Memorandum

To	Hamish Crawford
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From	Emma Cui and Allan Liu
Office	Auckland Westhaven
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File/Ref	2-37400.00
Subject	Nukuhau Plan Change

1 Introduction

Further to our memo of 22 September 2021, we have carried out additional SIDRA (v9) modelling to understand the performance of the Control Gates Bridge (CGB), Norman Smith Street/Wairakei Drive intersection and Spa Road/Tongariro Street roundabout with permitted land developments north of the Bridge (refer left-hand column of Figure 1) and with the proposed Nukuhau Plan Change, before there is a second bridge across the Waikato River to provide access to Taupō from the north.

The additional traffic models[1] also compare the traffic operation performance of the Control Gates Bridge, Norman Smith Street/Wairakei Drive intersection and Spa Road/Tongariro Street roundabout with and without Nukuhau Plan Change.

APPENDIX 1: DISTRICT RESIDENTIAL SUPPLY BREAKDOWN

Northern End of the Lake		Southern End of the Lake	
~~EOL~~	~~1,900~~	Kuratau/Omori	180
~~WEL~~	~~498~~	Mohi	50
Brentwood	120	Turang	400
Lakeside Brentwood	350	Whareroa	160
Vineyard on Huka falls	36	Undeveloped half charges	275
Acacia Bay	150	**Total Southern End**	**1,065**
Kinloch	334	**Unzoned**	
7 Oaks	162	Five Mile Bay site A and C	440
Undeveloped half charges	742	Nukuhau Private Plan Change	780
Total Northern End	**4,290**	**Total Unzoned**	**1,220**

Figure 1: Permitted Land Development North of Bridge, Taupo Residential Dwelling Demand Addendum Report (July 2021)

[1] Note that the naming convention for the models referred to in this memo is different to the naming convention used in our 22 September memo.

2 Trip generation and distribution assessments

Trip generation and distribution assessments were carried out to determine the additional trips generated from the permitted land developments and Nukuhau Plan Change.

2.1 Assessed Household Numbers

We assessed several scenarios as shown in Table 1 below. The number of dwellings for each scenario is not obtained by direct multiplication of the values in Figure 1; reference should be made to Section 2.5 of this memo, which describes assumptions made regarding trip distribution.

Table 1: Assessed Scenarios

Scenario Name	Name in SIDRA	New	Growth from 2021	All permitted land	Undeveloped half charges	Nukuhau	Houses	Trips*
2021 Scenario #0	2021 no dev	N	0%	0%	0%	0%	0	0
2025 Scenario #1	2025 no Nukuhau	N	1% p.a.	50%	30%	0%	781	645
2025 Scenario #2	2025 with Nukuhau	N	1% p.a.	50%	30%	40%	1093	930
2030 Scenario #0	2030 S1	Y	1% p.a.	0%	0%	0%	0	0
2030 Scenario #1	2030 no Nukuhau	N	1% p.a.	100%	60%	0%	1561	1290
2030 Scenario #2	2030 S3	Y	1% p.a.	100%	60%	30%	1801	1490
2030 Scenario #3	2030 with Nukuhau	N	1% p.a.	100%	60%	80%	2185	1860
2030 Scenario #4	2030 S2	Y	1% p.a.	50%	30%	30%	1018	852

*Trips: Additional trips generated from the development and 1% growth in base traffic volumes go to and from Taupo town centre via the Control Gates Bridge

Subsequent to completing our modelling analysis we noted that we had inadvertently omitted the trip generation associated with the 36 dwellings from Vineyard on Huka Falls. While this oversight results in a slight reduction in the overall trip generation from the permitted development, the volume of additional traffic is less than 1% of the total traffic volume, therefore, we conclude that the effect of the oversight is negligible on the results of our analysis.

Figure 2: Location of Permitted Land Development and Proposed PC 37 Nukuhau

2.2 Trip Generation Rate

We have used the trip generation rates from the Taupō Traffic Model, which is part of the Waikato Regional Transportation Model (WRTM); namely:

AM Peak 0.72 trips/household/hr

PM Peak 0.85 trips/household/hr

2.3 Trip Arrival and Departure Rate

We have used the trip arrival and departure rates from the Taupō Traffic Model (part of Waikato Regional Transportation Model).

Table 2: Trip Arrival and Departure Rates

Period	Movement	% Movements
AM Peak Hour	Arrival Split (Trips In)	0.25
	Departure Split (Trips Out)	0.75
PM Peak Hour	Arrival Split (Trips In)	0.63
	Departure Split (Trips Out)	0.37

2.4 Trip Distribution

Travel Route

We have assumed that different routes will be used for accessing Wairakei Drive, depending on the origin / destination of particular journeys. Table 3 below describes the assumed route assignments for the different origins.

Table 3: Travel Routes

	Pohipi Road and Wairakei Drive to and from Taupo town centre via CGB (Blue Route)	Norman Smith Street from Taupo town centre via CGB (Red Route)
Seven Oaks and Kinloch	100%	0%
Acacia Bay	0%	100%
Brentwood and Lakeside Brentwood	0%	100%
Undeveloped half charges	75%	25%
PC37 Nukuhau	50%	50%

Figure 3: Travel Route and Trip Distribution

2.5 Assumptions made

We have made the following assumptions in assigning trips to Wairakei Drive and Control Gates Bridge.

