

To: Environment and Planning Directorate, ACT Government  
Date: 18 November 2015  
Subject: Representation on the Capital Metro Light Rail Development Application

To whom it may concern,

I wish to make the following representation on the Capital Metro Light Rail Development Application.

Yours sincerely,

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# 1 Introduction

The first consideration to be used when deciding development approvals, as listed in the The Planning and Development Act, 2007 is:

*"the objectives for the zone in which the development is proposed to take place;"*

In the context of the Capital Metro application, this means *"Will the development, as proposed, meet its own objectives and the objectives for the transport zone, TSZ1, as defined in the ACT Territory Plan?"*

The Capital Metro Light Rail Development Application is supported by the Capital Metro Draft EIS. As shown in this response, the Capital Metro Draft EIS shows that the project fails to meet its own objectives and the objectives of the ACT Government's *"Transport for Canberra: Transport for a sustainable city transport"* planning document. As will be shown, it also fails to meet the efficiency and safety objectives defined for TSZ1 in the ACT Territory Plan:

*"Make provision for a transport network that can provide for the efficient, safe and convenient movement of people and goods"*

Any development application that fails to meet the objectives of the ACT Territory Plan, ACT Government policy objectives and even its own stated objectives could not expect to be accepted. For example, a development application for a road that failed to transport people efficiently and safely, that failed to meet its own objectives for capacity, that failed to meet the Government's objectives for road transport would be summarily rejected.

The Capital Metro Light Rail Development Application describes a project that fails all three sets of objectives: those of the ACT Territory Plan, those of the ACT Government and even those stated in the Development Application's EIS. These failures are systemic to the design of the project and they are comprehensive. It fails environmentally, economically, socially and as a transport solution. Hence, the project described in this application is not "fit for purpose" as a transport solution for Canberra, and the Capital Metro Light Rail Development Application should be rejected.

## 2 Objectives needed to be met by the Capital Metro Light Rail Development Application

### 2.1 The ACT Government's "Rapid Service" Speed Requirement

The ACT Government's 2012 document specifying its "foundation for transport planning for the next 20 years", *"Transport for Canberra: Transport for a sustainable city"*, defines four service types. At the top of the pyramid is "Rapid Service", defined as:

*"Public transport corridors for all day, high speed travel across the city along dense corridors. Analogous to a metro or rapid public transport system, and location for future light rail or bus rapid transit. Rapid services carry the majority of passengers, and can help achieve mode shift goals for work trips and associated emissions reductions."*

[*Transport for Canberra: Transport for a sustainable city*, Table 2, page 19]

The speed standard for "Rapid Service" is set at 40km/hr including stops, in Action Item 17 of *"Transport for Canberra"*:

*"Adopt an operating speed standard of 40km/hr for the rapid service to guide the infrastructure investment program [within 2 years]"*

Capital Metro adopted and publicised this goal in 2104, explicitly recognising the need to deliver rapid transport with an average speed, including stops, of at least 40km/hr. The Capital Metro website's FAQ page in March 2014 (archived by the Internet Archive, also in April 2014 version archived by NLA's Pandora) contained this commitment:

#### ***"How long will the journey/s take?"***

*The service will be a Rapid Service as defined in the Government's transport policy Transport for Canberra. An average speed of 40 km/hr (including stops) is required for this service."*

Yet the Capital Metro Business Case and EIS specifies a 25 minute trip over the 12 km route, at an average speed of 28.8km/hr.

Much scepticism has been expressed by informed commentators that even this slow speed service will not be achievable on the proposed route. The new Gold Coast line, to which Capital Metro is often compared, with the latest light rail rolling-stock achieves barely 21km/hr under similar running conditions. Even the new Dulwich Hill light rail extension in Sydney which is entirely "grade separated", crosses no intersections and is

entirely separated from other vehicles, achieves an average speed of under 26 km/hr, also with the latest rolling-stock. Capital Metro cannot nominate a comparable light rail system (running in an urban setting, not running in a segregated corridor, not protected by fencing and level crossings, crossing over 20 intersections in 12 km) achieving an average speed of 28km/hr. It is noted that Capital Metro assert that the 3.2 km journey from Civic to Russell (Stage 2) will take 15 minutes at an average speed of 12.8 km/hr, casting further doubt on the practical day-to-day achievability of 28.8km/hr on the Stage 1 route.

The theoretical 25 minute journey time is achieved only with very high top speeds and very high traffic signal priority which, as the Capital Metro EIS model shows, increases congestion for other vehicles and greatly reduces vehicle average speeds.

From discussions with Capital Metro, they have not yet gained accreditation from the Office of the National Rail Safety Regulator (ONRSR) for the proposed high-speed travel needed to average even 28.8 km/hr, and even if it was granted, the achievement of this speed comes at the cost of reducing the average network speed of road traffic very substantially (more below).

In any case, the ACT Government's required 40km/hr for "Rapid Service" travel required in this corridor by their own planning document is 39% higher than the 28.8km/hr optimistically forecast by Capital Metro.

**Hence, for falling far short of meeting the Government's objectives of "Rapid Service" in this major transport zone, even whilst increasing overall congestion and journey times, the Capital Metro Light Rail Development Application should be rejected.**

## 2.2 TSZ1 efficiency and safety objectives

The first objective of the Transport Zone TSZ1 defined in the ACT Territory plan is:

*"Make provision for a transport network that can provide for the **efficient, safe and convenient** movement of people and goods"*

### 2.2.1 Efficiency and convenience

Because the primary economic justification advanced for light rail in the Capital Metro Business Case was savings arising from reduced congestion and travel times, the modelling of travel times and congestion by the EIS is of great interest.

In Technical Paper 5: Traffic and Transport and Traffic and Transport Appendix B, "VISSIM model outputs", the EIS modelling compares "base-line 2021" travel times (no Capital Metro project) with the "project 2021" travel times (with the Capital Metro project). The results of this modelling include:

- Average combined AM and PM peak period vehicle speed over the road network around the proposed route (not just traffic on the direct route) decreases from 27.8

km/hr without light rail to 23.1 km/hr with light rail (Table 4.2, page 38).

- For traffic on the direct route, the travel time for a peak-period return trip from Gungahlin to Civic with the predominant traffic flow (to Civic in the AM, to Gungahlin in the PM) increases from 52 minutes 6 seconds without light rail to 55 minutes 23 seconds with light rail (Table 4.3, page 39).
- The analysis of intersection performance over AM and PM peaks shows that the combined number of intersections at which traffic will exceed capacity more than triples from 2 without light rail to 7 with light rail. Further, the combined number of intersections which will be operating at the limits of their capacity doubles from 3 without light rail to 6 with light rail (Table 4.5 to 4.10, pages 41 to 45).
- Increased delays attributable to the project both travelling along and across the route will be substantial. For example, the EIS model estimates these average delays during the AM peak in 2021:

<b>Intersection</b>	<b>Travel Direction</b>	<b>Delay without light rail (sec)</b>	<b>Delay with light rail (sec)</b>	<b>Increased delay attributable to the light rail project (sec)</b>
Flemington Road Federal Highway	East-South	29.4	125.0	95.6
	East-North	79.5	174.6	95.1
	North-East	11.6	49.5	37.9
	North-South	28.0	64.5	36.5
	South-East	24.5	56.0	31.5
Federal Highway Barton Highway	North-South	34.4	230.5	196.1
	North-West	141.0	268.4	127.4
	West-North	90.3	182.4	92.1
	West-South	132.8	266.7	133.9
Northbourne Avenue Mouat Street / Antill Street	North-South	66.4	36.9	-29.5
	West-North	34.2	124.9	90.7
	West-East	63.0	174.6	111.6
	West-South	63.5	155.2	91.7
Northbourne Avenue Barry Drive / Cooyong Street	North-South	23.7	9.7	-14.0
	West-North	14.7	177.5	162.8
	West-East	52.4	163.5	111.1
	West-South	51.5	151.9	100.4

Source: [Traffic and Transport Appendix B, Table B1.3 and Table B2.3.](#)

### Car travel times on individual legs

Southbound				Northbound			
AM		PM		AM		PM	
No light rail	With light rail	No light rail	With light rail	No light rail	With light rail	No light rail	With light rail
31:26	27:37	21:38	23:59	20:42	22:24	20:40	27:52

### Car travel times for commuter round-trips

Gungahlin - Civic - Gungahlin		Civic - Gungahlin - Civic	
No light rail	With light rail	No light rail	With light rail
52:06	55:23	42:20	46:23

Source: [Table 4.3, page 39](#).

As can be seen, both round trips and with one exception, the individual peak period route travel times are significantly longer with light rail. That one exception is the AM southbound trip. Looking at the route breakdown for this exception show that even for this trip, the time taken for the trip south of Wells Station Drive to Civic is 30 seconds **longer** with light rail: all the travel time savings are for the Gozzard Street to Wells Station Drive section, the modelled time for which drops from 16:58 (no light rail) to 7:27 (with light rail), a difference of 9:31.

This reduction with light rail seems rather extraordinary. Gozzard Street, on the western end of the Gungahlin Town Centre, Hinder Street at the eastern end, and Kate Crace Street will be the routes taken by cars from northern and western Gungahlin to the new Park and Ride facility (to the south of Hibberson Street), which is planned to accommodate commuters attracted to the light rail.

Yet the model assumes cumulative AM peak traffic volumes on the Hibberson/Gozzard, Hibberson/Hinder and Hibberson/KateCrace intersections will *drop* from 3645 vehicles to 2699 vehicles with the light rail project. It seemed that drop may be the cause of much of the modelled travel-time reduction on the Gozzard Street to Wells Station Drive section of the route, but if the Park and Ride facility is taken-up by light rail commuters more than bus commuters (in line with the modelled light rail patronage increasing), surely the traffic to the Park and Ride facility will increase as well, increasing, not reducing the vehicle traffic in these modelled intersections. However, there was another reason...

## **The uncosted duplication of Flemington Rd south of Wells Station Dr, providing advantage to the "tram" model**

The improvement of 9:31 with light rail on this short segment from Gozzard Street to Wells Station Drive section seems incredible and is unexplained. The ACT Government Environment and Planning Directorate (EPD) also noted this anomaly in their response to the EIS. The EIS preparation team explained that the "base" (no light rail) times were longer due to delays at Wells Station Drive arising from the two-to-one-lane merge just south of Wells Station intersection:

*“The travel times listed in Table 10.6 and Table 10.9, including for the Gozzard Street to Well Station Drive section in the Base case AM scenario, are correct. The travel time for the southbound AM peak travel on this section was forecast to be higher in the Base Case compared to the Project Case, primarily due to congestion experienced at the Well Station Drive intersection as a result of the two to one lane merge just south of the intersection. In the Project Case, this section of Flemington Road is proposed to be upgraded to two lanes south of Well Station Drive, removing the congestion, and resulting in the Project Case performing better than the Base Case.”*

Source: Capital Metro Light Rail Stage 1 - Gungahlin to Civic Environmental Impact Statement Addendum Report, August 2015, page 19

That is, the light rail "Project" case reduces travel time by 9:31 on this section by assuming construction of additional road lanes on Flemington Road as part of the project. However, the [Capital Metro Business Case](#), which described all associated road works in detail on page 40, makes no mention of this road duplication, and it was not costed as part of the Business Case.

Furthermore, Capital Metro admits in the above extract that this duplication results in the better performance of "project" case on this leg. Hence, a fair comparison would assume these road lanes were also constructed in the "base" case, greatly reducing the 16:58 road journey time from Gozzard to Wells Station, probably to around the same 7:27 as the light rail case, perhaps less (in keeping with other segments having lower travel times without light rail).

That is, although the "no-tram" return trip was modelled at 52:06, a fairer comparison in which Flemington south of Wells Station Drive is also duplicated, would give a time around **42 or 43 minutes**, compared to the "tram" model return trip time of **55:23**. That is, the EIS Model suggests the commuter round-trip car journey time between Gungahlin and Civic will be **around 13 minutes longer if the project goes ahead**.

## **The bizarre teleportation of cars away from the Barton/Federal intersection, providing advantage to the "tram" model**

The 2021 PM "tram"-model vehicle counts at the intersection of the Barton and Federal Highways are even more mysterious. Whereas the "no-tram" model has almost 1500 vehicles travelling from south to north along Northbourne onto Federal Highway at the Barton Highway intersection, the "tram" model has exactly 0 vehicles.

