OPUS

Hillcrest Paramics Model

SH1: One Network Solution

Performance Assessment of SH1 between SH1/SH26 and SH1/Grey St

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Performance Assessment of SH1 between SH1/SH26 and SH1/Grey St

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Appendices

1 Introduction

This technical report sets out the traffic modelling results of a network improvement solution along SH1 between SH1/SH26 and Cobham Drive/Grey Street intersections that aims to address the existing and predicted congestion in the morning and afternoon peak periods. It outlines the expected operating conditions in year 2021 and 2041 for a baseline (Do Min) and Scheme option scenario at five key intersections along the route.

1.1 Background

The NZ Transport Agency (Agency) and Hamilton City Council (HCC) are looking at a one network solution approach to SH1 between Howell Ave and Grey Street and removal of rat run traffic on Cambridge Road through the Hillcrest Shopping area. The Agency originally proposed to upgrade the existing two lane roundabout at SH1/26 intersection by adding some extra traffic lanes in isolation from the remaining network. Micro simulation modelling of the proposed improvements in the Hillcrest Paramics model identified that extensive queuing was still likely to occur after the improvements.

This resulted in a number of further testing and technical reports. This section briefly outlines these earlier studies.

Memo 16th Dec 2013

This report outlined the intersection performance results of a roundabout or traffic signal option at the Cobham Drive/Wairere Drive intersection using SIDRA software and traffic flows extracted from the Waikato Regional Transportation Model (WRTM) as the Paramics model flows were not available. No recommendations were provided, merely the expected operating conditions.

Memo 28th Jan 2014

Following a meeting on 18th December 2013, it was agreed to test two new scenario's which involved closure of the Burger King entrance directly onto the roundabout or ramp metering the SH26 approach, in addition to the Agency's proposed intersection upgrade. This exercise concluded that under the four test scenarios:

"Our current Paramics modelling appears to indicate that with the significant forecast traffic demands in year 2021, the network is sensitive to intersection improvements that provide an increase in capacity. This is evidenced by the change in traffic flows on the various links under the different scenarios and changes in queue locations. Whilst in most instances the SH1/SH26 intersection is improved, it is to the detriment of other sections of the network, mainly due to changes in rat run routes. For instance the effect of ramp metering on SH26 causes traffic to use Morris Road, Mansel Ave and Masters Ave to avoid the intersection, which in turn creates congestion on local streets. Or put another way, wrong traffic on wrong roads."

Memo 21st February 2014

Following a meeting with both HCC and the Agency on separate occasions, it was agreed that another scenario should be modelled that considered collective improvements to the SH1 corridor

based on Opus' knowledge of the area and previous modelling outputs. In developing a 2021 network solution, the following objectives were assumed as appropriate.

- Encourage right traffic on right roads,
- Minimise delays and queues on SH1 and SH26,
- Keep through traffic out of Cambridge Road (between Naylor St and Cobham Drive) and encourage traffic to use Wairere Drive and Cobham Drive, and
- Ensure the intersection of Wairere Drive/Cobham Drive fits within the existing designation.

Testing of the Opus 2021 solution (referred to as Option U1) considered improvements at:

- SH1/SH26
  - » Modify the Agency's layout, to include an extra through lane on SH1 approach from Howell Ave to Cobham Drive/Cambridge Road intersection. This would be marked up with a shared left and through lane, dedicated through lane, and a shared through and right turn lane.
- Cobham Drive/Cambridge Road
  - » Reduce Cambridge Road approach to a single lane exit with shared left and right movements
  - » Install a ramp meter on the right turn lane into Cambridge Road using a detector loop to control queue lengths on Cobham Drive southbound approach,
  - » Provide two northbound through lanes that are free movements, and
  - » The right turn lane out of Cambridge Road would merge with the outer northbound lane.
- Cobham Drive/Wairere Drive
  - » Adopt a two lane circulating roundabout on the basis that HCC have indicated it fits within the designation footprint.

This round of modelling concluded that:

Option U1, appears to put the right traffic on the right roads, as demonstrated by the higher link flows on Cobham Drive and SH1. In my view the main objectives stated in Section 1 have been achieved with this option, although it does require a number of improvements, being:

- *Adoption of the Agency's proposed SH1/SH26 intersection upgrade coupled with an additional northbound through lane (see below) that extends just north of the Cobham /Cambridge intersection. This is likely to require some property purchase on Cambridge Road (SH1),*
- *Upgrade of the Cobham/Cambridge intersection. Restrict the exit on Cambridge Road to one single lane, add a dedicated right turn lane into Cambridge Road that is ramp metered (using a queue detector on Cobham Drive southbound) and providing two northbound lanes on Cobham that are physically separated from the right turn lane (using an island) and operate as a free movement (see below). The right turn out of Cambridge Road would merge with the outer northbound flow. To avoid this merge, the right turn out of Cambridge could be banned,*

or alternatively, the through lane on Cambridge Road could be reduced to one lane although I am unsure whether this would reduce the capacity at SH1/SH26 without further testing.

- *If Council and the Agency consider Option U1 is a potential solution, then modelling of this network with year 2041 flows should be assessed. Once the year 2041 performance is known and accepted as meeting the objectives, then a feasibility assessment could be undertaken to determine the economic merits, project costs, and environmental effects.*

Email 18th March 2014

At the request of the Agency, a modification at Cobham Drive/Cambridge Road was required to minimise land purchase. This involved replacing the Roundabout Ramp metered option with a set of Traffic Signals, but retaining the two northbound lanes as unopposed (free flowing). In addition, the roundabout at Cobham/Wairere was tested as traffic signals. As a result two new tests (U3 & U4) were modelled for year 2021 and results provided to HCC and the Agency. Our investigation concluded that:

- *If the Cambridge Road/Cobham Drive intersection is to be traffic signals, then the green time for the right turn into Cambridge Road needs to be set low and on a fixed time, so that traffic is encouraged to stay on Cobham Drive northbound. This may help to achieve traffic flows similar to Opt U1. If it remains on SCATS then traffic flow on Cambridge Road in the morning are likely to be as high as would be experienced by the existing layout (Do Min).*

- *Changing the Wairere/Cobham intersection from a RAB to signals appears to have minimal impact on driver decision as to whether Cambridge Road is used or not.*

- *Overall, we believe the options that best achieve good overall traffic performance in Year 2021 as per the objectives (right traffic on right road), based on the Paramics results (ignoring Economics and Safety) is to adopt:*

  - *SH1/SH26 – Original Agency RAB layout, but with three SH1 northbound lanes from Howell Ave to north of the Cobham/Cambridge intersection.*
  - *Cobham/Cambridge – signalised option with two free flow lanes northbound on Cobham Drive and one exit lane on Cambridge Road. In addition in would require a short phase time on Cambridge Road right turn in and left turn out movement.*
  - *Wairere/Cobham – choice of either RAB or Signals. The pedestrian issue would suggest that signals is a more practical option as it avoids the need for a separate pedestrian grade separation across Cobham Drive.*

Email 10th April 2014

Further modelling was undertaken to determine the likely operation of the network in year 2031 (without Peacocks development) and with the intersection at Cobham Drive/Grey St restricted to left turn in and left turn out. This was referred to as test U4. Network traffic flows were produced for year 2021 and 2031, along with SIDRA assessments at five key intersections on SH1 being; SH1/SH26, Cobham/Cambridge, Cobham/Wairere, Cobham/Galloway and Cobham/Grey.

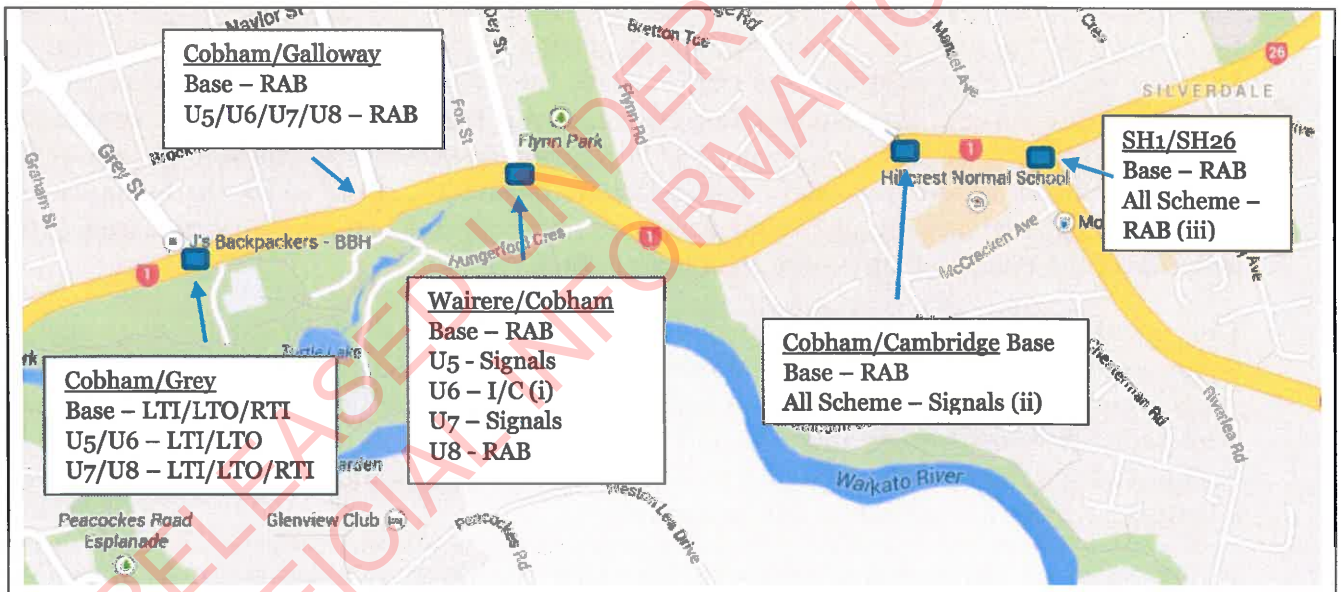
This exercise included a performance robustness test using the year 2021 Paramics flows increased by +20% to reflect a 2% linear growth over the ten year period to year 2031. This was considered

necessary as the year 2031 flows were not much different to the year 2021 flow. No conclusion or recommendations were made.

1.2 Current Proposal

At a meeting on the 17th April 2014, it was determined that further modelling work needed to be undertaken to assess an appropriate baseline and the performance of the proposed network improvements with year 2041 traffic flows. The final agreed scope was accepted on 30th May 2014 and included the task of determining corridor performance along SH1, and intersection performance at the five key junctions in year 2021 and 2041 for the baseline and a Scheme U5 and U6.

After producing a draft report in October 2014, HCC determined that the Grey Street/Cobham Drive intersection restriction to LTI/LTO should not be included as it was not a project in either the Agency or HCC's forward work programme. HCC also identified a need to better understand the network operation if traffic signals or a roundabout was adopted for the Wairere Drive/Cobham Drive intersection. The following diagram below indicates the Baseline and Scheme scenario's assessed and presented in the following sections of this report.



(i) = Year 2041 Grade Separation with Signals on the northbound Cobham Drive exit ramp
(ii) = includes no right turn out of Cambridge Road and two northbound free flow lanes on Cobham Drive
(iii) = three northbound lanes through RAB to Cambridge Road/Cobham Drive intersection, Free left slip from Cambridge Road to Morrinsville Road, two right turn lanes on Morrinsville Road

Figure 1: Layout Plan of Scheme Scenario's for SH1 Corridor Improvement

1.3 Purpose of This Report

The primary purpose of this report is to document the technical details of the micro simulation modelling work undertaken to assess the various intersection improvement options along SH1 between SH1/SH26 and Grey Street. The report only documents Scenario's U5 to U8. It is expected that this information will be used by the Transport Agency and HCC to inform other Scheme projects.

2 Model Inputs and Assumptions

Within the Paramics models the Baseline and Scheme networks all include the following:

- Full Waikato Expressway,
- Extension of Wairere Drive through to Cobham Drive,
- Ruakura Structure Plan landuse as envisaged by the Hamilton Proposed District Plan,
- Future Tamahere growth as per the Waikato District Council Tamahere Country Living Zone, and
- Peacockes development and new crossing over the Waikato River (but excludes Southern Links) in year 2041

A feedback interval of one minute has been set within Paramics to assist with route selection. This ensures that drivers are able to select the least cost route on a regular basis as traffic conditions change and not held un-necessarily on queued sections of the network if an alternative route is available.

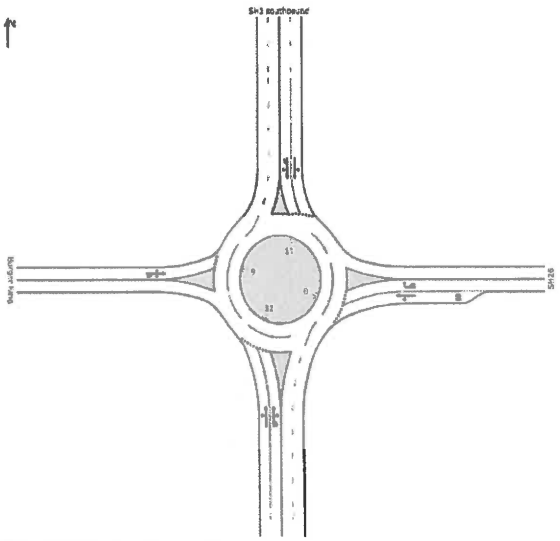
Note, whilst the Paramics model is not validated, an attempt has been made to calibrate a 2006 base Paramics model against existing 2006 traffic counts, the WRTM 2006 network flow outputs and a 2013 travel time survey. The resultant Base 2021 and 2041 Paramics models are deemed to be fit for purpose and capable of providing a comparative assessment of network improvement options. It is noted, that the 2021 and 2041 traffic forecasts from the WRTM (from which the Paramics model derived its matrices) indicate significant growth in traffic volumes in the Hillcrest area even with the inclusion of the Waikato Expressway Hamilton Section.

The trip matrices used in the Paramics model were sourced from the WRTM following a review by the project team. As a result the WRTM operators made some adjustments to refine zone loadings and trip purpose (eg Schools and Burgerking Supermarket were specifically addressed). The morning peak period represents 07:00 to 09:00 and the evening peak 16:00 to 18:00. The actual one hour peak period used for analysis in SIDRA modelling was based on 08:00 to 09:00 and 16:30 to 17:00 following a review of traffic count data in the area.

