Memorandum

To: Smart Growth

From: Bruce Robinson, Transport Advisor, Infrastructure Planning

Subject: Te Tumu Transportation Assessment: Stage 1 Sensitivity Analysis

Date: 1 June 2016

INTRODUCTION

This memorandum reports on the findings of strategic transportation modelling of three possible land-use permutations for Wairakei and Te Tumu, in terms of confirming the need for four-lane arterial and collector roads and their timing relative to two road networks, with or without the provision of the Papamoa East Interchange on the Tauranga Eastern Link (State Highway 2). This sensitivity testing is Stage 1 of a two-stage modelling scope. Stage 2 to follow will model a single feasible land-use scenario across a variety of refined road network permutations that have been informed by these Stage 1 findings.

METHODOLOGY

The land-use scenarios were derived from a prior RPS density study[1] which considered two possible land-use outcomes for Wairakei (S1, S2), as well as three possible outcomes for Te Tumu (S3 Low, S3 Medium, S3 High). The Te Tumu land-use also considered an additional two aspirational land-uses that were previously proposed by the land-owner group (S4, S5). These are summarised in Table 1.

[1] RPS, "Te Tumu and Wairakei Density Study", February 2016

Table 1 Range of Potential Land-Uses in Wairakei and Te Tumu

RPS's Scenarios	Location	Dwelling	Population	Commercial (ha)	Industrial (ha)	Town Centre (ha)
S1	Wairakei	3,127	7,866	22.67	114.67	22.55[1]
S2	Wairakei	4,840	11,811	11.59	40.42	22.68
S3 Low	Te Tumu	6,600	13,897		62.6	
S3 Medium	Te Tumu	7,846	15,817		62.6	
S3 High	Te Tumu	8,923	17,599		62.6	
S4	Te Tumu	12,922	26,032	45.16[2]		
S5	Te Tumu	14,181	28,009		62.6	

Of the ten possible permutations between Wairakei and Te Tumu densities, lowest, medium and highest land-use scenario were proposed for coding into the Tauranga Transport Model for the 2031+ horizon year (not to endorse any particular land-use but mainly for the purpose of testing a range of traffic demands). These were for Wairakei and Te Tumu, respectively:

- Low (S2 & S3 Low)
- Medium or Base (S1 & S4)
- High (S1 & S5)

Nominal year 2031+ is currently the most forward-looking horizon year available in TTM version 5.10 and has been previously used as the starting point for the Tauranga Urban Network Study as well as the Western Corridor study. The land use permutations, trip generation forecasts and trip assignment results of the TTM modelling are provided in Appendix 1[2]. Some key considerations are summarised as follows:

- Rangiuru Business Park is included in the model;
- The Kaituna Link bridge and road improvements between Te Tumu and Rangiuru are assumed in the standard TTM 2031+ model;
- The standard TTM 2031+ model assumes four-lane roads for Girven, Sandhurst, Domain, Tara, the western section of Te Okuroa Drive in Wairakei, The Papamoa East Interchange arterial link, Te Okuroa Drive in Te Tumu, and The Boulevard in Te Tumu. For this stage 1 modelling the external local road widenings for Domain, Sandhurst and Tara were removed from the standard model, but not for the roads internal to Wairakei or Te Tumu.

[2] Report: Papamoa East Interchange - Stage 1, Prepared for Tauranga City Council (Client) By Beca Ltd (Beca), 29 February 2016 (note: includes Appendices A through G)

For each land use scenario the TTM model results were post-processed to consider the need for widening eight key local roads along the coastal strip, their relative timing with/without PEI, and with/without Kaituna Link (which was tentatively re-assigned post-TTM modelling). For each road, this results in twelve traffic flow "data points" for each road, namely:

- 3 land-use scenarios x
- with or without PEI x
- with or without Kaituna Link

The methodology adopted for the evaluation of these forecast traffic flows is explained in the following section. Thereafter the findings are discussed under the three land-use sensitivity groupings.