The ACT Government's Territory and Municipal Services (TAMS) noted this anomaly:

*"P43, Table 4.8. At the Federal Highway/Barton Highway intersection there is a reduction in the pm peak traffic volumes between the 2021 Base and 2021 Project predictions of over 1,500veh. This seems significantly larger than differences predicted at other intersections."*

Source: Capital Metro Light Rail Stage 1 - Gungahlin to Civic Environmental Impact Statement Addendum Report, August 2015, page 32

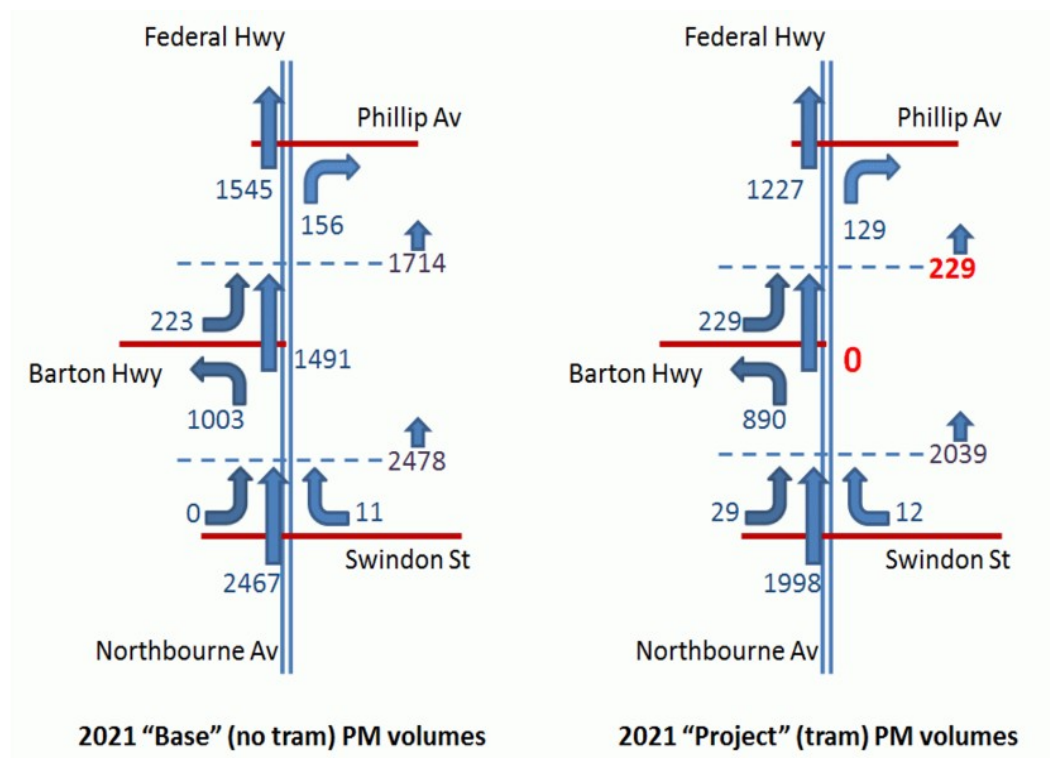
Capital Metro's response:

*"Road network upgrades on parallel routes (e.g. Gungahlin Drive) assumed to be included in the Project Case scenario are anticipated to result in changes to the routes that vehicles take through the network."*

Source: Capital Metro Light Rail Stage 1 - Gungahlin to Civic Environmental Impact Statement Addendum Report, August 2015, page 32

Capital Metro's response acknowledge that over 1100 vehicles seem to have just disappeared from the model at between Swinden St and Barton Highway, only to rematerialise at the next intersection, Phillip Av.

Summarising the flows graphically reveals the problem - the "tram" model loses all vehicles travelling south to north at the Barton Highway intersection, only to have them reappear at Phillip Av:





Capital Metro's response to the TAMS query is illogical.

1. Firstly, the road network upgrades on Gungahlin Drive are neither described nor costed in the Business Case in which the road upgrades to be undertaken as part of the project are enumerated on page 40.
2. Secondly, the road network upgrade to Gungahlin Drive is independent of the Capital Metro project, and work started in [November 2015](#); hence, the benefits of teletransportation of cars away from Federal Highway/Barton Highway intersection should be applied to both "base" and "project" cases, eliminating PM delays travelling north through this intersection.
3. Thirdly, if "changes to the routes that vehicles take through the network" really was happening, why do the cars rematerialise at Phillip Av, and how did they get there?

Unfortunately, this appears not to be a simple error, raising the possibility that it is a deliberate manipulation of the model to favour the "tram" case. It is implausible that the spreadsheets generated for the tables in EIS Volume 3, Part 5, Appendix B were generated by hand, and that these results are a simple omission. Firstly, the corresponding cell in the "signal delay" table is also missing for the "tram" model. Secondly, the same count is missing in the 2031 model. Thirdly, the VISSIM model "birds-eye" visualisation screenshots of traffic queues included at the end of EIS Volume 3, Part 5, Appendix B (page B-100) *do* indicate vehicles flowing in this direction in the "tram" PM models, which tends to suggest that one model was run for the screenshots and another for the detailed congestion data. Fourthly, when Capital Metro were given the opportunity to correct it as an error, they instead stated it was not.

The "tram" model benefits from the apparent omission of the traffic delay at Federal/Barton not being included in its PM travel time, but it is not trivial to estimate by how much. Looking at the South-North PM travel time delays at surrounding intersections provides an estimate:

<b>Intersection</b>	<b>Delay without light rail (sec)</b>	<b>Delay with light rail (sec)</b>
Federal Highway /Phillip Avenue	15.1	28.9
Federal Highway/Barton Highway	29.8	[no delay modelled]
Northbourne Avenue / Swinden Street	11.5	77.6
Northbourne Avenue / Mouat Street / Antill Street	68.1	251.0

For the 3 intersections with corresponding data, the total delay is 94.7 seconds without light rail and 357.5 seconds with light rail, a ratio of 1 : 3.77. Applying this ratio to the unknown Federal Highway/Barton Highway delay gives an estimate of 112 seconds delay with light rail.

Adding this time to the previous PM north bound car trip time given by Capital Metro for the "Project" case (27:52) gives a trip time of 29:44, and hence the "Project" car commuter round trip time increases from 55:23 to 57:15.

That is, a fair comparison of the car commuter round trip time in 2021 between Gungahlin and Civic based on the EIS model is **42 or 43 minutes** without light rail and **57:15** with light rail. That is, the EIS Model suggests the commuter round-trip car journey time between Gungahlin and Civic will be **around 15 minutes longer if the project goes ahead.**

Note also the implications for average combined AM and PM peak period vehicle speed in the road network, which Capital Metro model data shows as 27.8 km/hr without light rail, decreasing to 23.1 km/hr with light rail. Given the most trafficked route in the surrounding road network is Gungahlin-Civic, and given the "errors" leading to under-estimation of journey time with light rail and over-estimation of journey time without light rail, the difference in vehicle speeds for the two scenarios is certain to be considerably greater.

### **The cost of intersection delays along the route, AM and PM peaks, weekday**

The Traffic and Transport Appendix B contains tables of traffic volumes and delays through intersections along the route in 2021 for both AM and PM peaks with the light rail and without.

By multiplying volumes and delays at each intersection and summing them across all intersections, it is possible to calculate the total delays for all vehicles traversing these intersections for both scenarios. It is also possible to estimate the difference in fuel consumption and carbon dioxide pollution attributable to intersection delays (see Appendix).

Because the EIS model mistakenly omits PM northbound traffic at Barton Highway, this was added to the calculation of total delay. However, the very substantial improvements to the "no light rail" scenario were not reflected in these calculations. That is, the calculations summarised below are still incorrectly biased in favour of the "light rail" scenario.

<b>Scenario</b>	<b>AM peak delay (hours)</b>	<b>PM peak delay (hours)</b>	<b>Total delay (hours)</b>
Without light rail	751	654	1405
With light rail	978	1041	2019

Even so, AM and PM cumulative delays at intersections on the route **increase by 614 hours each day, or 44%** with light rail in 2021, compared to the "no light rail" scenario in 2021.

Fuel consumption, greenhouse-gas and pollution generation attributable to these increased delays will increase by more than 44% because under the "light rail" scenario, are vehicles are required to stop or slow and then re-accelerate.

Annualising these figures, at intersections on the direct route during AM and PM peak, the light rail project will cause:

- an extra **6,662 days of delays** to be incurred by commuters. Using the Business Case's value for travel time of \$19.10 (2014 dollars) for car passengers (and assuming no business travel at a much higher rate), and assuming 1.2 passengers per car, this alone amounts to an annual economic cost of \$3.6m, or a project lifetime cost (30 years) of **over \$100m** in 2014 dollars, assuming congestion attributable to light rail does not increase further.
- an extra **191 kilolitres of fuel** to be burnt. Assuming an average fuel cost of \$1.30 per litre, light rail caused congestion will impose an annual cost of \$250,000. Vehicle maintenance costs will also increase due to extra engine running time.
- an extra **725 tons of carbon dioxide** to be emitted.

*[Assuming 260 week days per year, an average idle fuel consumption of vehicles on the route of [1.1 litres/hour](#) and a gross carbon dioxide production of [3.78 kg/litre](#).]*

The total increases in delays and pollution caused by the light rail will be much greater, as these figures do not include associated delays off the route (intersections on cross-roads leading to the route will also experience extended delays) and additional delays outside AM and PM peaks and on the weekends. They also do not reflect the improvements to the "no light rail" scenario if the unbudgeted duplication of Flemington Rd southbound from Well Station Dr were applied.

## **Beyond 2021**

The EIS also models traffic for 2031. However, a projection 16 years into the future which takes no account of very probable developments in transport infrastructures (for example, shared fleets of autonomous cars, which all major auto-manufacturers expect to be commercialised during the early 2020's) and the rapid trend towards tele-working and virtual reality as facilitated and anticipated by the NBN project, is extremely unlikely to provide a sound and reliable basis for analysis.

Yet still, the average vehicle speed modelled in the 2031 network is faster without light rail (25.3 km/hr) than with (25.1 km/hr), although the difference is not as stark. However, the EIS assumes that in order to provide a faster average speed with light rail in 2031 than with light rail in 2021 (despite there being many more vehicles in the network), additional (uncosted) road-works will need to be taken to add additional lanes to Northbourne Av between Federal Highway and Antill Street (page 37).

## The Stage 2 extension

Capital Metro have modelled a 15 minute journey time from Civic to Russell on the 3.2km proposed Stage 2 light rail extension (average speed: 12.8km/hr). [Promotion for the extension](#) claimed it would remove the lunch-time “isolation” of workers in Russell. The light rail will offer 6 services running each way per hour at lunch-time (compared to the current 10 ACTION bus services per hour at lunch-time). Before road-works started on Constitution Avenue, the ACTION Bus trip time was just 8 minutes. Hence, the proposed light rail will not only reduce service frequency (and seats) but will also result in an 88% increase in journey time, increasing the occurrence of lunch-time isolation syndrome.

Appendix C of the Stage 2 Development Application, “[Russell Extension Traffic and Transport Impact Assessment](#)”, makes it perfectly clear that Stage 2 will seriously degrade road transport performance, and even attempts to make a virtue of “compromised performance”:

*“Traffic modelling of the Project scenario found that introduction of the light rail corridor within the City extent of the network generally leads to impacts to general traffic. **Whilst some impacts are expected and in some instances encouraged to facilitate a mode shift to public transport, in several locations delays and queues could result in a compromised performance of the wider road network.**”*  
[Executive summary, page vi]

and

*“Forecasted traffic demands along London Circuit and Constitution Avenue, particularly between London Circuit and Coranderrk Street intersections, for the 2031 scenario resulted in substantial delays and queueing. It was assumed that demand forecasts could not be realised due to the constrained nature of the corridor, and therefore manual manipulation were made to route choice and traffic volumes to alternate routes. **This represents a risk to the Project and wider road network.**”*  
[4.1.1 Model Assumptions, page 22]

and with regards to the Northbourne Avenue, Barry Drive and Cooyong Street intersection:

*“Considering this western approach and exit was already operating at or near LoS F in Stage 1, increasing the number of vehicles using Barry Drive is considered a risk as queues and delays for these vehicles will extend further.*

...

*In addition to delays on the side approaches, observations of the model showed queueing on northern approach (Figure 4.1). With an increase in the number of vehicles turning right from Northbourne Avenue (SB) to Barry Drive (WB), vehicles waiting to turn right extended beyond the auxiliary lane, hence also blocking the*

adjacent traffic lane, worsening delays for other movements.

As the intersection deteriorates in performance, there is the possibility that vehicles will opt to use the proposed Vernon Circle - Edinburgh Avenue connection to reach their final destination. Unfortunately, since the demand matrix in the model is manually adjusted (compared to a comprehensive model with all road connections) that would change dynamically based on capacity, **the impacts to other locations may be underestimated.** Such locations include the Northbourne Avenue/London Circuit intersection as well as Vernon Circle.”

[4.3.1.1 Intersection of Northbourne Avenue, Barry Drive and Cooyong Street, page 26]

Their modelling of other intersections also shows greatly increased congestion.

