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Report

State Highway 1 Revocation Mackays to Peka Peka Contract Number 820PN – Waikanae Town Centre Traffic Modelling

Prepared for NZ Transport Agency

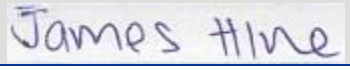
Prepared by (Beca)

24 August 2016

Revision History

Revision Nº	Prepared By	Description	Date
Revision A	**James Hine**	Draft Issue covering the Waikanae Traffic Modelling Work	9 August 2016
Revision B	**James Hine**	Update to include Hybrid Option + Extra Graphics	23 August 2016
Revision C	**James Hine**	Remove the draft stamp	24 August 2016

Document Acceptance

Action	Name	Signed	Date
Prepared by	**James Hine**		24 August 2016
Reviewed by	**Bob Hu**		24 August 2016
Approved by	**Stephen Hewett**		24 August 2016
on behalf of			

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1 Introduction

1.1 Background

The NZ Transport Agency (the Transport Agency) has commissioned Beca Ltd (Beca) to deliver the State Highway 1 (SH1) Revocation – Mackays to Peka Peka (M2PP) Project Contract Number 820PN (the Project). The purpose of this project is for the NZ Transport Agency (the Agency) to handover to Kapiti Coast District Council (the Council) the 14km section of what is currently SH1 from Poplar Avenue to Peka Peka Road. This handover is expected to be undertaken within 24 months after the completion of the M2PP Expressway. Before the Transport Agency undertake this handover, physical works need to be undertaken to transform the SH1 to the form and function of a local road, which will typically include (but not necessarily limited to) the following:

- The lowering of the speed limit,
- More connected walkways and cycleway opportunities including on-road cycle lanes, shared footpaths and safer pedestrian/cyclist crossings,
- Improving the layout and operation of the intersections to incorporate cycling, improve safety and enhance traffic flow through the urban and suburban areas,
- Enhancing the suburban and urban areas through more accessible parking, feature landscaping, tree planting and street furniture.

As part of this commission, the Transport Agency has instructed Beca to undertake further detailed traffic modelling work associated with the Waikanae and Paraparaumu town centres. The traffic modelling associated with the Paraparaumu town centres has already been undertaken and is documented in a separate report.

1.2 Report purpose

The purpose of this report is to outline the traffic modelling scope, methodology, assumptions, traffic analysis and results to inform the layout of the road, of what is currently known as SH1, through Waikanae town centre.

1.3 Report structure

The remainder of this report is structured as follows:

Chapter 2: Summarises previous modelling work (KTM3) which provides network and traffic demand options
Chapter 3: Summarises the detailed traffic modelling scopes
Chapter 4: Describes the methodology used in the analysis
Chapter 5: Summarises the results from the analysis
Chapter 6: Concludes the report
Chapter 7: Recommendation

2 Previous Traffic Modelling Work

2.1 Overview

The traffic modelling documented in this report builds on the findings and results from the traffic modelling review undertaken by Beca in June 2016 using the KTM 3 SATURN model.

The KTM3 SATURN model was used to undertake the macro traffic modelling analysis to:

- Review the performance of the14km section of what is currently SH1 from Poplar Avenue to Peka Peka Road once the Expressway is completed and the proposed transformation changes are implemented.
- Understand how the wider transport network is expected to perform once the Expressway is completed and the proposed transformation changes for the Project are implemented on the existing SH1.

2.2 Key Findings from the KTM3

The key points of the findings from the KTM3 SATURN Model are summarised as follows:

- The current transformation changes do not have any significant impact on the Expressway intersections at Te Moana Road.
- The Northbound and Southbound existing SH1 approaches to the Te Moana Road and Elizabeth Street intersections show significant delays – the worst case is approximately 45 seconds delay on the Northbound approach and 25 seconds on the Southbound approach due to the single lane arrangement incorporated into the model. The long platoon of vehicles in a single lane will also add to delays on side roads as it will take a longer green time to clear the queue from a single lane as opposed to a two lane discharge.
- Delays on Elizabeth Street show that there will still be queuing across the railway level crossing with the delays in all peaks around 45 seconds.
- Retaining the 2 lane approaches to the Elizabeth Street signals will reduce delays for old SH1 traffic and also relieve some of the risks and pressures on the Expressway/Te Moana Road intersection.
- The changes to the posted speed limit in Waikanae Town Centre will need incorporating into the SATURN model but is unlikely to impact traffic routing. Although traffic routing will be unaffected there will be more delays associated with a reduced speed limit, this will be more visible in both the micro simulation and signal operation models.
- Future design year 2031 should be used to predict the design traffic flows.

