Appendix A

Reeves Road Closure Detour Assessment

Eastern Busway Alliance

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Technical Advice Memorandum

To	Josie Jackson, Andy Gibbard, Julio Marti Herraiz, Ben Burrows	Page	1 of 27
CC	Jacques Van den Heever, Christine Lee, Josie Ackroyd		
Subject	AMETI Eastern Busway Stage 2 Reeves Road Closure & Detour Assessment - DRAFT		
From	Shane Doran		
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Summary

- Overall, it seems that only a small percentage of traffic is routing along the proposed detour route (probably due to the already congested nature of those intersections).
- As a result, in the **inbound** (citybound) direction during the AM demand seems to detour via Gossamer Road to Pakuranga Road in the north and Ti Rakau Drive in the south.
- In the PM in the **outbound** direction, demand seems to return via Pakuranga Road, and via SEART turning right onto Ti Rakau Drive.
- NOTE: Colour-coding of the tables below are in reference to the Do-Minimum scenario with green = improved, amber = similar and red = worse.

William Roberts Road / Reeves Road intersection:

- For the Stage 2 detour this intersection is expected to operate with good LOS in the AM and PM.

Scenario	LOS		DOS [v/c]		Average Delay [sec]	
	AM	PM	AM	PM	AM	PM
Do-Minimum	-	-	0.68	0.87	8	12
Stage 2 Detour	-	-	0.18	0.39	5	5

William Roberts Road / Pakuranga Road intersection:

- The assessment indicates that the Stage 2 detour results in overall intersection performance that is similar or worse than the Do-Minimum in the AM and PM, but in practical terms the intersection is already saturated, and the impact of the detour is considered negligible.

Scenario	LOS		DOS [v/c]		Average Delay [sec]	
	AM	PM	AM	PM	AM	PM
Do-Minimum	-	-	9.46	32.92	387	2260
Stage 2 Detour	-	-	10.96	19.93	443	1011

Pakuranga Road / Ti Rakau Drive intersection:

- Stage 2 intersection performance is LOS D during the AM peak, with the Ti Rakau Drive west left-turn lane expected to operate at LOS C.
- During the PM peak the intersection is expected to perform at LOS F during Stage 2, compared to the LOS E of the Do-Minimum scenario. Demand seems to have increased on Pakuranga Road west (and east), however the west approach is already saturated, causing delays to increase further.
- NOTE: The Ti Rakau Drive / SEART intersection below (**Section 3.4**) is also expected to experience poor LOS. It is expected that the mitigation measures discussed would remedy that intersection as well as this intersection by drawing demand away from Pakuranga Road eastbound to SEART, then turning right into Ti Rakau Drive. Therefore, mitigation measures are not recommended for the Pakuranga Road / Ti Rakau Drive intersection.

Scenario	LOS		DOS [v/c]		Average Delay [sec]	
	AM	PM	AM	PM	AM	PM
Do-Minimum	D	E	0.93	1.01	43	71
Stage 2 Detour	D	F	0.92	1.07	37	99

Ti Rakau Drive / SEART intersection:

- Intersection performance is poor (LOS F) during both the AM and PM peaks for the Do-Min scenario. The Stage 2 AM peak intersection performance is expected to be slightly improved (LOS E), however the PM peak is still poor (LOS F).
- The SEART right-turn lanes into Ti Rakau Drive are expected to operate at LOS F during the PM peak. The increase in demand (due to Reeves Road closure) results in delay increasing from around 50 sec to 215 sec (3.6 min), which would require mitigation.
- Mitigation 1 consists of an additional right-turn lane from SEART to Ti Rakau Drive eastbound and an additional exit lane on Ti Rakau Drive eastbound between SEART and William Roberts Road. Improved intersection performance is expected during both AM and PM peaks. This option is recommended to be discussed with key stakeholders.
- A further refinement of Mitigation 1 was also tested. It consisted of a 105 m short exit lane (AGRD04A (Austroads) – Table 5.5) on Ti Rakau Drive eastbound. Although intersection performance is expected to be similar to Mitigation 1 above, this geometric change would provide insufficient weave distance up to William Roberts Road and is not recommended.
- Mitigation 2 consists of the temporary removal of the pedestrian crossing on the eastern arm of the intersection, reducing phases to 3 and redistributing the greentime. Improved intersection performance is expected during both AM and PM peaks however, large queues are still expected in the SEART right-turn lanes.

Scenario	LOS		DOS [v/c]		Average Delay [sec]	
	AM	PM	AM	PM	AM	PM
Do-Minimum	F	F	0.89	1.15	178	98
Stage 2 Detour	E	F	0.91	1.13	60	120
Mitigation 1	D	E	0.89	1.06	53	41
Mitigation 2	D	E	0.87	0.97	41	77

Ti Rakau Drive / Gossamer Drive intersection:

- The right-turn traffic demand from Gossamer Drive into Ti Rakau Drive is expected to increase by around 160 veh/h. The resultant intersection performance is poor (LOS F) for the Stage 2 AM peak, compared to the LOS E of the Do-Min scenario. This would require mitigation.

- The intersection is expected to experience little change during the Stage 2 PM peak and will remain at LOS D.

- Mitigation 1 consists of the following changes to the northern Gossamer Drive approach: additional short right-turn lane (100 m), converting the short left-turn slip lane to pass through the intersection and providing 150 m stacking space and kerbside short exit lane length increased to 100 m. Intersection performance is expected to be slightly improved, compared to Stage 2 during the AM peak, however still LOS F. Furthermore, the additional control delay now imposed on the Gossamer Drive left-turn (previously a left-turn slip under the Do-Min and Stage 2 scenarios) has resulted in large delays (141 sec) and queues (478 m) in that lane. The PM peak is expected to experience improved performance.

- Mitigation 2 consists of the following changes to the northern Gossamer Drive approach: additional short lane (100 m) for the shared through and right-turn movements, converting the centre lane to a full left-turn lane, converting the short left-turn slip lane to pass through the intersection and providing 150 m stacking space and kerbside short exit lane length increased to 100 m. Improved intersection performance is expected during both the AM and PM peaks. This option is recommended to be discussed with key stakeholders.

Scenario	LOS		DOS [v/c]		Average Delay [sec]	
	AM	PM	AM	PM	AM	PM
Do-Minimum	D	D	1.02	0.90	48	45
Stage 2 Detour	F	D	1.25	0.88	168	43
Mitigation 1	F	D	1.09	0.86	118	38
Mitigation 2	D	D	0.89	0.86	37	37

- The impacts to buses through the project area are expected to be low as the frequencies of the 711 route in the AM inbound and PM outbound directions are only 4 buses/h (1 every 15min).

1.0 Introduction

The proposed construction sequencing of the Eastern Busway, relevant to this Technical Advice Note, are as follows:

- Stage 1 – Extension of William Roberts Road south to Ti Rakau Drive as well as completing the Cortina Place link between William Roberts Road and Reeves Road. During this stage, Reeves Road will remain open, providing site access through Cortina Place and William Roberts Road. **Figure 1** provides an overview of Stage 1.

Figure 1: Stage 1 overview

- Stage 2 – Closure of Reeves Road between Ti Rakau Drive and William Roberts Road. At the completion of Stage 1, William Roberts Road is intended to be a left-in left-out (LILO) only at the intersection with Ti Rakau Drive. Therefore, due to the Reeves Road closure and the LILO arrangement at the William Roberts Road / Ti Rakau Drive intersection, an alternative detour route is proposed for traffic usually traveling along Reeves Road toward the SEART. **Figure 2** provides an overview of Stage 2.

Figure 2: Stage 2 overview

The proposed detour will route traffic north along William Roberts Road, west along Pakuranga Road, south along Ti Rakau Drive and finally west along SEART. The purpose of this Technical Advice Note is to assess the proposed detour route.

2.0 Assessment Methodology

AIMSUN:

- Operational Microsimulation Models – These models provide information about travel times along different routes within the project area as well as turn movements and traffic demand along roads within the project area.
- The proposed geometric changes of Stage 1 and Stage 2 were updated within the AIMSUN model to determine re-routed traffic demands along roads within the project area.
- The turning movement outputs at intersections from this model were used as inputs into SIDRA models.

SIDRA:

- Intersection models – These models are used to determine the performance of intersections using traffic movement data from AIMSUN models. The key outputs include degree of saturation (DOS), level of service (LOS), delays and queue lengths.
- The proposed geometric changes of Stage 1 and Stage 2 were updated within the SIDRA model and the AIMSUN turning movements were imported.
- The results of this 'Stage 2' scenario were compared to a 'Do Minimum' scenario in order to determine and assess the potential impact of the proposed Stage 2 and associated disruption.

3.0 Lane Performance Summaries

3.1 William Roberts Road / Reeves Road

3.1.1 AM Peak

- NOTE: The Reeves Road west approach to this intersection in the Stage 2 scenario has been closed. For the Stage 2 detour this intersection is expected to operate with good LOS in the AM, the removal of the Reeves Road west approach reduces much of the opposing flows.
- Total intersection demand decreased by around 300 veh/h and the Reeves Road east approach right-turn increased by around 30 veh/h.
- It is clear from the comparison below that Reeves Road westbound traffic demand has decreased and only a small percentage of traffic is routing along the proposed detour north on William Roberts Road. This is a general trend for all intersection assessed and will be detailed further in later sections of this Technical Advice Note.

Table 1: William Roberts Rd / Reeves Rd – Do-Min vs Stage 2 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Rd (South)															
Lane 1	39	2.6	39	2.6	337	0.116	100	10.9	LOS B	0.1	0.9	Full	170	-20.4[N7]	0.0
Approach	39	2.6	39	2.6		0.116		10.9	LOS B	0.1	0.9				
East: Reeves Rd (East)															
Lane 1	375	6.1	375	6.1	1831	0.205	100	0.2	LOS A	0.0	0.0	Full	266	0.0	0.0
Lane 2	103	11.7	103	11.7	562	0.183	100	5.5	LOS A	0.2	1.2	Short	13	-49.9[N7]	NA
Approach	478	7.3	478	7.3		0.205		1.3	NA	0.2	1.2				
North: William Roberts Rd (North)															
Lane 1	283	5.7	235	4.2	344	0.683	100	24.2	LOS C	2.0	14.6	Full	244	0.0	0.0
Approach	283	5.7	235[N1]	4.2		0.683		24.2	LOS C	2.0	14.6				
West: Reeves Rd (West)															
Lane 1	41	9.8	40	9.9	832	0.048	100	4.1	LOS A	0.0	0.0	Short	53	-49.9[N7]	NA
Lane 2	143	12.6	139	12.8	1803	0.077	100	0.0	LOS A	0.0	0.0	Full	55	0.0	0.0
Lane 3	11	0.0	11	0.0	1238	0.009	100	5.4	LOS A	0.0	0.1	Short	13	0.0	NA
Approach	195	11.3	190[N1]	11.4		0.077		1.2	NA	0.0	0.1				
Intersection	995	7.4	942[N1]	7.9		0.683		7.4	NA	2.0	14.6				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Rd (South)															
Lane 1	136	7.4	135	7.4	745	0.182	100	5.9	LOS A	0.6[N5]	4.5[N5]	Full	243	-19.0[N3]	11.8
Approach	136	7.4	135[N1]	7.4		0.182		5.9	LOS A	0.6	4.5				
East: Reeves Rd (East)															
Lane 1	215	5.6	215	5.6	1758	0.122	100	4.6	LOS A	0.0	0.0	Full	266	0.0	0.0
Lane 2	134	9.0	134	9.0	1718	0.078	100	4.7	LOS A	2.6[N5]	19.4[N5]	Short	13	0.0	NA
Approach	349	6.9	349	6.9		0.122		4.6	NA	2.6	19.4				
North: William Roberts Rd (North)															
Lane 1	212	12.3	89	7.7	1216	0.073	100	5.3	LOS A	0.1	0.9	Full	244	0.0	0.0
Approach	212	12.3	89[N1]	7.7		0.073		5.3	LOS A	0.1	0.9				
Intersection	697	8.6	573[N1]	10.5		0.182		5.0	NA	2.6	19.4				

3.1.2 PM Peak

- The intersection is expected to operate with good LOS in PM with the Stage 2 detour.
- Total intersection demand decreased by around 500 veh/h and the Reeves Road east approach right-turn increased by around 30 veh/h. The William Roberts Road south approach demand increased by around 230 veh/h, indicating an increase in vehicles routing from Ti Rakau Drive at the new LILO intersection further south.