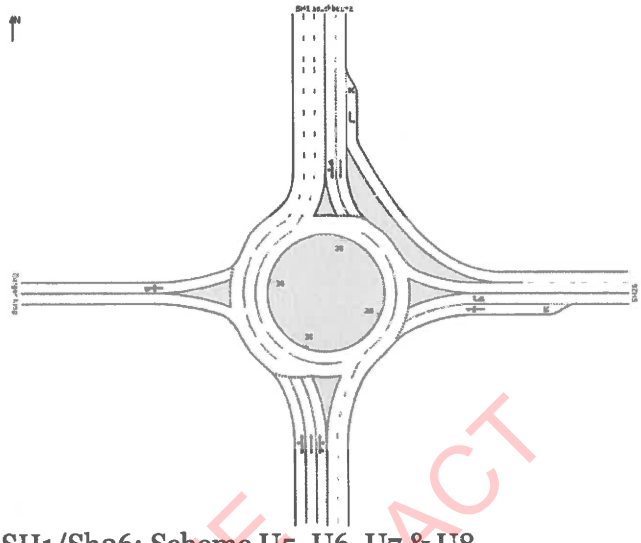
To determine the demand flow during the one hour afternoon peak period (16:30 to 17:30) the Paramics model was run from 16:30 to 19:00 to ensure all vehicles completed their trip. This subsequently required an adjustment factor to remove the vehicles that were released between 17:30 to 18:00. This process avoided the need to create multiple trip matrices for the afternoon peak period. This approach was not required for the morning peak as this conveniently covered the 08:00 to 09:00 time period.

2.1 Baseline and Scheme Intersection Layout

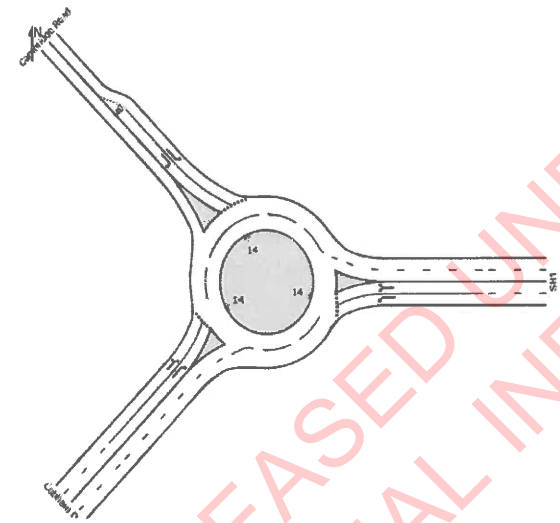
Figure 2 below indicates the intersection layout assumed for the Baseline and Scheme at the key intersections on SH1. The layout for the Cobham/Galloway intersection has not been included in Figure 2 as this intersection remains as the existing two-lane roundabout in all models assessed.



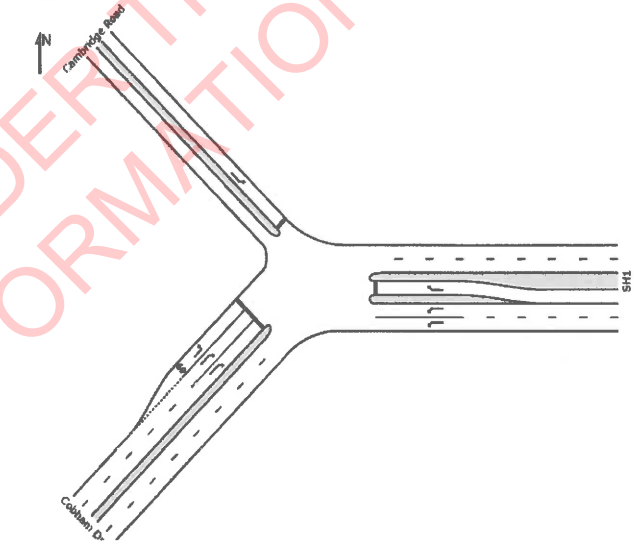
SH1/SH26: Baseline



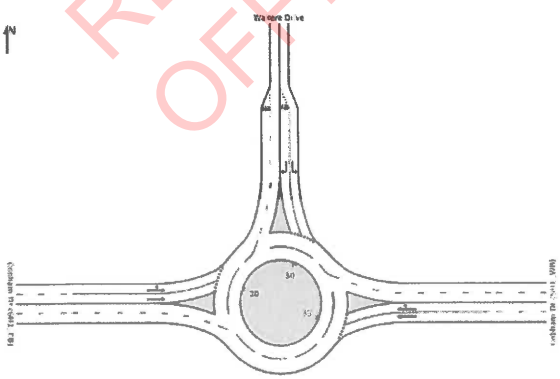
SH1/Sh26: Scheme U5, U6, U7 & U8

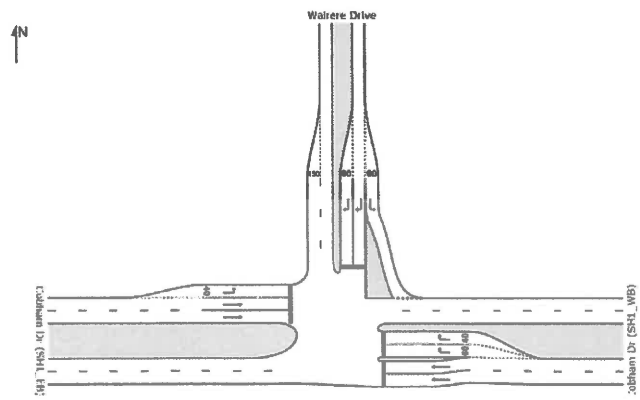


Cobham/Cambridge: Baseline



Cobham/Cambridge: Scheme U5, U6, U7 & U8





Cobham/Wairere: Scheme U5 & U7

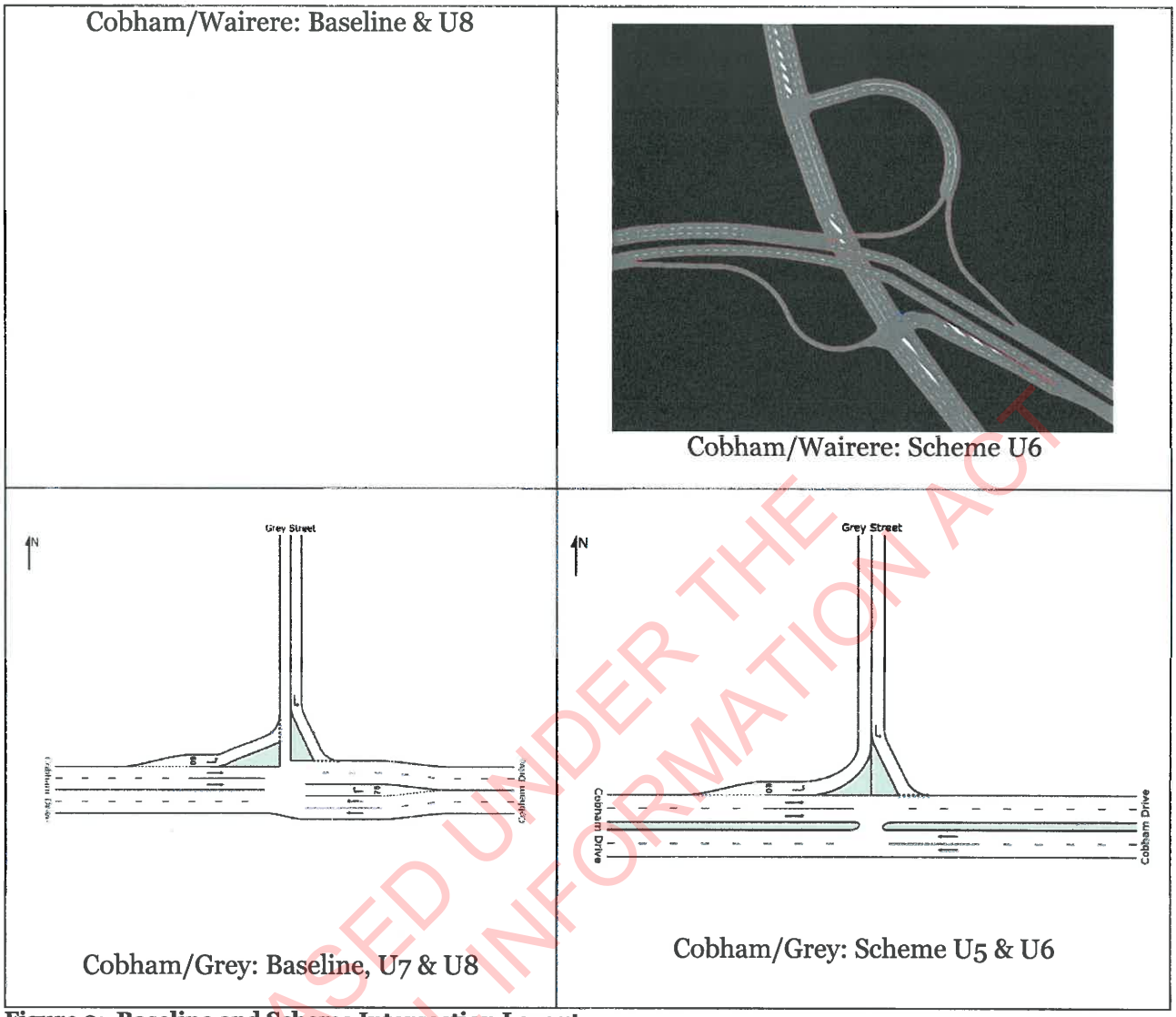


Figure 2: Baseline and Scheme Intersection Layout

2.2 Time Periods, Traffic Flows and Modelled Runs

Modelled time periods within the Paramics model consist of the two hour morning (7am to 9am) and afternoon (4pm to 6pm) peaks in line with the Waikato Regional Transportation Model, where the trip matrices were derived. Traffic flows from the Burger King and adjacent supermarket site have been adjusted based on a 2013 traffic survey undertaken by Opus during this study.

Traffic Flows

One hour demand and arrival flows have been extracted from Paramics for each modelled hour and assessed in SIDRA to illustrate intersection performance in terms of capacity and level of service. It should be noted that:

- Demand flows reflect the total amount of traffic between an origin and a destination during the modelled period, and are not affected by network capacity constraints. That is, traffic flows through the intersection represent the total number of vehicles wanting to use the junction, irrespective of any upstream bottlenecks that may prevent them from arriving at the junction

during the modelled time period. The demand flows have been captured by running the Paramics model for two hours beyond the peak period to ensure the road network is clear of all traffic and all flows are captured.

- Arrival flows represent the traffic volume released from an intersection during the modelled period, as it is recorded at the intersection limit line. Hence, if queues still exist at the end of the modelled time period, then they are not counted. In a congested network the arrival flow from Paramics is representative of the traffic volume that the junction can cope with. The arrival flows are therefore less than the demand flows.

It therefore stands to reason that when the arrival flows from Paramics are used in a SIDRA model, the performance indicators will be better than that indicated by Paramics because of the difference in traffic volumes. That is, the Paramics model is dealing with the arrival flows from upstream junctions, whereas SIDRA is dealing with the traffic flow that Paramics was able to release through the junction. For this reason, the SIDRA assessment has been undertaken using both the demand and arrival flows from Paramics. The most likely intersection performance lies somewhere between the two sets of results.

Modelled Runs

Generally the Hillcrest Paramics model output is based on the average of five separate runs within each time period. However, due to significant congestion in year 2041, we observed unusual (and hence unacceptable) driver behaviour in some of the model runs. Unfortunately even after 20 model runs the number of acceptable runs were still less than the desirable five. Hence, the number of useable Paramics model runs adopted for the assessment were limited to those indicated in Table 1 below.

Model	Arrivals		Demands	
	AM	PM	AM	PM
2021 Base Line	5	5	5	5
2021 U5	5	5	5	5
2021 U7	5	5	5	5
2021 U8	5	5	5	5
2041 Baseline	5	5	3	3
2041 U6	5	4	2	2

Table 1: Number of successful model runs used to determine output traffic flows

3 Modelled Results

Diagrams in Appendix A and B, illustrate the arrival and demand flows on the network for the four time periods. The SIDRA results for each time period are summarised below. Note, the tabulated total vehicles, is extracted from SIDRA and are slightly higher than the flow numbers in Appendix A and B due to the inclusion of the peak hour factor (which makes allowance for the peak 30minute within the peak hour). The yellow highlighted values indicate very high delays or long expected queue lengths.

3.1 Morning Peak Intersection Performance

Intersection	Scenario	Overall Intersection				Highest Movement Delay		
		Total Vehicles	LOS	Delay (s/veh)	95%ile Queue (m)	Delay (s/veh)	LOS	Movement
SH1/SH26	2021 Base	3258	B	11	58	20	B	U-turn BK
	2021 U5	4245	B	12	68	26	C	U-turn BK
	2021 U7	4278	B	12	77	28	C	U-turn BK
	2021 U8	4262	B	12	77	27	C	U-turn BK
	2041 Base	2915	B	13	63	22	C	U-turn BK
	2041 U6	3549	A	9	43	20	C	U-turn BK
	All scheme options in 2021 operate as well as the Base despite the additional +30% traffic flow travelling through the intersection. In 2041 the performance of U6 is slightly better than the 2041 Base despite the +22% traffic volume increase.							
Cambridge/ Cobham	2021 Base	2949	A	7	38	16	B	U-turn Camb Rd
	2021 U5	3716	B	14	81	27	C	R Turn Cobham SB
	2021 U7	3732	B	12	64	22	C	R Turn SH1 NB
	2021 U8	3752	B	12	56	22	C	R Turn SH1 NB
	2041 Base	2594	A	7	50	16	B	U-turn Cobham SB
	2041 U6	3155	B	14	97	24	C	R Turn Cobham SB
	All scheme options in 2021 operate as well as the Base despite the additional +26% traffic flow travelling through the intersection. In 2041 the performance is worse although still acceptable despite the +22% traffic volume increase.							
Wairere/ Cobham	2021 Base	3171	B	11	87	22	C	U-turn Cobham NB
	2021 U5	3405	B	13	88	34	C	R Turn Wairere
	2021 U7	3445	B	13	109	32	C	R Turn Wairere
	2021 U8	3501	A	7	98	17	B	U-turn Cobham NB
	2041 Base	3158	B	13	76	29	C	U-turn Peacocks
	2041 U6	3813	Grade Separated Intersection					
	Scheme U5 & U7 operate similar to the Base although the volume increase is marginally higher, however U8 operates marginally better than the Base and the other scheme options.							
Galloway/ Cobham	2021 Base	3052	A	8	45	17	B	U-turn Cobham NB
	2021 U5	3097	A	10	51	19	B	U-turn Cobham SB
	2021 U7	3354	A	9	74	18	B	U-turn Cobham NB
	2021 U8	3376	A	9	72	18	B	U-turn Cobham NB
	2041 Base	3522	E	59	947	134	F	U-turn Cobham SB
	2041 U6	2392	B	10	34	19	B	L Turn Cobham SB
	All scheme options in 2021 perform well with a similar overall vehicle volume and performance. In 2041 U6 performs far better than the 2041 Base. This is most likely due to the fact that it is catering for a much lower overall traffic volume (that is capable of getting through the intersection). Note, the previous right turn traffic at Grey Street now turns right at this intersection which adversely affects the left turn flow in Galloway St. Hence, vehicles turn left at Grey St instead.							
Grey/ Cobham	2021 Base	2935	-	32	384	193	F	R Turn Cobham NB
	2021 U5	2532	-	1	6	8	A	L Turn Cobham SB
	2021 U7	3175	-	86	872	>300	F	R Turn Cobham NB
	2021 U8	3218	-	96	956	>300	F	R Turn Cobham NB
	2041 Base	2232	-	4	37	15	C	R Turn Cobham NB
	2041 U6	1780	-	2	3	8	A	L Turn Cobham SB
	Due to the already congested right turn movement into Grey Street, the small increase in traffic flow results in significantly higher forecast delays for Scheme U7 & U8 than in the Base. In reality, with this level of delay drivers would select at alternative route or adopt much smaller headway gaps than assumed by the SIDRA software. Scheme U5 performs well due to the banned right turn into Grey Street. Note, the flow on 2041 U6 is less than 2041 Base due to the banned right turn into Grey Street.							