3 Modelling Scope

3.1 Overview

The Council requested further detailed modelling work to be undertaken in Waikanae town centres. The key tasks and requirements associated with the detailed modelling work are outlined in the following sections.

3.2 Tasks

The Council have requested the following traffic modelling tasks are undertaken for the Waikanae town centre:

- Update the existing S-Paramics model to include the 2031 design year traffic flows
- Make changes to the existing Linsig model to incorporate the proposed intersection designs with one and two lane approaches.
- Use the existing S-Paramics model to test three scenarios – the current pre-Expressway situation, the 2031 design year with two lane approaches and 2031 design year with single lane approaches

3.3 Requirements

The Council have requested the following:

- Factor in bus routes including the proposed Greater Wellington Regional Council bus routes
- Model the single lane and two lane approach scenario to determine the delays for each, when and what time those delays occur.
- Consider the context of Te Moana to Elizabeth Street and Elizabeth Street to Ngaio Road as the former may support east west connections.
- Factor in current and future level of service changes and compare the difference between current and future levels of service with the traffic reduction due to the Expressway i.e. how it compares to the existing conditions.
- Model or consider route switching/balancing through local route choices and make a judgement as to the expressway impact. Need to identify % transfer where the single lane reaches an acceptable level of service
- Use the future design year 2031 to predict the design traffic flows
- Incorporate the Park and Ride For both vehicles and pedestrians
- Clearly state assumptions.
- Current train timetables used for the main design comparisons and the future proposed train timetable used as a sensitivity test on the final model iteration

3.4 Other Considerations

It is important to the Council to understand the sensitivity for the reassignment of traffic between the Expressway and the existing SH1. This may become quite an important issue particularly for heavy vehicle movements.

4 Methodology

4.1 Overview

The SATURN model was updated to include the Park and Ride facility on the corner of Te Moana Road and then it was run to produce the initial 2031 traffic flows for the AM and PM peaks for inclusion into the S-Paramics model.

As previously agreed with the Council the following assumptions were used to update the existing S-Paramics model:

- The park and ride car park site on the corner of existing SH1/Te Moana Road has been incorporated into the models to provide traffic flows for the 2031 models.
- The existing train timetable has been retained and modelled as the future train services are not currently agreed. The proposed future train timetable has been incorporated into the final model iteration.
- Medium growth factors have been used as agreed
- Composite growth was used as agreed.

The S-Paramics model was then updated to also include the Park and Ride facility into the model. Initially the model was run with the signal timings from 2021 model and after some manual 'fine tuning' the signal timings were optimised and traffic flows generated for incorporation into the Linsig model to check the signal timings and allow levels of service for the intersections to be carried out.

The Linsig model was then updated to incorporate the flows from S-Paramics and the phasing and timings prepared for both the single lane and two lane arrangements. These confirmed the S-Paramics signal timings were optimal and thus route journey times and queue length graphs were derived from the S-Paramics outputs.

4.2 S-Paramics Model

Once the existing S-Paramics model was updated to include the 2031 design year traffic flows, the following scenarios were tested:

- The current pre-Expressway situation
- The 2031 design year with two through lanes
- The 2031 design year with a single through lane
- The 2031 design year with a single through lane and full right turning lanes into Te Moana Road & Elizabeth Street.

4.3 Linsig Model

The existing Linsig model was updated to incorporate the proposed intersection designs for all three 2031 scenarios.

5 Analysis

5.1 Overview

For the purposes of this report we have modelled the two 2031 scenarios as requested by the Council and have compared them to the 2015 Base Pre-Expressway model to allow a direct comparison of all three models to be undertaken.