Table 2: William Roberts Rd / Reeves Rd – Do-Min vs Stage 2 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV] %	ARRIVAL FLOWS [Total veh/h]	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Rd (South)															
Lane 1	46	4.3	46	4.3	270	0.170	100	13.3	LOS B	2.6[N5]	19.2[N5]	Full	170	-20.7[N3]	16.8
Approach	46	4.3	46	4.3		0.170		13.3	LOS B	2.6	19.2				
East: Reeves Rd (East)															
Lane 1	140	8.6	140	8.6	1794	0.078	100	0.3	LOS A	0.0	0.0	Full	266	0.0	2.7[8]
Lane 2	53	24.5	53	24.5	523	0.101	100	10.3	LOS B	11.7[N5]	98.8[N5]	Short	13	0.0	NA
Approach	193	13.0	193	13.0		0.101		3.1	NA	11.7	98.8				
North: William Roberts Rd (North)															
Lane 1	259	15.8	217	15.0	250	0.869	100	50.0	LOS F	3.3	25.9	Full	244	0.0	0.0
Approach	259	15.8	217[N1]	15.0		0.869		50.0	LOS F	3.3	25.9				
West: Reeves Rd (West)															
Lane 1	259	9.7	256	9.7	1665	0.154	100	4.1	LOS A	7.3[N6]	55.0[N6]	Short	53	0.0	NA
Lane 2	427	9.8	423	9.9	1841	0.230	100	0.0	LOS A	0.0	0.0	Full	55	0.0	49.9[8]
Lane 3	43	4.7	43	4.7	1542	0.028	100	4.5	LOS A	0.0	0.4	Short	13	0.0	NA
Approach	729	9.5	722[N1]	9.5		0.230		1.7	NA	7.3	55.0				
Intersection	1227	11.2	1178[N1]	11.6		0.869		11.3	NA	11.7	98.8				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV] %	ARRIVAL FLOWS [Total veh/h]	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Rd (South)															
Lane 1	274	9.2	273	9.2	698	0.391	100	5.0	LOS A	24.8[N5]	187.3[N5]	Full	243	-35.9[N3]	29.9
Approach	274	9.2	273[N1]	9.2		0.391		5.0	LOS A	24.8	187.3				
East: Reeves Rd (East)															
Lane 1	47	4.3	47	4.3	1774	0.026	100	4.6	LOS A	0.0	0.0	Full	266	0.0	5.6[8]
Lane 2	81	22.2	81	22.2	1578	0.051	100	4.8	LOS A	13.1[N5]	109.3[N5]	Short	13	0.0	NA
Approach	128	15.6	128	15.6		0.051		4.7	NA	13.1	109.3				
North: William Roberts Rd (North)															
Lane 1	342	9.6	162	7.8	1510	0.107	100	4.9	LOS A	0.2	1.5	Full	244	0.0	0.0
Approach	342	9.6	162[N1]	7.8		0.107		4.9	LOS A	0.2	1.5				
Intersection	744	10.5	563[N1]	13.9		0.391		4.9	NA	24.8	187.3				

3.2 William Roberts Road / Pakuranga Road

3.2.1 AM Peak

- The Do-Min scenario performance is poor, specifically the shared left and right-turn lane out of William Roberts Road and the Pakuranga Road west right-turn during the AM.
- The results below indicate that the Stage 2 detour results in overall intersection performance that is worse than the Do-Min in the AM, but in practical terms the intersection is saturated, and the impact of the detour is considered negligible.

Table 3: William Roberts Rd / Pakuranga Rd – Do-Min vs Stage 2 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Road															
Lane 1	147	9.5	146	9.6	15	9.462	100	7695.3	LOS F	32.2[N4]	243.9[N4]	Full	244	0.0	49.9
Approach	147	9.5	146[N1]	9.6		9.462		7695.3	LOS F	32.2	243.9				
East: Pakuranga Road (East)															
Lane 1	991	5.3	991	5.3	1824	0.543	100	1.4	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 2	825	5.7	825	5.7	1519	0.543	100	0.1	LOS A	0.0	0.0	Full	184	-17.0[N7]	0.0
Lane 3	866	5.7	866	5.7	1593	0.543	100	0.1	LOS A	0.0	0.0	Full	184	-13.9[N7]	0.0
Approach	2682	5.6	2682	5.6		0.543		0.6	NA	0.0	0.0				
West: Pakuranga Road (West)															
Lane 1	526	6.8	509	6.9	1847	0.276	100	0.0	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 2	509	6.8	493	6.9	1788	0.276	100	0.0	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 3	11	6.8	11	6.9	39[1]/5	0.276	100	498.4	LOS F	1.6	11.5	Full	152	0.0	48.6[8]
Lane 4	54	13.0	52	13.2	6	8.723	100	7175.8	LOS F	19.3	150.2	Short	60	0.0	NA
Approach	1100	7.1	1065[N]1	7.2		8.723		357.6	NA	19.3	150.2				
Intersection	3929	6.2	3893[N]1	6.2		9.462		386.9	NA	32.2	243.9				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Road															
Lane 1	159	8.2	159	8.2	32	4.904	100	3578.9	LOS F	32.6[N4]	243.9[N4]	Full	244	0.0	49.9
Approach	159	8.2	159	8.2		4.904		3578.9	LOS F	32.6	243.9				
East: Pakuranga Road (East)															
Lane 1	766	5.7	766	5.7	1832	0.418	100	0.6	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 2	765	5.9	765	5.9	1829	0.418	100	0.1	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 3	773	5.9	773	5.9	1849	0.418	100	0.1	LOS A	0.0	0.0	Full	184	0.0	0.0
Approach	2305	5.8	2305	5.8		0.418		0.2	NA	0.0	0.0				
West: Pakuranga Road (West)															
Lane 1	724	7.2	710	7.3	1842	0.386	100	0.0	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 2	701	7.2	688	7.3	1784	0.386	100	0.0	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 3	20	7.2	20	7.3	51[1]/5	0.386	100	268.2	LOS F	1.5	11.5	Full	152	0.0	49.9[8]
Lane 4	135	15.6	133	15.7	12	10.962	100	9061.0	LOS F	19.1[N4]	151.9[N4]	Short	60	0.0	NA
Approach	1580	7.9	1550[N]1	8.0		10.962		778.4	NA	19.1	151.9				
Intersection	4044	6.7	4014[N]1	6.8		10.962		442.4	NA	32.6	243.9				

3.2.2 PM Peak

- Similar to the AM, the Do-Min scenario performance is poor, specifically the shared left and right-turn lane out of William Roberts Road and the Pakuranga Road west right-turn during the PM.
- In practical terms the intersection is already over-saturated in the Do-Min PM peak, and the impact of the detour is considered negligible.
- During the Stage 2 detour the Pakuranga Road west right-turn lane is expected to perform worse than the Do-Min during the PM, with high delay and LOS F.

Table 4: William Roberts Rd / Pakuranga Rd – Do-Min vs Stage 2 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Road															
Lane 1	326	11.7	324	11.7	10	32.923	100	28787.8	LOS F	31.7[N4]	243.9[N4]	Full	244	0.0	49.9
Approach	326	11.7	324[N1]	11.7		32.923		28787.8	LOS F	31.7	243.9				
East: Pakuranga Road (East)															
Lane 1	469	8.0	469	8.0	1787	0.262	100	1.6	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 2	477	6.8	477	6.8	1818	0.262	100	0.0	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 3	482	6.8	482	6.8	1838	0.262	100	0.0	LOS A	0.0	0.0	Full	184	0.0	0.0
Approach	1427	7.2	1427	7.2		0.262		0.5	NA	0.0	0.0				
West: Pakuranga Road (West)															
Lane 1	1177	4.8	1047	4.8	1871	0.559	100	0.1	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 2	1140	4.8	1014	4.8	1812	0.559	100	0.1	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 3	250	4.8	222	4.8	397[1/5]	0.559	100	63.4	LOS F	4.6	33.5	Full	152	0.0	10.8[8]
Lane 4	133	20.3	118	20.4	91	1.298	100	349.8	LOS F	9.0	73.7	Short	60	0.0	NA
Approach	2700	5.5	2401[N1]	5.6		1.298		23.2	NA	9.0	73.7				
Intersection	4453	6.5	4152[N1]	7.0		32.923		2259.1	NA	31.7	243.9				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: William Roberts Road															
Lane 1	235	12.3	234	12.4	12	18.936	100	16209.3	LOS F	31.5[N4]	243.9[N4]	Full	244	0.0	49.9
Approach	235	12.3	234[N1]	12.4		18.936		16209.3	LOS F	31.5	243.9				
East: Pakuranga Road (East)															
Lane 1	496	6.5	496	6.5	1820	0.272	100	0.8	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 2	495	7.0	495	7.0	1816	0.272	100	0.0	LOS A	0.0	0.0	Full	184	0.0	0.0
Lane 3	500	7.0	500	7.0	1836	0.272	100	0.0	LOS A	0.0	0.0	Full	184	0.0	0.0
Approach	1490	6.8	1490	6.8		0.272		0.3	NA	0.0	0.0				
West: Pakuranga Road (West)															
Lane 1	1218	5.4	996	5.4	1864	0.534	100	0.1	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 2	1179	5.4	964	5.4	1805	0.534	100	0.1	LOS A	0.0	0.0	Full	152	0.0	0.0
Lane 3	178	5.4	145	5.4	272[1/8]	0.534	100	47.9	LOS E	2.1	15.4	Full	152	0.0	49.9[8]
Lane 4	273	11.4	223	11.4	93	2.390	100	1289.6	LOS F	19.8[N4]	151.9[N4]	Short	60	0.0	NA
Approach	2848	5.9	2328[N1]	6.0		2.390		126.6	NA	19.8	151.9				
Intersection	4573	6.6	4053[N1]	7.4		18.936		1010.3	NA	31.5	243.9				

3.3 Pakuranga Road / Ti Rakau Drive

3.3.1 AM Peak

- The Stage 2 detour intersection performance is expected to be only slightly improved during the AM peak compared to the Do-Min scenario.
- The Pakuranga Road east left-turn is expected to operate at LOS C.
- Total intersection demand increased by around 300 veh/h, with increases on Ti Rakau Drive south approach and the Pakuranga Road west approach.

Table 5: Pakuranga Rd / Ti Rakau Dr – Do-Min vs Stage 2 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV] %	ARRIVAL FLOWS [Total veh/h]	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Ti Rakau Drive															
Lane 1	583	7.5	509	7.8	759[1]	0.671	100	29.8	LOS C	14.4	107.9	Full	130	0.0	32.6
Lane 2 (B)	14	100.0	14	100.0	326	0.043	100	48.0	LOS D	0.5	6.0	Short	16	0.0	NA
Lane 3	166	4.6	145	4.8	502	0.288	100	50.5	LOS D	5.1	37.4	Full	130	0.0	0.0
Lane 4	166	4.6	145	4.8	502	0.288	100	50.5	LOS D	5.1	37.4	Full	130	0.0	0.0
Lane 5	166	4.6	145	4.8	502	0.288	100	50.5	LOS D	5.1	37.4	Short	40	0.0	NA
Approach	1094	7.4	957[N1]	7.8		0.671		39.5	LOS D	14.4	107.9				
East: Pakuranga Road (East)															
Lane 1	1019	4.2	974	4.3	1113	0.875	100	20.0	LOS B	15.6[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 2	757	5.8	724	6.0	781	0.927	100	62.7	LOS E	15.4[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 3	740	5.8	707	6.0	763[1]	0.927	100	62.6	LOS E	15.4[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 4 (B)	19	100.0	19	100.0	47	0.406	100	85.2	LOS F	0.9	12.2	Short	101	0.0	NA
Approach	2535	5.9	2424[N1]	6.0		0.927		45.7	LOS D	15.6	113.0				
West: Pakuranga Road (West)															
Lane 1 (B)	24	100.0	24	100.0	44	0.541	100	90.8	LOS F	1.2	15.6	Full	388	0.0	0.0
Lane 2	201	7.8	201	7.8	893	0.225	100	24.1	LOS C	5.2	39.0	Short	141	0.0	NA
Lane 3	201	7.8	201	7.8	893	0.225	100	24.1	LOS C	5.2	39.0	Full	388	0.0	0.0
Lane 4	201	7.8	201	7.8	893	0.225	100	24.1	LOS C	5.2	39.0	Full	388	0.0	0.0
Lane 5	177	13.6	177	13.6	226	0.782	100	62.4	LOS E	6.0	47.2	Short	184	0.0	NA
Lane 6	177	13.6	177	13.6	226	0.782	100	62.4	LOS E	6.0	47.2	Short	109	0.0	NA
Approach	981	12.1	981	12.1		0.782		39.5	LOS D	6.0	47.2				
Intersection	4610	7.6	4361[N1]	8.0		0.927		42.9	LOS D	15.6	113.0				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV] %	ARRIVAL FLOWS [Total veh/h]	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Ti Rakau Drive															
Lane 1	701	9.1	635	9.3	841[1]	0.754	100	24.4	LOS C	17.2[N4]	130.0[N4]	Full	130	0.0	50.0
Lane 2 (B)	16	100.0	16	100.0	348	0.046	100	45.7	LOS D	0.5	6.7	Short	16	0.0	NA
Lane 3	225	4.4	203	4.5	538	0.378	100	49.6	LOS D	7.3	52.9	Full	130	0.0	0.0
Lane 4	203	4.4	184	4.5	487[1]	0.378	100	49.0	LOS D	6.5	47.2	Full	130	0.0	0.0
Lane 5	203	4.4	184	4.5	487[1]	0.378	100	49.0	LOS D	6.5	47.2	Short	40	0.0	NA
Approach	1348	8.0	1221[N1]	8.2		0.754		36.3	LOS D	17.2	130.0				
East: Pakuranga Road (East)															
Lane 1	1062	4.8	1004	4.9	1097	0.915	100	29.6	LOS C	15.5[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 2	592	5.3	559	5.4	735	0.761	100	42.8	LOS D	15.4[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 3	574	5.3	543	5.4	713[1]	0.761	100	42.3	LOS D	15.4[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 4 (B)	19	100.0	19	100.0	47	0.406	100	85.2	LOS F	0.9	12.2	Short	101	0.0	NA
Approach	2247	5.9	2125[N1]	6.0		0.915		36.8	LOS D	15.5	113.0				
West: Pakuranga Road (West)															
Lane 1 (B)	24	100.0	24	100.0	35	0.690	100	95.0	LOS F	1.3	16.3	Full	388	-21.6[N7]	0.0
Lane 2	319	9.4	319	9.4	848	0.376	100	28.1	LOS C	9.3	70.2	Short	141	0.0	NA
Lane 3	319	9.4	319	9.4	848	0.376	100	28.1	LOS C	9.3	70.2	Full	388	0.0	0.0
Lane 4	319	9.4	319	9.4	848	0.376	100	28.1	LOS C	9.3	70.2	Full	388	0.0	0.0
Lane 5	187	13.9	187	13.9	236	0.792	100	64.6	LOS E	6.6	51.4	Short	184	0.0	NA
Lane 6	130	13.9	130	13.9	164	0.792	100	67.5	LOS E	4.7	37.0	Short	109	-30.6[N7]	NA
Approach	1297	12.2	1297	12.2		0.792		38.6	LOS D	9.3	70.2				
Intersection	4892	8.1	4643[N1]	8.6		0.915		37.2	LOS D	17.2	130.0				