Table 2: Morning Peak Performance with Arrival Flows (from SIDRA)

With the exception of the Grey/Cobham intersection, Table 2 indicates, most of the junctions operate at an acceptable level when the arrival flows are assessed. This is not surprising because

the arrival flow is what the Paramics model has managed to put through the junction. It is also worth noting that although the Scheme appears to operate worse than the Base, this is because it is catering for higher traffic flows.

Intersection	Scenario	Overall Intersection				Highest Movement Delay		
		Total Vehicles	LOS	Delay (s/veh)	95%ile Queue (m)	Delay (s/veh	LOS	Movement
SH1/SH26	2021 Base	3729	C	31	269	66	E	U-turn SH1 NB
	2021 U5	4520	B	16	102	34	C	U-turn BK
	2021 U7	4554	B	18	130	37	D	U-turn BK
	2021 U8	4553	B	18	128	35	D	U-turn BK
	2041 Base	4348	F	179	1909	>300	F	U-turn SH26
	2041 U6	4761	E	68	1093	>300	F	U-turn SH26
	All scheme options in 2021 provided an improved performance over the Base even with the higher traffic flows. In 2041, U6 whilst still performing with high delays is much better than the 2041 Base.							
Cambridge/ Cobham	2021 Base	3364	A	8	54	16	B	U-turn Camb Rd
	2021 U5	3977	B	13	79	24	C	R Turn SH1 NB
	2021 U7	3964	B	12	77	21	C	R Turn SH1 NB
	2021 U8	3998	B	13	71	28	C	R Turn SH1 NB
	2041 Base	3829	F	90	1287	254	F	L Turn Camb Rd
	2041 U6	4417	D	37	491	71	E	R Turn Cobham SB
	All scheme options in 2021 perform slightly worse than the Base due to the increased traffic volume, however still at an acceptable level. Scheme U6 operates significantly better than the 2041 Base case.							
Wairere/ Cobham	2021 Base	3657	D	38	411	72	E	U-turn Cobham NB
	2021 U5	3607	B	13	100	34	C	R Turn Wairere
	2021 U7	3652	B	13	139	35	D	R Turn Wairere
	2021 U8	3716	A	9	142	20	C	U-turn Cobham NB
	2041 Base	5005	F	>300	2062	>300	F	L Turn Peacocks
	2041 U6	5434	Grade Separated Intersection					
	In 2021 Scheme U8 appears to offer the best overall performance even though it caters for higher traffic flows. However, all schemes operate at an acceptable level.							
Galloway/ Cobham	2021 Base	3500	A	10	94	20	B	U-turn Cobham NB
	2021 U5	3281	B	11	67	21	C	U-turn Cobham SB
	2021 U7	3568	B	11	108	21	C	U-turn Cobham NB
	2021 U8	3588	B	10	101	20	B	U-turn Cobham NB
	2041 Base	3435	E	78	719	106	F	U-turn Cobham NB
	2041 U6	3549	D	52	624	121	F	U-turn Cobham NB
	All scheme options operate similar to the Base case, which is not surprising given that the intersection layout is not being modified.							
Grey/ Cobham	2021 Base	3352	-	93	991	>300	F	R Turn Cobham NB
	2021 U5	2680	-	1	7	8	A	L Turn Cobham SB
	2021 U7	3375	-	123	1173	>300	F	R Turn Cobham NB
	2021 U8	3400	-	122	1174	>300	F	R Turn Cobham NB
	2041 Base	2982	-	7	106	23	C	R Turn Cobham NB
	2041 U6	2436	-	2	4	8	A	L Turn Cobham SB
	As the scheme options do not change the intersection layout (except U5) there is no improvement to performance. The reason for the improvement in 2041, is due to the lower traffic volumes, which are most likely held back at upstream intersections.							

Table 3: Morning Peak Performance with Demand Flows (from SIDRA)

When looking at the results in Table 3, it is important to note that in reality only the SH1/SH26 intersection is likely to receive the full demand flows (from the south), hence downstream intersections (towards the city) would only need to deal with the traffic flows that get through the

SH1/SH26 junction. The predicted performance results for the other junctions are therefore worse than is likely to occur in reality.

3.2 Evening Peak Intersection Performance

Intersection	Scenario	Overall Intersection				Highest Movement Delay		
		Total Vehicles	LOS	Delay (s/veh)	95%ile Queue (m)	Delay (s/veh)	LOS	Movement
SH1/SH26	2021 Base	3348	B	12	58	24	C	U-turn BK
	2021 U5	4076	A	10	53	20	C	U-turn BK
	2021 U7	4187	A	10	58	21	C	U-turn BK
	2021 U8	4298	A	9	61	20	C	U-turn BK
	2041 Base	3132	B	12	50	24	C	U-turn BK
	2041 U6	4329	A	10	55	23	C	U-turn BK
	All scheme options in 2021 operate as well as the Base despite the additional +19% traffic flow travelling through the intersection. In 2041 the performance of U6 is also similar despite the +38% traffic volume increase.							
Cambridge/ Cobham	2021 Base	2687	A	8	54	14	B	U-turn Camb Rd
	2021 U5	3320	B	15	117	22	C	R Turn Cobham SB
	2021 U7	3473	B	17	129	31	C	R Turn SH1 NB
	2021 U8	3776	C	21	187	32	C	R Turn Cobham SB
	2041 Base	2502	A	8	43	17	B	U-turn Cobham SB
	2041 U6	3760	B	20	152	29	C	R Turn Cobham SB
	All scheme options in 2021 perform slightly worse than the Base due to the increased traffic volume, however still at an acceptable level. Option U6 operates worse than the Base due to the significant +50% higher traffic volumes, but still acceptable							
Wairere/ Cobham	2021 Base	2513	A	8	30	16	B	U turn Cobham NB
	2021 U5	3534	B	15	136	42	D	R Turn Cobham NB
	2021 U7	3759	B	15	181	50	D	R Turn Cobham NB
	2021 U8	3796	A	5	80	19	B	U-turn Wairere
	2041 Base	3436	B	14	78	34	C	U-turn Cobham NB
	2041 U6	5044	Grade Separated Intersection					
	Although scheme U8 caters for a much higher flow than the Base case, it operates with a slightly better performance. Scheme U5 and U7 predicted operation is noticeably worse than U8.							
Galloway/ Cobham	2021 Base	2646	A	7	23	16	B	U-turn Cobham NB
	2021 U5	3237	A	10	51	19	B	U-turn Cobham SB
	2021 U7	3631	A	8	60	17	B	U Turn Cobham SB
	2021 U8	3726	A	9	79	18	B	U-turn Galloway
	2041 Base	2159	A	8	21	16	B	U-turn Cobham NB
	2041 U6	3347	B	12	64	23	C	U-turn Cobham SB
	All scheme options operate similar to the Base case, which is not surprising given that the intersection layout is not being modified. This is despite the higher traffic flows using the intersection.							
Grey/ Cobham	2021 Base	3092	-	45	462	>300	F	R Turn Cobham NB
	2021 U5	3165	-	2	11	10	B	L Turn Grey
	2021 U7	3740	-	332	1258	>300	F	R Turn Cobham NB
	2021 U8	3896	-	349	1192	>300	F	R Turn Cobham NB
	2041 Base	2409	-	6	36	19	C	R Turn Cobham NB
	2041 U6	2832	-	2	10	9	A	L Turn Grey
	As the scheme options do not change the intersection layout (except U5) there is no improvement to performance although the intersection is expected to cater for higher traffic flows. The reason for the improved performance in U6 in 2041 is not obvious, given it is catering for a higher traffic flow.							

Table 4: Evening Peak Performance with Arrival Flows (from SIDRA)

Overall observations indicate that all scheme options are expected to cater for higher traffic flows than is likely to be experienced by the Base case. Hence it is natural to expect a drop in intersection

performance. However in all cases the results are still considered acceptable, except for the Grey/Cobham intersection, which has capacity problems on the right turn into Grey Street.

The evening peak demand flows show a similar trend to those for the morning peak as indicated in Table 5 below.

Intersection	Scenario	Overall Intersection				Highest Movement Delay		
		Total Vehicles	LOS	Delay (s/veh)	95%ile Queue (m)	Delay (s/veh)	LOS	Movement
SH1/SH26	2021 Base	4219	E	66	638	125	F	U-turn SH1 SB
	2021 U5	4696	B	17	152	48	D	U-turn SH26
	2021 U7	4758	B	15	134	45	D	U-turn SH26
	2021 U8	4772	B	13	117	24	C	U-turn SH1 SB
	2041 Base	4375	F	105	761	201	F	U-turn SH26
	2041 U6	5107	C	21	187	80	F	U-turn SH26
	All scheme options show a much improved operating performance							
Cambridge/ Cobham	2021 Base	3483	F	82	984	>300	F	L Turn Camb Rd
	2021 U5	3796	C	21	199	35	C	R Turn SH1 NB
	2021 U7	3923	C	21	251	41	D	R Turn SH1 NB
	2021 U8	4139	C	22	248	42	D	R Turn SH1 NB
	2041 Base	3600	F	140	1440	>300	F	L Turn Camb Rd
	2041 U6	4508	E	72	773	125	F	L Turn Camb Rd
	All scheme options show a much improved operating performance over the Base case in both 2021 and 2041							
Wairere/ Cobham	2021 Base	3187	A	8	35	17	B	U-Turn Wairere
	2021 U5	3989	B	18	225	55	D	R Turn Wairere
	2021 U7	4085	B	18	242	59	E	R Turn Cobham NB
	2021 U8	4132	A	8	126	28	C	U-turn Wairere
	2041 Base	5504	F	311	257	>300	F	U-turn Wairere
	2041 U6	5960	Grade Separated Intersection					
	Although Scheme U8 caters for a much higher flow than the Base case, it operates with a slightly better performance. Scheme U5 and U7 predicted operation is noticeably worse than U8 as noted in the morning peak.							
Galloway/ Cobham	2021 Base	3321	A	8	37	17	B	U-turn Cobham NB
	2021 U5	3657	B	12	93	23	C	U-turn Cobham SB
	2021 U7	4007	A	9	79	18	B	U-turn Galloway
	2021 U8	4159	B	11	127	32	C	U-turn Galloway
	2041 Base	3278	A	9	45	17	B	U-turn Cobham NB/SB
	2041 U6	4046	E	61	438	147	F	L Turn Galloway
	Scheme U6 caters for higher traffic flows than the 2041 Base case and hence has a significantly worse operating performance, with delays considered to be at the limit of what motorists would tolerate. Drivers in reality may choose to divert to the Wairere/Cobham intersection depending on their origin.							
Grey/ Cobham	2021 Base	3778	-	109	860	>300	F	R Turn Cobham NB
	2021 U5	3489	-	2	24	13	B	L Turn Grey
	2021 U7	4001	-	>300	1332	>300	F	R Turn Cobham NB
	2021 U8	4200	-	>300	1308	>300	F	R Turn Cobham NB
	2041 Base	3686	-	85	756	>300	F	R Turn Cobham NB
	2041 U6	3423	-	4	49	17	C	L Turn Grey
	As the scheme options do not change the intersection layout (except U5) there is a worsening in performance due to the expected traffic flows. The reason for the improved performance in scheme U6 in 2041 is not obvious. It is most likely related to the slightly lower traffic flows using the intersection, which the SIDRA model is particular sensitive to when dealing with flows close to approach capacity.							

Table 5: Evening Peak Performance with Demand Flows (from SIDRA)

Overall the general observations from the data provided above and a review of the Paramics models, indicates all scheme options operate at a similar or improved performance when compared to the Base case. This is despite catering for higher traffic flows. The exception is the Grey/Cobham intersection which continues to operate near on the right turn from Cobham Drive into Grey Street.

As the overall intersection flows are higher, we assume that traffic has been attracted from the rat run routes of Howell Ave, and to a lesser extent Cambridge Road through Hillcrest.

3.3 SH1 Corridor Performance

To assess the network improvement along SH1, both travel times and the number of vehicles that complete the journey during a 30min time interval have been captured from the successful Paramics model runs identified in Table 1 above.

The SH1 journey path is between Tamahere interchange and Grey St. Only vehicles that stay on SH1 are recorded, hence those that choose a short rat-run to avoid a congested intersection are excluded.

Appendix C includes a summary of the results for each of the five model runs on the existing network (Do Min) and scheme (U5, U6, U7 & U8) for year 2041. Figures 3 to 6 below visually illustrate the results. The vertical bars indicate the average travel time to complete the trip (read on the left side of the diagram), whilst the horizontal lines indicate the number of vehicles completing the trip in each 30min time period (read on the right side of the diagram). The time periods represent 30 min blocks; that is 7:00am to 7:30am, 7:30am to 8:00am and so forth.