For the 2031 flows in Waikanae, the following has been included in the modelling:

- The park and ride car park site on the corner of existing SH1/Te Moana Road has been incorporated into the SATURN model to provide traffic flows for the 2031 models.
- The existing train timetable has been retained and modelled as the future train services are not currently agreed.
- The future proposed train timetable has been incorporated into the final model iteration to assess the impact on the local road network.
- Medium growth factors have been used as agreed
- Composite growth was used as agreed.

5.2 2015 Base Model

This is the current 2015 base model and utilises the current traffic flows and network configuration in the Kapiti area. The Expressway is not included in this model and provides an accepted and calibrated base model with which to compare the future development options with.

5.3 2031 Single Lane Arrangement

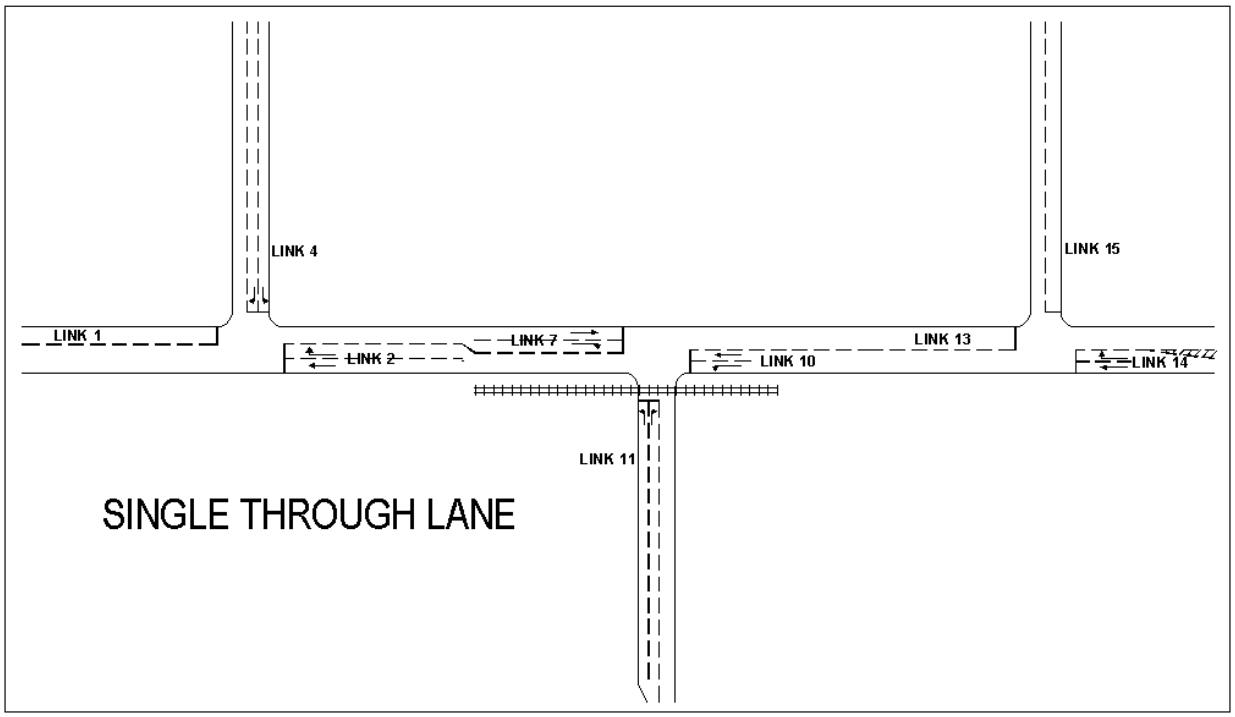


Figure 5.2.1 – Single Lane Arrangement (As per the proposed concept design for the Revocation)

A single lane through the existing SH1 Revocation corridor from Te Moana Road through to beyond the Ngaio Road intersection has been modelled. Right turning lanes have been incorporated for the right turn movements from the existing SH1 into Te Moana Road, Elizabeth Street and Ngaio Road respectively.