CRITERIA FOR STREET WIDENING

The need for road widening from two-lane to four-lane streets is dependent on critical traffic demands assigned as flows per travel lane in the peak flow periods, typically AM and PM. These flows are affected by the assumed land-use pattern in terms of trip generation and distribution, the assumed road pattern with or without the PEI or Kaituna Link.

Daily traffic flows are a useful but imprecise indicator of peak flows and the need for road widening, being typically in the range of 8 to 12 times the peak flows, often nominally assumed to be a factor of 10. For example, the Tauranga City Council Infrastructure Development Code suggests as an "indicator" that four-lane road widths be considered when flows >15,000 vehicles per day (combined, in both directions) are exceeded on lower speed urban streets with interrupted flows due to intersection controls and possible side-friction interactions from driveways, side roads and parking movements (Table 2). Other jurisdictions such as NZ Transport Agency, when considering higher speed uninterrupted flow facilities such as State Highways, consider the 19,000 to 22,000 vpd to be an indicator of the need for road widening. Thus, within an Average Daily Traffic (ADT) range between 15,000 and 20,000 vpd there is some uncertainty as to whether widening is necessary. Appendix 2 provides ADT plots of the various land-use and network model runs, with an initial highlighting of which sections fall within these indicative ranges.

Within this uncertainty range, it is necessary to focus on forecast peak hourly flows in the peak direction when considering road widening. The TTM model assumes capacity of >2000 vehicles per hour (per direction) to indicate a four lane road. However, the capacity of an urban road may be as low as 900 vph, depending on the specific road design environment and intersection controls, such as an unfavourable % red at traffic signals. As arterial or collector roads, the roads that are the subject of road widening in this study are coded in TTM with capacities in the range of 1300 to 1600 vph in their two lane configurations.

A final criterion in this assessment of the need for road widening is the peak direction in the peak period Level of Service as indicated in the TTM by the volume/capacity ratio. This performance measure represents the flow rate in terms of % capacity being consumed. For long-term planning purposes, a peak period volume/capacity ratio of less than or equal to 80% is desirable to minimise bumper-to-bumper conditions with unsafe car following and excessive queuing. Note therefore, that for the purposes of this assessment, a v/c >40% on a road coded as four lanes in the model was assumed to be equivalent to v/c >0.80% if it were assumed to be or compared with a two-lane road cross-section.

It should also be noted that the TTM is intended as a strategic macro-scopic network model, and any finer-grained analysis to confirm these preliminary findings should be conducted with operational models using a meso-scopic or micro-scopic level of analysis.

Table 2 Infrastructure Development Code Design Requirements for Arterial Road Classifications[3]