- 70% of the trips generated by Kinloch will travel to and from the Taupo Town Centre; the route used for all these trips will be via Poihipi Road, Wairakei Drive, and Control Gates Bridge in the AM and PM peak. The other trips generated by Kinloch will be not involve journeys to and from the Taupo Town Centre;
- 80% of the trips generated by Acacia Bay, Brentwood and Lakeside Brentwood will travel to and from Taupo Town Centre; the route used for all these trips will be via Norman Smith Street and Control Gates Bridge in the AM and PM peak;
- 85% of the trips generated by the Nukuhau Plan Change development will travel to and from Taupo Town Centre; the route used for these trips will be distributed between Norman Smith Street and Poihipi Road (as described in Table 3), with all these trips using Control Gates Bridge in the AM and PM peak;
- 1% net linear annual traffic growth rate, additional traffic growth subject to land developments aside from those listed above;
- any turning volumes for a particular movement at any intersection that were lower than 10 were rounded up to 10 vehicles.

2.6 Additional Trips

Tables 4 to 9 below summarise the additional trips generated by each of the permitted land developments and Nukuhau Plan Change.

Table 4: Additional Trips 2025 #1

	2025 #1			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	94	0	93	0
Acacia Bay	0	32	0	32
Brentwood and Lakeside Brentwood	0	102	0	101
Undeveloped half charges	72	24	72	24
PC37 Nukuhau	0	0	0	0
Total	**166**	**158**	**164**	**157**

With regard to these additional trips, it is important to note that while, in some cases (but not in others), there appears to be a direct correlation between AM peak and PM peak values, the reason for this is a mathematical coincidence rather than a mistake. The points below illustrate the basis on which values in the table have been calculated:

- Seven Oaks and Kinloch AM peak: 496 households x 50% developed x 70% to and from Taupo CBD x 0.72 AM peak trips per household x 75% into Taupo CBD = 93.7 ≈ 94 trips towards CBD on Control Gates Bridge.
- Seven Oaks and Kinloch PM peak: 496 households x 50% developed x 70% to and from Taupo CBD x 0.85 PM peak trips per household x 63% away from Taupo CBD = 92.9 ≈ 93 trips away from CBD on Control Gates Bridge.
- Acacia Bay AM peak: 150 households x 50% developed x 80% to and from Taupo CBD x 0.72 AM peak trips per household x 75% into Taupo CBD = 32.4 ≈ 32 trips towards CBD on Control Gates Bridge.
- Acacia Bay PM peak: 150 households x 50% developed x 80% to and from Taupo CBD x 0.85 PM peak trips per household x 63% away from Taupo CBD = 32.1 ≈ 32 trips away from CBD on Control Gates Bridge.

Table 5: Additional Trips 2025 #2

	2025 #2			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	94	0	93	0
Acacia Bay	0	32	0	32
Brentwood and Lakeside Brentwood	0	102	0	101
Undeveloped half charges	72	24	72	24
PC37 Nukuhau	72	72	71	71
Total	**237**	**230**	**235**	**228**

Table 6: Additional Trips 2030 #1

	2030 #1			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	187	0	186	0
Acacia Bay	0	65	0	64
Brentwood and Lakeside Brentwood	0	203	0	201
Undeveloped half charges	144	48	143	48
PC37 Nukuhau	0	0	0	0
Total	**332**	**316**	**329**	**313**

Table 7: Additional Trips 2030 #2

	2030 #2			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	187	0	186	0
Acacia Bay	0	65	0	64
Brentwood and Lakeside Brentwood	0	203	0	201
Undeveloped half charges	144	48	143	48
PC37 Nukuhau	54	54	53	53
Total	**385**	**370**	**382**	**367**

Table 8: Additional Trips 2030 #3

	2030 #3			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	187	0	186	0
Acacia Bay	0	65	0	64
Brentwood and Lakeside Brentwood	0	203	0	201
Undeveloped half charges	144	48	143	48
PC37 Nukuhau	143	143	142	142
Total	**475**	**459**	**471**	**455**

Table 9: Additional Trips 2030 #4

	2030 #4			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	94	0	93	0
Acacia Bay	0	32	0	32
Brentwood and Lakeside Brentwood	0	102	0	101
Undeveloped half charges	72	24	72	24
PC37 Nukuhau	54	54	53	53
Total	**220**	**212**	**218**	**210**

3 Traffic Model

3.1 Modelling Input

3.1.1 Traffic Volume

To determine future traffic volumes in the year 2025 and 2030, we have:

- Applied a 1% net linear annual traffic growth rate to the base traffic volumes (2021 base model from Taupo Traffic Model)
- Included additional forecast trips generated from the permitted land developments and Nukuhau Plan Change development

Additional modelling in SIDRA (v9) has been completed for the Norman Smith Street / Wairakei Drive intersection, the Control Gates Bridge, and the Spa Road/Tongariro Street roundabout for the scenarios summarised in Table 1.

3.1.2 Phasing and Timing

We have adopted Optimum Cycle Time for the Norman Smith signalised intersection. SIDRA identifies the cycle time for the model that will minimise overall delay for the intersection; Figure 4 below illustrates the option selected within SIDRA.