A pedestrian phase has been allowed for at both Elizabeth Street and Ngaio Road which allows for a pedestrian movement across all arms of the intersection. It has also been allowed to run in each cycle to obtain a 'worst case' scenario expected. The pedestrian phase at Te Moana Road has been omitted from the S-Paramics modelling due to the low impact on the modelled peak periods. It will be included in the detailed civil design layouts. A common cycle time has been used for all 3 intersections and manually adjusted offsets have been used to co-ordinate all 3 sets of signals along the corridor.

5.4 2031 Two Lane Arrangement

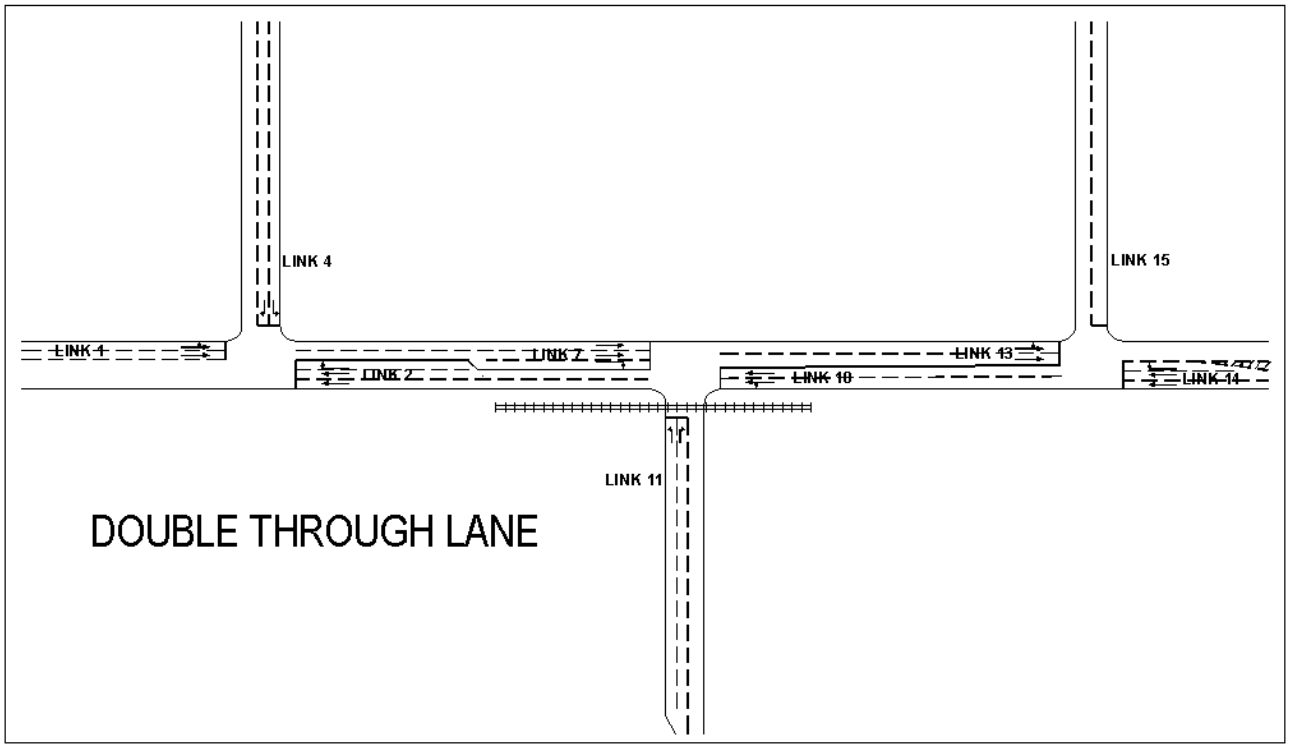


Figure 5.2.2 – Two Lane Arrangement

This allows for two through lanes to be provided on the northbound approach to Te Moana Road intersection and to carry the two lanes through the town centre area to merge to one lane beyond the Ngaio Road intersection, as the current lane arrangement operates. A similar arrangement is provided for the southbound approach with two lanes formed on the approach to Ngaio Road which carries through to beyond the Te Moana intersection. Right turning lanes have also been incorporated for the right turn movements from the existing SH1 into Te Moana Road, Elizabeth Street and Ngaio Road respectively.