Type	Drawing Number	Drawing Reference	Speed Value (kph)	Road Zone Width (m)	Maximum Gradient	Roadside Environment	Indicative Volume Range (vpd)	Tree Location	Safety Audit Requirement	Comments
Highways Expressways Motorways Primary Arterial Roads	n/a	n/a	Designed to *New Zealand Transport Agency* Manuals						In accordance with *NZTA* requirements	
Secondary Arterial Road Zone	*T101*	SA1 - Four Lanes/ Solid Median/ Positive Crossfall	> 70	34.0	5%	Four lane and two lane arterial *road* types. Intersections limited and often signal controlled. Typically have service *road*s and development frontage to support a mix of uses. Direct vehicle access from adjoining property should be limited.	>15,000 vpd	Berm	Checklist review at feasibility stage. Full *Road* Safety Audits at preliminary *design*, detail *design* and post construction stages.	Symmetrical layout Parking not required Cycle lane required
	T102	SA2 - Two Lanes/ Solid Median/ Positive Crossfall	> 70	28.0	5%		7,000 - 15,000 vpd	Berm		Symmetrical layout Parking not required Cycle lane required
	T103	SA3 - Four Lanes/ Solid Median/ Positive Crossfall	≤ 70	37.0	5%	Four lane and two lane arterial *road* types. Intersections limited and often signal controlled. Typically have service *road*s and development frontage to support a mix of uses. Direct vehicle access from adjoining property should be limited. On-*street* parking is desirable. Solid medians are preferred for *road* sections with high demand for cross pedestrian movements.	>15,000 vpd	Parking		Symmetrical layout Parking required Cycle Lane required
	T104	SA4 - Two Lanes/ Solid Median/ Negative Crossfall	≤ 70	33.0	5%		7,000 - 15,000 vpd	Berm		Symmetrical layout Parking required Cycle Lane required *Low Impact Design* option
	T105	SA5 - Two Lanes/ Solid Median/ Positive Crossfall	≤ 70	32.0	5%		7,000 - 15,000 vpd	Berm		Symmetrical layout Parking required Cycle Lane required
	T106	SA6 - Two Lanes/ Painted Median/ Positive Crossfall	≤ 70	30.0	5%		7,000 - 15,000 vpd	Berm		Symmetrical layout Parking required Cycle Lane required
Collector Road Zone	*T107*	CR1 - Four Lanes Median/ Positive Crossfall	50	31.0	8.33%	Typically have service *road*s and development frontage to support a mix of uses. Direct vehicle access from adjoining property should be limited. On-*street* parking could be considered inside activity centres and this would increase the *Road* Zone by 4.5m.	>15,000 vpd	Berm	Checklist review at preliminary *design* stage. Full *Road* Safety Audits at detail *design* and post construction stages.	Symmetrical layout Parking may be required. Cycle Lane required
	T108	CR2 - Two Lanes/ Solid Median/ Negative Crossfall	50	30.0	8.33%	Mostly residential frontage that links neighbourhoods with town centres. A two lane undivided *road* for higher volume collectors. Typically can accommodate buses and separate on-*street* cycle lanes. These are often 'special *road*s' and their *design* needs to have particular regard to context, function and adjacent land use.	7,000 – 15,000 vpd	Berm		Symmetrical layout Parking required Cycle Lane required *Low impact design* option
	T109	CR3 - Two Lanes/ Solid Median/ Positive Crossfall	50	29.0	8.33%		7,000 – 15,000 vpd	Berm		Symmetrical layout Parking required Cycle Lane required
	T110	CR4 - Two Lanes/ Painted Median/ Positive Crossfall	50	25.5	8.33%		5,000 – 12,000 vpd	Parking		Symmetrical layout Parking required Cycle Lane required Painted median may be reduced to 2.0m and *Road* Reserve reduced to 25.0m if there is a low proportion of heavy vehicles
	T111	CR5 - Two Lanes/ No Median/ Positive Crossfall	50	23.0	8.33%		3,000 – 5,500 vpd	Parking		Symmetrical layout Parking required Cycle Lane required

[3] http://econtent.tauranga.govt.nz/data/idc/04_design_standards/ds_4_transportation_network/DS-4_transportation_network.pdf

ANALYSIS AND FINDINGS

For each land-use scenario a Daily, then focussed Peak analysis filter was performed, according to the methodology described earlier. The tables are formatted with rows representing a particular numbered road from west to east on the coastal strip and the Te Tumu roads highlighted yellow in the case of no Kaituna link being assumed. The columns are grouped for 2031 flow without the PEI left and with the PEI in red to the right.

In the Daily flow table ADT's greater than the four lane indicator of 15,000 vpd are highlighted orange. To the right of each ADT there is an interpolation (between 2016 and nominally 2031 per theTTM) of the nominal year at which the 15,000 threshold is reached. The threshold timing in years are colour shaded as follows: red <2021 or 33% build-out, yellow <2026 or 66% build-out, green <2031 or 100% buildout, blue>2031 or beyond 100% buildout.