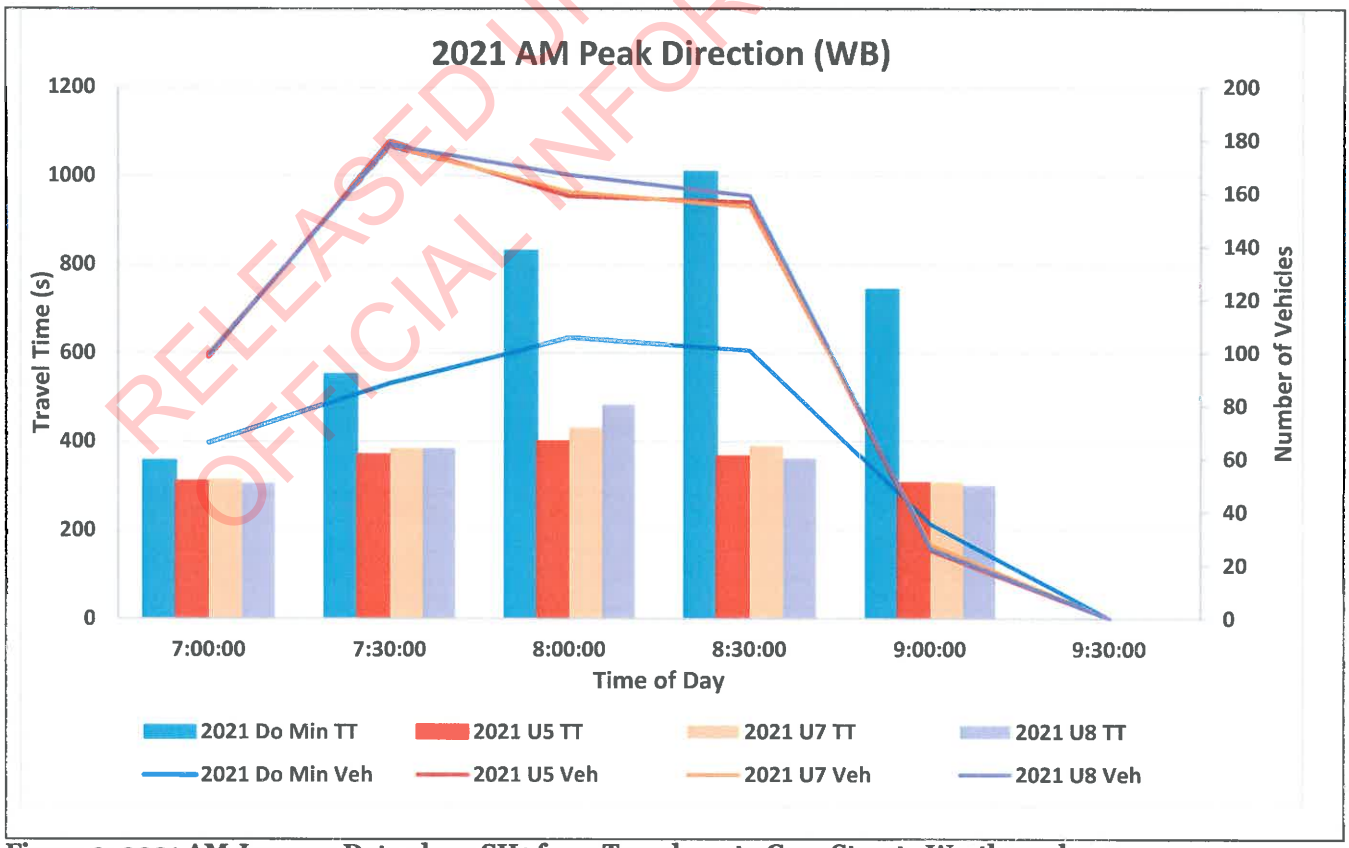


Figure 3: 2021 AM Journey Data along SH1 from Tamahere to Grey Street - Westbound

Clearly the Base case indicates much longer travel times than those experienced by drivers under the Schemes. This improvement occurs even though the Base case caters for less through traffic on Cobham Drive. For reasons unknown, scheme U8 incurs a longer travel time than Scheme U7 between 8:00am and 8:30am. A study of the Paramics model during this period indicates the difference may stem from a change in traffic operation at the SH1/SH26 intersection. This outcome is unusual as the SH1/SH26 and Cobham/Grey intersections are identical for all schemes. Hence, from a purely logical perspective we would not expect much difference in travel times between these two schemes and therefore consider this outcome to be related to the oversensitivity of the Paramics model for the given flows.

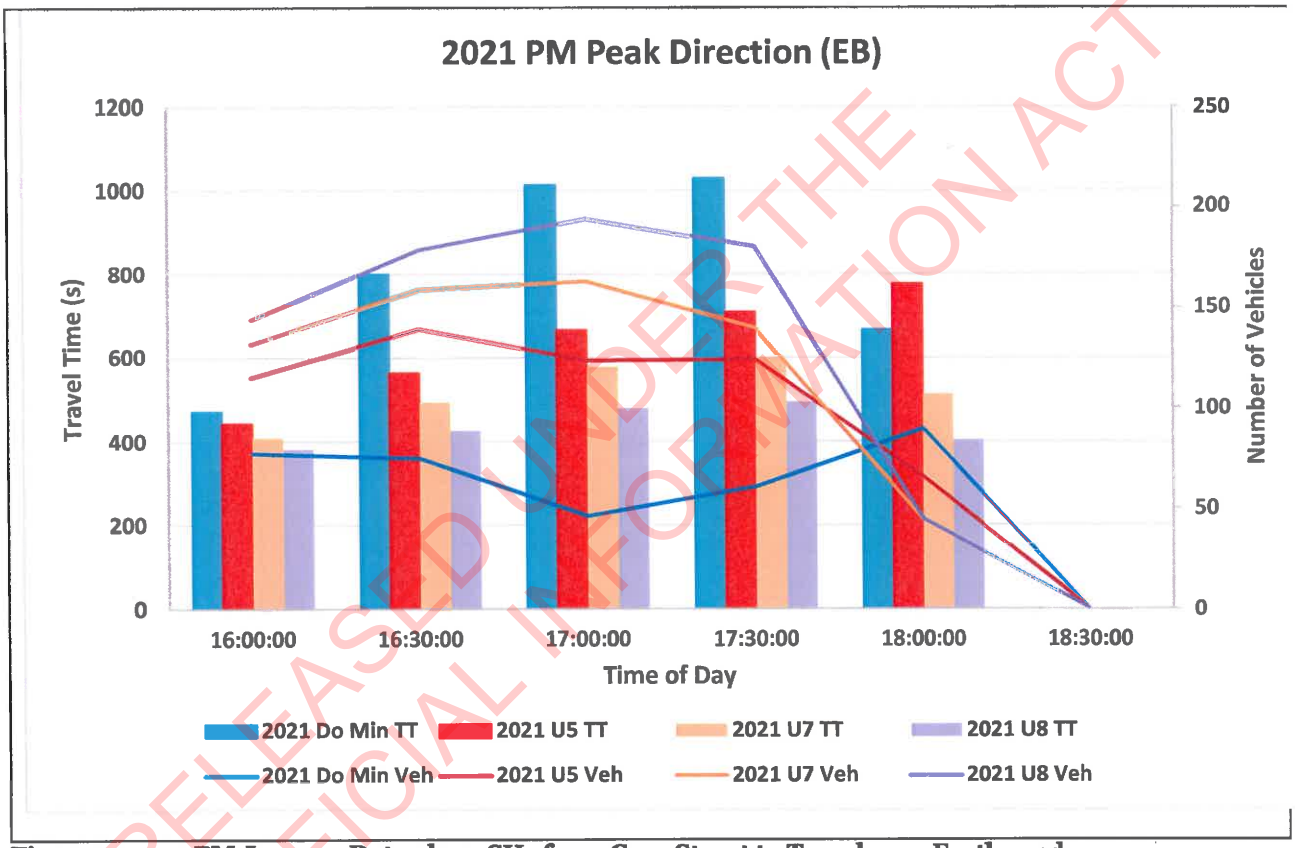


Figure 4: 2021 PM Journey Data along SH1 from Grey Street to Tamahere - Eastbound

As indicated by the morning peak trip times, all options improve travel times during the peak afternoon peak period being 16:30 to 18:00 even though they cater for a higher number of through trips on Cobham Drive.

Option U5 experiences longer travel times as the banned right turn into Grey Street means more right turn traffic into Galloway, which in turn causes delays to the southbound traffic on Cobham Drive.

Option U7 and U8 (which are the same except for the junction form at the Cobham/Wairere intersection), indicate a lower overall travel time in all time blocks, whilst Option U7 indicates a slightly lower travel time than Option U8.

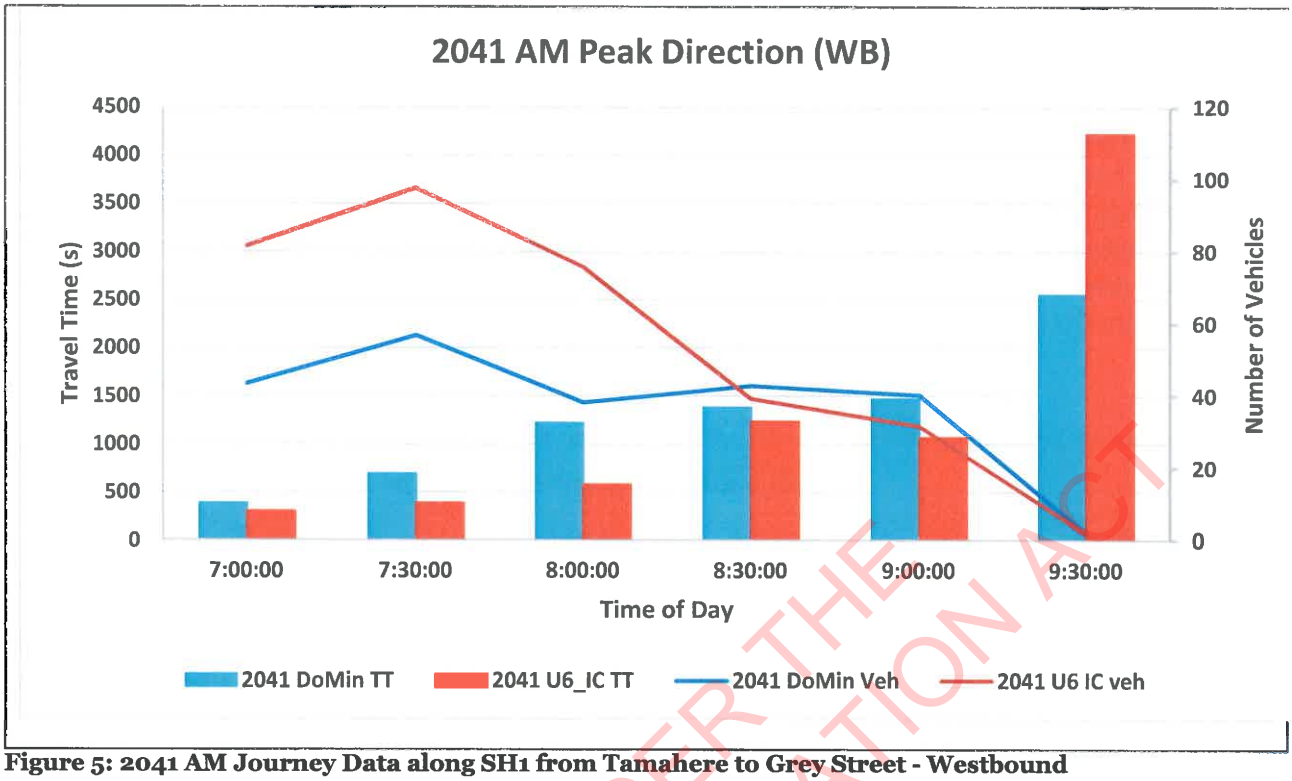


Figure 5: 2041 AM Journey Data along SH1 from Tamahere to Grey Street - Westbound

Figure 5 clearly indicates that between 7:00am and 9:30am Options U6 (red) has a shorter travel time than the Base case (blue). Although between 9:30am and 10:00am U6 travel times are much slower, this is due to a congestion issue that occurred in one of the 5 runs (the other four runs had no vehicles in the system after 9:30am). Hence, the results for the 09:30 to 10:00 period is not considered to be a reflection of the Scheme U6 operation and should be ignored (included for completeness only).

It is also noted significantly more vehicles complete a journey between 7:00am and 9:00am under Scheme U6 (as indicated by the lines). For instance between 07:30 and 08:00 Scheme U6 enables nearly 100 vehicles to complete their trip, whereas the Base case only manages around 55vehicles per 30minute time period.

Summarising the vehicle numbers in Appendix C, indicates that during the peak period 7:00am to 9:00am, 181vehicles used SH1 westbound in the Base case, whilst 294vehicles were able to do the same trip under Scheme U6.

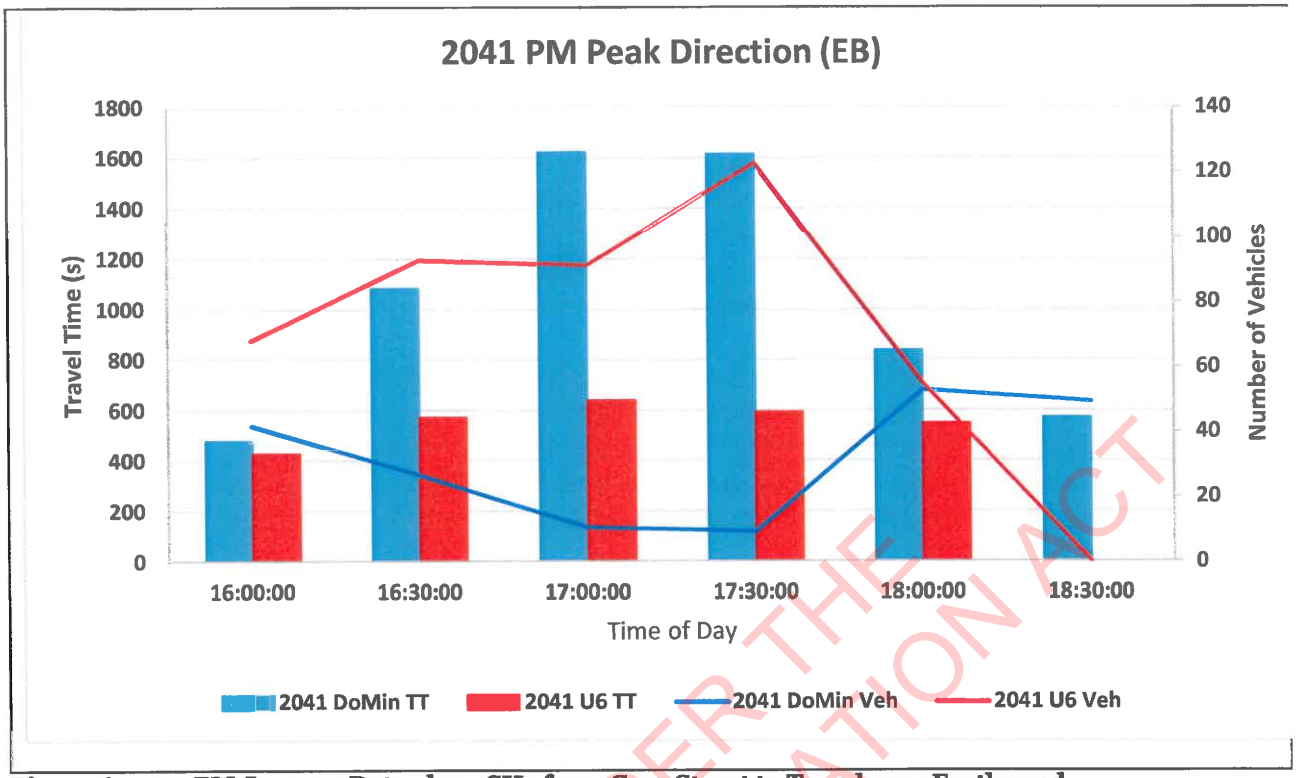


Figure 6: 2041 PM Journey Data along SH1 from Grey Street to Tamahere - Eastbound

Figure 6 indicates that between 16:00 and 18:30 Scheme U6 has a significantly shorter travel time than the Base case (blue) and significantly more vehicles to complete a journey between 16:00 and 18:00. For instance between 17:30 and 18:00 the scheme enables nearly 120 vehicles to complete their trip, whereas the Base case only manages around 15 to 20vehicles in the same 30minute time period.