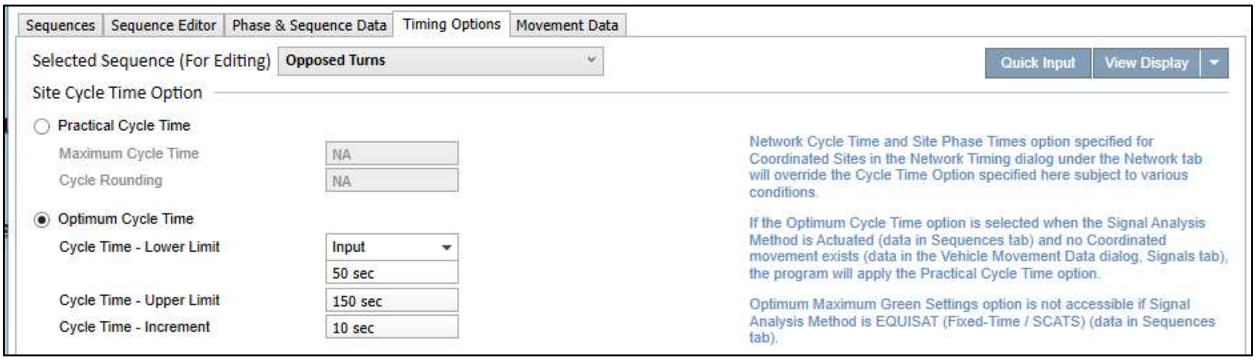


Figure 4: Phasing and Timing Input for the Norman Smith Intersection

3.1.3 Gap Acceptance

We have not calibrated the models based on observation of queuing and delay of the actual sites due to the lack of actual survey data. Instead we have used the SIDRA default or programmed gap acceptances for the Spa Road roundabout and the left turn from Norman Smith Street.

The SIDRA manual states that "For roundabouts, program / Input drop-down list controls the Critical Gap and Follow-up Headway data fields. The Program option (default) means that the Critical Gap and Follow-up Headway parameters will be determined by the program as a function of the roundabout geometry, circulating flow rate and other factors."

3.1.4 Bridge Saturation flow

We have adopted a saturation flow rate of 1550 vph per direction for the CGB, which is similar to historic traffic volumes on the bridge. We note that this rate is at the lower end of the range of "1550-1600 vehicles per lane per hour" described by Mr Smith in paragraph 4.11a of his statement of 30th September 2021. Therefore, our analysis of the CGB is likely to be conservative.

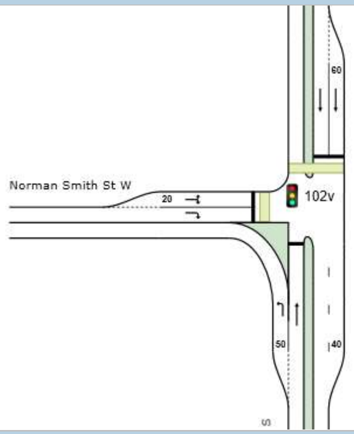
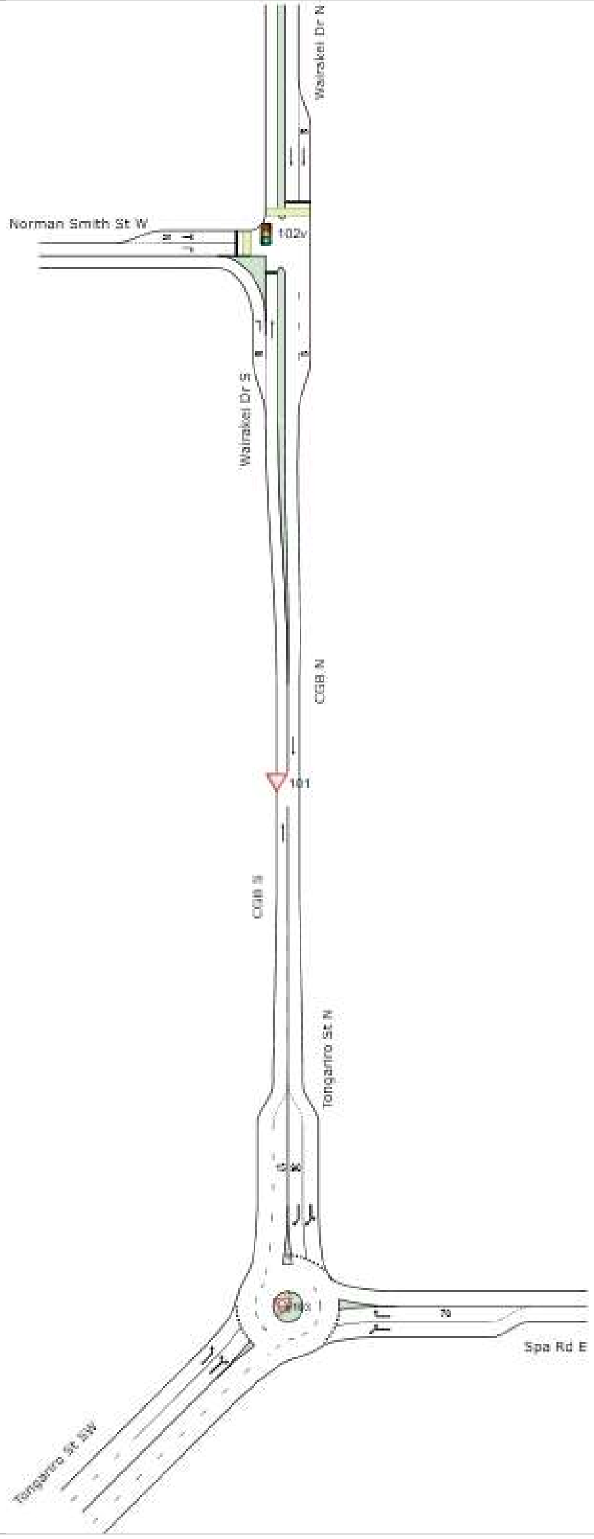
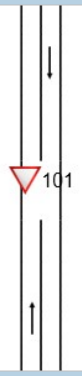
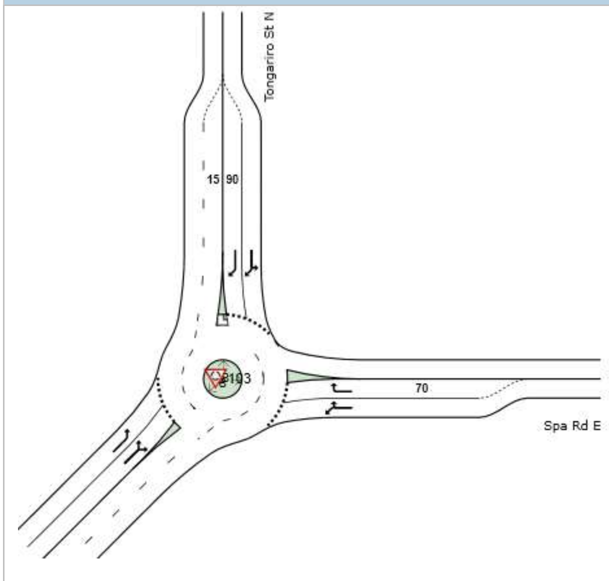
Vehicle queues are likely to develop in the models when the modelled traffic flows are greater than the designed saturation flow (designed capacity).