The visual representation of queuing modelled on Northbourne Av predicts extreme congestion should Stage 2 be built (Figure 4.1, page 25):

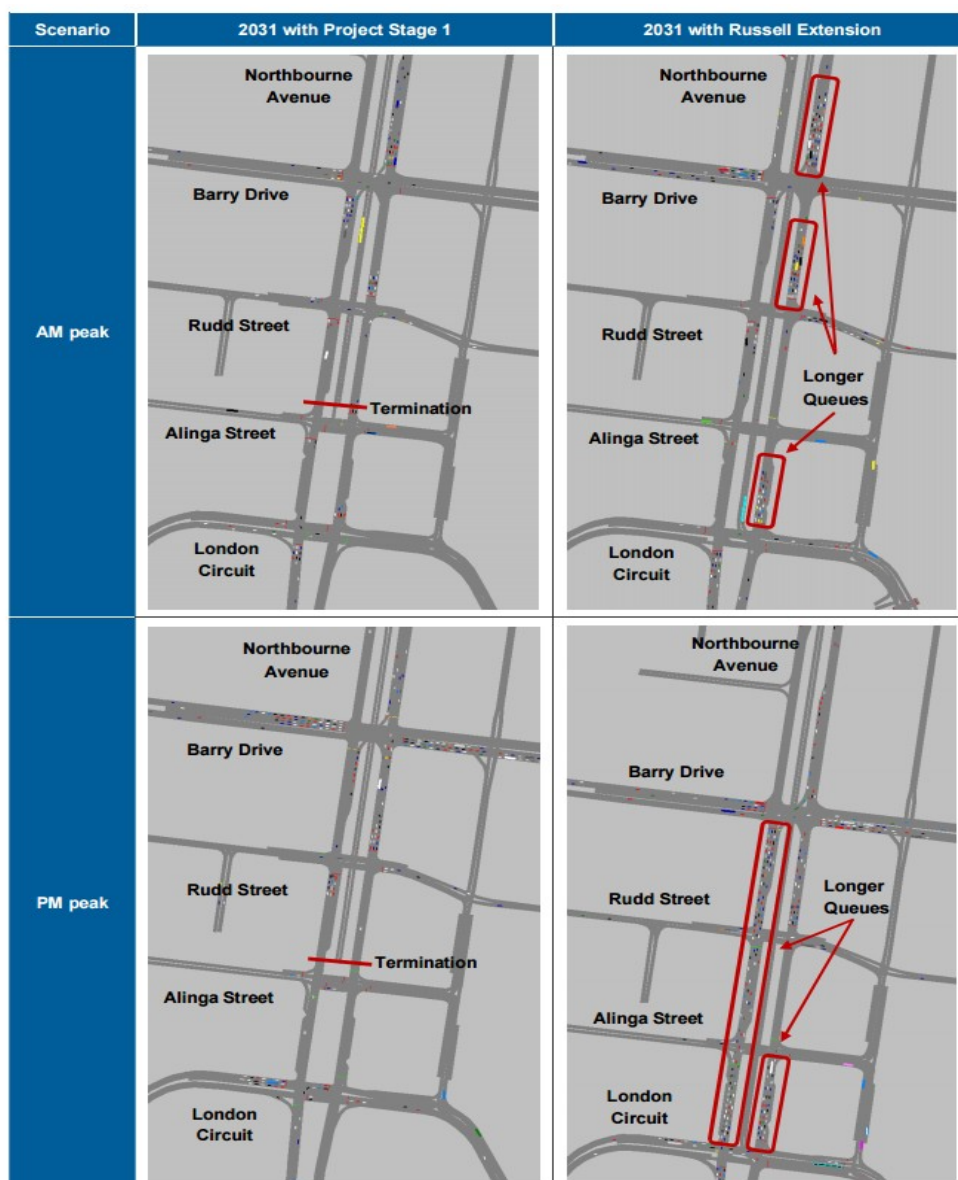


Figure 4.1 Comparison of impacts on Northbourne Avenue between Stage 1 and Russell Extension

A similar picture emerges at the intersection of London Crt and Constitution Av:

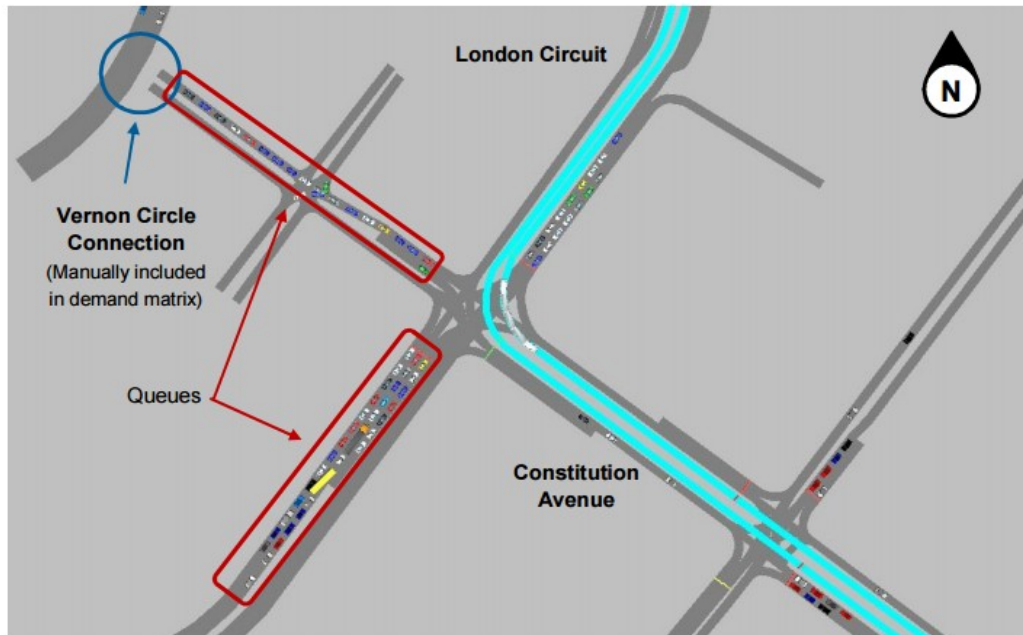


Figure 4.2 Constitution Avenue/London Circuit intersection – VISSIM modelling

And with regards Constitution Avenue and Coranderrk Street:

*“The intersection of Constitution Avenue and Coranderrk Street is a critical intersection, as the main traffic movement crosses the Project alignment. The southern approach and exit is major connection to Parkes Way, a dual carriageway Arterial Road that links the eastern and western suburbs of Canberra, illustrated by Figure 4.4, and confirmed by volumes in (Table 4.17). The predicted queues on Coranderrk Street southern approach **represent a significant risk due to the disruptions it could cause on Parkes Way.**”*

[4.3.2.3 Intersection of Constitution Avenue and Coranderrk Street, page 34]

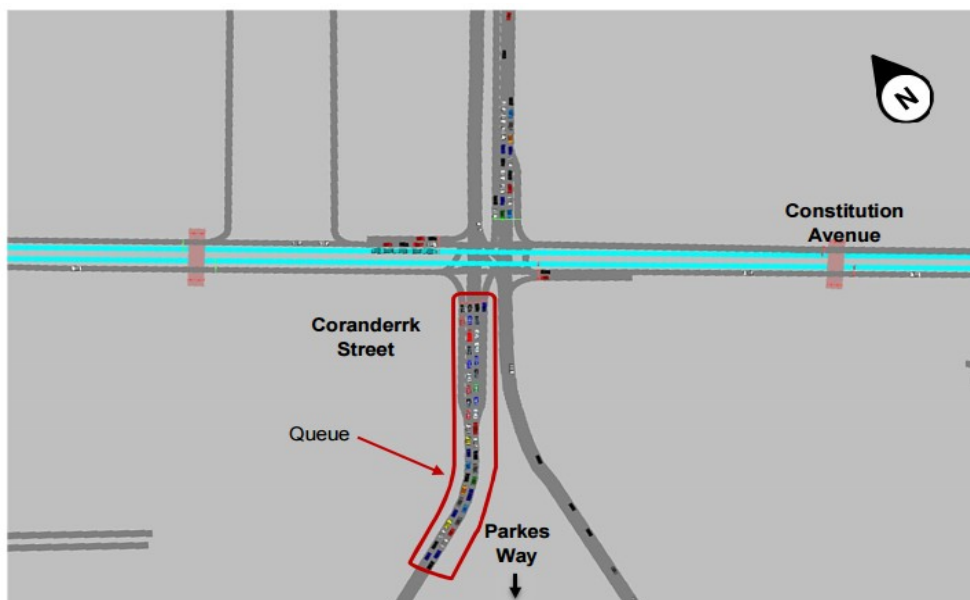


Figure 4.4 Constitution Avenue/Coranderrk Street intersection – VISSIM modelling

As with the Stage 1 EIS, this Stage 2 Appendix reads as a confession that the proposed project will create extensive and severe traffic congestion; it is unclear whether the authors are asking for absolution or hoping for a death-sentence.

## Summary

In summary, the proposed development will cause significant loss of transport efficiency in the Gungahlin-Civic corridor. The cost of additional delays attributable to intersection congestion alone amount to over \$100m (2014 dollars) over the life of the project. According to Capital Metro's own modelling published in their EIS, average speeds in the associated road network fall significantly and congestion and associated transport costs increase. Carbon dioxide and other pollutants attributable to delays at intersections will increase by at least 44%.

The Stage 2 development will add further to congestion on Northbourne Avenue, and extend congestion along London Circuit, Constitution Av, and the wider road network towards Russell.

**The development application as presented fails to deliver efficient transport, as it is required to do by the Territory Plan Transport Zone TSZ1 objectives. Hence, the Capital Metro Light Rail Development Application should be rejected.**

### 2.2.2 Safety

Capital Metro is proposing to run vehicles at posted road speed limits, such as 70 km/hr along Flemington Drive between Manning Clarke and Wells Station Dr. The maximum emergency deceleration rates of the likely light rail vehicles (CAF Urbos 3 and Bombardier Flexity2) is between  $2.4\text{m/s}^2$  and  $2.7\text{m/s}^2$  in good conditions and level track.

Imagine this:

A cyclist falls on the Flemington Rd tram track, 85m in front of a 55 ton tram travelling at 70km/hr. The tram driver takes 1.5 seconds to observe, react, and apply the emergency brake (1.5 seconds being the standard and real-world-typical "reaction time" used in speed and safety scenario planning). Four second later, now travelling at 31km/hr, the tram hits the cyclist with the same kinetic energy as a 2-ton SUV at 150km/hr.

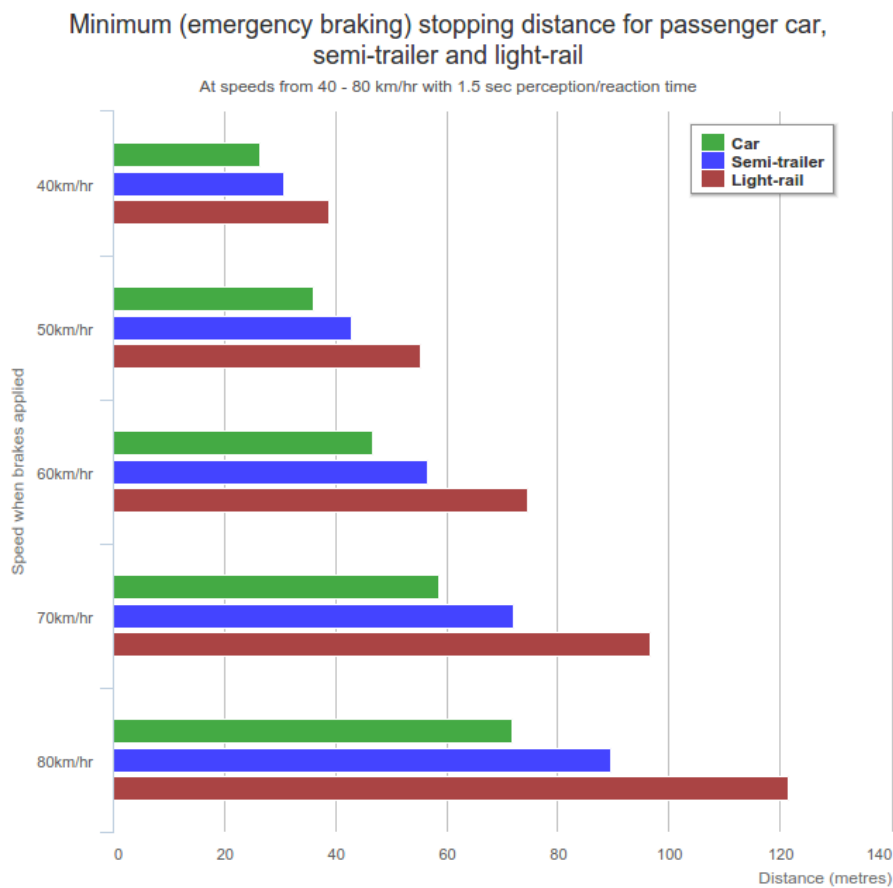
As well as fallen cyclists, likely obstacles in the path of a tram include stalled vehicles, ear-phone-wearing distracted pedestrians sending a text message, and a pram with a wheel caught in the rail.

Clearly, this is a vital safety issue which needs to be mitigated by boom-gates at intersections (as is done by some other jurisdictions running trams above 50 km/hr), fencing (also popular, and used, for example, along some of the highest-speed parts of the

Gold Coast G:Link), a completely segregated/separate right-of-way (such as the Lilyfield to Dulwich Hill light rail extension in Sydney), or lower speeds (by far the most common approach). However, Capital Metro “artist impressions” represent the track as unencumbered by safety barriers and the development application seems to rely on “safety awareness”.