4 Conclusion

Our observation of the working Paramics model identifies a very congested network in both year 2021 and 2041. The outcome is that the micro simulation model is very sensitive to small network changes.

Regardless of this, the assessment work indicates that the proposed network upgrade along SH1 at the two current congested intersections of SH1/SH26 and Cobham/Cambridge will provide a significantly improved network operation. The proposed improvements include:

- The SH1/SH26 roundabout is upgraded to provide an additional approach lane on SH26, an additional dedicated left turn slip lane into SH26 for eastbound traffic on Cambridge Road, and three northbound approach lanes on Cambridge Road that continues through to the Cobham/Cambridge Road intersection, and

- The Cobham/Cambridge roundabout is replaced with traffic signals providing two northbound uninterrupted northbound lanes, and banned right turn out of Cambridge Road. The traffic signal phase time on the right turn into Cambridge Road is kept to a minimum to encourage vehicles currently traveling through Hillcrest on Cambridge Road, to stay on Cobham Drive.

In addition to these upgrades, the new proposed Wairere Drive/Cobham Dr intersection operates satisfactorily at year 2021 using either traffic signals or a roundabout. However, when the Peacockes area is developed, an additional connection across the Waikato River is required, and the intersection will require upgrading to a grade separated layout in order to maintain adequate efficiency. We also note that a set of traffic signals will be necessary at the exit ramp terminal junction (with Wairere Drive) to prevent the northbound right turn flow into Wairere Drive from blocking the northbound flow on Cobham Drive.

The option of closing the right turn into Grey Street (Option U5) is likely to increase delays to southbound traffic on Cobham Drive at the Cobham Drive/Galloway Street roundabout, as vehicles instead make the right turn movements at the roundabout. This increased delay, is likely to cause some drivers on Cobham Drive who are destined for Galloway Street to avoid the roundabout by instead turning left into Grey Street and rat running through local roads.

With regards to intersection performance, the actual performance on site will lie between the results given for the arrival and demand flows in Section 3 of this report.

Tables 6 and 7 (below), summarise the overall predicted Level of Service (LOS) for the intersections under the different scheme options. With the exception of the demand flows in year 2041, we consider the operating performance of all schemes acceptable and virtually the same as the Base case despite the fact they cater for much higher traffic volumes.

Intersection	2021 Arrival Flow				2041 Arrival Flow	
	Base	Scheme U5	Scheme U7	Scheme U8	Base	Scheme U6
SH1/SH26	B	B	B	B	B	A
Cambridge/Cobham	A	B	B	B	A	B
Wairere/Cobham	B	B	B	A	B	D
Galloway/Cobham	A	A	A	A	A	B
Grey/Cobham	-	-	-	-	-	-

Table 6: LOS at Intersections using Total Arrival Traffic Flow in the Morning Peak

Intersection	2021 Demand Flow				2041 Demand Flow	
	Base	Scheme U5	Scheme U7	Scheme U8	Base	Scheme U6
SH1/SH26	C	B	B	B	F	E
Cambridge/Cobham	A	B	B	B	F	D
Wairere/Cobham	C	B	B	A	F	-
Galloway/Cobham	A	B	B	B	E	D
Grey/Cobham	-	-	-	-	-	-

Table 7: LOS at Intersections using Total Demand Traffic Flow in the Morning Peak

Figures 7 and 8 (below) illustrates the volume of traffic through the intersections under the Base case in year 2021 and 2041 during the morning, and afternoon, peaks; respectively.

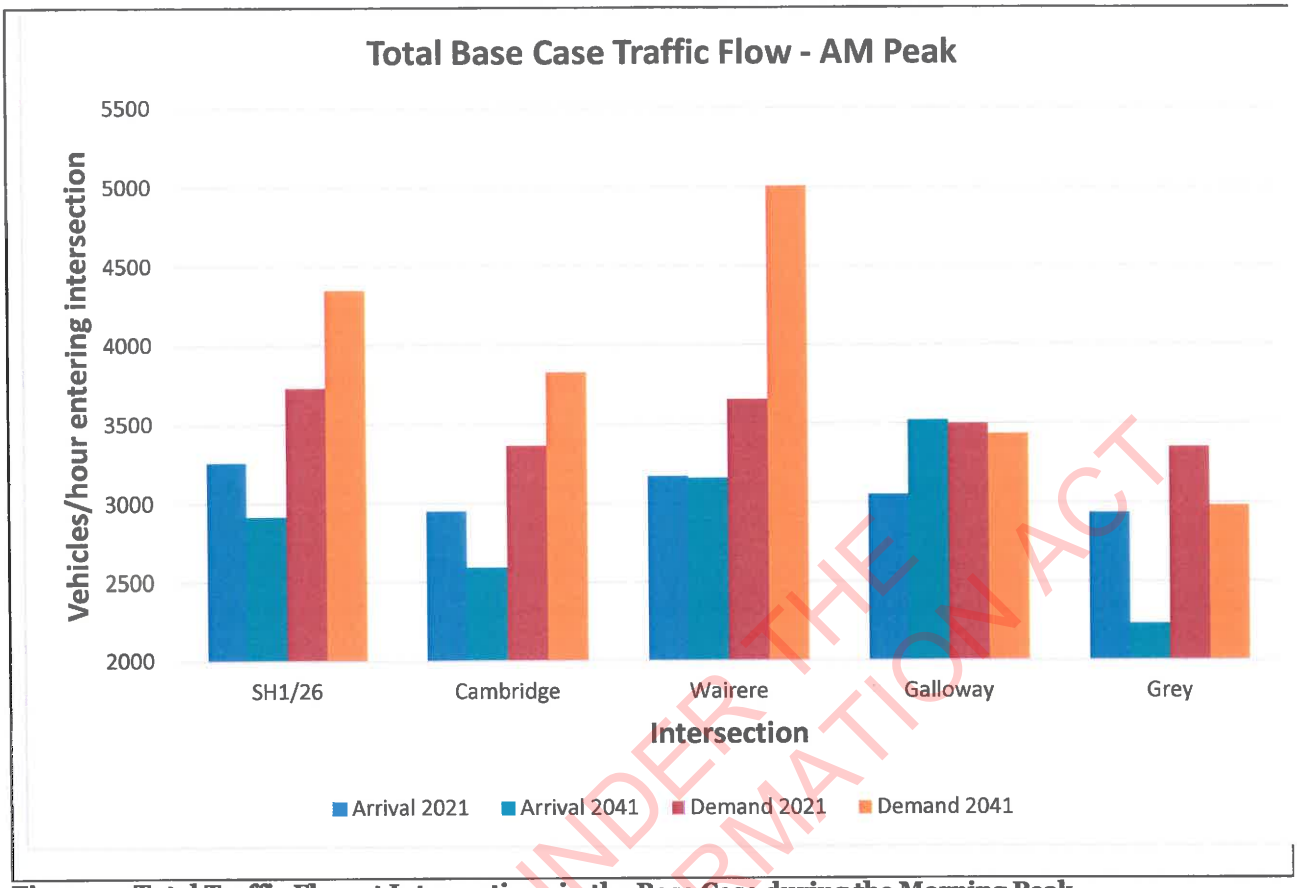


Figure 7: Total Traffic Flow at Intersections in the Base Case during the Morning Peak

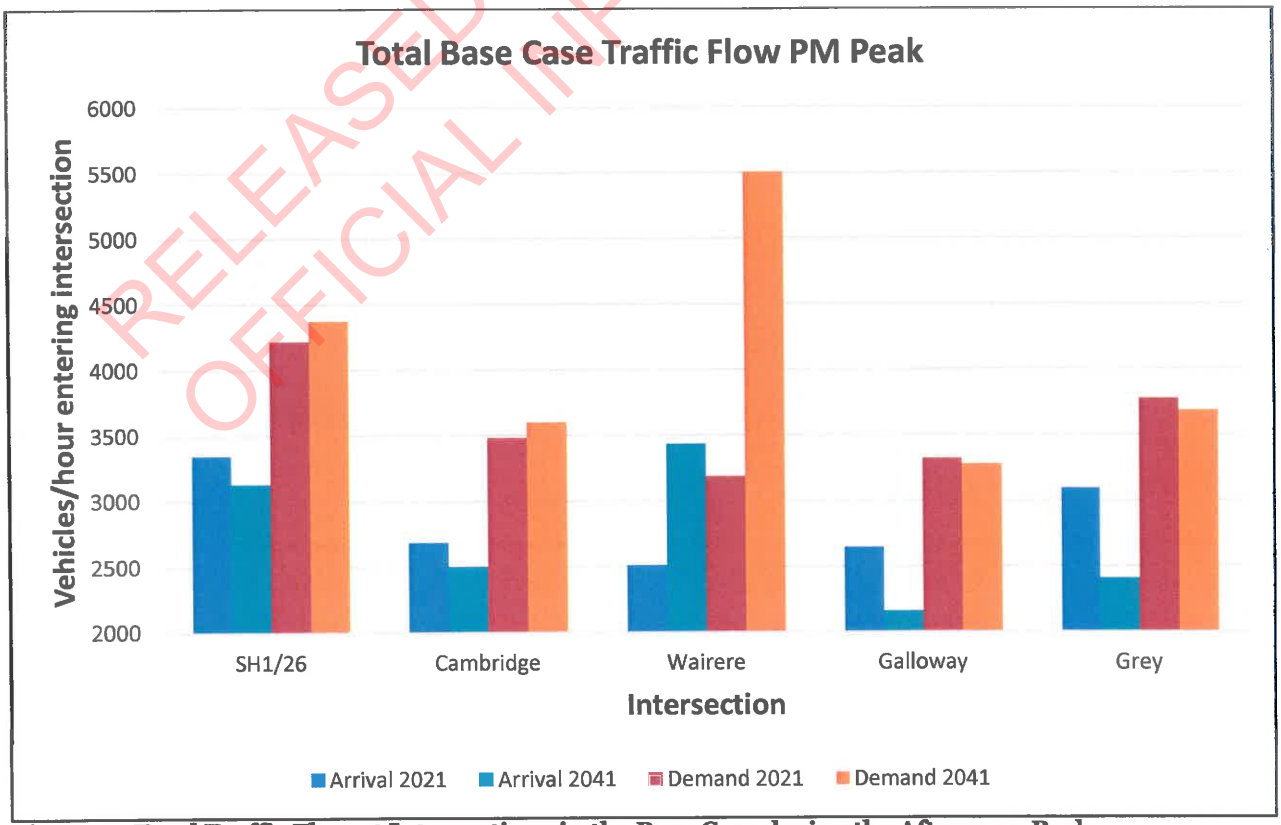


Figure 7: Total Traffic Flow at Intersections in the Base Case during the Afternoon Peak

The main observations of Figures 7 and 8 are:

- At SH1/26, Cambridge Road, and Grey Street intersections, the arrival flows in year 2041 are less than in year 2021, most likely due to the network congestion restricting vehicle movements.

- A significant spike in demand flow occurs at Wairere Drive intersection in year 2041. This is due to the introduction of the Peacockes development that enters the network at Wairere Drive. Despite the significant increase in demand flows at year 2041, the arrival flows handled by the intersection is similar in year 2021 and 2041.

- Year 2041 congestion at Grey Street prevents vehicles from getting through the intersection (right turn in and left turn out) as indicated by the significant drop in arrival flows. The congestion in year 2041 also reduces the demand flows, indicating vehicles may have chosen alternative routes to avoid this intersection.

The volume of traffic through the intersections, with the proposed scheme improvements, are shown in Figures 9 and 10 below, for the AM and PM Peaks; respectively.

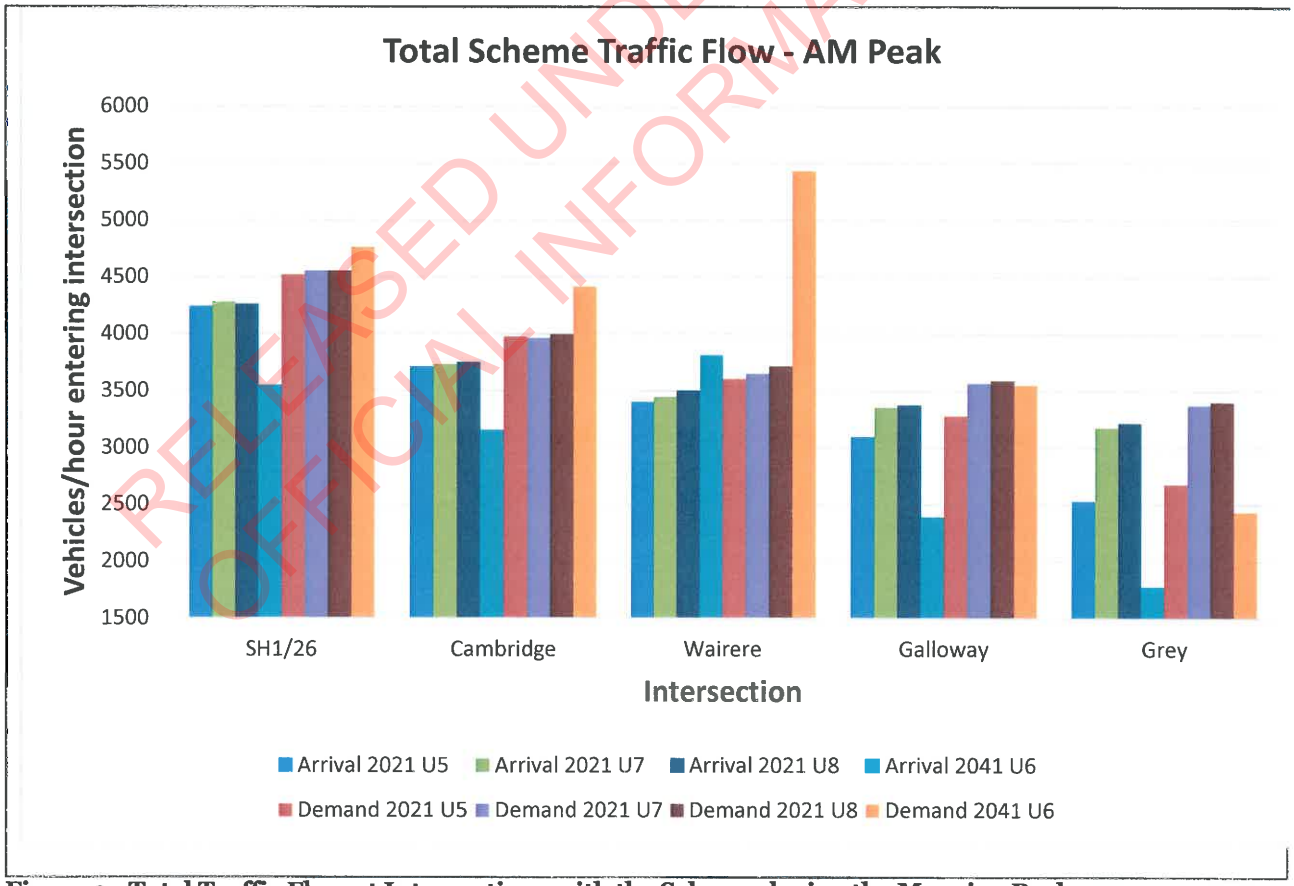


Figure 9: Total Traffic Flow at Intersections with the Scheme during the Morning Peak