3.2 Site Layout

We ran models for three discrete sites on the network; namely, Norman Smith Street intersection, Control Gates Bridge, and the Spa Road roundabout. We also modelled travel along various routes (using the Route function under SIDRA network) that combined the three discrete sites into a small network.

Table 10 illustrates the discrete sites and a truncated version of the network configuration.

Table 10: SIDRA Site and network Layouts

<table>
<tr><th>Norman Smith Street Intersection</th><th>Network</th></tr>
<tr><td>
</td><td rowspan="5">
</td></tr>
<tr><td>Control Gates Bridge</td></tr>
<tr><td>
</td></tr>
<tr><td>Spa Road Roundabout</td></tr>
<tr><td>
</td></tr>
</table>

3.3 Modelling Output

The following sections summarise the outputs from the SIDRA models.

We ran the models for each of the individual sites separately and together as a network. For each site, we have reported both the individual site performance and the performance of the site in the network. Listed below are the key differences in the reporting for the individual sites and the network:

1. Queue Length: SIDRA models report the 95th percentile (95%ile) queue for individual sites and the average queue for the site in a network. That is, the queue lengths for the site outputs are not directly comparable with the queue lengths for the Network outputs.

2. Arrival Flow: In the network, arrival flow value is reduced if there is a capacity constraint (capacity restrained) in upstream lanes. Essentially, if an upstream site limits the rate at which vehicles can arrive at a downstream site, the modelling for the downstream site is based on the arrival rate dictated by the upstream constraint.

3. Approaching Distance: Approaching distance is set up as 500 m when assessing an individual site. In the network, the approaching distance is set up to align with the actual distance between the sites. This has been measured using Google Maps.

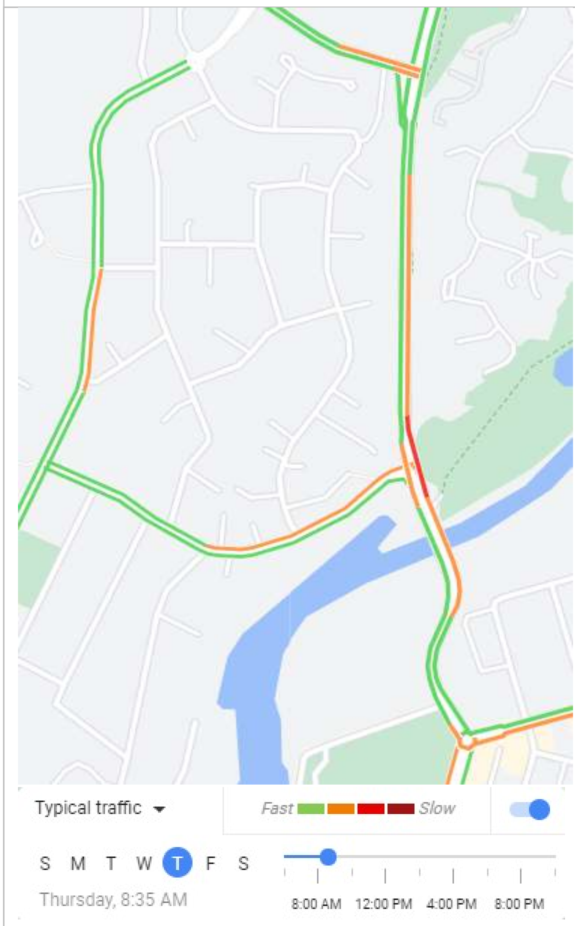
We have also reported total travel time for eight different routes in the network (Table 23 and Table 25), four for each peak period and compared the travel times between different scenarios.

3.3.1 Current Model vs Google Typical Traffic

Google records the operational performance of typical traffic and it can be compared with the 2021 modelled results.

For the comparison, we have chosen Thursday, which is the “worst” day of the week in Google Maps and the time period that presents the worst conditions for the peak period.

Table 11: Google Maps Typical Traffic Speed

2021 AM	2021 PM
	

3.3.2 Norman Smith Street/Wairakei Drive Intersection

For the Norman Smith intersection, we have reported modelling results for the overall site and the two movements that have the longest queues and greatest delays for each peak period. While there is some queuing and delay on the third approach in each case, it is less significant, therefore, we have focused on the worst cases.