3.3.2 PM Peak

- During the PM peak the intersection is expected to perform at LOS F during Stage 2, compared to the LOS E of the Do-Min scenario.
- Demand seems to have increased on Pakuranga Road west (and east), however the west approach is already saturated, causing delays to increase further.
- NOTE: The Ti Rakau Drive / SEART intersection (**Section 3.4** below) is also expected to experience poor LOS. It is expected that the mitigation measures discussed in **Section 3.4.3** would remedy that intersection as well as this intersection by drawing demand away from Pakuranga Road eastbound to SEART, then turning right into Ti Rakau Drive. Therefore, mitigation measures are not recommended for the Pakuranga Road / Ti Rakau Drive intersection.

Table 6: Pakuranga Rd / Ti Rakau Dr – Do-Min vs Stage 2 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Ti Rakau Drive															
Lane 1	680	6.6	655	6.6	1109[1]	0.591	100	13.5	LOS B	12.3	90.6	Full	130	0.0	16.7
Lane 2 (B)	12	100.0	12	100.0	528	0.023	100	28.6	LOS C	0.3	3.8	Short	16	0.0	NA
Lane 3	654	3.1	630	3.1	657	0.960	100	83.7	LOS F	18.1[N4]	130.0[N4]	Full	130	-21.7[N3]	50.0
Lane 4	393	3.1	379	3.1	394[1]	0.960	100	86.6	LOS F	18.1[N4]	130.0[N4]	Full	130	-22.5[N3]	50.0[8]
Lane 5	389	3.1	375	3.1	390[1]	0.960	100	87.0	LOS F	18.1[N4]	130.0[N4]	Short	40	-24.0[N3]	NA
Approach	2128	4.8	2051[N 1]	4.8		0.960		62.1	LOS E	18.1	130.0				
East: Pakuranga Road (East)															
Lane 1	575	2.3	514	2.4	1116	0.461	100	14.2	LOS B	6.6	47.1	Full	113	0.0	0.0
Lane 2	426	8.0	382	8.5	420	0.909	100	77.6	LOS E	15.0[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 3	421	8.0	378	8.5	416[1]	0.909	100	77.6	LOS E	15.0[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 4 (B)	11	100.0	11	100.0	47	0.235	100	83.9	LOS F	0.5	6.9	Short	101	0.0	NA
Approach	1433	6.4	1285[N 1]	6.9		0.909		52.3	LOS D	15.0	113.0				
West: Pakuranga Road (West)															
Lane 1 (B)	40	100.0	40	100.0	40	1.008	100	135.2	LOS F	2.6	33.3	Full	388	-11.1[N7]	0.0
Lane 2	426	6.7	426	6.7	437	0.975	100	99.5	LOS F	26.1	192.9	Short	141	-21.7[N3]	NA
Lane 3	422	6.7	422	6.7	433	0.975	100	99.7	LOS F	25.8	191.2	Full	388	-22.5[N3]	0.0
Lane 4	414	6.7	414	6.7	424	0.975	100	100.1	LOS F	25.4	187.9	Full	388	-24.0[N3]	0.0
Lane 5	195	7.7	195	7.7	245	0.796	100	73.6	LOS E	7.0	52.1	Short	184	0.0	NA
Lane 6	195	7.7	195	7.7	245	0.796	100	73.6	LOS E	7.0	52.1	Short	109	0.0	NA
Approach	1692	9.2	1692	9.2		1.008		94.6	LOS F	26.1	192.9				
Intersection	5253	6.6	5028[N 1]	6.9		1.008		70.5	LOS E	26.1	192.9				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Ti Rakau Drive															
Lane 1	725	6.5	696	6.4	1074[1]	0.648	100	14.4	LOS B	14.7	108.8	Full	130	0.0	33.4
Lane 2 (B)	12	100.0	12	100.0	492	0.024	100	31.6	LOS C	0.3	4.0	Short	16	0.0	NA
Lane 3	604	4.2	580	4.1	545	1.064	100	153.3	LOS F	17.9[N4]	130.0[N4]	Full	130	-29.6[N3]	50.0
Lane 4	378	4.2	363	4.1	341[1]	1.064	100	164.3	LOS F	17.9[N4]	130.0[N4]	Full	130	-30.4[N3]	50.0[8]
Lane 5	406	4.2	390	4.1	366[1]	1.064	100	162.4	LOS F	17.9[N4]	130.0[N4]	Short	40	-20.0[N7]	NA
Approach	2125	5.5	2040[N 1]	5.5		1.064		108.9	LOS F	17.9	130.0				
East: Pakuranga Road (East)															
Lane 1	722	4.0	660	4.2	1126	0.587	100	14.7	LOS B	9.5	69.1	Full	113	0.0	4.8
Lane 2	420	8.3	385	8.6	504	0.764	100	55.6	LOS E	15.0[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 3	414	8.3	379	8.6	496[1]	0.764	100	55.4	LOS E	15.0[N4]	113.0[N4]	Full	113	0.0	50.0
Lane 4 (B)	11	100.0	11	100.0	47	0.235	100	83.9	LOS F	0.5	6.9	Short	101	0.0	NA
Approach	1567	7.0	1436[N 1]	7.3		0.764		37.0	LOS D	15.0	113.0				
West: Pakuranga Road (West)															
Lane 1 (B)	40	100.0	40	100.0	38	1.066	100	169.5	LOS F	2.9	38.3	Full	388	-15.9[N7]	0.0
Lane 2	463	6.4	463	6.4	437	1.059	100	149.9	LOS F	35.0	258.6	Short	141	-29.6[N3]	NA
Lane 3	458	6.4	458	6.4	432	1.059	100	150.2	LOS F	34.7	256.0	Full	388	-30.4[N3]	12.6[8]
Lane 4	526	6.4	526	6.4	497	1.059	100	147.0	LOS F	39.3	290.4	Full	388	-20.0[N7]	23.2
Lane 5	180	7.5	180	7.5	222	0.807	100	72.2	LOS E	6.3	46.6	Short	184	0.0	NA
Lane 6	180	7.5	180	7.5	222	0.807	100	72.2	LOS E	6.3	46.6	Short	109	0.0	NA
Approach	1845	8.7	1845	8.7		1.066		134.5	LOS F	39.3	290.4				
Intersection	5537	7.0	5321[N 1]	7.3		1.066		98.4	LOS F	39.3	290.4				

3.4 Ti Rakau Drive / SEART (Pakuranga HWY)

3.4.1 AM Peak

- Do-Min scenario performance is poor, LOS F in the AM peak.
- Stage 2 intersection performance is expected to be improved with lower delay but poorer DOS, LOS is E in the AM peak.
- The Ti Rakau Drive west approach right-turn into SEART is expected to operate at LOS E during the AM.

Table 7: Ti Rakau Dr / SEART – Do-Min vs Stage 2 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	1735	9.7	1499	10.2	1677	0.894	100	464.6	LOS F	0.0	0.0	Full	91	0.0	0.0
Lane 2	238	11.1	206	11.9	273	0.757	100	60.5	LOS E	8.1	62.6	Full	91	0.0	15.5
Lane 3	240	11.1	208	11.9	276	0.757	100	60.4	LOS E	8.2	63.2	Full	91	0.0	16.4
Lane 4	54	5.6	47	5.9	270	0.172	100	56.7	LOS E	1.6	11.7	Full	91	0.0	0.0
Approach	2267	9.9	1961[N 1]	10.5		0.894		369.5	LOS F	8.2	63.2				
NorthEast: Reeves Road															
Lane 1	240	6.8	228	6.5	255[1]	0.894	100	71.8	LOS E	9.7[N4]	72.0[N4]	Short	52	0.0	NA
Lane 2	253	5.8	240	5.5	268[1]	0.894	100	71.0	LOS E	9.8[N4]	72.0[N4]	Full	72	0.0	50.0[6]
Lane 3	26	3.8	25	3.7	83	0.299	100	73.6	LOS E	1.0	7.2	Short	16	0.0	NA
Approach	519	6.2	493[N1]	5.9		0.894		71.5	LOS E	9.8	72.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	251	20.7	235	21.4	605	0.389	45[5]	33.4	LOS C	6.8	56.0	Full	84	0.0	12.5
Lane 2	610	5.0	568	5.1	651	0.872	100	54.9	LOS D	11.5[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	594	5.0	553	5.1	634	0.872	100	55.3	LOS E	11.5[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1455	7.7	1356[N 1]	7.9		0.872		51.3	LOS D	11.5	84.0				
SouthWest: Pakuranga HWY															
Lane 1	268	4.6	268	4.6	1189	0.226	100	16.8	LOS B	4.1	29.5	Short	308	0.0	NA
Lane 2	273	4.6	273	4.6	1208	0.226	100	16.8	LOS B	4.1	29.9	Short	132	0.0	NA
Lane 3	155	11.0	155	11.0	455	0.341	100	46.3	LOS D	4.9	37.7	Full	1650	0.0	0.0
Lane 4	217	7.3	217	7.3	257	0.847	100	74.3	LOS E	9.2	68.1	Full	1650	0.0	0.0
Lane 5	220	7.3	220	7.3	259	0.847	100	74.3	LOS E	9.2	68.7	Short	277	0.0	NA
Approach	1133	6.5	1133	6.5		0.847		43.0	LOS D	9.2	68.7				
Intersection	5374	8.2	4943[N 1]	9.0		0.894		177.6	LOS F	11.5	84.0				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	1662	9.2	1235	9.3	1688	0.732	100	53.1	LOS D	0.0	0.0	Full	91	0.0	0.0
Lane 2	308	11.3	229	11.6	260	0.882	100	86.0	LOS F	11.8[N4]	91.0[N4]	Full	91	0.0	50.0
Lane 3	311	11.3	232	11.6	263	0.882	100	85.9	LOS F	11.8[N4]	91.0[N4]	Full	91	0.0	50.0
Approach	2281	9.8	1696[N 1]	9.9		0.882		62.0	LOS E	11.8	91.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	198	24.2	186	24.8	588	0.316	35[5]	41.0	LOS D	6.5	55.5	Full	84	0.0	11.8
Lane 2	620	5.0	577	5.1	637	0.905	100	71.9	LOS E	11.5[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	604	5.0	562	5.1	621	0.905	100	72.5	LOS E	11.5[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1422	7.7	1324[N 1]	7.8		0.905		67.8	LOS E	11.5	84.0				
SouthWest: Pakuranga HWY															
Lane 1	354	5.2	354	5.2	1398	0.253	100	12.8	LOS B	4.6	33.6	Short	308	0.0	NA
Lane 2	359	5.2	359	5.2	1420	0.253	100	12.8	LOS B	4.7	34.1	Short	132	0.0	NA
Lane 3	385	8.4	385	8.4	431	0.893	100	84.5	LOS F	20.6	154.4	Full	1650	0.0	0.0
Lane 4	389	8.4	389	8.4	436	0.893	100	84.3	LOS F	20.8	155.8	Full	1650	0.0	0.0
Approach	1487	6.9	1487	6.9		0.893		50.1	LOS D	20.8	155.8				
Intersection	5190	8.4	4507[N 1]	9.6		0.905		59.8	LOS E	20.8	155.8				

3.4.2 PM Peak

- Similar to the AM, the Do-Min intersection performance is poor (LOS F). The intersection performance is also expected to be poor during the Stage 2 detour.
- The SEART right-turn lanes into Ti Rakau Drive are expected to operate at LOS F during the PM. The increase in demand (due to Reeves Road closure) results in delay increasing from around 50 sec to 215 sec (3.6 min), which would require mitigation.