The following sub-sections provide the capacity analyses for the Low, Medium and High scenarios, together with identifying any incremental changes in widening indications.

LOW SCENARIO

Thus in terms of daily traffic forecasts, for the Low land-use scenario Table 3 indicates which roads and in what timeframe each road may be a candidate for widening without then with the PEI. For the Te Tumu roads, the estimated effects of removing the Kaituna link are highlighted in yellow.

Table 3 Daily Flow Analysis (Low)

Te Tumu Stage 1 TTM Model Post-Analysis				Criteria:					
				15000	IDC max	2031			
				2031 WITHOUT PEI (DO MINIMUM			2031 WITH PEI (OPTION 1)		
	Location	Description	Scenario	daily flows			daily flows		
			RPS	2 way	theshold test		2 way	threshold test	
			Land Use	ADT	need 4ln?	year need	ADT	need 4ln?	year need
	1	Girven Road (E.ofGloucester*)	L	10100	0	0	10400	0	0
	2	Sandhurst Drive (W.ofGloucester)	L	15300	1	2031	16000	1	2030
	3	Domain Road	L	17300	1	2008	20800	1	2014
	4	Tara Road	L	24100	1	2021	13700	0	0
	5	Te Okuroa Drive (Wairakei)	L	29500	1	2020	18200	1	2026
	6	Boulevard (Wairakei)	L	18900	1	2027	10700	0	0
with Kaituna Link	7	PEI Arterial	L	0	0	0	24400	1	2025
with Kaituna Link	8	Te Okuroa Drive (Te Tumu)	L	3800	0	0	16400	1	2030
with Kaituna Link	9	Boulevard (Te Tumu)	L	19900	1	2027	12400	0	0
with Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	L	11745	0	0	8529	0	0
No Kaituna Link	7	PEI Arterial	L	0	0	0	32929	1	2023
No Kaituna Link	8	Te Okuroa Drive (Te Tumu)	L	15545	1	2030	24929	1	2025
No Kaituna Link	9	Boulevard (Te Tumu)	L	31645	1	2023	20929	1	2027
No Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	L	0	0	#DIV/0!	0	0	#DIV/0!

As discussed in the methodology, to confirm the daily indications of whether a widening may be necessary, a second filter is applied in terms of focussing on the peak period flows in the peak direction, as shown in Table 4.

Table 4 Peak Flow Analysis (Low)

Te Tumu Stage 1 TTM Model Post-Analysis				Criteria:								
				15000	TTM Model year							
				2031 WITHOUT PEI (DO MINIM			2031 WITH PEI (OPTION 1)			4 lane decision summary		
	Location	Description	Scenario	daily flow	peak flows		daily flow	peak flows		0=2ln both	Years	Years Change
			RPS	2 way	peak direction only		2 way	peak direction only		1=2/4ln	deferred	without-withPEI
			Land Use	ADT	AM	PM	ADT	AM	PM	2=4ln both		
	1	Girven Road (E.ofGloucester*)	L	10100	400	540	10400	400	540	0		beyond 2031
	2	Sandhurst Drive (W.ofGloucester)	L	15300	990	1030	16000	990	1030	2	-1	2031 vs 2030
	3	Domain Road	L	17300	726	764	20800	882	997	2	0	2016 vs 2016
	4	Tara Road	L	24100	1302	1329	13700	817	788	1	10	2021 vs no need
	5	Te Okuroa Drive (Wairakei)	L	29500	1417	1500	18200	897	937	2	5	2020 vs 2026
	6	Boulevard (Wairakei)	L	18900	1006	1010	10700	438	355	1	4	2027 vs no need
with Kaituna Link	7	PEI Arterial	L	0	0	0	24400	1218	1300	1	-6	no need vs 2025
with Kaituna Link	8	Te Okuroa Drive (Te Tumu)	L	3800	225	182	16400	797	815	1	-1	no need vs 2030
with Kaituna Link	9	Boulevard (Te Tumu)	L	19900	1117	1162	12400	774	790	1	4	2027 vs no need
with Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	L	11745	599	761	8529	431	609	0		beyond 2031
No Kaituna Link	7	PEI Arterial	L	0	0	0	32929	1649	1909	1	-8	no need vs 2023
No Kaituna Link	8	Te Okuroa Drive (Te Tumu)	L	15545	824	943	24929	1228	1424	2	-6	2030 vs 2025
No Kaituna Link	9	Boulevard (Te Tumu)	L	31645	1716	1923	20929	1205	1399	2	4	2023 vs 2027
No Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	L	0	0	0	0	0	0	0		beyond 2031