In the tables below, we have included three numeric values in parentheses beneath the name of each scenario. These values represent the assumed percentage development for each of (Brentwood, Lakeside Brentwood, Vineyard on Huka Falls, Acacia Bay, Kinloch, and Seven Oaks combined / Undeveloped half charges / Nukuhau).

Table 12: Norman Smith Street Intersection – Site Output AM

AM Site performance	LOS Intersection	Average Delay (sec)	Southbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	95%ile Queue (m)	Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	C	21	28	115	22	142
2025 Scenario #1 (50/30/0)	E	70	105	409	79	530
2025 Scenario #2 (50/30/40)	F	105	144	518	130	698
2030 Scenario #0 (0/0/0)	C	29	39	154	36	215
2030 Scenario #1 (100/60/0)	F	180	255	803	215	995
2030 Scenario #2 (100/60/30)	F	217	222	923	318	1548
2030 Scenario #3 (100/60/80)	F	281	300	1103	397	1736
2030 Scenario #4 (50/30/30)	F	119	179	574	138	707

By way of explanation, as an example, the results in

Table 12 illustrate the following:

(a) Adding 50% of all other developments (except Nukuhau) and 30% of the Half charges (2025 Scenario #1) to the 2021 base (2021 Scenario #0) volumes reduces the level of service for the intersection from LOS C to LOS E and increases the average delay from 21 seconds to 70 seconds.

(b) Adding 40% of the traffic from Nukuhau (2025 Scenario #2) to the 2025 Scenario #1 traffic volumes reduces the level of service for the intersection from LOS E to LOS F, and increses the delay from 70 seconds to 105 seconds.

(c) Reducing additional traffic for Nukuhau from 40% to 30% and adding 1% traffic growth per year to base traffic volumes (2030 Scenario #4) results in no change to the level of service, when compared with 2025 Scenario #2, and increases the average delay from 105 seconds to 119 seconds.

Table 13: Norman Smith Street Intersection – Network Output AM

AM Site performance in network	LOS Intersection	Average Delay (sec)	Southbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	Average Queue (m)	Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	C	21	28	71	22	87
2025 Scenario #1 (50/30/0)	E	70	105	251	79	325
2025 Scenario #2 (50/30/40)	F	105	144	317	130	427
2030 Scenario #0 (0/0/0)	C	29	39	94	36	132
2030 Scenario #1 (100/60/0)	F	180	255	492	215	610
2030 Scenario #2 (100/60/30)	F	217	222	565	318	949
2030 Scenario #3 (100/60/80)	F	281	300	676	397	1064
2030 Scenario #4 (50/30/30)	F	118	179	352	138	433

Table 14: Norman Smith Street Intersection – Site Output PM

PM Site performance	LOS Intersection	Average Delay (sec)	Northbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	95%ile Queue (m)	Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	B	11	15	84	18	65
2025 Scenario #1 (50/30/0)	D	45	114	374	63	173
2025 Scenario #2 (50/30/40)	E	63	154	495	97	229
2030 Scenario #0 (0/0/0)	B	13	15	93	24	92
2030 Scenario #1 (100/60/0)	F	99	226	724	178	364
2030 Scenario #2 (100/60/30)	F	111	267	848	178	364
2030 Scenario #3 (100/60/80)	F	133	300	999	239	442
2030 Scenario #4 (50/30/30)	E	71	161	513	128	290

Table 15: Norman Smith Street Intersection – Network Output PM

PM Site performance in network	LOS Intersection	Average Delay (sec)	Northbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	Average Queue (m)	Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	B	11	15	51	18	40
2025 Scenario #1 (50/30/0)	B	12	16	59	20	46
2025 Scenario #2 (50/30/40)	B	12	15	57	22	50
2030 Scenario #0 (0/0/0)	B	12	17	58	19	48
2030 Scenario #1 (100/60/0)	B	14	17	58	22	57
2030 Scenario #2 (100/60/30)	B	13	17	60	21	52
2030 Scenario #3 (100/60/80)	B	16	13	56	37	77
2030 Scenario #4 (50/30/30)	B	13	16	58	21	52

3.3.3 Control Gates Bridge

For the CGB, we have reported modelling results for the worst movement, which we have identified as being the movement with the greatest delays for each peak period. While there is delay on the other approach it is essentially insignificant by comparison. SIDRA determines the delay for a network feature like the CGB based on comparison between the modelled flow rate and the saturation flow rate. Delay and LOS will deteriorate as the modelled flow rate approaches and exceeds the saturation flow rate (designed capacity), which in this case we have set as 1550 vph per lane.