Table 8: Ti Rakau Dr / SEART – Do-Min vs Stage 2 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV] %	ARRIVAL FLOWS [Total veh/h]	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	862	8.9	821	8.6	1695	0.484	100	6.0	LOS A	0.0	0.0	Full	91	0.0	0.0
Lane 2	173	6.9	166	6.8	165	1.003	100	137.4	LOS F	11.8	87.7	Full	91	-50.0[N7]	46.5
Lane 3	351	6.9	335	6.8	334	1.003	100	123.3	LOS F	12.3[N4]	91.0[N4]	Full	91	0.0	50.0
Lane 4	192	3.1	183	3.0	162	1.132	100	226.2	LOS F	12.7[N4]	91.0[N4]	Full	91	-49.9[N7]	50.0
Approach	1578	7.5	1505[N1]	7.3		1.132		73.4	LOS E	12.7	91.0				
NorthEast: Reeves Road															
Lane 1	187	8.3	178	7.9	249[1]	0.718	100	75.4	LOS E	8.5	63.9	Short	52	0.0	NA
Lane 2	175	11.1	167	10.5	233[1]	0.718	100	75.3	LOS E	8.1	61.8	Full	72	0.0	38.8[8]
Lane 3	34	14.7	32	14.0	60	0.535	100	96.0	LOS F	1.7	13.4	Short	16	0.0	NA
Approach	396	10.1	378[N1]	9.6		0.718		77.1	LOS E	8.5	63.9				
NorthWest: Ti Rakau Drive (West)															
Lane 1	332	10.3	305	10.5	267	1.145	100	222.0	LOS F	11.0[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 2	341	5.0	313	5.3	273	1.145	100	225.0	LOS F	11.5[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	331	4.4	304	4.6	265	1.145	100	226.2	LOS F	11.5[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1004	6.6	922[N1]	6.8		1.145		224.4	LOS F	11.5	84.0				
SouthWest: Pakuranga HWY															
Lane 1	1029	4.0	1029	4.0	1218	0.844	100	29.1	LOS C	37.7	272.7	Short	308	0.0	NA
Lane 2	522	4.0	522	4.0	619	0.844	100	38.0	LOS D	21.8	158.1	Short	132	-50.0[N7]	NA
Lane 3	547	9.7	547	9.7	475[1]	1.152	100	227.4	LOS F	54.0	409.1	Full	1650	-33.3[N7]	0.0
Lane 4	476	6.9	476	6.9	679	0.700	100	53.1	LOS D	19.6	145.4	Full	1650	0.0	0.0
Lane 5	480	6.9	480	6.9	686	0.700	100	53.1	LOS D	19.8	146.9	Short	277	0.0	NA
Approach	3054	5.9	3054	5.9		1.152		73.6	LOS E	54.0	409.1				
Intersection	6032	6.7	5859[N1]	6.9		1.152		97.5	LOS F	54.0	409.1				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV] %	ARRIVAL FLOWS [Total veh/h]	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	961	8.3	885	8.1	1702	0.520	100	6.3	LOS A	0.0	0.0	Full	91	0.0	0.0
Lane 2	288	7.9	266	7.9	241	1.105	100	199.1	LOS F	12.2[N4]	91.0[N4]	Full	91	-50.0[N7]	50.0
Lane 3	319	7.9	294	7.9	266	1.105	100	197.0	LOS F	12.2[N4]	91.0[N4]	Full	91	-45.3[N7]	50.0
Approach	1568	8.2	1445[N1]	8.0		1.105		80.6	LOS F	12.2	91.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	406	8.7	378	8.5	341	1.106	100	190.1	LOS F	11.2[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 2	396	6.5	369	6.7	333	1.106	100	194.8	LOS F	11.3[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	385	6.4	359	6.7	324	1.106	100	195.4	LOS F	11.4[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1188	7.2	1105[N1]	7.3		1.106		193.4	LOS F	11.4	84.0				
SouthWest: Pakuranga HWY															
Lane 1	1031	4.7	1031	4.7	1191	0.866	100	30.9	LOS C	39.5	287.7	Short	308	0.0	NA
Lane 2	508	4.7	508	4.7	587	0.866	100	44.5	LOS D	22.7	165.1	Short	132	-50.0[N7]	NA
Lane 3	488	7.6	488	7.6	431[1]	1.132	100	216.1	LOS F	44.3	330.3	Full	1650	0.0	0.0
Lane 4	598	7.6	598	7.6	528	1.132	100	212.7	LOS F	53.8	400.7	Full	1650	0.0	0.0
Approach	2625	5.9	2625	5.9		1.132		109.4	LOS F	53.8	400.7				
Intersection	5381	6.8	5175[N1]	7.1		1.132		119.3	LOS F	53.8	400.7				

3.4.3 Mitigation 1

- Mitigation 1, to remedy the Ti Rakau Drive / SEART intersection during the PM peak, includes converting the through lane from SEART to Reeves Road to a right-turn lane (note Reeves Road is closed during Stage 2), thus providing a 3rd lane for this turning movement onto Ti Rakau Drive eastbound.
- In addition, a 3rd exit lane is proposed on Ti Rakau Drive eastbound between the SEART intersection and the newly completed William Roberts Road intersection. The proposed layout is shown below.
- As stated in **Section 3.3** above, it is expected that the Pakuranga Road / Ti Rakau Drive intersection performance during the PM peak would also be improved as demand would be drawn away from that intersection to the Ti Rakau Drive / SEART intersection, which could have more spare capacity.

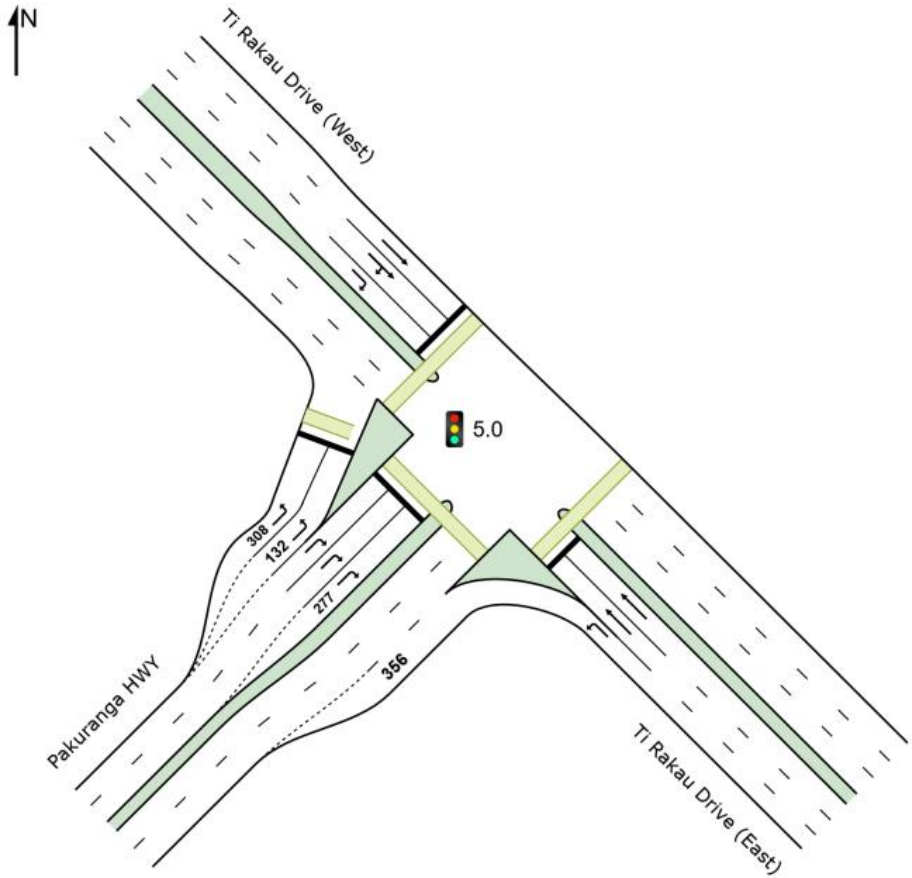

Figure 3: Ti Rakau Dr / SEART - Mitigation 1 proposed layout

- The Stage 2 intersection performance (without mitigation) is expected to be poor (LOS F), especially in the SEART right-turn lanes into Ti Rakau Drive where delay increases from around 50 sec in the Do-Min scenario, to 215 sec (3.6 min).
- With the measures in place proposed under Mitigation 1, intersection performance during the detour is expected to improve to LOS E, with an average delay of 70 sec. This is also an improvement compared to the Do-Min scenario (LOS F and delay of 98 sec)
- Delay and queue lengths in the SEART right-turn lanes are improved under Mitigation 1 (delay of 85 sec and average queue length of 145 m), compared to the Stage 2 detour.

Table 9: Ti Rakau Dr / SEART – Stage 2 vs Mitigation 1 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	961	8.3	885	8.1	1702	0.520	100	6.3	LOS A	0.0	0.0	Full	91	0.0	0.0
Lane 2	288	7.9	266	7.9	241	1.105	100	199.1	LOS F	12.2[N4]	91.0[N4]	Full	91	-50.0[N7]	50.0
Lane 3	319	7.9	294	7.9	266	1.105	100	197.0	LOS F	12.2[N4]	91.0[N4]	Full	91	-45.3[N7]	50.0
Approach	1568	8.2	1445[N 1]	8.0		1.105		80.6	LOS F	12.2	91.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	406	8.7	378	8.5	341	1.106	100	190.1	LOS F	11.2[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 2	396	6.5	369	6.7	333	1.106	100	194.8	LOS F	11.3[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	385	6.4	359	6.7	324	1.106	100	195.4	LOS F	11.4[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1188	7.2	1105[N 1]	7.3		1.106		193.4	LOS F	11.4	84.0				
SouthWest: Pakuranga HWY															
Lane 1	1031	4.7	1031	4.7	1191	0.866	100	30.9	LOS C	39.5	287.7	Short	308	0.0	NA
Lane 2	508	4.7	508	4.7	587	0.866	100	44.5	LOS D	22.7	165.1	Short	132	-50.0[N7]	NA
Lane 3	488	7.6	488	7.6	431	1.132	100	216.1	LOS F	44.3	330.3	Full	1650	0.0	0.0
Lane 4	598	7.6	598	7.6	528	1.132	100	212.7	LOS F	53.8	400.7	Full	1650	0.0	0.0
Approach	2625	5.9	2625	5.9		1.132		109.4	LOS F	53.8	400.7				
Intersection	5381	6.8	5175[N 1]	7.1		1.132		119.3	LOS F	53.8	400.7				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	961	8.3	885	8.1	1702	0.520	100	6.6	LOS A	0.0	0.0	Full	91	0.0	0.0
Lane 2	288	7.9	266	7.9	252	1.057	100	165.1	LOS F	12.2[N4]	91.0[N4]	Full	91	-50.0[N7]	50.0
Lane 3	319	7.9	294	7.9	278	1.057	100	162.8	LOS F	12.2[N4]	91.0[N4]	Full	91	-45.3[N7]	50.0
Approach	1568	8.2	1445[N 1]	8.0		1.057		67.6	LOS E	12.2	91.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	406	8.7	378	8.5	397	0.952	100	96.9	LOS F	11.2[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 2	396	6.5	369	6.7	387	0.952	100	101.6	LOS F	11.3[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	385	6.4	359	6.7	376	0.952	100	102.4	LOS F	11.4[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1188	7.2	1105[N 1]	7.3		0.952		100.2	LOS F	11.4	84.0				
SouthWest: Pakuranga HWY															
Lane 1	1029	4.7	1029	4.7	1169	0.880	100	32.5	LOS C	40.7	296.6	Short	308	0.0	NA
Lane 2	510	4.7	510	4.7	580	0.880	100	50.0	LOS D	24.4	177.3	Short	132	-50.0[N7]	NA
Lane 3	359	7.6	359	7.6	408	0.882	100	84.8	LOS F	19.2	142.8	Full	1650	0.0	0.0
Lane 4	363	7.6	363	7.6	412	0.882	100	84.7	LOS F	19.3	144.1	Full	1650	0.0	0.0
Lane 5	363	7.6	363	7.6	412	0.882	100	84.7	LOS F	19.3	144.1	Short	277	0.0	NA
Approach	2625	5.9	2625	5.9		0.882		57.5	LOS E	40.7	296.6				
Intersection	5381	6.8	5175[N 1]	7.1		1.057		69.4	LOS E	40.7	296.6				

- A further refinement of Mitigation 1 was also tested. It consisted of a 105 m short exit lane (AGRD04A (Austroads) – Table 5.5) on Ti Rakau Drive eastbound. Although intersection performance is expected to be similar to Mitigation 1 above, this geometric change would provide insufficient weave distance up to William Roberts Road and is not recommended.
- The construction costs of and effort to implement the measures proposed under Mitigation 1 are potentially considerable. Mitigation 1 could require the buildout of the southern side of Ti Rakau Drive and the relocation of the centreline in order to provide the additional exit lane along Ti Rakau Drive eastbound.
- Therefore, alternative measures are proposed under Mitigation 2.