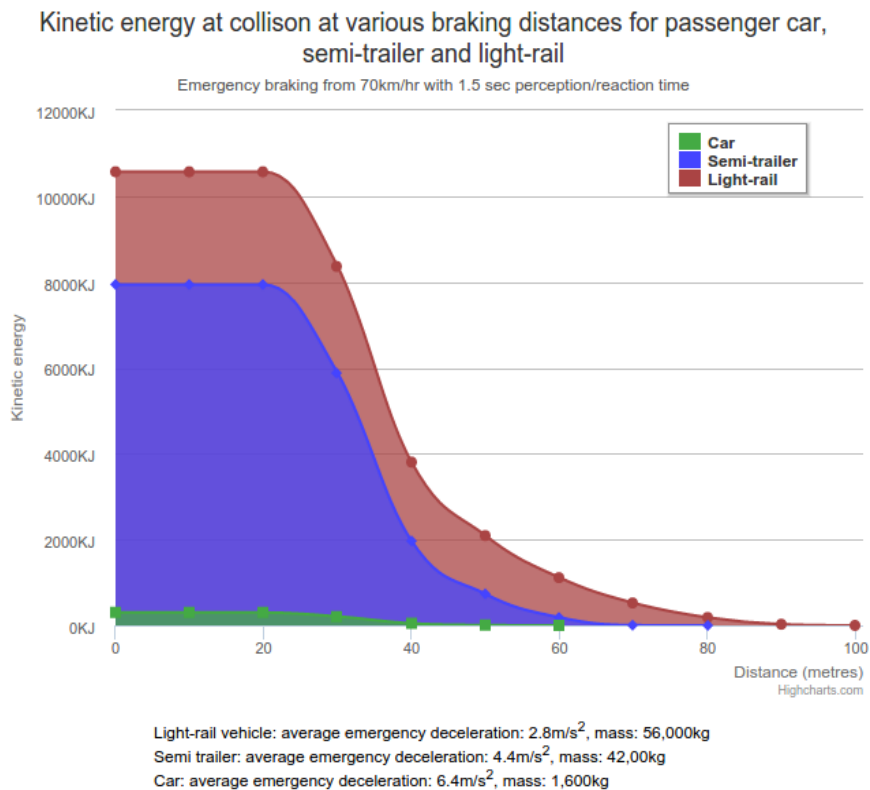
To be specific, the proposal to run 55 ton light rail vehicles along a densely populated and traversed corridor (increasing density being the *raison d'être* of the project) at intervals of 3 minutes (both directions) at 70km/hr in peak hours is like suggesting it would be OK to run fully-laden b-double trailers with grossly defective braking systems every 3 minutes at the same speed, except that drivers of the b-double at least have the option of swerving to avoid a collision.

The following graphs show comparative emergency stopping distance for cars, semi-trailers and light rail vehicles, and the kinetic energy each carries into collisions at various speeds:



Light-rail vehicle: average emergency deceleration:  $2.8\text{m/s}^2$   
 Semi trailer: average emergency deceleration:  $4.4\text{m/s}^2$   
 Car: average emergency deceleration:  $6.4\text{m/s}^2$   
 NB: semi-trailer and car may also swerve to avoid a collision





**In summary, the development application as presented fails to deliver safe movement of people, as it is required to do by the Territory Plan Transport Zone TSZ1 objectives. Hence, the Capital Metro Light Rail Development Application should be rejected.**

## 2.3 Capital Metro's own objectives for the project

The Executive summary of the "*Capital Metro Light Rail Stage 1 - Gungahlin to Civic Draft Environmental Impact Statement*" states the objectives of the project (page xxiii):

### ***"What are the objectives of the Project?"***

*The Project's vision is to boost Canberra's sustainable growth by changing and improving transport options, settlement patterns and employment opportunities. In meeting this vision, eight objectives have been identified to guide the development of the Project.*

*These objectives are to:*

- *increase the mode share of public transport*
- *optimise frequency and service reliability*
- *provide the Project at affordable capital and operational costs*
- *grow a more diversified Canberra economy*
- *stimulate sustainable, urban re-development along the corridor*
- *increase social and economic participation*

- *revitalise the Northbourne Avenue corridor*
- *reduce carbon and other emissions.*"

Each objective is examined below to see whether it is met by the proposed development.

### 2.3.1 Increase the mode share of public transport

Increasing the mode share of public transport requires public transport to become more attractive than the alternatives of private motor vehicle, walking and cycling. The proposed route for light rail is already well served by ACTION buses. The primary claim for the light rail is to reduce peak period congestion and provide a better transport option for commuters from Canberra's fastest Gungahlin, into Civic. Hence, a fair test of the improvements or otherwise the light rail will provide is to compare the service it will offer to that of the current ACTION bus service in the weekday AM extended peak period from 6:30am to 9:00am.

Comparing current (2015) ACTION bus services from Gungahlin to Civic with proposed light rail services in 2021:

Criteria	ACTION (2015)	Light Rail (2021)	Improvement
Number of seats all services	2860	1495	-48%
Percentage of passengers seated	64	33	-48%
Bicycles carried all services	120	92	-23%
Seated capacity per 1000 Gungahlin residents	47.4	20.5	-57%
Total capacity (seated & standing) per 1000 Gungahlin residents	74.1	61.8	-17%
Passenger services	63	23	-63%
Routes	3	1	-67%

Not included in this comparison, but negatively affecting the attractiveness of light rail is the need for light rail passengers to:

- walk further to a light rail stop
- change modes from bus to light rail back to bus with walks and waits between each change when travelling from a source location not on the direct route in Gungahlin and to a destination beyond Civic (many current Gungahlin-Civic services traverse suburbs in Gungahlin and travel to popular work destinations beyond Civic (such as Barton, Russell, Kingston, Fyshwick), removing the need to change modes).

Comparing average travel time on the route, Gungahlin to Civic in this AM extended peak:

- the average time of ACTION "red rapid express" services (no stops) is 22.5 minutes
- the average time of all ACTION "red rapid" services is 29.5 minutes
- Capital Metro's current optimistic forecast for light rail is 25 minutes

- based on Gold Coast light rail and on rolling stock provision by Capital Metro, a more likely forecast is 32 minutes

Hence, even with much higher-than-normal running speeds (which are yet to be sanctioned by Office of the National Rail Safety Regulator ) and very high traffic signal priority, the light rail is slower than the current “red rapid express” services on the same route. With likely speeds based on Gold Coast's actual operation and the rolling-stock requirements anticipated by Capital Metro itself (12 running trams plus 2 spares to provide a 6 minute service frequency at peak times), the light rail will be slower than the average “red rapid” service from Gungahlin to Civic.

Outside peak periods, the current ACTION “red rapid” services are even faster: 21 minutes from Gungahlin to Civic, compared to 25 minutes currently forecast for light rail.

In summary, compared to the current ACTION bus service, the AM peak-period light rail service proposed in this development application will be:

- less frequent, having **63% fewer services**
- have **48% fewer seats**, and **57% fewer seats on a 2021 population basis**
- be able to carry **17% fewer passengers** (seated and standing) on a 2021 population basis
- be able to carry **23% fewer bicycles**
- will provide **a longer journey time than the current "red rapid express"** and is very likely to provide a longer journey time than the average service on this route

Furthermore, many more passengers will be required to "change modes" to get to a light rail stop and reach their destination. Mode changes with their accompanying walk and wait are acknowledged as a strong disincentive to use public transport.

Consequently, it is very likely that light rail will not only fail to increase mode share of public transport, but it will trigger a further decline as potential passengers will be reluctant to be more likely to stand for a longer journey requiring multiple transfers.

**Hence, for contributing to a reduction in the mode share of public transport, the Capital Metro Light Rail Development Application should be rejected.**

### 2.3.2 Optimise frequency and service reliability

As noted above, light rail will reduce service frequency in the critical AM peak period by 63%, and provide 57% fewer seats using the 2021 population projections and 17% fewer total passengers (seated and standing) on the same basis.

Furthermore, as a single-line system, service reliability is not as robust as the bus alternative. As tram and light rail users in other locations know, an accident on the tram line or breakdown of a vehicle or problem with electrical infrastructure completely disables travel in one or both directions. Unlike buses, light rail vehicles can not be routed around trouble spots. The road infrastructure contains redundancy, as was evidenced in Canberra recently with the Acton Tunnel closure.

**In summary, the proposed light rail offers both reduced frequency and reliability to the current bus system, and hence the Capital Metro Light Rail Development Application should be rejected.**

### 2.3.3 Provide the Project at affordable capital and operational costs

The Capital Metro Business Case estimates construction costs of \$783m and average annual (real) operating costs of \$22.2m for the first 20 years. Assuming annual financing or equivalent asset holding costs of 10% (\$78m) and a 5% profit on assets (\$39m), the winning consortium hence requires annual revenue of around \$139m (\$22m + \$78m + \$39m). Assuming that the Business Case's projection of 6.37 million journeys in 2031 is the 20 year average, the real commercial cost of each journey is hence almost **\$22** (\$139m/6.37m journeys).

Assuming travellers pay an average net fare of \$2 per journey, a fair contract would require rate-payers to subsidise each journey by an average of **\$20**. An up-front capital contribution from the Government **does not change the effect of this subsidy on funds available for Government spending**, but does obfuscate it (by reducing the success payment to the consortium whilst not providing any return on the Government's contributed capital or accounting for the opportunity cost of the use of that capital in other productive ways such as health, education and community services)<sup>1</sup>

<sup>1</sup> Consider the case where the Government makes an up-front capital payment of say, 50%, or around \$400m. It may be argued correctly that doing so reduces the Consortium's borrowing costs, but it is wrong to conclude that as a consequence, the commercial cost of a single journey on the light rail is reduced from \$22 to \$13. (Annual operating expenses of \$22m plus annual interest expense on \$400m of \$40m, plus profit on 5% of \$400 of \$20m give a total apparent annual costs of \$82m, which amortised over 6.37m trips gives a per-trip cost of almost \$13.)

This mistake arises from not considering the opportunity cost of spending \$400m as a capital contribution, that is, of not considering the opportunities forgone which could return a far better yield to the community than the 10% effective yield achieved by the capital contribution. For example, this \$400m could be applied to provide:

- Better insulation and heating for community housing. \$2000 spent on insulation and replacing gas heating with a heat pump typically returns much more than 10% pa in cost savings. Solar PV typically [yields over 10%](#), as does solar hot water.
- Preventive health and dental programs [are very cost-effective](#) in reducing demand for intensive and expensive health services and improving quality of life
- Improving early education [has a very high economic return](#), as does wider investment in education and training
- Prisoner rehabilitation programs [are very cost-effective](#) in reducing recidivism and improving lives

Alternatively, the ACT Government could just invest the \$400m in an ASX accumulation index vehicle, and with a high probability, achieve a long term return of 10%.

So, if the ACT Government could not achieve savings, income, or benefits to the community of at least \$40m per annum by investing a lazy \$400m in improving services and facilities, then using \$400m as capital to avoid additional "availability" payments of \$40m per annum may be the appropriate thing to do. However, with so many worthy projects currently waiting for funding, this is not the case.

Note that the direct and wider benefits to the community provided by light rail (and even whether it is net positive or negative) is a separate issue to this discussion, which is just about calculating the real cost of the provision of the service. Some component of that cost might be accounted as transfers of cash (by way of an availability payment), and some component might be accounted as a lost opportunity for more effective use of funds. Both components are equally "real" because it is the sum of both that determines the funds remaining to implement Government programs.

Is 10% a realistic financing cost? The consortium bears all risks resulting from construction and operating cost overruns. Further, the Business Case estimate of construction costs (\$783m) seems low in comparison with [similar projects](#), and recent large civil engineering and construction projects in the ACT have a history of cost and time over-runs ([GDE](#), [Cotter Dam](#), [Alexander Maconochie Centre](#), [Constitution Avenue](#)). The construction is inherently complex and risky, and the project is not popular with the community. There is the added element of "sovereign risk" based on the Opposition's promise to "tear up" the contract noted above. In addition, if the Business Case assumptions on travel times are to have any hope of being met, the trams will need to travel at speeds far in excess of those operated by the new Gold Coast service, or on the Dulwich Hill extension in Sydney (which runs using latest rolling-stock in a completely separated and dedicated right of way). Such speeds will necessarily incur an operational safety risk premium.

Given these risks, an investor would need to compare an investment in Capital Metro with the risk and [100+ year \(long term\) return from the ASX accumulation index](#), of 10%.

These calculations do not include the added costs of capital which must be borne by the consortium prior to completion when the first "availability" payment becomes due. They also do not include the additional revenue to repay the loan principal: if the principal is repaid, annual loan servicing costs on \$783m over 20 years at 10% increase from \$78m to almost \$91m, requiring an extra \$2 revenue per trip.

In the unlikely event that financing at 7% is secured, annual asset holding costs fall from \$78m to \$55m and annual revenue required falls from \$139m to \$116m, giving a real commercial cost of each journey of just over **\$18**.

If, on the other hand, construction costs eventually come in at \$900m rather than \$783m, and financing can only be secured at 11%, and average patronage is 10% less than the optimistic estimate of the Business Case, then required annual revenue rises to \$166m, and the real commercial cost of each journey rises to **\$29**.

**At a real commercial cost per journey of at least \$18, the Capital Metro project compares very unfavourably with ACTION. Hence on the grounds of affordable capital and operation costs, the Capital Metro Light Rail Development Application should be rejected.**

#### 2.3.4 Grow a more diversified Canberra economy

The development application supplies no evidence that aside from providing very limited opportunities for light rail drivers and maintenance staff, it will diversify the Canberra economy. **To the contrary, the transport and economic inefficiencies it introduces will act as a dead-weight on the ACT economy for many decades.**

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### 2.3.5 Stimulate sustainable, urban re-development along the corridor

As demonstrated by the Capital Metro EIS and referenced above (2.3.1, 2.3.2), the proposed development will increase transport travel times and congestion along the corridor. Consequently, transport-related pollution will also increase. Public transport services will be diminished in frequency, capacity and speed in comparison to the current ACTION bus services. **The effect of these negative developments will be to dampen demand for housing and workplaces along the corridor: far from becoming desirable, it will become a locality to avoid.**

### 2.3.6 Increase social and economic participation

As demonstrated above (2.3.3), the proposed development will act as a dead-weight on the ACT economy for decades. Furthermore, the reduced public transport capacity and capability (2.3.1) and increased congestion and travel times caused by the project will make social and economic participation more difficult, particularly for the economically disadvantaged. **Hence on the grounds of reducing social and economic participation, the Capital Metro Light Rail Development Application should be rejected.**

### 2.3.7 Revitalise the Northbourne Avenue corridor

It is hard to know how this objective would be measured. However, as demonstrated by the Capital Metro EIS and referenced above (2.3.1, 2.3.2), the proposed development will increase transport travel times and congestion along the corridor. Consequently, transport-related pollution will also increase. Public transport services will be diminished in frequency, capacity and speed in comparison to the current ACTION bus services. The effect of these negative developments will be to dampen demand for housing and workplaces along the corridor, including Northbourne Avenue. **Far from becoming desirable, it will become a locality to avoid.**

### 2.3.8 Reduce carbon and other emissions

As shown in 2.2.1, the proposed development will increase travel times and congestion and as a result, emissions of carbon and other pollutants will increase. The Capital Metro EIS model indicates that by 2021, emissions attributable to delays at on-route intersections in AM and PM weekday peaks alone will increase by over 44%.