Table 16: Control Gates Bridge – Site Output

Site performance	LOS Worst Movement		Average Delay (sec)		AM - Southbound Delay (sec)	PM - Northbound Delay (sec)
	AM	PM	AM	PM		
2021 Scenario #0 (0/0/0)	B	A	10	4	14	7
2025 Scenario #1 (50/30/0)	F	F	94	71	128	110
2025 Scenario #2 (50/30/40)	F	F	130	102	173	155
2030 Scenario #0 (0/0/0)	E	D	34	19	49	32
2030 Scenario #1 (100/60/0)	F	F	194	158	254	234
2030 Scenario #2 (100/60/30)	F	F	223	184	288	268
2030 Scenario #3 (100/60/80)	F	F	272	228	346	325
2030 Scenario #4 (50/30/30)	F	F	138	108	185	166

Table 17: Control Gates Bridge – Network Output

Site performance in network	LOS Worst Movement		Average Delay (sec)		AM - Southbound Delay (sec)	PM - Northbound Delay (sec)
	AM	PM	AM	PM		
2021 Scenario #0 (0/0/0)	A	A	2	3	3	6
2025 Scenario #1 (50/30/0)	C	E	18	25	24	41
2025 Scenario #2 (50/30/40)	D	E	19	28	26	46
2030 Scenario #0 (0/0/0)	B	C	7	14	11	23
2030 Scenario #1 (100/60/0)	D	F	21	32	29	53
2030 Scenario #2 (100/60/30)	D	F	24	41	33	67
2030 Scenario #3 (100/60/80)	D	F	26	36	35	58
2030 Scenario #4 (50/30/30)	D	F	18	27	25	45

3.3.4 Spa Road Roundabout

For the Norman Smith Street intersection, the modelling results were reported based on a single movement for each approach, however, we have reported the modelling outcomes based on approaches for the Spa Road roundabout. This is because traffic volumes for individual movements approaching the Spa Road roundabout are affected by other movements (Figure 5) whereas the effect is less pronounced for the approaches to the Norman Smith Street intersection. As such, at the Spa Road roundabout, the delays for some movements, where traffic volumes are low, may be relatively significant. However, we do not want to underrepresent the delays for those other movements.

For the Spa Road roundabout, we have reported modelling results for the overall site and the two approaches that have the longest queues and greatest delays for each peak period. While there is some queuing and delay on the third approach in each case, it is less significant, therefore, we have focused on the worst cases.

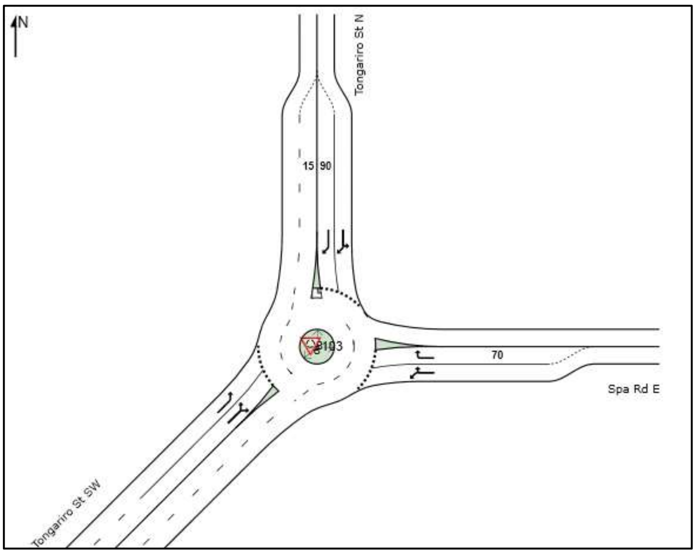


Figure 5: Spa Road Roundabout Layout

Table 18: Spa Road Roundabout – Site Output AM

AM Site performance	LOS Intersection	Average Delay (sec)	Southbound Approach		Westbound Approach	
			Average Delay (sec)	95%ile Queue (m)	Average Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	A	7	6	35	12	23
2025 Scenario #1 (50/30/0)	A	8	6	56	17	41
2025 Scenario #2 (50/30/40)	A	8	6	67	21	51
2030 Scenario #0 (0/0/0)	A	7	6	42	14	32
2030 Scenario #1 (100/60/0)	B	12	6	99	49	113
2030 Scenario #2 (100/60/30)	B	19	7	119	99	212
2030 Scenario #3 (100/60/80)	D	45	7	170	307	540
2030 Scenario #4 (50/30/30)	A	9	6	71	25	63

Table 19: Spa Road Roundabout – Network Output AM

AM Site performance in network	LOS Intersection	Average Delay (sec)	Southbound Approach		Westbound Approach	
			Average Delay (sec)	Average Queue (m)	Average Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	A	7	6	14	12	9
2025 Scenario #1 (50/30/0)	A	7	6	14	12	10
2025 Scenario #2 (50/30/40)	A	7	6	14	12	10
2030 Scenario #0 (0/0/0)	A	7	6	14	12	11
2030 Scenario #1 (100/60/0)	A	7	6	14	12	11
2030 Scenario #2 (100/60/30)	A	7	6	14	12	11

2030 Scenario #3 (100/60/80)	A	7	6	14	12	11
2030 Scenario #4 (50/30/30)	A	7	6	14	12	11

Table 20: Spa Road Roundabout – Site Output PM

PM Site performance	LOS Intersection	Average Delay (sec)	Northeast bound Approach		Westbound Approach	
			Average Delay (sec)	95%ile Queue (m)	Average Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	B	11	17	84	13	56
2025 Scenario #1 (50/30/0)	F	107	324	1082	24	156
2025 Scenario #2 (50/30/40)	F	170	499	1536	43	288
2030 Scenario #0 (0/0/0)	C	23	55	239	16	82
2030 Scenario #1 (100/60/0)	F	266	689	2070	121	722
2030 Scenario #2 (100/60/30)	F	304	742	2253	177	1019
2030 Scenario #3 (100/60/80)	F	382	879	2632	245	1402
2030 Scenario #4 (50/30/30)	F	176	500	1566	63	390

Table 21: Spa Road Roundabout – Network Output PM

PM Site performance in network	LOS Intersection	Average Delay (sec)	Northeast bound Approach		Westbound Approach	
			Average Delay (sec)	Average Queue (m)	Average Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	B	11	17	34	13	23
2025 Scenario #1 (50/30/0)	F	107	324	435	24	63
2025 Scenario #2 (50/30/40)	F	170	499	618	43	116
2030 Scenario #0 (0/0/0)	C	23	55	96	16	33
2030 Scenario #1 (100/60/0)	F	266	689	832	121	291
2030 Scenario #2 (100/60/30)	F	304	742	906	177	410
2030 Scenario #3 (100/60/80)	F	382	879	1060	245	564
2030 Scenario #4 (50/30/30)	F	176	500	630	63	157

3.3.5 Network En-route travel time

En-route travel time analysis has been undertaken using the Route function in the modelled SIDRA networks.