In summary, the red highlighted roads are showing confirmation of required widening in terms of peak performance:

- Without PEI only
    - Tara Road (based on v/c>80%),
    - Te Okuroa Drive (Wairakei), and
    - The Boulevard (Te Tumu) (based on v/c>0.80%)
- Without PEI or Kaituna Link:
    - The Boulevard (Te Tumu)
- With PEI regardless of Kaituna Link:
    - PEI Arterial
- With PEI and without Kaituna Link:
    - Te Okuroa Drive (Te Tumu)
    - The Boulevard (Te Tumu)

MEDIUM SCENARIO

A similar daily and peak capacity analysis for the Medium land-use scenario is presented in Tables 5 and Table 6, respectively.

Table 5 Daily Flow Analysis (Medium)

Te Tumu Stage 1 TTM Model Post-Analysis				Criteria:					
				15000	IDC max	2031			
				2031 WITHOUT PEI (DO MINIMUM			2031 WITH PEI (OPTION 1)		
	Location	Description	Scenario	daily flows			daily flows		
			RPS	2 way	theshold test		2 way	threshold test	
			Land Use	ADT	need 4ln?	year need	ADT	need 4ln?	year need
	1	Girven Road (E.ofGloucester*)	M	10300	0	0	10500	0	0
	2	Sandhurst Drive (W.ofGloucester)	M	15100	1	2031	16100	1	2030
	3	Domain Road	M	16900	1	2005	21300	1	2014
	4	Tara Road	M	26700	1	2021	14500	0	0
	5	Te Okuroa Drive (Wairakei)	M	32300	1	2020	19100	1	2025
	6	Boulevard (Wairakei)	M	20800	1	2026	10700	0	0
with Kaituna Link	7	PEI Arterial	M	0	0	0	29300	1	2024
with Kaituna Link	8	Te Okuroa Drive (Te Tumu)	M	5200	0	0	21900	1	2026
with Kaituna Link	9	Boulevard (Te Tumu)	M	25100	1	2025	16400	1	2030
with Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	M	14674	0	0	11559	0	0
No Kaituna Link	7	PEI Arterial	M	0	0	0	40859	1	2022
No Kaituna Link	8	Te Okuroa Drive (Te Tumu)	M	19874	1	2027	33459	1	2023
No Kaituna Link	9	Boulevard (Te Tumu)	M	39774	1	2021	27959	1	2024
No Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	M	0	0	#DIV/0!	0	0	#DIV/0!

Comparing Table 3 and 5 reveal that at the daily level of analysis, the widening indicators are identical, except for:

- The Boulevard (Te Tumu) in the case of with the PEI but without the Kaituna Link for which widening is now indicated.

As expected given higher trip generation, the threshold timings have moved forward in some cases.

The peak period analysis for the Medium scenario is summarised in Table 6 below.