3.4.4 Mitigation 2

- Mitigation 2 includes the temporary removal of the pedestrian crossing on the eastern arm of the Ti Rakau Drive / SEART intersection, thus reducing signal phasing down to 3 phases and allowing for more greentime to be allocated to the SEART right-turn movements into Ti Rakau Drive eastbound during the PM peak.
- It is noted that pedestrian amenity at this intersection would be temporarily reduced, however the intersection would still provide the ability to cross Ti Rakau Drive from all directions, albeit with some increase in travel time and distance. The pedestrian crossing would be reinstated in the final build-out of the intersection.
- The proposed layout is shown below.

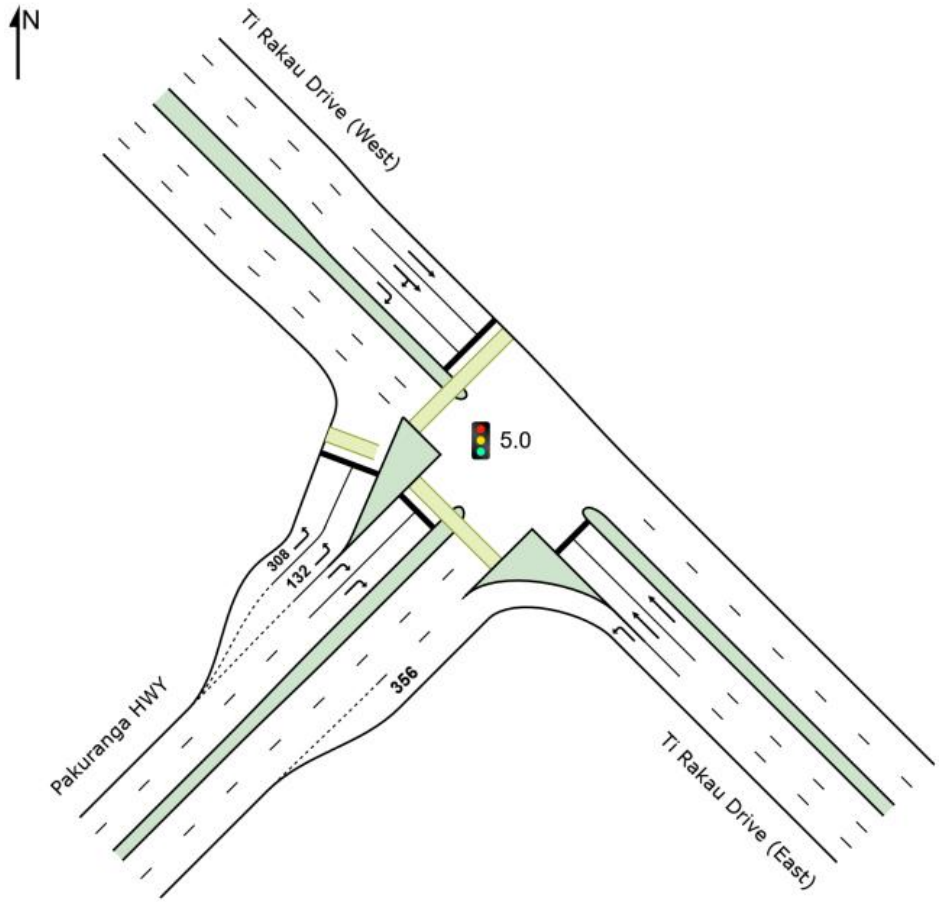

Figure 4: Ti Rakau Dr / SEART - Mitigation 2 proposed layout

- Again, the Stage 2 intersection performance (without mitigation) is expected to be poor (LOS F), especially in the SEART right-turn lanes into Ti Rakau Drive where delay increases from around 50 sec in the Do-Min scenario, to 215 sec (3.6 min).
- With the measures in place proposed under Mitigation 2, intersection performance during the detour is expected to improve to LOS E, with an average delay of 78 sec. This is also an improvement compared to the Do-Min scenario (LOS F and delay of 98 sec).
- Delay and queue lengths in the SEART right-turn lanes are improved under Mitigation 2 (delay of 92 sec and average queue length of 280 m), compared to the Stage 2 detour. However, these are still larger than the Do-Min scenario.

Table 10: Ti Rakau Dr / SEART – Stage 2 vs Mitigation 2 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	961	8.3	885	8.1	1702	0.520	100	6.3	LOS A	0.0	0.0	Full	91	0.0	0.0
Lane 2	288	7.9	266	7.9	241	1.105	100	199.1	LOS F	12.2[N4]	91.0[N4]	Full	91	-50.0[N7]	50.0
Lane 3	319	7.9	294	7.9	266	1.105	100	197.0	LOS F	12.2[N4]	91.0[N4]	Full	91	-45.3[N7]	50.0
Approach	1568	8.2	1445[N] [1]	8.0		1.105		80.6	LOS F	12.2	91.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	406	8.7	378	8.5	341	1.106	100	190.1	LOS F	11.2[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 2	396	6.5	369	6.7	333	1.106	100	194.8	LOS F	11.3[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	385	6.4	359	6.7	324	1.106	100	195.4	LOS F	11.4[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1188	7.2	1105[N] [1]	7.3		1.106		193.4	LOS F	11.4	84.0				
SouthWest: Pakuranga HWY															
Lane 1	1031	4.7	1031	4.7	1191	0.866	100	30.9	LOS C	39.5	287.7	Short	308	0.0	NA
Lane 2	508	4.7	508	4.7	587	0.866	100	44.5	LOS D	22.7	165.1	Short	132	-50.0[N7]	NA
Lane 3	488	7.6	488	7.6	431[1]	1.132	100	216.1	LOS F	44.3	330.3	Full	1650	0.0	0.0
Lane 4	598	7.6	598	7.6	528	1.132	100	212.7	LOS F	53.8	400.7	Full	1650	0.0	0.0
Approach	2625	5.9	2625	5.9		1.132		109.4	LOS F	53.8	400.7				
Intersection	5381	6.8	5175[N] [1]	7.1		1.132		119.3	LOS F	53.8	400.7				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: Ti Rakau Drive (East)															
Lane 1	961	8.3	885	8.1	1702	0.520	100	6.6	LOS A	0.0	0.0	Full	91	0.0	0.0
Lane 2	289	7.9	266	7.9	274	0.973	100	115.0	LOS F	12.2[N4]	91.0[N4]	Full	91	-50.0[N7]	50.0
Lane 3	318	7.9	294	7.9	302	0.973	100	112.7	LOS F	12.2[N4]	91.0[N4]	Full	91	-45.4[N7]	50.0
Approach	1568	8.2	1445[N] [1]	8.0		0.973		48.1	LOS D	12.2	91.0				
NorthWest: Ti Rakau Drive (West)															
Lane 1	406	8.7	378	8.5	397	0.954	100	97.4	LOS F	11.2[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 2	396	6.5	369	6.7	387	0.954	100	102.2	LOS F	11.3[N4]	84.0[N4]	Full	84	0.0	50.0
Lane 3	385	6.4	359	6.7	376	0.954	100	102.9	LOS F	11.4[N4]	84.0[N4]	Full	84	0.0	50.0
Approach	1188	7.2	1106[N] [1]	7.3		0.954		100.8	LOS F	11.4	84.0				
SouthWest: Pakuranga HWY															
Lane 1	1040	4.7	1040	4.7	1067[1]	0.974	100	70.3	LOS E	59.0	429.6	Short	308	0.0	NA
Lane 2	499	4.7	499	4.7	513[1]	0.974	100	95.2	LOS F	31.6	230.2	Short	132	-50.0[N7]	NA
Lane 3	460	7.6	460	7.6	481[1]	0.956	100	91.8	LOS F	26.0	193.9	Full	1650	0.0	0.0
Lane 4	626	7.6	626	7.6	655	0.956	100	91.1	LOS F	37.6	280.4	Full	1650	0.0	0.0
Approach	2625	5.9	2625	5.9		0.974		83.7	LOS F	59.0	429.6				
Intersection	5381	6.8	5176[N] [1]	7.1		0.974		77.4	LOS E	59.0	429.6				

- The construction costs of and effort to implement the measures proposed under Mitigation 2 are considered more economically viable, compared to Mitigation 1. The measure would include minor road marking removal, signal head amendments and signal phasing adjustments. However, large queues are still expected in the SEART right-turn lanes. Therefore, it is recommended that Mitigation 1 be discussed with key stakeholders.

3.5 Ti Rakau Drive / Gossamer Drive

3.5.1 AM Peak

- The relatively low increase in traffic demand on the right-turn from Reeves Road to William Roberts (**Section 3.1**) indicated that traffic would be diverting to other links in the network. **Section 4.0** below provides further detail to this, but in summary, traffic demand is expected to detour from Gossamer Drive, north to Pakuranga Road and south Ti Rakau Drive.
- As a result, more demand would be experienced on the turning movements into Pakuranga Road and Ti Rakau Drive at these intersections. The Gossamer Drive left-turn into Pakuranga Road is expected to experience an increase of around 40 veh/h only, and was therefore not analysed.
- However, the right-turn from Gossamer Drive into Ti Rakau Drive is expected to increase by around 160 veh/h. The resultant intersection performance is poor (LOS F) for the Stage 2 AM peak, compared to the LOS E of the Do-Min scenario. This may require mitigation.

Table 11: Ti Rakau Dr / Gossamer Dr – Do-Min vs Stage 2 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	25	4.0	25	4.0	82	0.305	100	73.7	LOS E	1.0	7.3	Short	26	0.0	NA
Lane 2	31	3.2	31	3.2	85	0.363	100	71.9	LOS E	1.3	9.0	Full	285	0.0	0.0
Approach	56	3.6	56	3.6		0.363		72.7	LOS E	1.3	9.0				
East: Ti Rakau Drive (East)															
Lane 1	866	11.2	866	11.2	1010	0.857	100	29.3	LOS C	29.7	227.8	Full	636	0.0	0.0
Lane 2	827	11.3	827	11.3	964[1]	0.857	100	29.2	LOS C	28.1	215.6	Full	636	0.0	0.0
Lane 3	47	8.4	47	8.4	318	0.147	23[6]	30.2	LOS C	0.9	6.8	Short	150	0.0	NA
Lane 4	203	8.4	203	8.4	318	0.639	100	33.2	LOS C	4.4	33.2	Short	103	0.0	NA
Approach	1943	10.9	1943	10.9		0.857		29.7	LOS C	29.7	227.8				
North: Gossamer Drive															
Lane 1	1053	7.5	1053	7.5	1033[1]	1.020	100	87.5	LOS F	58.7	437.3	Short	30	0.0	NA
Lane 2	100	8.0	100	8.0	268	0.374	100	58.3	LOS E	3.6	26.6	Full	1010	0.0	0.0
Approach	1153	7.5	1153	7.5		1.020		85.0	LOS F	58.7	437.3				
West: Ti Rakau Drive (West)															
Lane 1	428	10.2	360	10.4	701	0.514	100	33.7	LOS C	10.5	80.0	Full	479	0.0	0.0
Lane 2	409	10.4	343	10.6	669[1]	0.514	100	32.6	LOS C	10.1	77.2	Full	479	0.0	0.0
Lane 3	10	10.0	8	9.9	90	0.093	100	70.7	LOS E	0.3	2.5	Short	27	0.0	NA
Approach	847	10.3	712[N1]	10.5		0.514		33.6	LOS C	10.5	80.0				
Intersection	3999	9.7	3864[N 1]	10.0		1.020		47.5	LOS D	58.7	437.3				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV %	ARRIVAL FLOWS [Total veh/h]	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	23	8.7	23	8.7	63	0.367	100	94.2	LOS F	1.2	8.9	Short	26	0.0	NA
Lane 2	28	7.1	28	7.1	65	0.429	100	92.7	LOS F	1.4	10.8	Full	285	0.0	0.0
Approach	51	7.8	51	7.8		0.429		93.4	LOS F	1.4	10.8				
East: Ti Rakau Drive (East)															
Lane 1	832	10.3	832	10.3	680	1.224	100	272.4	LOS F	85.1	648.8	Full	636	0.0	51.9
Lane 2	792	10.5	792	10.5	646[1]	1.224	100	277.1	LOS F	83.4	635.9	Full	636	0.0	50.0
Lane 3	65	7.8	65	7.8	262	0.247	23[6]	41.4	LOS D	1.8	13.7	Short	150	0.0	NA
Lane 4	282	7.8	282	7.8	262	1.075	100	137.8	LOS F	16.5	123.4	Short	103	0.0	NA
Approach	1971	9.9	1971	9.9		1.224		247.4	LOS F	85.1	648.8				
North: Gossamer Drive															
Lane 1	960	9.0	960	9.0	1066[1]	0.901	100	28.7	LOS C	30.7	231.8	Short	30	0.0	NA
Lane 2	264	6.4	264	6.4	212[1]	1.246	100	319.1	LOS F	29.7	219.6	Full	1010	0.0	0.0
Approach	1224	8.4	1224	8.4		1.246		91.3	LOS F	30.7	231.8				
West: Ti Rakau Drive (West)															
Lane 1	523	11.8	432	11.6	451	0.958	100	98.1	LOS F	26.1	200.6	Full	479	0.0	0.0
Lane 2	500	11.9	413	11.7	431[1]	0.958	100	96.7	LOS F	25.1	193.1	Full	479	0.0	0.0
Lane 3	10	10.0	8	9.6	102	0.081	100	85.7	LOS F	0.4	3.0	Short	27	0.0	NA
Approach	1033	11.8	854[N1]	11.7		0.958		97.3	LOS F	26.1	200.6				
Intersection	4279	9.9	4100[N 1]	10.4		1.246		167.6	LOS F	85.1	648.8				