There are two points to make regarding the replacement of diesel and LNG-burning buses with light rail:

### 2.3.8.1 Replacement of buses on the route

The ACT Government claimed that light rail will “free up” one million bus kilometres (Mick Gentleman quoted in Canberra Times, 8 Nov 2015, “Gungahlin tram to free up more than one million bus kilometres, government says” [

<http://www.canberratimes.com.au/act-news/gungahlin-tram-to-free-up-more-than-one-million-bus-kilometres-government-says-20151108-gktneu.html> ]

ACTION buses travelled 25.6 million km in 2014-15, and used 11 million litres of diesel and CNG to do so. Hence, “freeing up” one million km can be expected to save 1/25.6th, that is 430 kL of fuel, equating to **1160 tons** of greenhouse gases (CO<sub>2</sub>-e) (based on the EIS calculations, as discussed below), which seems like a good thing to do.

However, by 2021, ACTION would probably be following many other jurisdictions around the world in replacing diesel and CNG powered buses with electric buses, able to use the same 100% renewable power as the light rail, so these savings may be much smaller or even zero.

### 2.3.8.2 Carbon cost of the construction

Table 11.4 of the Capital Metro Stage 1 EIS (Volume 1, Chapter 11, page 278) contains the following table of greenhouse gas emissions for the project:

**Table 11.4 Summary of GHG emissions for the Project**

	Quantity	Energy conversion	Energy GJ	Greenhouse conversion	GHG t CO <sub>2</sub> -e
<b>Diesel</b>					
Fuel for transport purposes off and on site	3066.08kL	38.60 GJ/kL	118,350.69	69.90kg CO <sub>2</sub> -e/GJ	<b>8,272.71</b>
<b>Electricity</b>					
Site offices	821,061kWh	3.6 GJ/kWh	2,955.82	0.86kg CO <sub>2</sub> -e/kWh	<b>706.11</b>
<b>Materials</b>					
Steel					
■ Rebar	6,584 t				10,472.58
■ Rail tracks	3,003 t				3,557.29
■ Other	1,699 t				6,309.11
Concrete	156,874 t				29,436.11
Asphalt	9,356 t				600.69
<b>Materials Subtotal</b>					<b>50,375.78</b>
<b>Vegetation cleared</b>	7.17ha			209t CO <sub>2</sub> -e/ha	<b>1,499.16</b>
<b>Total</b>					<b>60,853.76</b>

As seen, Capital Metro expect the project's construction will generate **60,864 tons** of greenhouse gases (CO<sub>2</sub>-e) . In contrast, the predicted annual savings by removing the specified ACTION diesel and CNG buses is **1,160 tons** of greenhouse gases (CO<sub>2</sub>-e). Even assuming the buses were not converted to electricity, the greenhouse “pay back” time of the project is  $60864/1160 = 52$  years. It is very unlikely that greenhouse fuels will be powering buses in 15 years, let alone 52 years.

As has been noted, even Capital Metro's forecasts show that the light rail will change the commuting habits of very few people, and indeed, the planned passenger capacity per 1000 Gungahlin residents is lower with the light rail than with ACTION buses (see 2.3.1 above). Furthermore, Capital Metro's own modelling shows that as a consequence of increased congestion, greenhouse gas generation attributable to delays at intersections are at least 44% higher with light rail than without (an extra approximately 725 tons of carbon dioxide).

In summary, the construction of this proposed development will generate more than 52 times the greenhouse gases generated annually by the buses it will replace, and its operation will greatly increase congestion and consequent production of greenhouse gases. The net effect of the development is to produce a net increase of greenhouse gases and other pollutants.

**Hence on the grounds of increasing carbon and other emissions, the Capital Metro Light Rail Development Application should be rejected.**



### 3 Conclusion

As shown above, the Capital Metro Light Rail Development Application

- does not meet the objectives of safe and efficient transport required for developments in transport zone TSZ1 in the ACT Territory plan
- does not meet the objectives of “*high speed travel across the city along dense corridors*” as defined in the ACT Government's transport blueprint, “*Transport for Canberra: Transport for a sustainable city*”
- does not meet its own objectives as outlined in Capital Metro Stage 1 EIS.

Its transport, environmental and economic failures against these objectives are systemic to the design of the project and they are comprehensive. The Stage 2 development application warns it will cause severe and widespread congestion, but suggests this may be a positive, encouraging public transport (despite the current ACTION service being faster, more frequent and offering more seats).

The project described in this application is not "fit for purpose" as a transport solution for Canberra, and the Capital Metro Light Rail Development Application should be rejected.

#### Sources:

*Transport for Canberra: Transport for a sustainable city, ACT Government, 2012*

[http://www.transport.act.gov.au/\\_\\_data/assets/pdf\\_file/0003/397245/Pages\\_from\\_EDS\\_ACT\\_Transport\\_Policy\\_FA\\_final\\_web.pdf](http://www.transport.act.gov.au/__data/assets/pdf_file/0003/397245/Pages_from_EDS_ACT_Transport_Policy_FA_final_web.pdf)

Capital Metro Light Rail Stage 1 - Gungahlin to Civic, Draft Environmental Impact Statement Volume 1, Executive Summary

[http://www.planning.act.gov.au/\\_\\_data/assets/pdf\\_file/0018/41328/Capital\\_Metro\\_Light\\_Rail\\_Stage\\_1\\_Draft\\_EIS\\_Volume\\_01\\_Executive\\_Summary\\_and\\_Contents-printable\\_version.pdf](http://www.planning.act.gov.au/__data/assets/pdf_file/0018/41328/Capital_Metro_Light_Rail_Stage_1_Draft_EIS_Volume_01_Executive_Summary_and_Contents-printable_version.pdf)

Capital Metro Light Rail Development Application, Stages 1 and 2

[http://www.planning.act.gov.au/development\\_applications/capital\\_metro\\_light\\_rail\\_development\\_application](http://www.planning.act.gov.au/development_applications/capital_metro_light_rail_development_application)

"Is the TRAM a good idea? What the proposed tram means for Canberra, by the numbers"

<http://www.projectcomputing.com/resources/cacs/TramsForCanberra/tramsAndCanberra.html> , which in turn sources information from:

- *ACTION Route Website*: [https://www.action.act.gov.au/timetables\\_and\\_maps/routes\\_by\\_number](https://www.action.act.gov.au/timetables_and_maps/routes_by_number)
- *Characteristics of ACTION fleet*: <https://docs.google.com/spreadsheets/d/1nOSEDsNZohu80QDHeZb2m-vit6-000LeBn6rrXdSeA/edit#gid=0>
- *Capital Metro Draft EIS Technical Paper 5: Traffic and Transport*:  
[http://www.planning.act.gov.au/\\_\\_data/assets/pdf\\_file/0015/41352/Capital\\_Metro\\_Light\\_Rail\\_Stage\\_1\\_Draft\\_EIS\\_Volume\\_03\\_Part\\_5-Traffic\\_and\\_Transport.pdf](http://www.planning.act.gov.au/__data/assets/pdf_file/0015/41352/Capital_Metro_Light_Rail_Stage_1_Draft_EIS_Volume_03_Part_5-Traffic_and_Transport.pdf)
- *BACKGROUND PAPER 9: Population growth and demographic change, ACT Government, October 2011*:  
[http://www.planning.act.gov.au/\\_\\_data/assets/pdf\\_file/0005/25682/Planning\\_Background09\\_Population.pdf](http://www.planning.act.gov.au/__data/assets/pdf_file/0005/25682/Planning_Background09_Population.pdf)

# Appendix

**Intersection volume and delay spreadsheets taken from the CMA EIS Volume 3 Part 5 Appendix B, with an additional spreadsheet for each scenario (base/project) and period (AM/PM) showing total intersection delay accumulated all vehicles.**

Table B1.1 2021 Base AM volumes

AM peak Intersection	Volume																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	61	91	25	16	201	13	23	106	86	182	32	78	38	0	0	0	836
Hibberson Street/ Gungahlin Place	68	139	0	16	40	23	23	106	11	11	13	37	73	0	0	0	549
Hibberson Street/ Hinder Street	52	180	84	125	154	14	23	136	37	11	58	55	0	0	0	0	930
Hibberson Street/ Kate Crace Street	179	270	146	443	230	44	33	282	4	4	93	152	0	0	0	0	1879
Flemington Road/ Manning Clark Crescent/Hamer Street	2	539	46	20	5	0	8	780	90	57	3	1	0	38	0	0	1590
Flemington Road/ Wizard Street	0	556	56	114	0	2	35	807	0	0	0	0	0	6	0	0	1576
Flemington Road/ De Bortoli Street	0	0	0	0	335	0	26	0	901	0	0	0	0	0	0	0	1262
Flemington Road/ Diane Barwick Street	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	4
Flemington Road/ Moonlight Avenue	0	0	0	0	1194	40	0	0	89	0	0	0	0	0	0	0	1324
Flemington Road/ Mapleton Avenue	119	30	181	237	1047	25	19	74	116	23	432	71	6	0	24	0	2404
Flemington Road/ Nullabor Avenue	380	67	146	82	1138	18	28	134	52	14	346	91	0	0	29	0	2526
Flemington Road/ Well Station Drive	63	112	65	0	1233	394	128	145	114	50	296	65	0	0	0	0	2665
Flemington Road/ Mitchell Resource Management Centre	0	0	0	0	1411	0	0	0	0	0	415	0	0	0	0	0	1826
Flemington Road/ Lysaght Street	0	0	0	0	1243	166	80	0	106	234	335	0	0	0	0	0	2165
Flemington Road/ Sandford Street/ Morisset Road	1	252	113	371	947	33	58	227	184	203	410	0	1	0	0	0	2800
Flemington Road/ Randwick Road	0	0	0	0	1039	91	31	0	13	48	576	0	0	0	0	0	1797
Flemington Road/ EPIC	0	0	0	4	1051	0	0	0	0	0	638	4	0	0	0	0	1697
Flemington Road/ Federal Highway	1104	0	109	15	1035	0	0	0	0	0	529	358	0	0	0	0	3151
Federal Highway/ Phillip Avenue	133	0	176	725	1434	0	0	0	0	0	706	218	0	0	0	0	3392
Federal Highway/ Barton Highway	0	0	0	0	1196	381	328	0	1246	227	607	0	0	0	0	0	3976
Northbourne Avenue/ Swinden Street	68	0	24	487	1953	0	0	0	0	11	831	21	0	0	0	0	3396
Northbourne Avenue/ Moutat Street/ Antill Street	388	445	158	95	1719	161	113	630	606	150	564	143	0	0	10	0	5182
Northbourne Avenue/ Morphett Street	0	0	0	0	2585	158	0	0	0	7	779	0	0	0	0	0	3617
Northbourne Avenue/ Wakefield Avenue/ Macarthur Avenue	64	277	180	598	1804	154	256	597	340	233	683	41	5	0	8	0	5240
Northbourne Avenue/ Ipima Street/ Condamine Street	147	116	121	251	1811	23	23	215	153	46	832	85	49	0	0	0	3873
Northbourne Avenue/ Masson Street/ Girraheen Street	70	107	116	305	1739	81	33	298	106	50	825	30	15	0	0	0	3775
Northbourne Avenue/ Gould Street/ Elouera Street	86	124	88	45	1765	13	29	56	24	33	744	116	32	0	17	0	3169
Northbourne Avenue/ Barry Drive/ Cooyong Street	103	328	145	193	1405	320	89	576	304	147	765	230	0	0	0	0	4605
Northbourne Avenue/ Rudd Street/Bunda Street	118	97	38	64	1690	63	72	83	16	137	1035	145	0	0	30	0	3587
Northbourne Avenue/ Alinga Street	3	26	2	0	1811	50	15	30	50	106	1337	0	0	0	0	0	3431
Northbourne Avenue/ London Circuit	6	81	109	337	1399	112	136	150	255	123	1192	126	0	0	0	0	4027