Table 6 Peak Flow Analysis (Medium)

Te Tumu Stage 1 TTM Model Post-Analysis				Criteria:								
				15000	TTM Model year							
				2031 WITHOUT PEI (DO MINIM			2031 WITH PEI (OPTION 1)			4 lane decision summary		
	Location	Description	Scenario	daily flow	peak flows		daily flow	peak flows		0=2ln both	Years	Years Change
			RPS	2 way	peak direction only		2 way	peak direction only		1=2/4ln	deferred	without-withPEI
			Land Use	ADT	AM	PM	ADT	AM	PM	2=4ln both		
	1	Girven Road (E.ofGloucester*)	M	10300	420	540	10500	420	540	0		beyond 2031
	2	Sandhurst Drive (W.ofGloucester)	M	15100	970	1010	16100	970	1010	2	-1	2031 vs 2031
	3	Domain Road	M	16900	690	725	21300	890	994	2	0	2016 vs 2016
	4	Tara Road	M	26700	1359	1369	14500	720	754	1	10	2021 vs no need
	5	Te Okuroa Drive (Wairakei)	M	32300	1503	1597	19100	882	937	2	5	2020 vs 2025
	6	Boulevard (Wairakei)	M	20800	1054	1110	10700	576	539	1	5	2026 vs no need
with Kaituna Link	7	PEI Arterial	M	0	0	0	29300	1630	1687	1	-7	no need vs 2024
with Kaituna Link	8	Te Okuroa Drive (Te Tumu)	M	5200	342	442	21900	1305	1307	1	-5	no need vs 2026
with Kaituna Link	9	Boulevard (Te Tumu)	M	25100	1758	1682	16400	1388	1332	2	5	2025 vs 2030
with Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	M	14674	782	922	11559	565	809	0		beyond 2032
No Kaituna Link	7	PEI Arterial	M	0	0	0	40859	2195	2496	1	-9	no need vs 2022
No Kaituna Link	8	Te Okuroa Drive (Te Tumu)	M	19874	1124	1364	33459	1870	2116	2	-5	2027 vs 2023
No Kaituna Link	9	Boulevard (Te Tumu)	M	39774	2540	2604	27959	1953	2141	2	2	2021 vs 2024

For the peak periods comparing Table 4 with Table 6 for changes reveals that in addition to the Low scenario, the following incremental triggers would be reached because of the Medium scenario trip increment:

- The Boulevard (Wairakei) without PEI (v/c=85%)
- Te Okuroa Drive (Te Tumu) with PEI
- The Boulevard (Te Tumu) with PEI
- Te Okuroa Drive (Te Tumu) without PEI and without Kaituna Link
- PEI Arterial may need widening to 6 lanes with PEI and without Kaituna Link

HIGH SCENARIO

The High land use scenario represents a “worst case” in terms of the extent of road widening. Compared with the Medium scenario in Table 5, Table 7 shows one incremental trigger for possible widening being met at the daily flow level of detail:

- Kaituna Link without the PEI (when including the Kaituna Link).

As with the Low to Medium comparisons made earlier, Medium to High trigger times would occur earlier in some cases.

Table 7 Daily Flow Analysis (High)

Te Tumu Stage 1 TTM Model Post-Analysis				Criteria:					
				15000	IDC max	2031			
				2031 WITHOUT PEI (DO MINIMUM			2031 WITH PEI (OPTION 1)		
	Location	Description	Scenario	daily flows			daily flows		
			RPS	2 way	theshold test		2 way	threshold test	
			Land Use	ADT	need 4ln?	year need	ADT	need 4ln?	year need
	1	Girven Road (E.ofGloucester*)	H	10400	0	0	10500	0	0
	2	Sandhurst Drive (W.ofGloucester)	H	15100	1	2031	16100	1	2030
	3	Domain Road	H	16900	1	2005	21300	1	2014
	4	Tara Road	H	26900	1	2021	14400	0	0
	5	Te Okuroa Drive (Wairakei)	H	32500	1	2020	19100	1	2025
	6	Boulevard (Wairakei)	H	20900	1	2026	10800	0	0
with Kaituna Link	7	PEI Arterial	H	0	0	0	30400	1	2023
with Kaituna Link	8	Te Okuroa Drive (Te Tumu)	H	5600	0	0	23100	1	2026
with Kaituna Link	9	Boulevard (Te Tumu)	H	25600	1	2025	17100	1	2029
with Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	H	15010	1	2031	11892	0	0
No Kaituna Link	7	PEI Arterial	H	0	0	0	42292	1	2021
No Kaituna Link	8	Te Okuroa Drive (Te Tumu)	H	20610	1	2027	34992	1	2022
No Kaituna Link	9	Boulevard (Te Tumu)	H	40610	1	2021	28992	1	2024
No Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	H	0	0	#DIV/0!	0	0	#DIV/0!