3.5.2 PM Peak

- The intersection is expected to experience little change during the Stage 2 PM peak and will remain at LOS D.
- It is noted that an equivalent in traffic demand returning to this intersection, compared to AM peak, does not occur as expected in the Ti Rakau Drive west left-turn. This could be due to the completion of the William Roberts Road link to Ti Rakau Drive.

Table 12: Ti Rakau Dr / Gossamer Dr – Do-Min vs Stage 2 (PM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	12	0.0	12	0.0	64	0.187	100	95.8	LOS F	0.6	4.4	Short	26	0.0	NA
Lane 2	27	3.7	27	3.7	65	0.418	100	95.8	LOS F	1.4	10.4	Full	285	0.0	0.0
Approach	39	2.6	39	2.6		0.418		95.8	LOS F	1.4	10.4				
East: Ti Rakau Drive (East)															
Lane 1	863	6.9	863	6.9	1037	0.832	100	32.6	LOS C	35.4	262.7	Full	636	0.0	0.0
Lane 2	779	7.0	779	7.0	936[1]	0.832	100	30.4	LOS C	30.0	223.0	Full	636	0.0	0.0
Lane 3	113	8.9	113	8.9	553	0.205	23[6]	28.4	LOS C	2.5	18.9	Short	150	0.0	NA
Lane 4	494	8.9	494	8.9	553	0.893	100	48.2	LOS D	17.4	130.7	Short	103	0.0	NA
Approach	2249	7.5	2249	7.5		0.893		35.1	LOS D	35.4	262.7				
North: Gossamer Drive															
Lane 1	475	17.3	475	17.3	911[1]	0.522	100	18.4	LOS B	11.3	91.1	Short	30	0.0	NA
Lane 2	41	4.9	41	4.9	241	0.170	100	74.3	LOS E	1.9	13.6	Full	1010	0.0	0.0
Approach	516	16.3	516	16.3		0.522		22.8	LOS C	11.3	91.1				
West: Ti Rakau Drive (West)															
Lane 1	587	5.2	563	5.2	629	0.895	100	73.2	LOS E	29.7	217.3	Full	479	0.0	0.0
Lane 2	554	5.5	532	5.5	594[1]	0.895	100	68.8	LOS E	28.3	207.4	Full	479	0.0	0.0
Lane 3	18	0.0	17	0.0	231	0.075	100	75.1	LOS E	0.8	5.4	Short	27	0.0	NA
Approach	1159	5.3	1112[N] 1	5.3		0.895		71.2	LOS E	29.7	217.3				
Intersection	3963	7.9	3916[N] 1	8.0		0.895		44.3	LOS D	35.4	262.7				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	ARRIVAL FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	10	0.0	10	0.0	65	0.155	100	94.9	LOS F	0.5	3.6	Short	26	0.0	NA
Lane 2	27	3.7	27	3.7	65	0.416	100	95.2	LOS F	1.4	10.4	Full	285	0.0	0.0
Approach	37	2.7	37	2.7		0.416		95.1	LOS F	1.4	10.4				
East: Ti Rakau Drive (East)															
Lane 1	888	6.9	888	6.9	1032	0.860	100	33.7	LOS C	37.5	277.7	Full	636	0.0	0.0
Lane 2	806	7.0	806	7.0	937[1]	0.860	100	32.3	LOS C	32.3	239.9	Full	636	0.0	0.0
Lane 3	110	8.5	110	8.5	548	0.201	23[6]	28.5	LOS C	2.4	18.2	Short	150	0.0	NA
Lane 4	480	8.5	480	8.5	548	0.876	100	45.3	LOS D	16.1	121.1	Short	103	0.0	NA
Approach	2284	7.4	2284	7.4		0.876		35.4	LOS D	37.5	277.7				
North: Gossamer Drive															
Lane 1	455	16.0	455	16.0	909[1]	0.501	100	17.2	LOS B	10.3	81.8	Short	30	0.0	NA
Lane 2	51	5.9	51	5.9	240	0.212	100	74.6	LOS E	2.3	17.1	Full	1010	0.0	0.0
Approach	506	15.0	506	15.0		0.501		23.0	LOS C	10.3	81.8				
West: Ti Rakau Drive (West)															
Lane 1	603	4.9	560	4.8	639	0.876	100	66.0	LOS E	28.0	203.8	Full	479	0.0	0.0
Lane 2	564	5.8	523	5.7	597[1]	0.876	100	64.7	LOS E	26.8	196.6	Full	479	0.0	0.0
Lane 3	18	0.0	17	0.0	233	0.072	100	74.5	LOS E	0.7	5.2	Short	27	0.0	NA
Approach	1185	5.2	1100[N] 1	5.2		0.876		65.5	LOS E	28.0	203.8				
Intersection	4012	7.7	3927[N] 1	7.8		0.876		42.8	LOS D	37.5	277.7				

3.5.3 Mitigation 1

- Mitigation 1, to remedy the Ti Rakau Drive / Gossamer Drive intersection during the AM peak, includes the following on the northern Gossamer Drive approach (see figure below):
    - Adding an additional short right-turn lane (100 m).
    - Converting the short left-turn slip lane to pass through the intersection and providing 150 m stacking space.
    - The kerbside short exit lane length is increased from 24 m to 100 m.

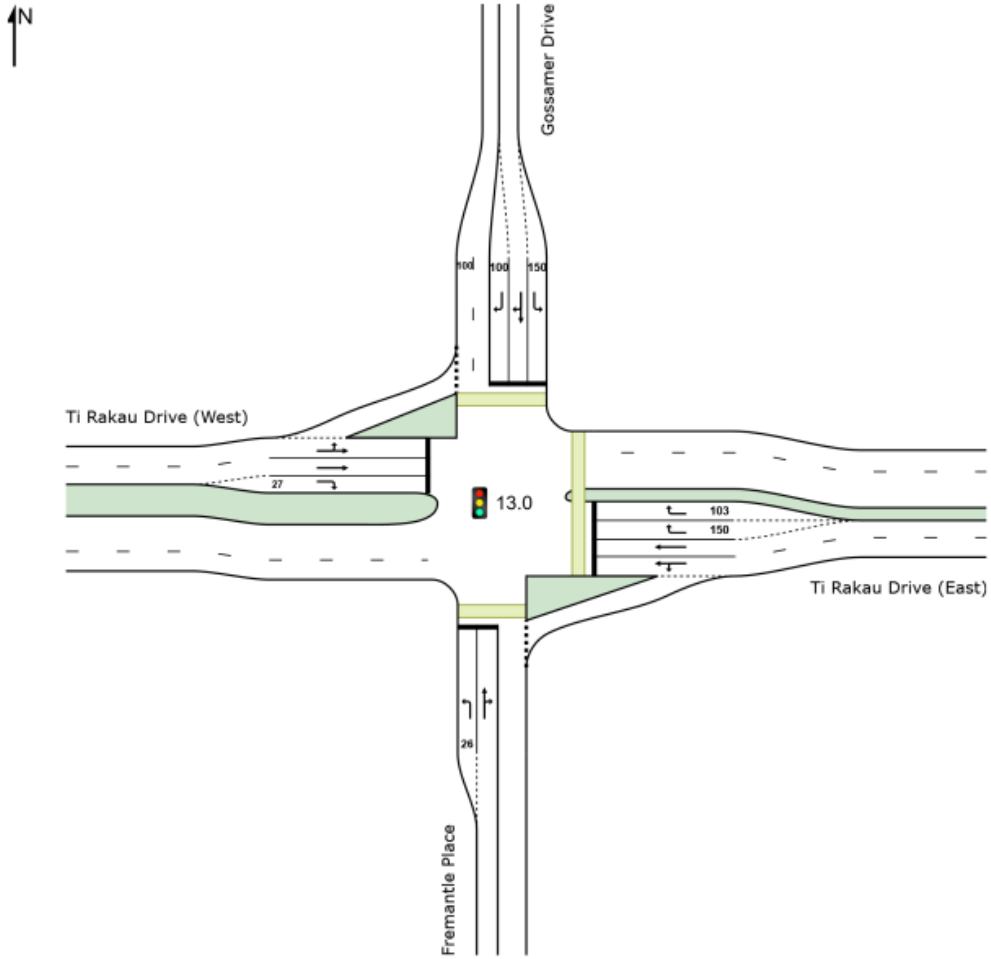

Figure 5: Ti Rakau Drive / Gossamer Drive – Mitigation 1 proposed layout

- The Stage 2 intersection performance (without mitigation) is expected to be poor (LOS F), especially in the Gossamer Drive right-turn lane into Ti Rakau Drive where delay increases from around 59 sec in the Do-Min scenario, to 320 sec (5.3 min).
- With the measures in place proposed under Mitigation 1, intersection performance during the detour is expected to be slightly improved, however still LOS F, with an average delay of 117 sec.
- Delay and queue lengths in the Gossamer Drive right-turn lanes are improved under Mitigation 1 (delay of 78 sec and average queue length of 46 m), compared to the Stage 2 detour.
- However, the additional control delay now imposed on the Gossamer Drive left-turn (previously a left-turn slip under the Do-Min and Stage 2 scenarios) has resulted in large delays (141 sec) and queues (478 m) in that lane. Traffic demand in this lane is around 960 veh/h.