Table B1.3 2021 Base AM Delay

AM peak Intersection	Delay (seconds)																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	45.4	38.8	56.9	20.5	16.4	39.4	53.8	55.2	56.7	14.6	18.5	39.3					36.9
Hibberson Street/ Gungahlin Place	0.3	0.3		1.1	0.9	1.7	0.5	2.8	0.5	1.2	1.1	1.4					1.2
Hibberson Street/ Hinder Street	1.1	8.9	0.7	1.5	2.6	2.7	0.6	0.8	1.3	1.3	1.9	3.8					3.1
Hibberson Street/ Kate Crace Street	20.7	19.9	20.5	23.3	21.2	20.6	8.4	7.9	21.6	10.6	7.5	7.4					17.4
Flemington Road/ Manning Clark Crescent/Hamer Street	0.3	6.4	44.7	0.9	45.0	15.7	21.8	21.8	50.5	1.2	48.6	47.5		47.3			18.6
Flemington Road/ Wizard Street		8.3	32.2	2.5		43.6	3.6	15.1						36.2			12.3
Flemington Road/ De Bortoli Street					16.6		1.2		5.3								8.2
Flemington Road/ Diane Barwick Street										0.0	0.0						0.0
Flemington Road/ Moonlight Avenue					21.8	15.1			211.2								34.4
Flemington Road/ Mapleton Avenue	26.4	42.8	54.7	78.7	103.6	51.3	1.0	47.5	57.2	1.6	13.9	61.4	64.4		56.4		68.7
Flemington Road/ Nullabor Avenue	29.4	55.1	48.2	21.7	51.7	17.5	4.6	45.0	46.7	3.4	36.0	52.1	21.0		53.0		43.6
Flemington Road/ Well Station Drive	25.6	44.8	55.6		68.9	38.0	1.2	46.3	77.6	3.6	35.0	51.8					52.4
Flemington Road/ Mitchell Resource Management Centre					13.2						0.3						10.3
Flemington Road/ Lysaght Street					0.4	2.3	1.6		3.3	1.9	2.0						1.2
Flemington Road/ Sandford Street/ Morisset Road	11.5	35.9	34.5	3.5	37.8	42.5	35.5	40.2	45.9	20.6	20.4	46.1	56.1				29.9
Flemington Road/ Randwick Road					9.6	11.0	0.5		9.2	3.2	1.1						6.6
Flemington Road/ EPIC				2.4	12.5		6.0				0.3	5.2					7.9
Flemington Road/ Federal Highway	29.4		79.5	11.6	28.0						8.4	24.5					26.5
Federal Highway/ Phillip Avenue	0.8		44.5	6.7	16.6						39.1	98.1					25.2
Federal Highway/ Barton Highway					34.4	141.0	90.3		132.8	2.0	32.8						78.0
Northbourne Avenue/ Swinden Street	6.2		14.0	3.4	7.9					0.8	1.2	2.6					5.6
Northbourne Avenue/ Moutat Street/ Antill Street	10.8	62.4	55.6	9.8	66.4	137.2	34.2	63.0	63.5	4.8	48.7	80.9			92.2		58.3
Northbourne Avenue/ Morphett Street					25.3	14.1	1.2			0.5	0.3						18.8
Northbourne Avenue/ Wakefield Avenue/ Macarthur Avenue	12.9	55.5	55.0	13.7	40.7	34.9	132.4	185.9	175.5	21.4	62.0	47.7	29.8		79.5		70.2
Northbourne Avenue/ Ipima Street/ Condamine Street	30.5	70.2	66.1	16.3	22.6	65.3	43.5	63.6	63.4	21.3	35.0	46.5	69.4				33.3
Northbourne Avenue/ Masson Street/ Girraheen Street	58.2	57.6	59.5	11.7	14.8	70.1	156.7	185.5	186.5	3.9	6.6	46.7	46.7				37.2
Northbourne Avenue/ Gould Street/ Elouera Street	58.8	61.5	59.8	29.7	4.3	41.6	53.1	56.1	52.7	47.1	44.1	46.9	87.7		70.0		24.3
Northbourne Avenue/ Barry Drive/ Cooyong Street	55.8	53.1	52.0	19.8	23.7	110.6	14.7	52.5	51.5	13.4	21.9	74.0					40.4
Northbourne Avenue/ Rudd Street/Bunda Street	55.5	57.8	50.7	1.9	9.9	91.7	54.8	59.3	66.2	6.6	9.5	118.6			88.1		21.5
Northbourne Avenue/ Alinga Street	26.0	60.0	88.4	24.9	7.4	66.1	51.0	56.4	59.4	3.3	5.2						9.1
Northbourne Avenue/ London Circuit	4.0	57.9	52.7	13.7	7.1	83.1	51.6	56.0	51.1	12.5	21.7	87.2					25.1

2021 Base AM delay \* volume

AM peak Intersection	Delay * vehicles (vehicle seconds)																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	2769.4	3530.8	1422.5	328.0	3296.4	512.2	753.2	4747.2	10137.4	467.2	1443.0	1493.4	0.0	0.0	0.0	0.0	30900.7
Hibberson Street/ Gungahlin Place	20.4	41.7	0.0	17.6	36.0	39.1	11.5	296.8	5.5	15.6	40.7	102.2	0.0	0.0	0.0	0.0	627.1
Hibberson Street/ Hinder Street	57.2	1602.0	58.8	187.5	400.4	37.8	13.8	108.8	48.1	14.3	110.2	209.0	0.0	0.0	0.0	0.0	2847.9
Hibberson Street/ Kate Crace Street	3705.3	5373.0	2993.0	10321.9	4876.0	906.4	277.2	2227.8	86.4	42.4	697.5	1124.8	0.0	0.0	0.0	0.0	32631.7
Flemington Road/ Manning Clark Crescent/Hamer Street	0.6	3449.6	2056.2	18.0	225.0	0.0	125.6	17004.0	4545.0	68.4	145.8	47.5	0.0	1797.4	0.0	0.0	29483.1
Flemington Road/ Wizard Street	0.0	4614.8	1803.2	285.0	0.0	87.2	126.0	12185.7	0.0	0.0	0.0	0.0	0.0	0.0	217.2	0.0	19319.1
Flemington Road/ De Bortoli Street	0.0	0.0	0.0	0.0	5561.0	0.0	31.2	0.0	4775.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10367.5
Flemington Road/ Diane Barwick Street	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flemington Road/ Moonlight Avenue	0.0	0.0	0.0	0.0	26029.2	604.0	0.0	0.0	18796.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45430.0
Flemington Road/ Mapleton Avenue	3141.6	1284.0	9900.7	18651.9	108469.2	1282.5	19.0	3515.0	6635.2	36.8	6004.8	4359.4	386.4	0.0	1353.6	0.0	165040.1
Flemington Road/ Nullabor Avenue	11722.0	3691.7	7037.2	1779.4	58834.6	315.0	128.8	6030.0	2428.4	47.6	12456.0	4741.1	0.0	0.0	1537.0	0.0	110198.8
Flemington Road/ Well Station Drive	1612.8	5017.6	3614.0	0.0	84953.7	14972.0	153.6	6713.5	8946.4	180.0	10360.0	3367.0	0.0	0.0	0.0	0.0	139790.6
Flemington Road/ Mitchell Resource Management Centre	0.0	0.0	0.0	0.0	18625.2	0.0	0.0	0.0	0.0	0.0	124.5	0.0	0.0	0.0	0.0	0.0	18743.7
Flemington Road/ Lysaght Street	0.0	0.0	0.0	0.0	497.2	381.8	128.0	0.0	349.8	444.6	670.0	0.0	0.0	0.0	0.0	0.0	2471.4
Flemington Road/ Sandford Street/ Morisset Road	11.5	9046.8	3998.5	1298.5	35796.6	1402.5	2059.0	9125.4	8445.6	4181.8	8364.0	0.0	56.1	0.0	0.0	0.0	63686.3
Flemington Road/ Randwick Road	0.0	0.0	0.0	0.0	9974.4	1001.0	15.5	0.0	119.6	153.6	633.6	0.0	0.0	0.0	0.0	0.0	11897.7
Flemington Road/ EPIC	0.0	0.0	0.0	9.6	13137.5	0.0	0.0	0.0	0.0	0.0	191.4	20.8	0.0	0.0	0.0	0.0	13359.3
Flemington Road/ Federal Highway	32457.6	0.0	8665.5	174.0	28980.0	0.0	0.0	0.0	0.0	0.0	4443.6						

Table B1.5 2021 Base PM Volumes

PM peak Intersection	Volume																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	55	69	82	53	134	22	20	146	135	141	212	55	0	0	0	0	1124
Hibberson Street/ Gungahlin Place	126	198	33	0	0	0	23	180	50	10	61	44	0	0	0	0	724
Hibberson Street/ Hinder Street	149	310	138	102	61	10	27	132	66	36	223	26	0	0	0	0	1279
Hibberson Street/ Kate Crace Street	155	512	197	102	100	84	23	234	4	4	211	231	0	0	0	0	1857
Flemington Road/ Manning Clark	5	771	21	3	5	0	12	36	418	120	105	13	0	0	73	0	1568
Flemington Road/ Wizard Street	0	830	151	16	0	12	72	426	0	0	0	0	0	12	0	0	1518
Flemington Road/ De Bortoli Street	0	0	0	0	154	0	35	0	419	0	0	0	0	0	0	0	608
Flemington Road/ Diane Barwick Street	0	0	0	0	0	0	2	0	0	0	37	0	0	0	0	0	39
Flemington Road/ Moonlight Avenue	0	0	0	0	510	56	0	0	33	0	0	0	0	0	0	0	600
Flemington Road/ Mapleton Avenue	58	54	151	159	313	60	36	41	40	64	854	137	9	0	0	0	1977
Flemington Road/ Nullabor Avenue	134	68	89	42	333	26	21	28	19	37	948	292	0	0	19	0	2057
Flemington Road/ Well Station Drive	18	187	32	0	330	170	366	269	22	107	941	191	0	0	0	0	2633
Flemington Road/ Mitchell Resource Management	0	0	0	0	371	0	0	0	0	0	1247	0	0	0	0	0	1618
Flemington Road/ Lysaght Street	0	0	0	0	280	92	190	0	131	177	1081	0	0	0	0	0	1931
Flemington Road/ Sandford Street/ Morisset Road	0	122	80	76	314	25	45	301	111	191	1118	0	0	0	0	0	2383
Flemington Road/ Randwick Road	0	0	0	0	415	12	8	0	5	25	1305	0	0	0	0	0	1770
Flemington Road/ EPIC	0	0	0	1	420	0	7	0	0	0	1326	1	0	0	0	0	1755
Flemington Road/ Federal Highway	554	0	80	35	388	0	0	0	0	0	1246	716	0	0	0	0	3018
Federal Highway/ Phillip Avenue	150	0	417	167	775	0	0	0	0	0	1545	156	0	0	0	0	3210
Federal Highway/ Barton Highway	0	0	0	0	610	320	223	0	337	1003	1491	0	0	0	0	0	3984
Northbourne Avenue/ Swinden Street	40	0	11	16	965	0	0	0	0	9	2467	73	0	0	0	0	3581
Northbourne Avenue/ Mouat Street/ Antill Street	204	544	532	183	685	156	179	378	243	445	1860	156	0	0	1	0	5566
Northbourne Avenue/ Morphett Street	78	0	0	13	1097	40	18	0	0	17	2438	0	0	0	0	0	3610
Northbourne Avenue/ Wakefield Avenue/ Macarthur	55	413	443	199	852	157	309	326	237	303	1891	63	28	0	6	0	5283
Northbourne Avenue/ Ipima Street/ Condamine Street	105	188	286	135	987	55	21	89	44	89	2062	119	5	0	0	0	4185
Northbourne Avenue/ Masson Street/ Girraheen	69	174	311	161	957	30	117	102	41	31	1981	20	3	0	3	0	4000
Northbourne Avenue/ Gould Street/ Elouera Street	150	91	213	35	1053	0	79	67	22	25	1726	54	11	0	32	0	3558
Northbourne Avenue/ Barry Drive/ Cooyong Street	144	740	349	163	860	244	247	524	294	205	1254	175	0	0	0	0	5200
Northbourne Avenue/ Rudd Street/Bunda Street	159	76	94	39	1228	30	103	93	97	88	1447	114	0	0	9	0	3577
Northbourne Avenue/ Alinga Street	3	26	2	0	1441	42	53	30	77	42	1610	0	0	0	0	0	3326
Northbourne Avenue/ London Circuit	66	140	258	258	1198	67	189	141	412	109	1203	145	0	0	0	0	4185