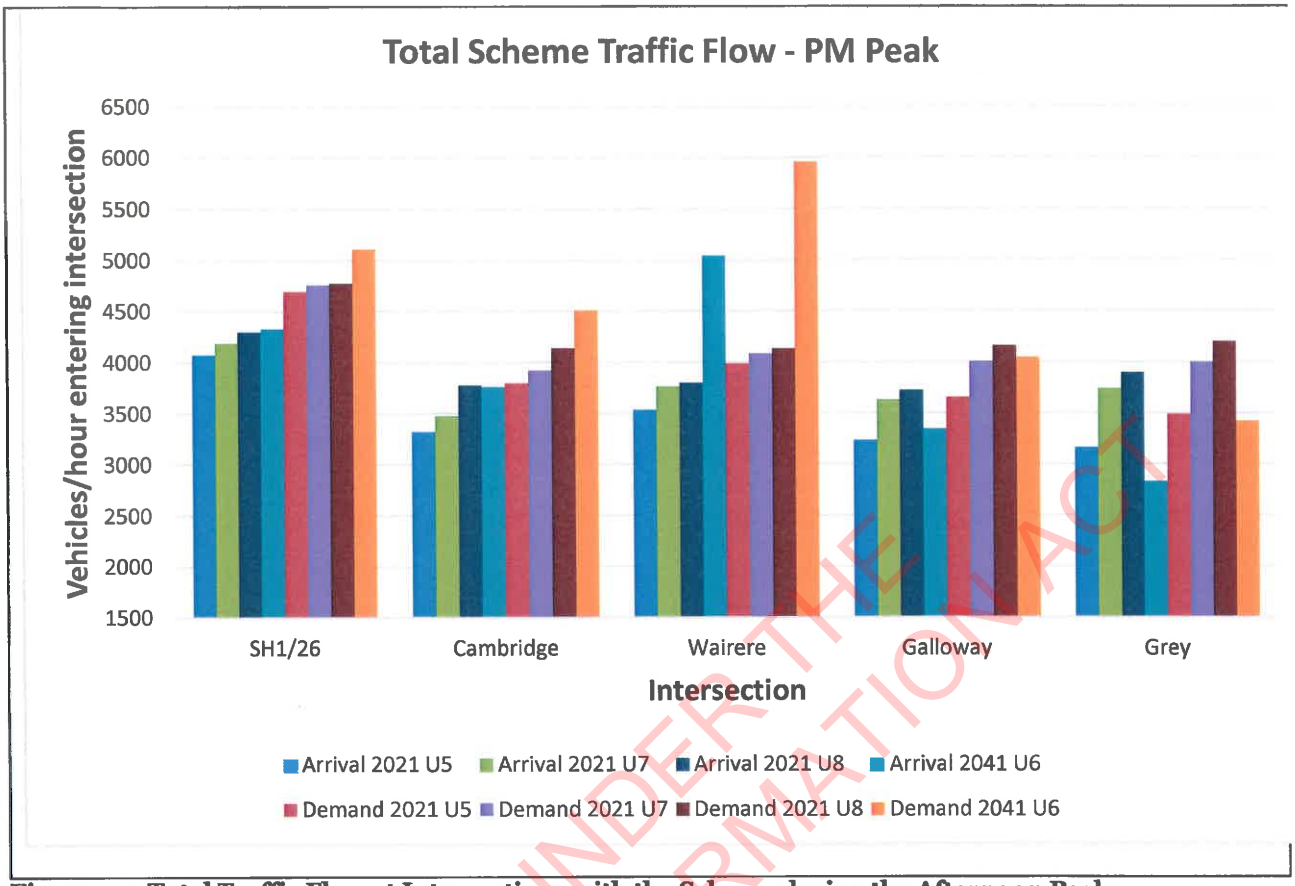


Figure 10: Total Traffic Flow at Intersections with the Scheme during the Afternoon Peak

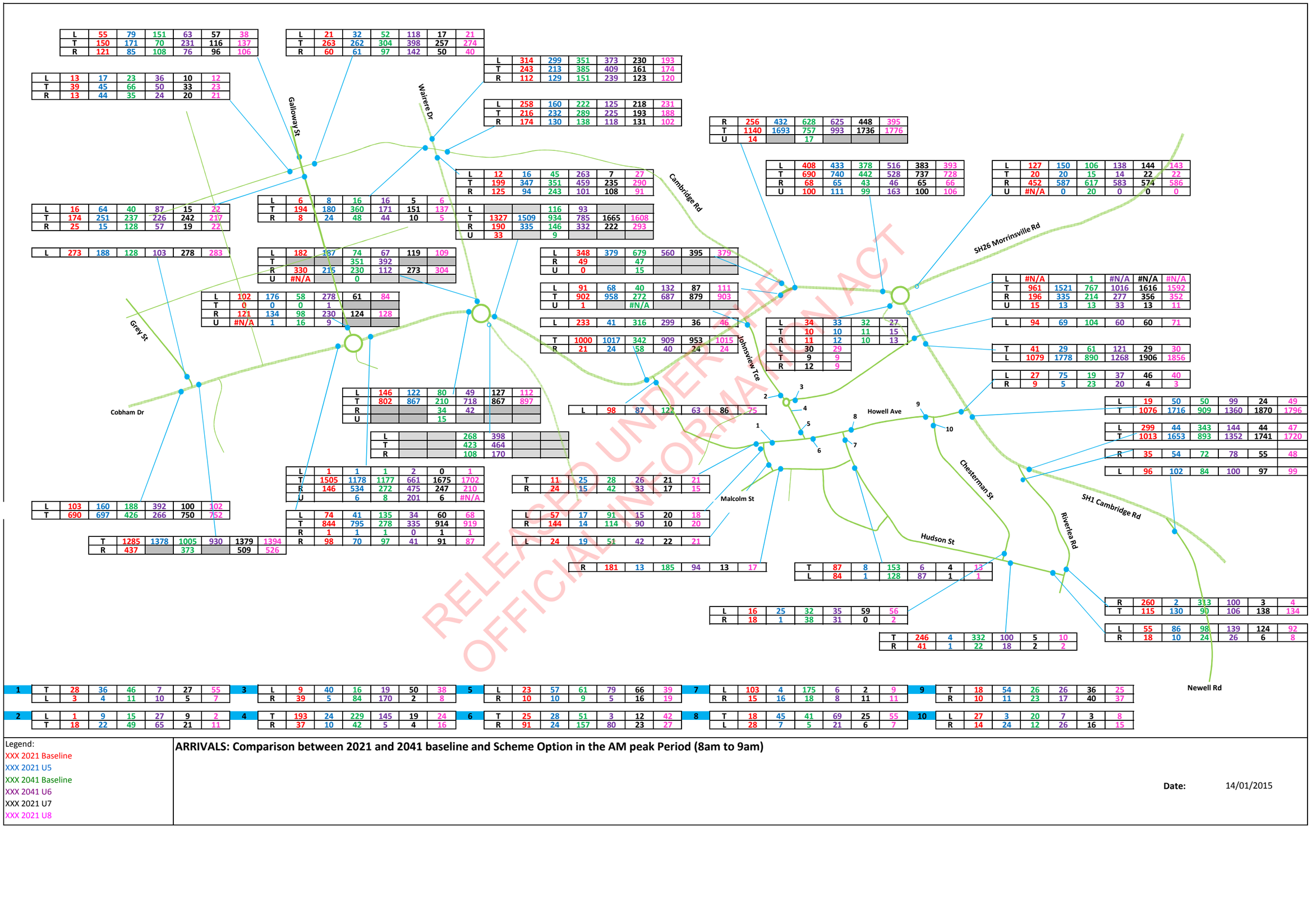
Comparing Figure 9 with Figure 7 (AM Peak), and Figure 10 with Figure 8 (PM Peak) indicates that arrival flows through the intersections are much higher with the scheme options in place. The exception is at Grey Street (U5 and U6), which is lower in the AM Peak because of the right turn ban which shifts city-bound traffic to other routes. Figures 9 and 10, also imply the upgraded intersections can cope with higher arrival and demand flows in year 2041, when compared with year 2021.

Our overall conclusion, is that the Scheme options proposed along SH1 (refer Figure 1 in Section 1.2) between the SH1/SH26 and Grey Street intersections will improve the operational performance of the SH1 corridor, relieve congestion at the two existing problem sites[1] and remove rat-run traffic from local roads (such as Howell Ave and Cambridge Road through Hillcrest) onto the appropriate arterial corridor. Hence, "right traffic" on "right roads".

However, by year 2041, some congestion issues will arise due to the high demand for travel predicted by the WRTM, which will most likely result in some problematic rat-running through many local streets in the Hillcrest area. Regardless of this, the improved corridor using Scheme U7 or U8 will still perform far better than the Base case.

