E Master Plan Stage 2 is completed would be a similar amount of work and constitutes a variation.
9	Comment on coverage of the O&E report to respond to the following matters included in the ESDD scope for a planning report	
	- proposed vehicle access and traffic impact assessment, if development of the site was to achieve full capacity under the proposal	This is likely to be conducted in a later stage of the planning project.
	- transport studies, including access to current and future stops/nodes on the high frequency public transport network	Pedestrian/cycle access to the proposed stop on the high frequency public transport network (Adelaide Avenues) is addressed (Figures 29 and 31). Coverage of the proposed stop is also shown (Figure 27) and discussed.