Table B1.7 2021 Base PM Delay

PM peak Intersection	Delay (seconds)																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	35.3	40.2	45.1	19.7	18.2	46.0	38.8	37.1	36.4	20.9	23.5	50.7					30.9
Hibberson Street/ Gungahlin Place	0.4	0.4	1.3					0.8	2.2	2.0	1.3	2.4					1.2
Hibberson Street/ Hinder Street	1.0	9.6	0.9	1.1	3.6	7.3	1.4	1.5	3.0	1.6	3.3	4.6					3.9
Hibberson Street/ Kate Crace Street	42.2	36.9	41.4	4.9	5.5	5.7	10.3	10.0	21.7	79.9	77.5	79.6					39.2
Flemington Road/ Manning Clark	0.3	11.0	55.7	0.8	39.2		23.0	21.6	54.7	2.4	41.3	40.7		53.6			19.7
Flemington Road/ Wizard Street		1.5	39.2	1.3		38.9	4.5	37.2						35.4			16.0
Flemington Road/ De Bortoli Street					1.0		1.0		1.5								1.3
Flemington Road/ Diane Barwick Street							0.1				0.0						0.0
Flemington Road/ Moonlight Avenue					0.4	1.1			0.5								0.5
Flemington Road/ Mapleton Avenue	1.4	44.9	46.4	3.1	32.4	60.9	1.5	43.7	42.4	0.6	6.2	19.6		36.4			18.1
Flemington Road/ Nullabor Avenue	2.5	43.5	38.4	5.1	39.3	33.7	1.8	39.8	38.8	1.3	8.2	21.5			17.7		18.1
Flemington Road/ Well Station Drive	0.6	37.1	45.9		33.7	56.7	6.2	42.2	35.2	15.9	35.7	55.1					34.0
Flemington Road/ Mitchell Resource Management					2.0						0.6						0.9
Flemington Road/ Lysaght Street					0.5	12.5	10.8		14.8	5.9	6.9						7.1
Flemington Road/ Sandford Street/ Morisset Road		28.5	26.2	1.8	30.8	51.2	26.6	32.0	36.1	29.8	37.0						33.0
Flemington Road/ Randwick Road					7.0	12.6	0.6		9.5	2.4	0.8						2.4
Flemington Road/ EPIC	13.3			0.2	12.0		11.0				0.5	2.7					3.3
Flemington Road/ Federal Highway	5.9		64.2	2.2	51.8						14.4	24.5					21.2
Federal Highway/ Phillip Avenue	2.3		50.2	3.9	20.8						15.1	64.5					22.3
Federal Highway/ Barton Highway					12.2	61.0	6.1		48.8	7.2	29.8						24.2
Northbourne Avenue/ Swinden Street	1.9		10.5	3.0	7.0					4.1	11.5	3.8					10.0
Northbourne Avenue/ Mouat Street/ Antill Street	3.9	60.2	64.2	3.4	57.4	98.6	22.7	60.0	57.1	15.4	68.1	44.9			70.0		54.6
Northbourne Avenue/ Morphett Street	1.3			1.1	0.5						0.5						4.8
Northbourne Avenue/ Wakefield Avenue/ Macarthur	23.3	57.8	65.8	3.0	46.9	71.5	6.3	61.3	60.8	46.1	52.3	81.7	74.4		83.4		11.6
Northbourne Avenue/ Ipima Street/ Condamine Street	101.6	127.5	127.4	21.4	40.9	55.0	17.0	53.3	49.2	28.7	32.6	85.2	62.4				49.0
Northbourne Avenue/ Masson Street/ Girraheen	80.2	81.1	83.9	40.7	59.5	60.4	16.0	56.2	56.7	19.7	14.1	69.9	35.8		93.1		37.8
Northbourne Avenue/ Gould Street/ Elouera Street	409.7	275.1	275.9	5.0	11.9		52.7	50.8	57.7	33.7	16.2	82.6	60.6		50.5		56.9
Northbourne Avenue/ Barry Drive/ Cooyong Street	41.4	40.4	43.9	38.0	51.8	73.7	16.7	80.6	57.2	18.1	22.3	63.5					41.4
Northbourne Avenue/ Rudd Street/Bunda Street	52.2	55.5	53.8	2.8	13.8	85.9	51.7	57.5	55.7	10.5	14.1	60.2			50.8		22.9
Northbourne Avenue/ Alinga Street	47.4	62.4	86.5		10.2	83.7	60.4	60.0	58.5	5.6	6.1						12.0
Northbourne Avenue/ London Circuit	9.1	52.7	53.5	16.2	6.1	67.1	49.5	49.9	49.8	17.7	29.2	95.8					30.3

2021 Base PM Volume \* Delay

PM peak Intersection	Delay * vehicles (vehicle seconds)																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	1941.5	2773.8	3698.2	1044.1	2438.8	1012.0	776.0	5416.6	4914.0	2946.9	4982.0	2788.5	0.0	0.0	0.0	0.0	34732.4
Hibberson Street/ Gungahlin Place	50.4	79.2	42.9	0.0	0.0	0.0	18.4	396.0	100.0	12.0	79.3	105.6	0.0	0.0	0.0	0.0	883.8
Hibberson Street/ Hinder Street	149.0	2976.0	124.2	112.2	219.6	73.0	37.8	198.0	198.0	57.6	735.9	119.6	0.0	0.0	0.0	0.0	5000.9
Hibberson Street/ Kate Crace Street	6541.0	18992.8	8155.8	499.8	550.0	478.8	236.9	2340.0	86.8	319.6	16352.5	18387.6	0.0	0.0	0.0	0.0	72841.6
Flemington Road/ Manning Clark	1.5	8481.0	1169.7	2.4	196.0	0.0	828.0	9028.8	6564.0	252.0	536.9	0.0	0.0	3912.8	0.0	0.0	30973.1
Flemington Road/ Wizard Street	0.0	1245.0	5919.2	20.8	0.0	466.8	324.0	15847.2	0.0	0.0	0.0	0.0	0.0	424.8	0.0	0.0	24247.8
Flemington Road/ De Bortoli Street	0.0	0.0	0.0	0.0	154.0	0.0	35.0	0.0	628.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	817.5
Flemington Road/ Diane Barwick Street	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Flemington Road/ Moonlight Avenue	0.0	0.0	0.0	0.0	204.0	61.6	0.0	0.0	16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	282.1
Flemington Road/ Mapleton Avenue	81.2	2424.6	7006.4	492.9	10141.2	3654.0	54.0	1791.7	1696.0	38.4	5294.8	2685.2	327.6	0.0	0.0</		

Table B2.1 2021 Project AM Volumes

AM peak Intersection	Volume																Total		
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W			
Hibberson Street/ Gozzard Street	33	79	18	0	216	6	15	65	205	33	120	16	87	54	0	0	0	0	794
Hibberson Street/ Gungahlin Place	0	0	0	0	100	10	86	0	0	0	0	0	0	0	0	0	0	0	444
Hibberson Street/ Hinder Street	0	0	0	0	211	0	0	0	0	0	0	222	0	0	0	0	0	0	433
Hibberson Street/ Kate Crace Street	378	0	128	519	252	0	0	0	0	0	0	24	171	0	0	0	0	0	1472
Flemington Road/ Manning Clark Crescent/Hamer Street	3	458	0	21	5	0	0	10	571	110	51	2	2	0	27	0	0	0	1259
Flemington Road/ Wizard Street	0	452	0	106	0	3	23	600	0	0	0	0	0	0	0	0	0	0	1184
Flemington Road/ De Bortoli Street	319	0	0	24	690	0	0	0	0	0	0	0	0	0	0	0	0	0	1033
Flemington Road/ Diane Barwick Street	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2
Flemington Road/ Moonlight Avenue	69	0	0	42	963	0	0	0	0	0	0	0	0	0	0	0	0	0	1075
Flemington Road/ Mapleton Avenue	124	19	171	233	803	14	16	85	107	0	333	56	5	0	18	0	0	0	1983
Flemington Road/ Nullabor Avenue	398	72	116	56	960	15	22	155	37	14	265	98	0	0	29	0	0	0	2237
Flemington Road/ Well Station Drive	69	146	32	8	1089	386	55	120	30	50	337	104	0	0	0	0	0	0	2424
Flemington Road/ Mitchell Resource Management Centre	0	0	0	0	1199	0	0	0	0	0	496	0	0	0	0	0	0	0	1695
Flemington Road/ Lysaught Street	152	0	119	161	1037	0	0	0	0	0	378	233	0	0	0	0	0	0	2080
Flemington Road/ Sandford Street/ Morisset Road	0	249	112	359	810	38	73	289	175	197	433	0	2	0	0	0	0	0	2736
Flemington Road/ Randwick Road	5	0	1	2	949	49	34	0	4	22	594	2	0	0	0	0	0	0	1662
Flemington Road/ EPIC	0	0	0	0	954	0	0	0	0	0	616	0	0	0	0	0	0	0	1570
Flemington Road/ Federal Highway	1072	0	81	10	945	0	0	0	0	0	535	304	0	0	0	0	0	0	2947
Federal Highway/ Phillip Avenue	124	0	165	576	1438	0	0	0	0	0	671	140	0	0	0	0	0	0	3115
Federal Highway/ Barton Highway	0	0	0	0	1153	383	230	0	966	219	590	0	0	0	0	0	0	0	3540
Northbourne Avenue/ Swindon Street	52	1	18	18	2126	8	3	1	3	12	795	20	0	0	5	0	0	0	3062
Northbourne Avenue/ Moutat Street/ Antill Street	370	406	172	0	447	1551	144	85	564	563	138	563	151	0	0	51	0	0	5234
Northbourne Avenue/ Morphett Street	4	0	0	0	2396	152	88	0	0	0	13	802	0	1	0	0	0	0	3452
Northbourne Avenue/ Wakefield Avenue/ Macarthur Avenue	65	281	186	588	1610	144	249	586	330	216	678	44	4	0	9	0	0	0	4991
Northbourne Avenue/ Ipina Street/ Condamine Street	0	110	112	228	1664	25	23	258	193	40	827	67	47	0	0	0	0	0	3594
Northbourne Avenue/ Masson Street/ Girraheen Street	79	101	103	386	1554	81	17	213	111	51	846	41	9	0	0	0	0	0	3992
Northbourne Avenue/ Gould Street/ Elouera Street	104	141	47	48	1557	31	29	79	18	58	825	103	33	0	20	0	0	0	3092
Northbourne Avenue/ Barry Drive/ Cooyong Street	85	327	154	138	1208	355	103	585	351	154	835	190	0	0	0	0	0	0	4485
Northbourne Avenue/ Rudd Street/Bunda Street	116	97	44	72	1575	0	74	82	17	143	1065	147	0	0	26	0	0	0	3458
Northbourne Avenue/ Alinga Street	2	26	2	0	1703	32	14	30	44	76	1379	0	0	0	0	0	0	0	3308
Northbourne Avenue/ London Circuit	6	88	109	296	1329	115	144	151	270	141	1202	121	0	0	0	0	0	0	3973

Table B2.3 2021 Project AM Delay

AM peak Intersection	Delay (seconds)																Total		
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W			
Hibberson Street/ Gozzard Street	32.6	32.9	37.7		27.2	54.3	41.0	40.8	40.3	29.0	27.3	44.2							34.4
Hibberson Street/ Gungahlin Place					0.3	0.3	0.7		0.6	0.8	0.2								0.5
Hibberson Street/ Hinder Street					14.1						12.6								13.3
Hibberson Street/ Kate Crace Street				55.2	6.1	43.2					46.2	69.9							26.5
Flemington Road/ Manning Clark Crescent/Hamer Street	3.0	14.7		2.1	67.3		17.2	15.8	62.9	56.5	63.1	71.1		64.8					22.4
Flemington Road/ Wizard Street		2.9		42.7		33.0	1.3	22.0											16.2
Flemington Road/ De Bortoli Street	2.3			0.6	0.6														1.1
Flemington Road/ Diane Barwick Street										0.0	0.0								0.0
Flemington Road/ Moonlight Avenue	1.0			0.8	0.5														0.6
Flemington Road/ Mapleton Avenue	49.3	57.2	51.9	29.5	36.0	84.5	55.4	53.3	52.7		20.3	91.4	39.0		107.2				39.4
Flemington Road/ Nullabor Avenue	6.4	43.3	56.3	7.0	16.9	56.0	8.4	43.6	46.1	1.8	23.6	146.9	56.3		161.9				28.4
Flemington Road/ Well Station Drive	5.7	48.7	60.5	4.9	29.6	40.2	1.3	50.9	60.3	9.5	36.2	76.6							35.4
Flemington Road/ Mitchell Resource Management Centre					15.5						3.0								11.9
Flemington Road/ Lysaught Street	64.2		34.3	56.5	14.4						23.4	18.0							23.9
Flemington Road/ Sandford Street/ Morisset Road		100.0	102.3	25.1	31.8	66.0	50.8	54.2	46.6	42.4	40.5	15.5	54.5						46.4
Flemington Road/ Randwick Road	53.1		51.1	29.6	43.8	104.9	1.3		50.2	20.6	24.2	102.3							37.5
Flemington Road/ EPIC					17.9						0.4								11.0
Flemington Road/ Federal Highway	125.0		174.6	49.5	64.5						7.7	56.0							78.3
Federal Highway/ Phillip Avenue	70.9		59.9	24.3	74.8						22.6	168.1							57.5
Federal Highway/ Barton Highway					230.5	268.4	182.4			266.7	3.1	42.1							195.9
Northbourne Avenue/ Swindon Street	61.6	51.9	68.1	80.1	62.0	148.0	58.3	39.0	65.7	7.0	27.0	71.1			70.5				67.0
Northbourne Avenue/ Moutat Street/ Antill Street	7.8	96.2	67.2	7.6	36.9	89.0	124.9	174.6	155.2	1.8	52.0	102.7			97.1				72.2
Northbourne Avenue/ Morphett Street	2.8			0.6	0.3	33.1	1.6			0.8	0.3		28.6						8.4
Northbourne Avenue/ Wakefield Avenue/ Macarthur Avenue	17.7	88.9	89.3	6.2	34.9	39.3	127.4	183.8	177.0	19.4	50.1	63.6	40.4		62.9				69.7
Northbourne Avenue/ Ipina Street/ Condamine Street		64.6	62.0	19.3	27.1	102.0	7.1	57.4	60.1	26.0	39.5	67.3	107.9						37.8
Northbourne Avenue/ Masson Street/ Girraheen Street	86.5	83.3	83.5	10.0	11.7	81.0	55.6	76.1	71.7	6.0	13.8	56.9	71.2						25.7
Northbourne Avenue/ Gould Street/ Elouera Street	86.2	93.6	99.3	26.8	5.3	53.1	54.2	56.8	60.1	31.3	31.5	74.1	87.2		82.0				27.5
Northbourne Avenue/ Barry Drive/ Cooyong Street	85.3	80.9	58.5	12.3	9.7	68.2	177.5	163.5	151.9	27.9	30.7	76.1							65.1
Northbourne Avenue/ Rudd Street/Bunda Street	71.5	86.0	85.6	7.0	13.9	72.5	68.2	71.8	3.2	3.3	171.9				152.4				25.5
Northbourne Avenue/ Alinga Street	16.9	60.8	88.3		5.0	57.0	58.7	54.3	54.8	4.0	7.2								8.2
Northbourne Avenue/ London Circuit	3.2	55.8	62.4	9.0	4.5	80.3	54.1	52.7	53.4	13.9	21.6	81.0							24.6