[1] Intersections of SH1/SH26 and Cobham/Cambridge

Appendix A – Intersection Arrival Flows



L	55	79	151	63	57	38
T	150	171	70	231	116	137
R	121	85	108	76	96	106

L	21	32	52	118	17	21
T	263	262	304	398	257	274
R	60	61	97	142	50	40

L	314	299	351	373	230	193
T	243	213	385	409	161	174
R	112	129	151	239	123	120

L	13	17	23	36	10	12
T	39	45	66	50	33	23
R	13	44	35	24	20	21

L	258	160	222	125	218	231
T	216	232	289	225	193	188
R	174	130	138	118	131	102

R	256	432	628	625	448	395
T	1140	1693	757	993	1736	1776
U	14		17			

L	408	433	378	516	383	393
T	690	740	442	528	737	728
R	68	65	43	46	65	66
U	100	111	99	163	100	106

L	127	150	106	138	144	143
T	20	20	15	14	22	22
R	452	587	617	583	574	586
U	#N/A	0	20	0	0	0

L	12	16	45	263	7	27
T	199	347	351	459	235	290
R	125	94	243	101	108	91

L	6	8	16	16	5	6
T	194	180	360	171	151	137
R	8	24	48	44	10	5

L			116	93		
T	1327	1509	934	785	1665	1608
R	190	335	146	332	222	293
U	33		9			

L	16	64	40	87	15	22
T	174	251	237	226	242	217
R	25	15	128	57	19	22

L	273	188	128	103	278	283

L	182	187	74	67	119	109
T			351	392		
R	330	215	230	112	273	304
U	#N/A		0			

L	348	379	679	560	395	379
R	49		47			
U	0		15			

L	91	68	40	132	87	111
T	902	958	272	687	879	903
U	1		#N/A			

L	#N/A		1	#N/A	#N/A	#N/A
T	961	1521	767	1016	1616	1592
R	196	335	214	277	356	352
U	15	13	13	33	13	11

L	102	176	58	278	61	84
T	0	0	0	1		
R	121	134	98	230	124	128
U	#N/A	1	16	9		

L	233	41	316	299	36	46
T	1000	1017	342	909	953	1015
R	21	24	58	40	24	24

L	34	33	32	27
T	10	10	11	15
R	11	12	10	13
L	30	29		
T	9	9		
R	12	9		

L	94	69	104	60	60	71

T	41	29	61	121	29	30
L	1079	1778	890	1268	1906	1856

L	27	75	19	37	46	40
R	9	5	23	20	4	3

L	146	122	80	49	127	112
T	802	867	210	718	867	897
R			34	42		
U			15			

L	98	87	122	63	86	75

L	19	50	50	99	24	49
T	1076	1716	909	1360	1870	1796

L	299	44	343	144	44	47
T	1013	1653	893	1352	1741	1720

R	35	54	72	78	55	48

L	96	102	84	100	97	99

L			268	398		
T			423	464		
R			108	170		

L	1	1	1	2	0	1
T	1505	1178	1177	661	1675	1702
R	146	534	272	475	247	210
U		6	8	201	6	#N/A

T	11	25	28	26	21	21
R	24	15	42	33	17	15

L	103	160	188	392	100	102
T	690	697	426	266	750	752

L	74	41	135	34	60	68
T	844	795	278	335	914	919
R	1	1	1	0	1	1

L	57	17	91	15	20	18
R	144	14	114	90	10	20

T	1285	1378	1005	930	1379	1394
R	437		373		509	526

R	98	70	97	41	91	87

L	24	19	51	42	22	21

R	181	13	185	94	13	17

T	87	8	153	6	4	13
L	84	1	128	87	1	1

L	16	25	32	35	59	56
R	18	1	38	31	0	2

T	246	4	332	100	5	10
R	41	1	22	18	2	2

R	260	2	313	100	3	4
T	115	130	90	106	138	134

L	55	86	98	139	124	92
R	18	10	24	26	6	8

1

T	28	36	46	7	27	55
L	3	4	11	10	5	7

2

L	1	9	15	27	9	2
T	18	22	49	65	21	11

3

L	9	40	16	19	50	38
R	39	5	84	170	2	8

4

T	193	24	229	145	19	24
R	37	10	42	5	4	16

5

L	23	57	61	79	66	39
R	10	10	9	5	16	19

6

T	25	28	51	3	12	42
R	91	24	157	80	23	27

7

L	103	4	175	6	2	9
R	15	16	18	8	11	11

8

T	18	45	41	69	25	55
L	28	7	5	21	6	7

9

T	18	54	26	26	36	25
R	10	11	23	17	40	37

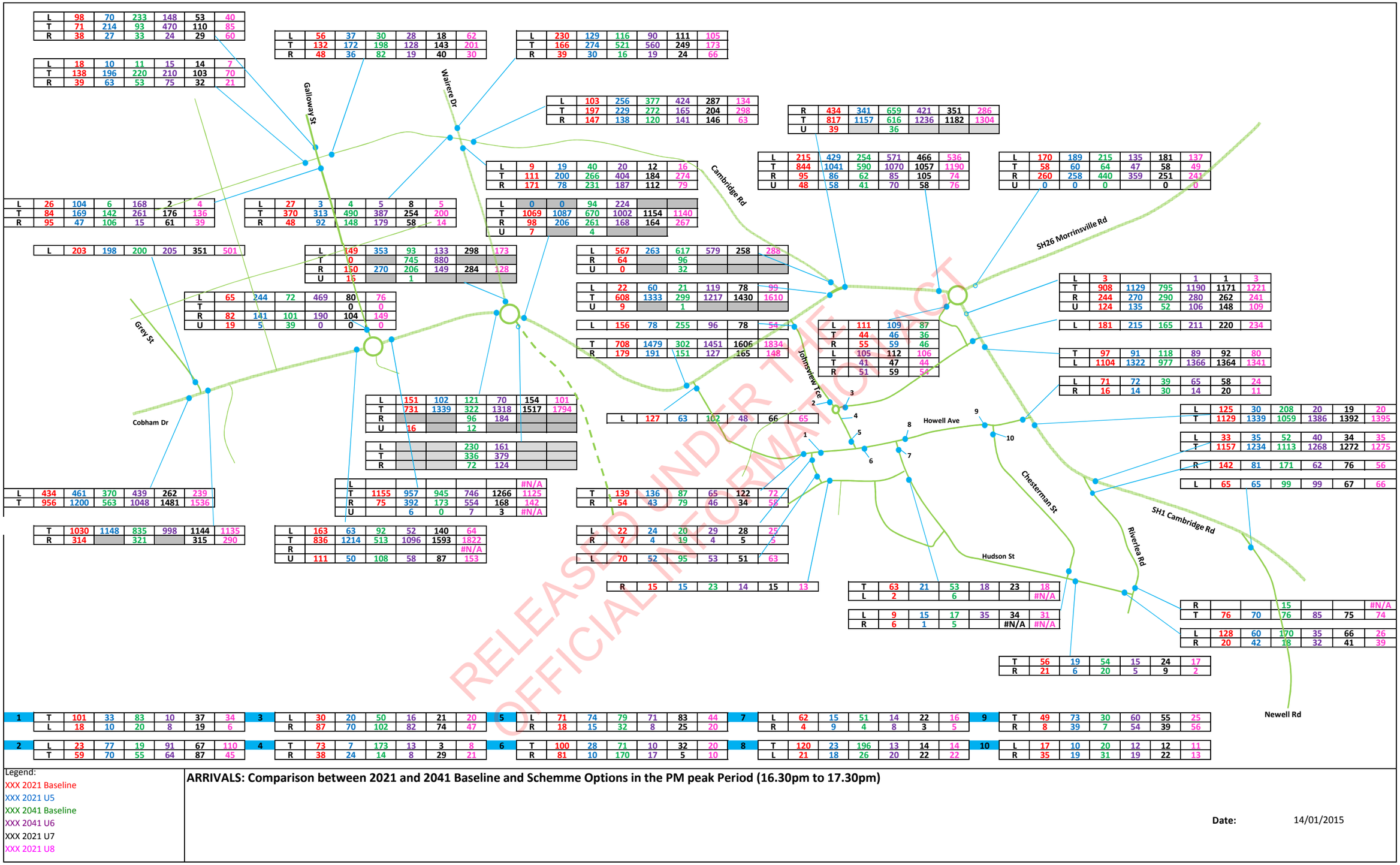
10

L	27	3	20	7	3	8
R	14	24	12	26	16	15

Legend:
XXX 2021 Baseline
XXX 2021 U5
XXX 2041 Baseline
XXX 2041 U6
XXX 2021 U7
XXX 2021 U8

ARRIVALS: Comparison between 2021 and 2041 baseline and Scheme Option in the AM peak Period (8am to 9am)

Date: 14/01/2015



L	98	70	233	148	53	40
T	71	214	93	470	110	85
R	38	27	33	24	29	60

L	18	10	11	15	14	7
T	138	196	220	210	103	70
R	39	63	53	75	32	21

L	26	104	6	168	2	4
T	84	169	142	261	176	136
R	95	47	106	15	61	39

L	203	198	200	205	351	501

L	434	461	370	439	262	239
T	956	1200	563	1048	1481	1536

T	1030	1148	835	998	1144	1135
R	314		321		315	290

L	56	37	30	28	18	62
T	132	172	198	128	143	201
R	48	36	82	19	40	30

L	27	3	4	5	8	5
T	370	313	490	387	254	200
R	48	92	148	179	58	14

L	149	353	93	133	298	173
T	0		745	880		
R	150	270	206	149	284	128
U	16		1			

L	65	244	72	469	80	76
T					0	0
R	82	141	101	190	104	149
U	19	5	39	0	0	0

L	151	102	121	70	154	101
T	731	1339	322	1318	1517	1794
R			96	184		
U	16		12			

L			230	161		
T			336	379		
R			72	124		

L						#N/A
T	1155	957	945	746	1266	1125
R	75	392	173	554	168	142
U		6	0	7	3	#N/A

L	163	63	92	52	140	64
T	836	1214	513	1096	1593	1822
R						#N/A
U	111	50	108	58	87	153

L	230	129	116	90	111	105
T	166	274	521	560	249	173
R	39	30	16	19	24	66

L	103	256	377	424	287	134
T	197	229	272	165	204	298
R	147	138	120	141	146	63

L	9	19	40	20	12	16
T	111	200	266	404	184	274
R	171	78	231	187	112	79

L	0	0	94	224		
T	1069	1087	670	1002	1154	1140
R	98	206	261	168	164	267
U	7		4			

L	567	263	617	579	258	288
R	64		96			
U	0		32			

L	22	60	21	119	78	99
T	608	1333	299	1217	1430	1610
U	9		1			

L	156	78	255	96	78	54

T	708	1479	302	1451	1606	1834
R	179	191	151	127	165	148

L	127	63	102	48	66	65

T	139	136	87	65	122	72
R	54	43	79	46	34	58

L	22	24	20	29	28	25
R	7	4	19	4	5	6

L	70	52	95	53	51	63

R	15	15	23	14	15	13

R	434	341	659	421	351	286
T	817	1157	616	1236	1182	1304
U	39		36			

L	215	429	254	571	466	536
T	844	1041	590	1070	1057	1190
R	95	86	62	85	105	74
U	48	58	41	70	58	76

L	111	109	87			
T	44	46	36			
R	55	59	46			
L	105	112	106			
T	41	47	44			
R	51	59	54			

T	63	21	53	18	23	18
L	2		6			#N/A

L	9	15	17	35	34	31
R	6	1	5		#N/A	#N/A

T	56	19	54	15	24	17
R	21	6	20	5	9	2

L	170	189	215	135	181	137
T	58	60	64	47	58	49
R	260	258	440	359	251	241
U	0	0	0		0	0

L	3			1	1	3
T	908	1129	795	1190	1171	1221
R	244	270	290	280	262	241
U	124	135	52	106	148	109

L	181	215	165	211	220	234

T	97	91	118	89	92	80
L	1104	1322	977	1366	1364	1341

L	71	72	39	65	58	24
R	16	14	30	14	20	11

L	125	30	208	20	19	20
T	1129	1339	1059	1386	1392	1395

L	33	35	52	40	34	35
T	1157	1234	1113	1268	1272	1275

R	142	81	171	62	76	56

L	65	65	99	99	67	66

R			15			#N/A
T	76	70	76	85	75	74

L	128	60	170	35	66	26
R	20	42	18	32	41	39

1	T	101	33	83	10	37	34
	L	18	10	20	8	19	6

2	L	23	77	19	91	67	110
	T	59	70	55	64	87	45

3	L	30	20	50	16	21	20
	R	87	70	102	82	74	47

4	T	73	7	173	13	3	8
	R	38	24	14	8	29	21

5	L	71	74	79	71	83	44
	R	18	15	32	8	25	20

6	T	100	28	71	10	32	20
	R	81	10	170	17	5	10

7	L	62	15	51	14	22	16
	R	4	9	4	8	3	5

8	T	120	23	196	13	14	14
	L	21	18	26	20	22	22

9	T	49	73	30	60	55	25
	R	8	39	7	54	39	56

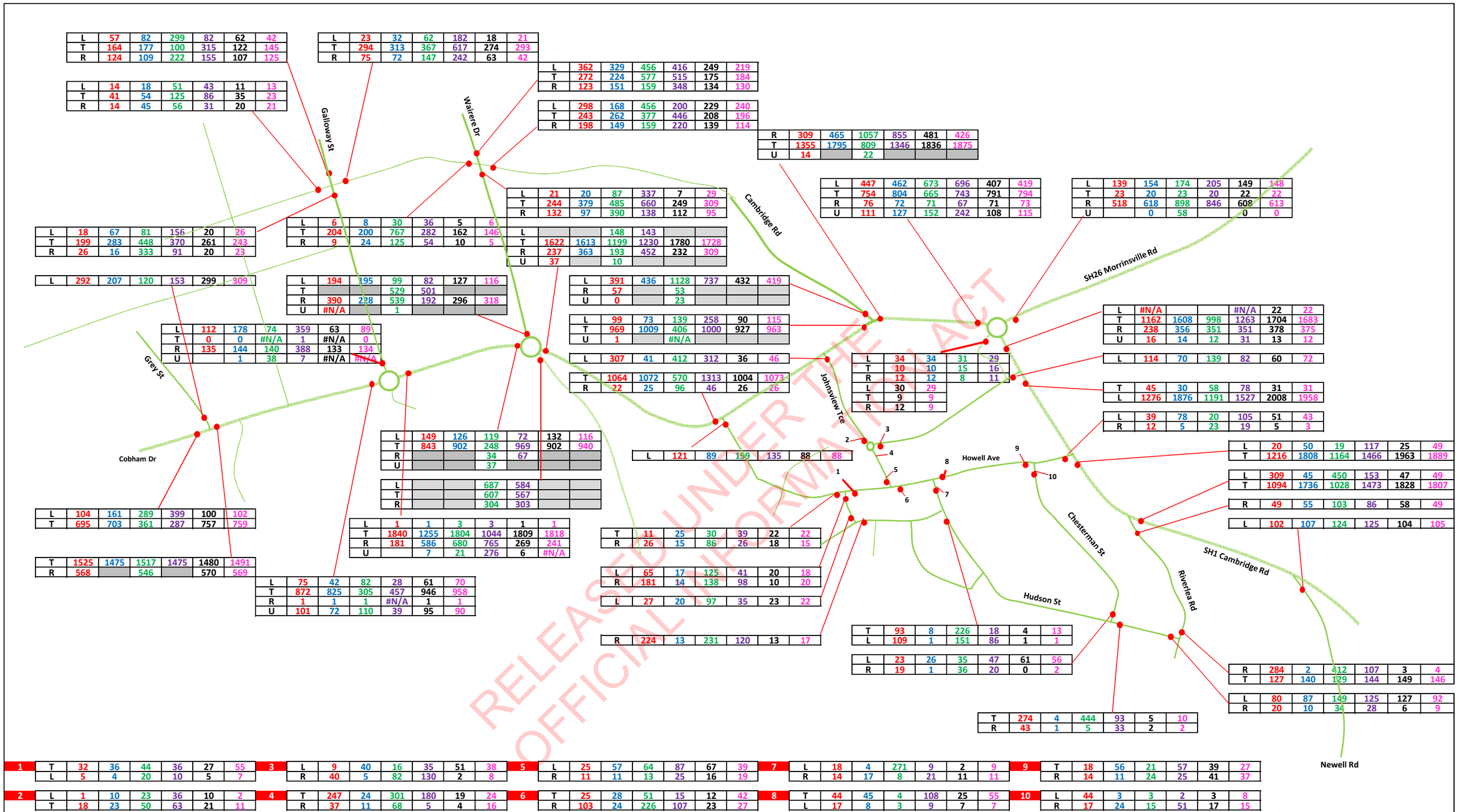
10	L	17	10	20	12	12	11
	R	35	19	31	19	22	13

Legend:
XXX 2021 Baseline
XXX 2021 U5
XXX 2041 Baseline
XXX 2041 U6
XXX 2021 U7
XXX 2021 U8

ARRIVALS: Comparison between 2021 and 2041 Baseline and Schemme Options in the PM peak Period (16.30pm to 17.30pm)