We have set up the following routes in the SIDRA network in all modelled scenarios to understand the overall en-route travel between (and including) the Norman Smith Street / Wairakei Drive intersection and the Spa Road roundabout via Control Gates Bridge.

The routes modelled and the summarised predicted results are described in the tables below.

Table 22: SIDRA Network En-Route AM

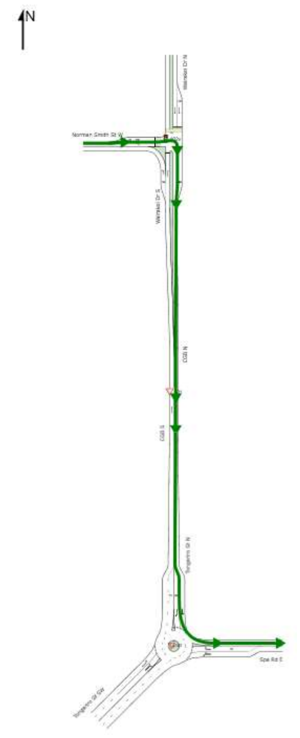
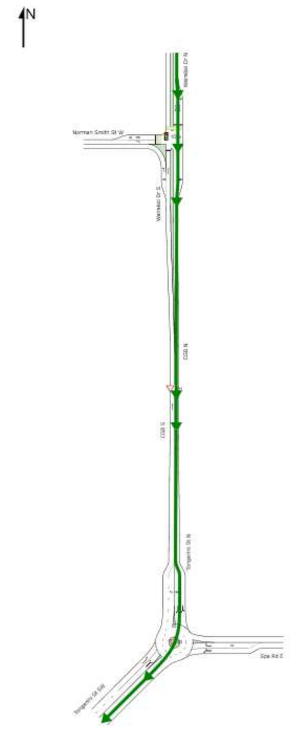
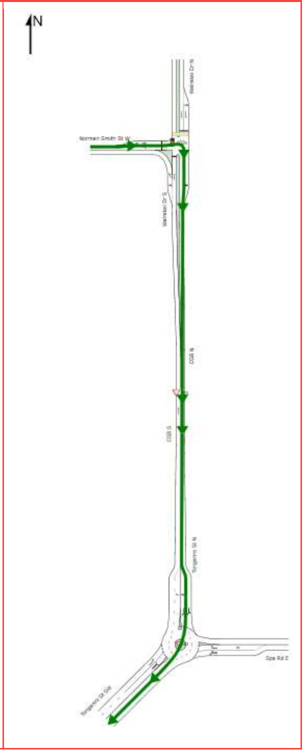
AM Peak			
Route 1	Route 2	Route 3	Route 4
			

Table 23: En-Route Travel Time AM

Scenarios	AM En-route Travel Time (seconds)			
	Route 1	Route 2	Route 3	Route 4
2021 Scenario #0 (0/0/0)	149	142	150	144
2025 Scenario #1 (50/30/0)	247	220	249	221
2025 Scenario #2 (50/30/40)	289	274	291	275
2030 Scenario #0 (0/0/0)	166	164	168	166
2030 Scenario #1 (100/60/0)	405	364	407	365
2030 Scenario #2 (100/60/30)	375	472	377	474
2030 Scenario #3 (100/60/80)	448	544	449	546
2030 Scenario #4 (50/30/30)	324	281	326	283