Table 13: Ti Rakau Dr / Gossamer Dr – Stage 2 vs Mitigation 1 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV [ ] %	ARRIVAL FLOWS [Total veh/h]	HV [ ] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	AVERAGE BACK OF QUEUE Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	23	8.7	23	8.7	63	0.367	100	94.2	LOS F	1.2	8.9	Short	26	0.0	NA
Lane 2	28	7.1	28	7.1	65	0.429	100	92.7	LOS F	1.4	10.8	Full	285	0.0	0.0
Approach	51	7.8	51	7.8		0.429		93.4	LOS F	1.4	10.8				
East: Ti Rakau Drive (East)															
Lane 1	832	10.3	832	10.3	680	1.224	100	272.4	LOS F	85.1	648.8	Full	636	0.0	51.9
Lane 2	792	10.5	792	10.5	646[1]	1.224	100	277.1	LOS F	83.4	635.9	Full	636	0.0	50.0
Lane 3	65	7.8	65	7.8	262	0.247	23[6]	41.4	LOS D	1.8	13.7	Short	150	0.0	NA
Lane 4	282	7.8	282	7.8	262	1.075	100	137.8	LOS F	16.5	123.4	Short	103	0.0	NA
Approach	1971	9.9	1971	9.9		1.224		247.4	LOS F	85.1	648.8				
North: Gossamer Drive															
Lane 1	960	9.0	960	9.0	1066[1]	0.901	100	28.7	LOS C	30.7	231.8	Short	30	0.0	NA
Lane 2	264	6.4	264	6.4	212[1]	1.246	100	319.1	LOS F	29.7	219.6	Full	1010	0.0	0.0
Approach	1224	8.4	1224	8.4		1.246		91.3	LOS F	30.7	231.8				
West: Ti Rakau Drive (West)															
Lane 1	523	11.8	432	11.6	451	0.958	100	98.1	LOS F	26.1	200.6	Full	479	0.0	0.0
Lane 2	500	11.9	413	11.7	431[1]	0.958	100	96.7	LOS F	25.1	193.1	Full	479	0.0	0.0
Lane 3	10	10.0	8	9.6	102	0.081	100	85.7	LOS F	0.4	3.0	Short	27	0.0	NA
Approach	1033	11.8	854[N1]	11.7		0.958		97.3	LOS F	26.1	200.6				
Intersection	4279	9.9	4100[N 1]	10.4		1.246		167.6	LOS F	85.1	648.8				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	HV [ ] %	ARRIVAL FLOWS [Total veh/h]	HV [ ] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	AVERAGE BACK OF QUEUE Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	23	8.7	23	8.7	63	0.367	100	94.2	LOS F	1.2	8.9	Short	26	0.0	NA
Lane 2	28	7.1	28	7.1	65	0.429	100	92.7	LOS F	1.4	10.8	Full	285	0.0	0.0
Approach	51	7.8	51	7.8		0.429		93.4	LOS F	1.4	10.8				
East: Ti Rakau Drive (East)															
Lane 1	847	10.4	847	10.4	778	1.088	100	158.3	LOS F	68.2	519.8	Full	636	0.0	31.2
Lane 2	777	10.5	777	10.5	714[1]	1.088	100	163.8	LOS F	64.8	494.0	Full	636	0.0	26.6
Lane 3	126	7.8	126	7.8	598	0.210	57[6]	26.0	LOS C	2.6	19.4	Short	150	0.0	NA
Lane 4	221	7.8	221	7.8	598	0.370	100	27.5	LOS C	4.9	36.6	Short	103	0.0	NA
Approach	1971	9.9	1971	9.9		1.088		137.3	LOS F	68.2	519.8				
North: Gossamer Drive															
Lane 1	960	9.0	960	9.0	884[1]	1.086	100	141.0	LOS F	63.4	478.0	Short	150	0.0	NA
Lane 2	132	5.9	132	5.9	235	0.562	100	77.6	LOS E	6.2	45.6	Full	1010	0.0	0.0
Lane 3	131	6.3	131	6.3	233	0.562	100	77.9	LOS E	6.2	45.5	Short	100	0.0	NA
Approach	1223	8.3	1223	8.3		1.086		127.4	LOS F	63.4	478.0				
West: Ti Rakau Drive (West)															
Lane 1	522	11.8	431	11.6	549	0.786	100	57.6	LOS E	19.4	149.0	Full	479	0.0	0.0
Lane 2	501	11.9	413	11.8	526[1]	0.786	100	57.3	LOS E	18.7	144.5	Full	479	0.0	0.0
Lane 3	10	10.0	8	9.6	429	0.019	100	53.1	LOS D	0.3	2.3	Short	27	0.0	NA
Approach	1033	11.8	853[N1]	11.7		0.786		57.4	LOS E	19.4	149.0				
Intersection	4278	9.9	4098[N 1]	10.3		1.088		117.2	LOS F	68.2	519.8				

- Therefore, alternative measures are proposed under Mitigation 2.

3.5.4 Mitigation 2

- Mitigation 2, to remedy the Ti Rakau Drive / Gossamer Drive intersection during the AM peak, includes the following on the northern Gossamer Drive approach (see figure below):
    - Adding an additional short lane (100 m) for the shared through and right-turn movements.
    - Converting the centre lane to a full left-turn lane.
    - Converting the short left-turn slip lane to pass through the intersection and adding 150 m stacking space.
    - The kerbside short exit lane length is increased from 24 m to 100 m.

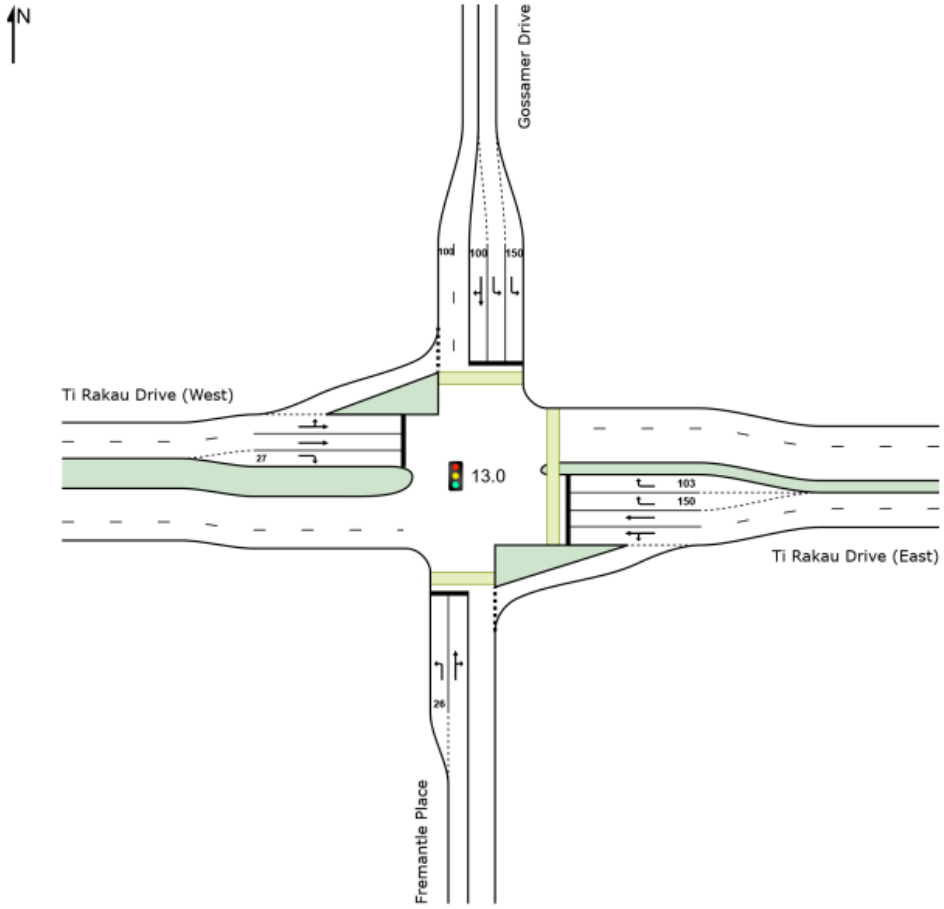

Figure 6: Ti Rakau Drive / Gossamer Drive – Mitigation 1 proposed layout

- The Stage 2 intersection performance (without mitigation) is expected to be poor (LOS F), especially in the Gossamer Drive right-turn lane into Ti Rakau Drive where delay increases from around 59 sec in the Do-Min scenario, to 320 sec (5.3 min).
- With the measures in place proposed under Mitigation 2, intersection performance during the detour is expected to be improved to LOS D and with an average delay of 37 sec. This is also an improvement compared to the Do-Min scenario (LOS D and delay of 48 sec).
- Delays and queue lengths in the Gossamer Drive right-turn lane are improved under Mitigation 2 (delay of 75 sec and average queue length of 86 m), compared to the Stage 2 detour.
- The Gossamer Drive left-turn lanes (previously a single left-turn slip under the Stage 2 scenario) are expected to experience improved performance (LOS C), with an average delay of 28 sec and average queue length of 91 m.

Table 14: Ti Rakau Dr / Gossamer Dr – Stage 2 vs Mitigation 2 (AM)

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	DEMAND FLOWS HV [%]	ARRIVAL FLOWS [Total veh/h]	ARRIVAL FLOWS HV [%]	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	AVERAGE BACK OF QUEUE Dist [m]	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	23	8.7	23	8.7	63	0.367	100	94.2	LOS F	1.2	8.9	Short	26	0.0	NA
Lane 2	28	7.1	28	7.1	65	0.429	100	92.7	LOS F	1.4	10.8	Full	285	0.0	0.0
Approach	51	7.8	51	7.8		0.429		93.4	LOS F	1.4	10.8				
East: Ti Rakau Drive (East)															
Lane 1	832	10.3	832	10.3	680	1.224	100	272.4	LOS F	85.1	648.8	Full	636	0.0	51.9
Lane 2	792	10.5	792	10.5	646[1]	1.224	100	277.1	LOS F	83.4	635.9	Full	636	0.0	50.0
Lane 3	65	7.8	65	7.8	262	0.247	23[6]	41.4	LOS D	1.8	13.7	Short	150	0.0	NA
Lane 4	282	7.8	282	7.8	262	1.075	100	137.8	LOS F	16.5	123.4	Short	103	0.0	NA
Approach	1971	9.9	1971	9.9		1.224		247.4	LOS F	85.1	648.8				
North: Gossamer Drive															
Lane 1	960	9.0	960	9.0	1066[1]	0.901	100	28.7	LOS C	30.7	231.8	Short	30	0.0	NA
Lane 2	264	6.4	264	6.4	212[1]	1.246	100	319.1	LOS F	29.7	219.6	Full	1010	0.0	0.0
Approach	1224	8.4	1224	8.4		1.246		91.3	LOS F	30.7	231.8				
West: Ti Rakau Drive (West)															
Lane 1	523	11.8	432	11.6	451	0.958	100	98.1	LOS F	26.1	200.6	Full	479	0.0	0.0
Lane 2	500	11.9	413	11.7	431[1]	0.958	100	96.7	LOS F	25.1	193.1	Full	479	0.0	0.0
Lane 3	10	10.0	8	9.6	102	0.081	100	85.7	LOS F	0.4	3.0	Short	27	0.0	NA
Approach	1033	11.8	854[N1]	11.7		0.958		97.3	LOS F	26.1	200.6				
Intersection	4279	9.9	4100[N 1]	10.4		1.246		167.6	LOS F	85.1	648.8				

Lane Use and Performance

	DEMAND FLOWS [Total veh/h]	DEMAND FLOWS HV [%]	ARRIVAL FLOWS [Total veh/h]	ARRIVAL FLOWS HV [%]	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Veh]	AVERAGE BACK OF QUEUE Dist [m]	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Fremantle Place															
Lane 1	23	8.7	23	8.7	79	0.289	100	73.8	LOS E	0.9	7.0	Short	26	0.0	NA
Lane 2	28	7.1	28	7.1	83	0.338	100	72.2	LOS E	1.1	8.4	Full	285	0.0	0.0
Approach	51	7.8	51	7.8		0.338		72.9	LOS E	1.1	8.4				
East: Ti Rakau Drive (East)															
Lane 1	846	10.4	846	10.4	960	0.881	100	36.2	LOS D	31.8	242.5	Full	636	0.0	0.0
Lane 2	778	10.5	778	10.5	883[1]	0.881	100	36.1	LOS D	28.5	217.7	Full	636	0.0	0.0
Lane 3	126	7.8	126	7.8	320	0.393	57[6]	31.4	LOS C	2.5	18.8	Short	150	0.0	NA
Lane 4	221	7.8	221	7.8	320	0.692	100	33.9	LOS C	4.8	36.0	Short	103	0.0	NA
Approach	1971	9.9	1971	9.9		0.881		35.6	LOS D	31.8	242.5				
North: Gossamer Drive															
Lane 1	480	9.0	480	9.0	687	0.698	100	27.4	LOS C	12.0	90.2	Short	150	0.0	NA
Lane 2	480	9.0	480	9.0	687	0.698	100	27.4	LOS C	12.0	90.2	Full	1010	0.0	0.0
Lane 3	264	6.4	264	6.4	296	0.891	100	74.7	LOS E	11.6	85.9	Short	100	0.0	NA
Approach	1224	8.4	1224	8.4		0.891		37.6	LOS D	12.0	90.2				
West: Ti Rakau Drive (West)															
Lane 1	523	11.8	431	11.6	669	0.645	100	37.1	LOS D	13.6	104.3	Full	479	0.0	0.0
Lane 2	500	11.9	413	11.8	640[1]	0.645	100	36.2	LOS D	13.1	101.3	Full	479	0.0	0.0
Lane 3	10	10.0	8	9.6	117	0.071	100	67.7	LOS E	0.3	2.3	Short	27	0.0	NA
Approach	1033	11.8	852[N1]	11.7		0.645		37.0	LOS D	13.6	104.3				
Intersection	4279	9.9	4098[N 1]	10.4		0.891		36.9	LOS D	31.8	242.5				

- Mitigation 2 is expected to result in improved performance compared to Mitigation 1 and it is recommended that this mitigation measure be discussed with key stakeholders.