2021 Project AM Delay \* Vol

AM peak Intersection	Delay * vehicles (vehicle seconds)																Total		
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W			
Hibberson Street/ Gozzard Street	1075.8	2599.1	678.6	0.0	5875.2	325.8	615.0	2652.0	8251.5	454.0	2375.1	2386.8	0.0	0.0	0.0	0.0	0.0	0.0	27398.9
Hibberson Street/ Gungahlin Place	0.0	0.0	0.0	0.0	30.0	3.0	60.2	0.0	15.8	96.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	227.8
Hibberson Street/ Hinder Street	0.0	0.0	0.0	0.0	2075.1	0.0	0.0	0.0	0.0	0.0	2797.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5772.3
Hibberson Street/ Kate Crace Street	4838.4	0.0	7065.6	3165.9	10896.4	0.0	0.0	0.0	0.0	0.0	1108.8	11952.9	0.0	0.0	0.0	0.0	0.0	0.0	39018.0
Flemington Road/ Manning Clark Crescent/Hamer Street	9.0	6732.6	0.0	44.1	336.5	0.0	172.0	9021.8	6919.0	2881.5	126.2	142.2	0.0	1749.6	0.0	0.0	0.0	0.0	28134.5
Flemington Road/ Wizard Street	0.0	1310.8	0.0	4526.2	0.0	99.0	29.9	13200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19165.9
Flemington Road/ De Bortoli Street	733.7	0.0	0.0	14.4	414.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1162.1
Flemington Road/ Diane Barwick Street	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flemington Road/ Moonlight Avenue	69.0	0.0	0.0	33.6	481.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	584.1
Flemington Road/ Mapleton Avenue	6113.2	1086.8	8874.9	6873.5	28908.0	1183.0	886.4	4530.5	5638.9	0.0	6759.9	5118.4	195.0	0.0	1929.6	0.0	0.0	0.0	78098.1
Flemington Road/ Nullabor Avenue	2547.2	3117.6	6530.8	392.0	16224.0	840.0	184.8	6758.0	1705.7	25.2	6254.0	14396.2	0.0	0.0	4695.1	0.0	0.0	0.0	63670.6
Flemington Road/ Well Station Drive	393.3	7110.2	1936.0	39.2	32234.0	15517.2	71.5	6108.0	1809.0	475.0	12199.4	7966.4	0.0	0.0	0.0	0.0	0.0	0.0	85859.6
Flemington Road/ Mitchell Resource Management Centre	0.0	0.0	0.0	0.0	18584.5	0.0	0.0	0.0	0.0	0.0	1488.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20072.5
Flemington Road/ Lysaught Street	9758.4	0.0	2891.7	9096.5	14932.8	0.0	0.0												

Table B2.5 2021 Project PM Volumes

Intersection	Volume																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	50	60	76	18	150	26	29	95	133	107	219	80	0	0	0	0	1041
Hibberson Street/ Gungahlin Place	0	0	0	0	53	79	145	0	48	109	245	0	0	0	0	0	678
Hibberson Street/ Hinder Street	0	0	0	0	133	0	0	0	0	0	467	0	0	0	0	0	601
Hibberson Street/ Kate Craca Street	356	0	273	280	169	0	0	0	0	0	49	309	0	0	0	0	1436
Flemington Road/ Manning Clark Crescent/Hamer Street	6	520	0	7	4	10	47	441	98	99	14	0	0	79	0	0	1325
Flemington Road/ Wizard Street	0	591	0	21	0	7	77	451	0	0	0	0	0	0	0	0	1147
Flemington Road/ De Bortoli Street	148	0	0	36	446	0	0	0	0	0	0	0	0	0	0	0	630
Flemington Road/ Diane Barwick Street	0	0	0	0	0	0	3	0	0	0	35	0	0	0	0	0	38
Flemington Road/ Moonlight Avenue	35	0	0	56	531	0	0	0	0	0	0	0	0	0	0	0	622
Flemington Road/ Mapleton Avenue	79	60	118	177	322	57	27	39	41	0	617	125	6	0	0	0	1667
Flemington Road/ Nullabor Avenue	135	78	78	52	353	23	13	34	21	25	690	275	0	0	21	0	1797
Flemington Road/ Well Station Drive	21	189	34	0	369	149	387	292	27	65	628	133	0	0	0	0	2294
Flemington Road/ Mitchell Resource Management Centre	0	0	0	0	417	0	0	0	0	0	834	0	0	0	0	0	1252
Flemington Road/ Lysight Street	129	0	152	86	334	0	0	0	0	0	685	119	0	0	0	0	1504
Flemington Road/ Sandford Street/ Morisset Road	0	154	71	76	360	28	31	316	94	183	700	0	0	0	0	0	2014
Flemington Road/ Randwick Road	3	0	5	1	446	13	8	0	4	20	872	1	0	0	0	0	1372
Flemington Road/ EPIC	0	0	0	0	450	0	0	0	0	0	886	0	0	0	0	0	1335
Flemington Road/ Federal Highway	531	0	61	36	420	0	0	0	0	0	829	702	0	0	0	0	2578
Federal Highway/ Phillip Avenue	160	0	320	173	781	0	0	0	0	0	1227	129	0	0	0	0	2790
Federal Highway/ Barton Highway	0	0	0	0	614	321	229	0	351	890	1199	0	0	0	0	0	2406
Northbourne Avenue/ Swindon Street	37	1	12	17	962	5	29	2	22	7	1588	78	0	0	17	0	3177
Northbourne Avenue/ Moutat Street/ Antill Street	189	498	467	190	684	142	183	376	231	384	1455	141	0	0	43	0	4985
Northbourne Avenue/ Morphett Street	0	0	0	0	1115	35	15	0	0	17	2073	0	12	0	0	0	3267
Northbourne Avenue/ Wakefield Avenue/ Macarthur Avenue	112	0	0	57	1063	0	0	0	0	0	2120	180	0	0	3	0	3534
Northbourne Avenue/ Ipina Street/ Condamine Street	52	373	368	194	881	118	288	334	237	376	1786	67	29	0	7	0	5109
Northbourne Avenue/ Masson Street/ Girraheen Street	0	208	295	135	979	46	20	87	45	101	1964	110	53	0	0	0	4044
Northbourne Avenue/ Gould Street/ Elouera Street	69	174	313	158	956	33	119	98	43	29	1903	20	10	0	2	0	3928
Northbourne Avenue/ Barry Drive/ Cooyong Street	156	120	271	36	1037	0	80	64	22	25	1590	52	8	0	30	0	3491
Northbourne Avenue/ Rudd Street/Bunda Street	123	669	296	139	853	279	217	486	281	205	1195	180	0	0	0	0	4922
Northbourne Avenue/ Alinga Street	169	80	85	41	1226	0	110	95	103	90	1395	113	0	0	9	0	3516
Northbourne Avenue/ London Circuit	2	26	2	0	1444	53	57	30	77	52	1570	0	0	0	0	0	3312
Northbourne Avenue/ London Circuit	65	140	252	260	1196	61	178	145	407	113	1195	153	0	0	0	0	4165

S-N 1199 inserted

Table B2.7 2021 Project PM Delay

Intersection	Delay (seconds)																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	33.4	40.5	47.9	25.7	25.1	44.2	40.3	36.4	38.6	31.0	36.2	61.6					37.5
Hibberson Street/ Gungahlin Place					0.5	0.5	2.1		1.0	1.3	0.4						1.0
Hibberson Street/ Hinder Street					13.2						19.4						18.0
Hibberson Street/ Kate Craca Street	12.5			37.2	6.2	36.3					124.6	68.5					34.7
Flemington Road/ Manning Clark Crescent/Hamer Street	0.6	9.9		1.4	52.1	64.4	13.6	13.7	54.7	60.8	59.1	2.8		55.9			22.1
Flemington Road/ Wizard Street		5.2			42.6	38.8	5.3	42.6									20.8
Flemington Road/ De Bortoli Street	1.0				1.1	0.9											0.9
Flemington Road/ Diane Barwick Street							0.0				0.0						0.0
Flemington Road/ Moonlight Avenue	0.3				1.2	0.6											0.6
Flemington Road/ Mapleton Avenue	47.1	49.3	45.4	25.6	32.2	77.0	51.1	49.9	48.9		19.0	28.9	79.7				31.5
Flemington Road/ Nullabor Avenue	1.7	41.6	51.1	4.2	23.4	58.8	1.4	37.7	48.2	1.3	14.9	72.1			62.7		28.4
Flemington Road/ Well Station Drive	1.1	35.1	44.2		27.3	59.9	7.4	45.0	44.0	9.9	29.1	78.8					32.2
Flemington Road/ Mitchell Resource Management Centre					1.2						2.4						2.0
Flemington Road/ Lysight Street	62.3		26.1	22.9	3.0						8.2	8.4					14.4
Flemington Road/ Sandford Street/ Morisset Road	2.2	60.4	55.4	9.7	15.7	66.8	39.8	50.4	42.2	23.3	21.1		34.7				30.6
Flemington Road/ Randwick Road	49.9		35.6	1.9	18.4	95.1	2.6	40.5	29.0	26.5	51.0						24.5
Flemington Road/ EPIC					3.3						0.3						1.3
Flemington Road/ Federal Highway	10.9		91.3	12.1	40.1						12.1	42.8					26.6
Federal Highway/ Phillip Avenue	4.0		58.3	2.4	20.1						28.9	96.0					29.9
Federal Highway/ Barton Highway					12.0	77.5	4.9		45.1	9.7	112						24.1
Northbourne Avenue/ Swindon Street	56.6	66.1	53.0	25.6	31.0	86.5	53.9	42.6	69.7	63.3	77.6	170.6			975.2		69.5
Northbourne Avenue/ Moutat Street/ Antill Street	53.4	158.5	231.0	4.3	53.1	69.1	56.8	73.7	65.6	92.6	251.0	171.7					147.0
Northbourne Avenue/ Morphett Street	1.6				0.6	0.4					19.8	32.5		51.0			24.5
Northbourne Avenue/ Wakefield Avenue/ Macarthur Avenue	178.0	254.4	261.9	1.4	27.4	123.7	32.5	104.5	99.4	19.3	33.2	92.7	119.4			118.6	78.9
Northbourne Avenue/ Ipina Street/ Condamine Street		107.1	106.6	15.4	32.4	110.2	0.9	55.4	59.8	23.4	33.9	141.6	106.9			84.7	75.2
Northbourne Avenue/ Masson Street/ Girraheen Street	81.9	82.2	79.7	31.6	51.2	74.4	46.4	71.1	65.5	19.7	20.1	83.7	63.8			92.1	40.2
Northbourne Avenue/ Gould Street/ Elouera Street	330.8	195.6	197.4	18.7	20.3	59.8	59.8	59.4	32.6	25.6	103.7	74.0					60.0
Northbourne Avenue/ Barry Drive/ Cooyong Street	69.2	63.9	60.8	65.8	61.6	84.5	254.1	184.9	156.4	33.6	33.6	64.4					82.2
Northbourne Avenue/ Rudd Street/Bunda Street	75.7	76.4	76.5	40.5	34.1	57.9	59.5	63.5	14.1	15.2	34.7				36.9		32.5
Northbourne Avenue/ Alinga Street	36.7	62.3	76.6		17.8	84.4	56.7	59.2	56.0	5.9	7.2						15.9
Northbourne Avenue/ London Circuit	11.1	53.8	60.9	12.1	3.4	84.5	49.5	51.2	50.4	19.4	27.7	94.7					29.4

S-N 112 inserted

2021 Project PM Delay \* Volumes

Intersection	Delay * vehicles (vehicle seconds)																Total
	E-S	E-W	E-N	N-E	N-S	N-W	W-N	W-E	W-S	S-W	S-N	S-E	N-N	E-E	S-S	W-W	
Hibberson Street/ Gozzard Street	1670.0	2430.0	3640.4	462.6	3765.0	1149.2	1168.7	3458.0	5133.8	3317.0	7527.8	4928.0	0.0	0.0	0.0	0.0	39055.5
Hibberson Street/ Gungahlin Place	0.0	0.0	0.0	0.0	26.5	39.5	304.5	0.0	48.0	141.7	98.0	0.0	0.0	0.0	0.0	0.0	658.2
Hibberson Street/ Hinder Street	0.0	0.0	0.0	0.0	1755.6	0.0	0.0	0.0	0.0	0.0	9059.8	0.0	0.0	0.0	0.0	0.0	10815.4
Hibberson Street/ Kate Craca Street	4450.0	0.0	10155.6	1738.0	6134.7	0.0	0.0	0.0	0.0	0.0	6105.4	21166.5	0.0	0.0	0.0	0.0	49748.2
Flemington Road/ Manning Clark Crescent/Hamer Street	3.6	5148.0	0.0	9.8	208.4	644.0	639.2	6041.7	5360.6	6019.2	827.4	0.0	0.0	4416.1	0.0	0.0	29318.0
Flemington Road/ Wizard Street	0.0	3073.2	0.0	894.6	0.0	271.6	408.1	18212.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23860.1
Flemington Road/ De Bortoli Street	148.0	0.0	0.0	39.6	401.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	589.0
Flemington Road/ Diane Barwick Street	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flemington Road/ Moonlight Avenue	10.5	0.0	0.0	67.2	318.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	396.3
Flemington Road/ Mapleton Avenue																	