Table 24: SIDRA Network En-Route PM

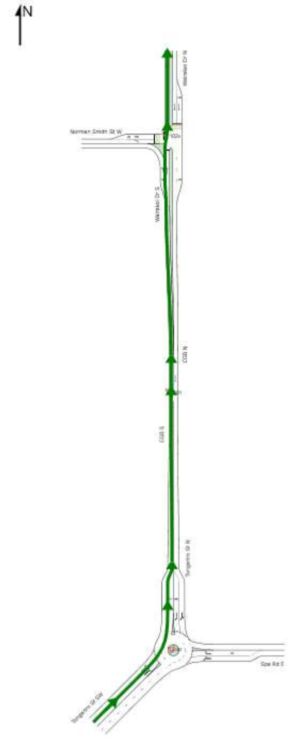
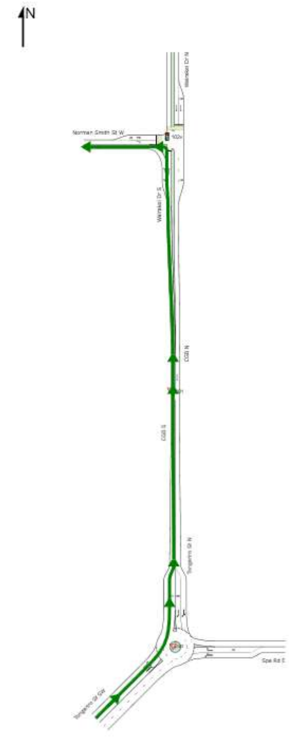
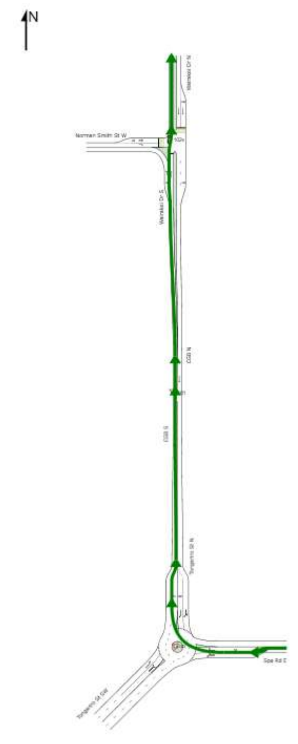
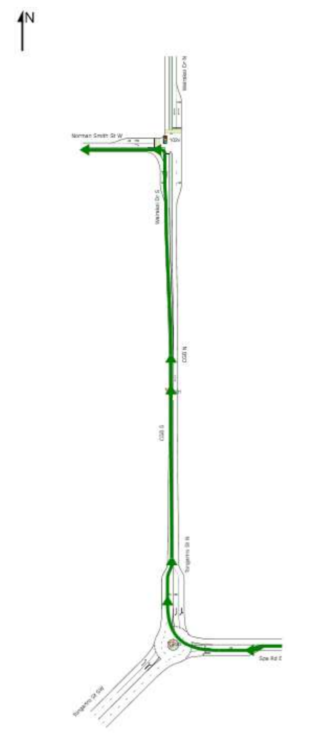
PM Peak			
Route 5	Route 6	Route 7	Route 8
			

Table 25: En-Route Travel Time PM

Scenarios	PM En-route Travel Time (seconds)			
	Route 5	Route 6	Route 7	Route 8
2021 Scenario #0 (0/0/0)	148	139	145	135
2025 Scenario #1 (50/30/0)	505	493	192	181
2025 Scenario #2 (50/30/40)	688	678	215	205
2030 Scenario #0 (0/0/0)	208	195	168	155
2030 Scenario #1 (100/60/0)	891	879	302	290
2030 Scenario #2 (100/60/30)	959	947	372	360
2030 Scenario #3 (100/60/80)	1086	1078	428	420
2030 Scenario #4 (50/30/30)	690	679	235	224

4 Summary

4.1 Individual vs. Network

As noted in this memo, discrete elements of a transport network do not function in isolation, but rather they are components of the network. Therefore, in this summary section, we have compared the site individual outputs and the site network outputs for the three discrete elements of the network when modelled. Listed below are the key findings.

4.1.1 AM Peak

Norman Smith Intersection

In the AM Peak, the individual and network delay time is the same at this intersection; this is because the intersection is acting as the upstream constraint for the southbound vehicles approaching the bridge. Southbound vehicles in the network queue at this intersection before crossing the bridge, therefore, the number of vehicles that can travel south through the bridge is controlled by the capacity of the intersection to release those vehicles.

Control Gates Bridge

The network model indicated less delay time for the network site compared to the individual site. This is because the southbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Norman Smith Street intersection.

Spa Road Roundabout

Similar to above, the network site indicated less delay time compared to the individual site. This is because the southbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Norman Smith Street intersection.

4.1.2 PM Peak

Spa Road Roundabout

In the PM Peak, the individual and network delay time is the same at the Spa Road roundabout This is because this intersection is acting as the upstream constraint for the northbound vehicles approaching the bridge. Northbound vehicles in the network queue up at this intersection before going through the bridge.

Control Gates Bridge

The network model indicated less delay time compared to the individual site. This is because the northbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Spa Road roundabout.

Norman Smith Intersection

The network model indicated less delay time compared to the individual site. This is because the northbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Spa Road roundabout.

4.2 En_Route Travel Time

We have also compared the route travel times between the key scenarios and summarised the results in Table 26 and Table 27.

Comparing the modelling output of travel time for permitted land only with permitted land plus Nukuhau (2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)):

- In the AM peak, the worst route (right turn out from Norman Smith Street intersection) had an increase of around 3 minutes (181 seconds).
- In the PM peak, the worst route (southwest approach of the Spa Road roundabout) had an increase of around 3.3 minutes (199 seconds).

Table 26: Difference in Travel Time AM

Compared scenarios		AM additional En-route Travel Time (seconds)			
		Route 1	Route 2	Route 3	Route 4
2030 Scenario #1 (100/60/0) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted land only	239	200	239	199
2030 Scenario #3 (100/60/80) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted land and Nukuhau	282	380	281	380
2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)	Delay time added due to Nukuhau on top of permitted land	43	180	42	181
2030 Scenario #4 (50/30/30) minus 2030 Scenario #0 (0/0/0)	Delay time added due to reduced development of permitted land and Nukuhau	158	117	158	117

Table 27: Difference in Travel Time PM

Compared scenarios		PM additional En-route Travel Time (seconds)			
		Route 5	Route 6	Route 7	Route 8
2030 Scenario #1 (100/60/0) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted Land Only	683	684	134	135
2030 Scenario #3 (100/60/80) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted Land and Nukuhau	878	883	260	265
2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)	Delay time added due to Nukuhau on top of permitted land	195	199	126	130
2030 Scenario #4 (50/30/30) minus 2030 Scenario #0 (0/0/0)	Delay time added due to reduced development at permitted Land and Nukuhau	482	484	67	69