Date: 14/01/2015

Appendix B – Intersection Demand Flows



L	57	82	299	82	62	42
T	164	177	100	315	122	145
R	124	109	222	155	107	125

L	14	18	51	43	11	13
T	41	54	125	86	35	23
R	14	45	56	31	20	21

L	18	67	81	156	20	26
T	199	283	448	370	261	243
R	26	16	333	91	20	23

L	292	207	120	153	299	309

L	112	178	74	359	63	89
T	0	0	#N/A	1	#N/A	0
R	135	144	140	388	133	134
U		1	38	7	#N/A	#N/A

L	104	161	289	399	100	102
T	695	703	361	287	757	759

T	1525	1475	1517	1475	1480	1491
R	568		546		570	569

L	23	32	62	182	18	21
T	294	313	367	617	274	293
R	75	72	147	242	63	42

L	362	329	456	416	249	219
T	272	224	577	515	175	184
R	123	151	159	348	134	130

L	298	168	456	200	229	240
T	243	262	377	446	208	196
R	198	149	159	220	139	114

R	309	465	1057	855	481	426
T	1355	1795	809	1346	1836	1875
U	14		22			

L	21	20	87	337	7	29
T	244	379	485	660	249	309
R	132	97	390	138	112	95

L	6	8	30	36	5	6
T	204	200	767	282	162	146
R	9	24	125	54	10	5

L			148	143		
T	1622	1613	1199	1230	1780	1728
R	237	363	193	452	232	309
U	37		10			

L	194	195	99	82	127	116
T			529	501		
R	390	228	539	192	296	318
U	#N/A		1			

L	391	436	1128	737	432	419
R	57		53			
U	0		23			

L	99	73	139	258	90	115
T	969	1009	406	1000	927	963
U	1		#N/A			

L	307	41	412	312	36	46
T	1064	1072	570	1313	1004	1073
R	22	25	96	46	26	26

L	121	89	190	135	88	88

L	149	126	119	72	132	116
T	843	902	248	969	902	940
R			34	67		
U			37			

L			687	584		
T			607	567		
R			304	303		

L	1	1	3	3	1	1
T	1840	1255	1804	1044	1809	1818
R	181	586	680	765	269	241
U		7	21	276	6	#N/A

L	75	42	82	28	61	70
T	872	825	305	457	946	958
R	1	1	1	#N/A	1	1
U	101	72	110	39	95	90

T	11	25	30	39	22	22
R	26	15	86	26	18	15

L	65	17	125	41	20	18
R	181	14	138	98	10	20

L	27	20	97	35	23	22

R	224	13	231	120	13	17

L	447	462	673	696	407	419
T	754	804	665	743	791	794
R	76	72	71	67	71	73
U	111	127	152	242	108	115

L	139	154	174	205	149	148
T	23	20	23	20	22	22
R	518	618	898	846	608	613
U		0	58		0	0

L	34	34	31	29
T	10	10	15	16
R	12	12	8	11

L	30	29
T	9	9
R	12	9

T	93	8	226	18	4	13
L	109	1	151	86	1	1

L	23	26	35	47	61	56
R	19	1	36	20	0	2

T	274	4	444	93	5	10
R	43	1	5	33	2	2

L	#N/A			#N/A	22	22
T	1162	1608	998	1263	1704	1683
R	238	356	351	351	378	375
U	16	14	12	31	13	12

L	114	70	139	82	60	72

T	45	30	58	78	31	31
L	1276	1876	1191	1527	2008	1958

L	39	78	20	105	51	43
R	12	5	23	19	5	3

L	20	50	19	117	25	49
T	1216	1808	1164	1466	1963	1889

L	309	45	450	153	47	49
T	1094	1736	1028	1473	1828	1807

R	49	55	103	86	58	49

L	102	107	124	125	104	105

R	284	2	412	107	3	4
T	127	140	129	144	149	146

L	80	87	149	125	127	92
R	20	10	34	28	6	9

1	T	32	36	44	36	27	55
	L	5	4	20	10	5	7

2	L	1	10	23	36	10	2
	T	18	23	50	63	21	11

3	L	9	40	16	35	51	38
	R	40	5	82	130	2	8

4	T	247	24	301	180	19	24
	R	37	11	68	5	4	16

5	L	25	57	64	87	67	39
	R	11	11	13	25	16	19

6	T	25	28	51	15	12	42
	R	103	24	226	107	23	27

7	L	18	4	271	9	2	9
	R	14	17	8	21	11	11

8	T	44	45	4	108	25	55
	L	17	8	3	9	7	7

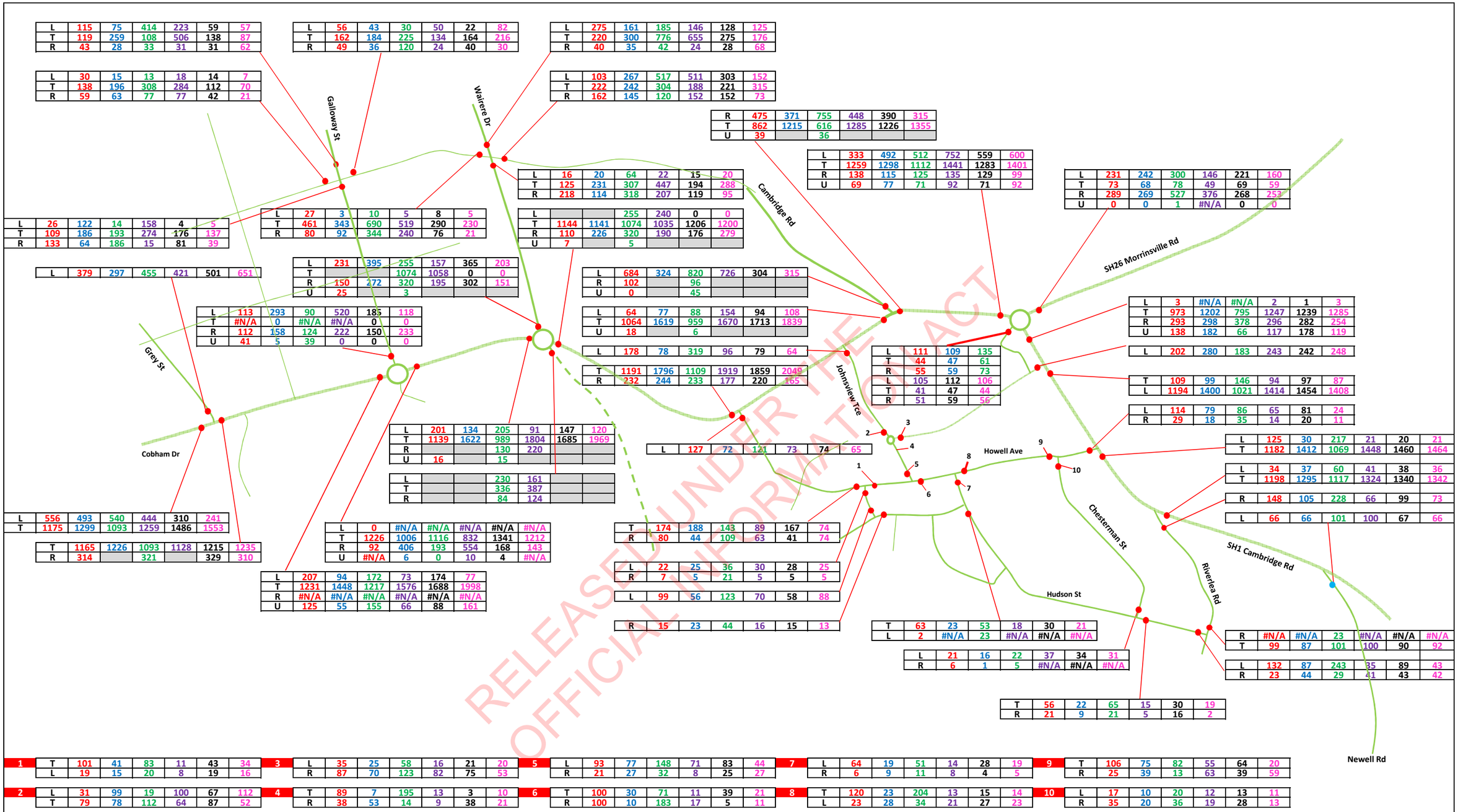
9	T	18	56	21	57	39	27
	R	14	11	24	25	41	37

10	L	44	3	3	2	3	8
	R	17	24	15	51	17	15

Legend:
XXX 2021 Baseline
XXX 2021 U5
XXX 2041 Baseline
XXX 2041 U6
XXX 2021 U7
XXX 2021 U8

DEMAND: Comparison between 2021 and 2041 Baseline and Scheme Options in the AM peak Period (8am to 9am)

Date: 14/01/2015



L	115	75	414	223	59	57
T	119	259	108	506	138	87
R	43	28	33	31	31	62

L	56	43	30	50	22	82
T	162	184	225	134	164	216
R	49	36	120	24	40	30

L	275	161	185	146	128	125
T	220	300	776	655	275	176
R	40	35	42	24	28	68

L	30	15	13	18	14	7
T	138	196	308	284	112	70
R	59	63	77	77	42	21

L	103	267	517	511	303	152
T	222	242	304	188	221	315
R	162	145	120	152	152	73

R	475	371	755	448	390	315
T	862	1215	616	1285	1226	1355
U	39		36			

L	333	492	512	752	559	600
T	1259	1298	1112	1441	1283	1401
R	138	115	125	135	129	99
U	69	77	71	92	71	92

L	231	242	300	146	221	160
T	73	68	78	49	69	59
R	289	269	527	376	268	253
U	0	0	1	#N/A	0	0

L	16	20	64	22	15	20
T	125	231	307	447	194	288
R	218	114	318	207	119	95

L	27	3	10	5	8	5
T	461	343	690	519	290	230
R	80	92	344	240	76	21

L			255	240	0	0
T	1144	1141	1074	1035	1206	1200
R	110	226	320	190	176	279
U	7		5			

L	26	122	14	158	4	5
T	109	186	193	274	176	137
R	133	64	186	15	81	39

L	231	395	255	157	365	203
T			1074	1058	0	0
R	150	272	320	195	302	151
U	25		3			

L	379	297	455	421	501	651

L	684	324	820	726	304	315
R	102		96			
U	0		45			

L	3	#N/A	#N/A	2	1	3
T	973	1202	795	1247	1239	1285
R	293	298	378	296	282	254
U	138	182	66	117	178	119

L	113	293	90	520	185	118
T	#N/A	0	#N/A	#N/A	0	0
R	112	158	124	222	150	233
U	41	5	39	0	0	0

L	64	77	88	154	94	108
T	1064	1619	959	1670	1713	1839
U	18		6			

L	202	280	183	243	242	248

L	178	78	319	96	79	64
T	1191	1796	1109	1919	1859	2049
R	232	244	233	177	220	165

L	111	109	135
T	44	47	61
R	55	59	73
L	105	112	106
T	41	47	44
R	51	59	56

T	109	99	146	94	97	87
L	1194	1400	1021	1414	1454	1408

L	114	79	86	65	81	24
R	29	18	35	14	20	11

L	201	134	205	91	147	120
T	1139	1622	989	1804	1685	1969
R			130	220		
U	16		15			

L	127	72	121	73	74	65

L			230	161		
T			336	387		
R			84	124		

L	125	30	217	21	20	21
T	1182	1412	1069	1448	1460	1464

L	34	37	60	41	38	36
T	1198	1295	1117	1324	1340	1342

R	148	105	228	66	99	73

L	66	66	101	100	67	66

L	556	493	540	444	310	241
T	1175	1299	1093	1259	1486	1553

T	1165	1226	1093	1128	1215	1235
R	314		321		329	310

L	0	#N/A	#N/A	#N/A	#N/A	#N/A
T	1226	1006	1116	832	1341	1212
R	92	406	193	554	168	143
U	#N/A	6	0	10	4	#N/A

L	207	94	172	73	174	77
T	1231	1448	1217	1576	1688	1998
R	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
U	125	55	155	66	88	161

T	174	188	143	89	167	74
R	80	44	109	63	41	74

L	22	25	36	30	28	25
R	7	5	21	5	5	5

L	99	56	123	70	58	88

R	15	23	44	16	15	13

T	63	23	53	18	30	21
L	2	#N/A	23	#N/A	#N/A	#N/A

L	21	16	22	37	34	31
R	6	1	5	#N/A	#N/A	#N/A

T	56	22	65	15	30	19
R	21	9	21	5	16	2

R	#N/A	#N/A	23	#N/A	#N/A	#N/A
T	99	87	101	100	90	92

L	132	87	243	85	89	43
R	23	44	29	41	43	42

1	T	101	41	83	11	43	34
	L	19	15	20	8	19	16

3	L	35	25	58	16	21	20
	R	87	70	123	82	75	53

5	L	93	77	148	71	83	44
	R	21	27	32	8	25	27

7	L	64	19	51	14	28	19
	R	6	9	11	8	4	5

9	T	106	75	82	55	64	20
	R	25	39	13	63	39	59

2	L	31	99	19	100	67	112
	T	79	78	112	64	87	52

4	T	89	7	195	13	3	10
	R	38	53	14	9	38	21

6	T	100	30	71	11	39	21
	R	100	10	183	17	5	11

8	T	120	23	204	13	15	14
	L	23	28	34	21	27	23

10	L	17	10	20	12	13	11
	R	35	20	36	19	28	13

Legend:
XXX 2021 Baseline
XXX 2021 U5
XXX 2041 Baseline
XXX 2041 U6
XXX 2021 U7
XXX 2021 U8

DEMAND: Comparison between 2021 and 2041 Baseline and Scheme Options in the PM peak Period (16.30pm to 17.30pm)

If the adjusted (factored) demand is less than the 1hr arrival flow, then arrival flow has been adopted as the 1hr demand flow

Note: These flows have been used in the Intersection Modelling Assessment

Date: 14/01/2015

Appendix C – Cobham Drive Trip Summary

AM	Time Period 07:00 -07:30							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:05:57	00:05:10	00:05:15	00:05:06	66.2	98.6	99.8	99.4
SH1-EB from Grey to Tamahere via Cobham	00:05:33	00:05:31	00:05:24	00:05:10	34.8	47.6	51.6	51.4

AM	Time Period 07:30 -08:00							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:09:12	00:06:10	00:06:24	00:06:25	88.6	179.4	177.8	178.2
SH1-EB from Grey to Tamahere via Cobham	00:06:27	00:06:42	00:05:49	00:05:42	71.6	78.6	90.6	92.4

AM	Time Period 08:00 -08:30							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:13:51	00:06:40	00:07:11	00:08:03	105.6	159.0	160.6	167.0
SH1-EB from Grey to Tamahere via Cobham	00:06:09	00:06:59	00:05:52	00:05:34	69.6	80.8	86.0	84.4

AM	Time Period 08:30 -09:00							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:16:50	00:06:06	00:06:30	00:06:02	101.0	156.8	155.0	159.2
SH1-EB from Grey to Tamahere via Cobham	00:05:45	00:06:46	00:05:42	00:05:26	55.6	68.2	70.2	70.4

AM	Time Period 09:00 -09:30							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:12:23	00:05:06	00:05:08	00:05:01	35.4	25.6	27.8	26.2
SH1-EB from Grey to Tamahere via Cobham	00:05:56	00:05:46	00:05:28	00:05:48	10.4	12.8	12.6	12.4

AM	Time Period 09:30 -10:00							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.0	0.0	0.0	0.0
SH1-EB from Grey to Tamahere via Cobham	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.0	0.0	0.0	0.0

PM	Time Period 16:00 -16:30							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U8	2021 U8	2021 Domin	2021 U5	2021 U8	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:05:41	00:04:56	00:04:57	00:04:54	79.4	94.4	95.0	98.0
SH1-EB from Grey to Tamahere via Cobham	00:07:52	00:07:23	00:06:49	00:06:22	77.4	115.6	132.2	144.2

PM	Time Period 16:30 -17:00							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:05:39	00:04:59	00:04:57	00:04:53	98.0	122.0	120.2	117.0
SH1-EB from Grey to Tamahere via Cobham	00:13:21	00:09:24	00:08:14	00:07:06	75.0	139.4	159.0	178.8

PM	Time Period 17:00 -17:30							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:05:49	00:05:04	00:04:59	00:04:57	87.8	122.8	131.2	131.6
SH1-EB from Grey to Tamahere via Cobham	00:16:53	00:11:06	00:09:38	00:07:59	46.2	123.6	163.0	194.2

PM	Time Period 17:30 -18:00							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:05:48	00:04:56	00:04:56	00:04:52	84.6	117.6	116.8	118.6
SH1-EB from Grey to Tamahere via Cobham	00:17:09	00:11:49	00:10:00	00:08:14	60.6	124.0	139.8	180.4

PM	Time Period 18:00 -18:30							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	00:05:30	00:04:53	00:04:52	00:04:45	21.6	21.8	22.0	19.8
SH1-EB from Grey to Tamahere via Cobham	00:11:07	00:12:57	00:08:33	00:06:43	89.6	65.8	44.4	44.6

PM	Time Period 18:30 -19:00							
Path Name	Journey Times Comparison				Number of Vehicles			
	2021 Domin	2021 U5	2021 U7	2021 U8	2021 Domin	2021 U5	2021 U7	2021 U8
SH1-WB from Tamahere to Grey via Cobham	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.0	0.0	0.0	0.0
SH1-EB from Grey to Tamahere via Cobham	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.0	0.0	0.0	0.0