4.0 Traffic Volumes in the wider Project Area

- **Table 15** below shows an increase in demand in the Gossamer Drive left-turn at the intersection with Pakuranga Road, and in the Gossamer Drive right-turn lane at Ti Rakau Drive during the AM and PM.
- The table below also shows an increase in the Ti Rakau Drive west approach left-turn lane into Gossamer Drive during the PM.
- Overall, it seems that only a small percentage of traffic is routing along the proposed detour route (probably due to the already congested nature of those intersections).
- As a result, in the **inbound** (citybound) direction during the AM demand seems to detour via Gossamer Road to Pakuranga Road in the north and Ti Rakau Drive in the south.
- In the PM in the **outbound** direction, demand seems to return via Pakuranga Road, and via SEART turning right onto Ti Rakau Drive.

Table 15: Gossamer Road traffic volumes

			DM AM peak 0645-0745 Traffic Flow (Vehicles / hr)				Stage 2 AM peak 0800-0900 Traffic Flow (Vehicles / hr)			
			Car	Truck	Bus	Total	Car	Truck	Bus	Total
Pakuranga Road / Gossamer Drive	Pakuranga Road (West)	Through	503	28	6	**536**	613	40	6	**659**
		Right	143	13	0	**156**	139	19	0	**158**
	Pakuranga Road (East)	Left	847	20	3	**871**	839	32	3	**874**
		Through Bus-lane	0	0	12	**12**	0	0	10	**10**
		Through	1632	83	0	**1715**	1032	50	0	**1082**
	Gossamer Drive	Left	59	5	0	**63**	100	7	0	**107**
		Right	273	10	2	**285**	253	13	2	**268**
	Total (Maximum in Red)		3457	159	23	**3639**	2975	162	21	**3158**
Ti Rakau Drive / Gossamer Drive / Fremantle Place	Ti Rakau Drive (North)	Left	18	1	0	**19**	34	4	0	**37**
		Through	733	71	14	**817**	868	104	13	**985**
		Right	9	1	0	**10**	9	1	0	**10**
	Gossamer Drive	Left	974	79	0	**1053**	874	86	0	**960**
		Through	9	1	0	**10**	9	1	0	**10**
		Right	83	7	0	**90**	238	16	0	**255**
	Ti Rakau Drive (South)	Left	13	1	0	**14**	18	1	0	**18**
		Through	1490	173	16	**1679**	1437	152	16	**1605**
		Right	229	21	0	**250**	320	27	0	**347**
	Fremantle Place	Left	24	1	0	**25**	21	2	0	**23**
		Through	13	0	0	**13**	10	0	0	**10**
		Right	17	1	0	**18**	16	2	0	**18**
	Total (Maximum in Red)		3602	357	29	**3988**	3842	396	29	**4267**

			DM PM peak 1615-1715 Traffic Flow (Vehicles / hr)				Stage 2 PM peak 1615-1715 Traffic Flow (Vehicles / hr)			
			Car	Truck	Bus	Total	Car	Truck	Bus	Total
Pakuranga Road / Gossamer Drive	Pakuranga Road (West)	Through	1920	84	14	**2017**	1795	79	14	**1887**
		Right	44	2	0	**46**	47	5	0	**51**
	Pakuranga Road (East)	Left	248	7	2	**257**	232	7	2	**241**
		Through Bus-lane	0	0	6	**6**	0	0	6	**6**
		Through	1104	45	0	**1149**	1107	45	0	**1152**
	Gossamer Drive	Left	4	6	0	**10**	4	6	0	**10**
		Right	593	14	4	**611**	595	14	4	**614**
	Total (Maximum in Red)		3911	158	26	**4095**	3779	155	26	**3960**
Ti Rakau Drive / Gossamer Drive / Fremantle Place	Ti Rakau Drive (North)	Left	59	2	0	**61**	126	2	0	**128**
		Through	1021	42	17	**1079**	979	43	17	**1039**
		Right	18	0	0	**19**	18	0	0	**19**
	Gossamer Drive	Left	393	82	0	**475**	382	73	0	**456**
		Through	9	1	0	**10**	8	2	0	**10**
		Right	30	1	0	**31**	40	1	0	**41**
	Ti Rakau Drive (South)	Left	20	0	0	**20**	20	0	0	**21**
		Through	1508	101	13	**1622**	1556	105	13	**1674**
		Right	553	54	0	**606**	540	50	0	**590**
	Fremantle Place	Left	12	0	0	**12**	10	0	0	**10**
		Through	10	0	0	**10**	10	0	0	**10**
		Right	16	1	0	**18**	16	1	0	**18**
	Total (Maximum in Red)		3640	285	30	**3956**	3700	278	30	**4008**

5.0 Impacts to Buses

- The impacts to buses through the project area are expected to be low as the frequency of the 711 route in the AM inbound direction is only 4 buses/h (1 every 15min).
- As shown above, the William Roberts Road / Reeves Road intersection is expected to operate with good LOS in the AM.
- The William Roberts Road / Pakuranga Road intersection is already saturated in the Do-Min AM scenario and the impact of the detour is expected to be negligible.
- The Pakuranga Road / Ti Rakau Drive intersection is expected to operate at LOS D during the AM.

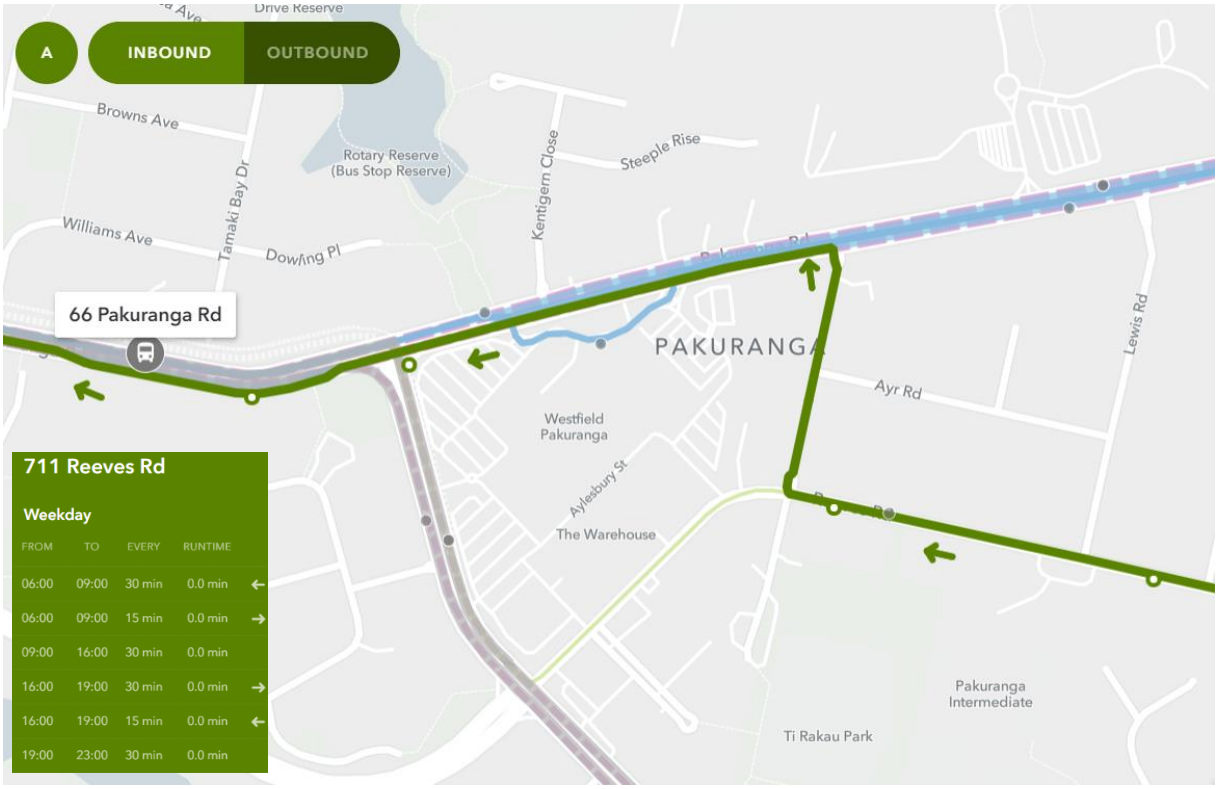

Figure 7: Inbound buses through project area

- NOTE: The 711 outbound route below is based on the Do-Min scenario. During Stage 2, with Reeves Road closed between Ti Rakau Drive and William Roberts Road, it is anticipated buses will continue along Ti Rakau Drive and turn left at the newly completed Ti Rakau Drive / William Roberts Road intersection.
- The impacts to buses through the project area are expected to be low as the frequency of the 711 route in the PM outbound direction is only 4 buses/h (1 every 15min).
- The Pakuranga Road / Ti Rakau Drive intersection is expected to perform at LOS F during the Stage 2 PM scenario, compared to the LOS E of the Do-Min scenario, however, the Pakuranga Road west approach is already at capacity (including the bus lanes).
    - However, performance is expected to improve at this intersection with the mitigation measures proposed under **Section 3.4**.
- The Ti Rakau Drive / SEART intersection is already saturated during the PM peak and the impact of the detour is expected to be negligible.
    - However, performance is expected to improve at this intersection with the mitigation measures proposed under **Section 3.4**.
- It is expected that the Ti Rakau Drive / William Roberts Road LILO intersection would operate with acceptable LOS and the impact of the detour would be negligible at this intersection.

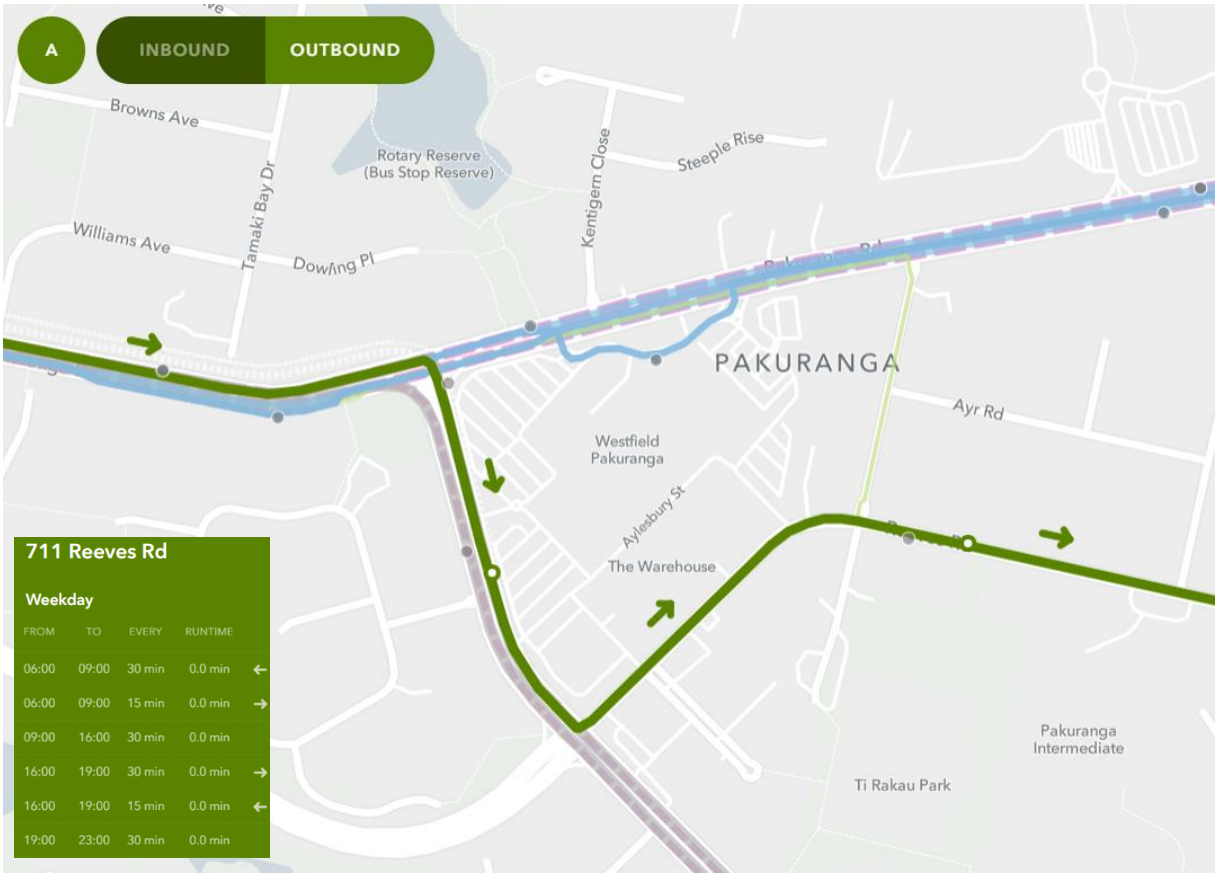

Figure 8: Outbound buses through project area