As before the definitive widening needs for the High scenario are provided by the peak period analysis in Table 8.

Table 8 Peak Flow Analysis (High)

Te Tumu Stage 1 TTM Model Post-Analysis				Criteria:								
				15000	TTM Model year							
				2031 WITHOUT PEI (DO MINIM			2031 WITH PEI (OPTION 1)			4 lane decision summary		
	Location	Description	Scenario	daily flow	peak flows		daily flow	peak flows		0=2ln both	Years	Years Change
			RPS	2 way	peak direction only		2 way	peak direction only		1=2/4ln	deferred	without-withPEI
			Land Use	ADT	AM	PM	ADT	AM	PM	2=4ln both		
	1	Girven Road (E.ofGloucester*)	H	10400	420	540	10500	420	540	0		beyond 2031
	2	Sandhurst Drive (W.ofGloucester)	H	15100	950	1000	16100	950	1000	2	-1	2031 vs 2032
	3	Domain Road	H	16900	682	717	21300	888	992	2	0	2016 vs 2016
	4	Tara Road	H	26900	1371	1376	14400	717	749	1	10	2021 vs no need
	5	Te Okuroa Drive (Wairakei)	H	32500	1496	1603	19100	889	931	2	5	2021 vs 2025
	6	Boulevard (Wairakei)	H	20900	1168	1110	10800	585	544	1	5	2026 vs no need
with Kaituna Link	7	PEI Arterial	H	0	0	0	30400	1703	1700	1	-8	no need vs 2023
with Kaituna Link	8	Te Okuroa Drive (Te Tumu)	H	5600	387	480	23100	1379	1379	1	-5	no need vs 2026
with Kaituna Link	9	Boulevard (Te Tumu)	H	25600	1841	1722	17100	1439	1475	2	4	2025 vs 2029
with Kaituna Link	10	Kaituna Link (to Te Tumu Rd)	H	15010	807	945	11892	579	823	1		beyond 2033
No Kaituna Link	7	PEI Arterial	H	0	0	0	42292	2282	2523	1	-10	no need vs 2021
No Kaituna Link	8	Te Okuroa Drive (Te Tumu)	H	20610	1194	1425	34992	1958	2202	2	-5	2027 vs 2022
No Kaituna Link	9	Boulevard (Te Tumu)	H	40610	2648	2667	28992	2018	2298	2	2	2021 vs 2024

In this case, there is only one incremental change in widening need relative to the Medium scenario:

- PEI Arterial may need widening to 6 lanes with PEI and even with the Kaituna Link

CONCLUSIONS & SCOPE FOR STAGE 2 REFINEMENT

These Stage 1 results from a sensitivity analysis of land use densities in Wairakei and Te Tumu have confirmed that the earlier provision of the Papamoa East Interchange has the potential to avoid the need for widening a number of local arterial and collector roads. This may be desirable from both an economic (cost avoidance) and urban planning (e.g. liveability and safety) perspective.

The findings of Stage 1 indicate sensitivity to land use density assumptions on some of the roads in question. However, there appears to be greater sensitivity to the provision of regional access in terms of the Papamoa East Interchange and the Kaituna Link. The next stage 2 modelling will therefore be focussed on modelling a single, refined land use to investigate these network effects in more detail as to their need and timing.