A pedestrian phase has been allowed for at both Elizabeth Street and Ngaio Road which allows for a pedestrian movement across all arms of the intersection. It has also been allowed to run in each cycle to obtain a 'worst case' scenario expected. The pedestrian phase at Te Moana Road has been omitted from the S-Paramics modelling due to the low impact on the modelled peak periods. It will be included in the detailed civil design layouts. A common cycle time has been used for all 3 intersections and manually adjusted offsets have been used to co-ordinate all 3 sets of signals along the corridor.

5.5 2031 Single Lane with Enhanced Turning Lanes (Hybrid Layout)

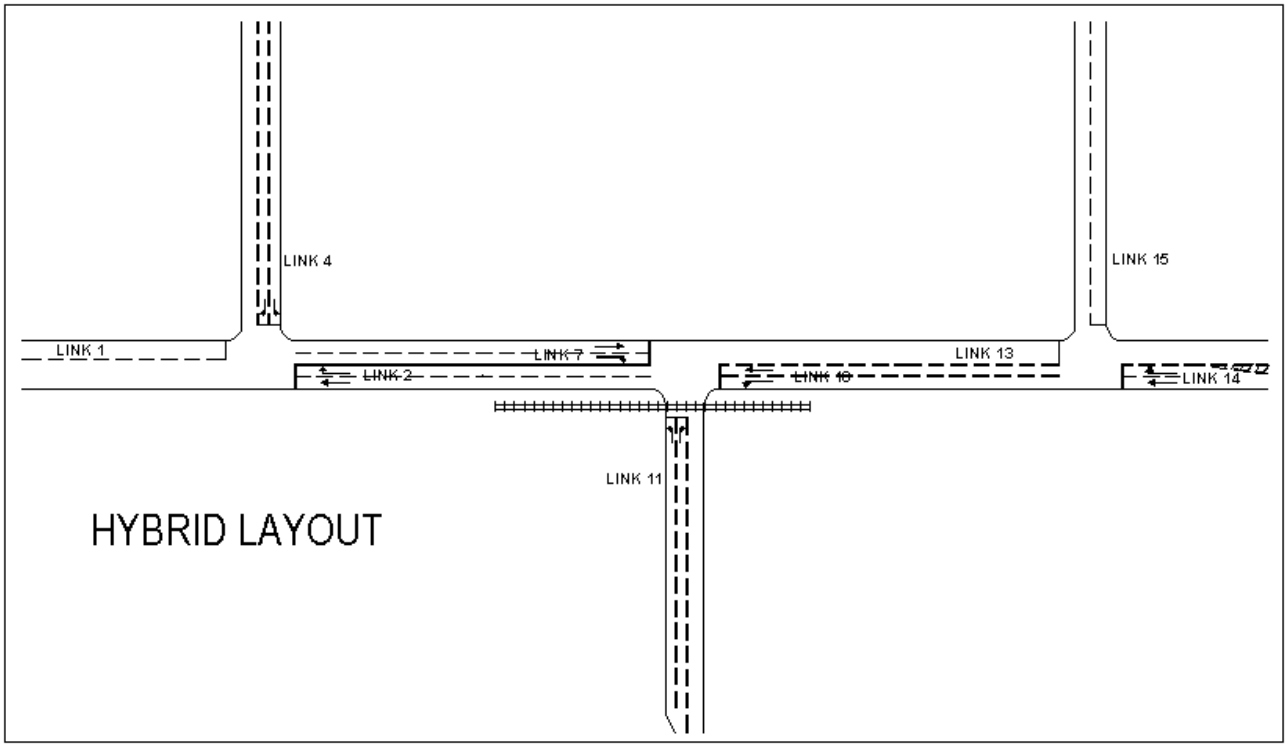


Figure 5.2.3 – Hybrid Lane Arrangement

This allows for a single lane through on the northbound approach to Te Moana Road intersection and to carry a single through lane through the town centre area with an extended right turn lane from Te Moana Road to allow for queuing right turning traffic turning into Elizabeth Street. A similar arrangement is provided for the southbound direction with two lanes formed on the exit from Ngaio Road intersection with a dedicated left turning lane into Elizabeth Street and a single through lane. Two lanes will then continue from Elizabeth Street with a single through lane and an extended right turning lane to allow for queuing traffic turning into Te Moana Road.

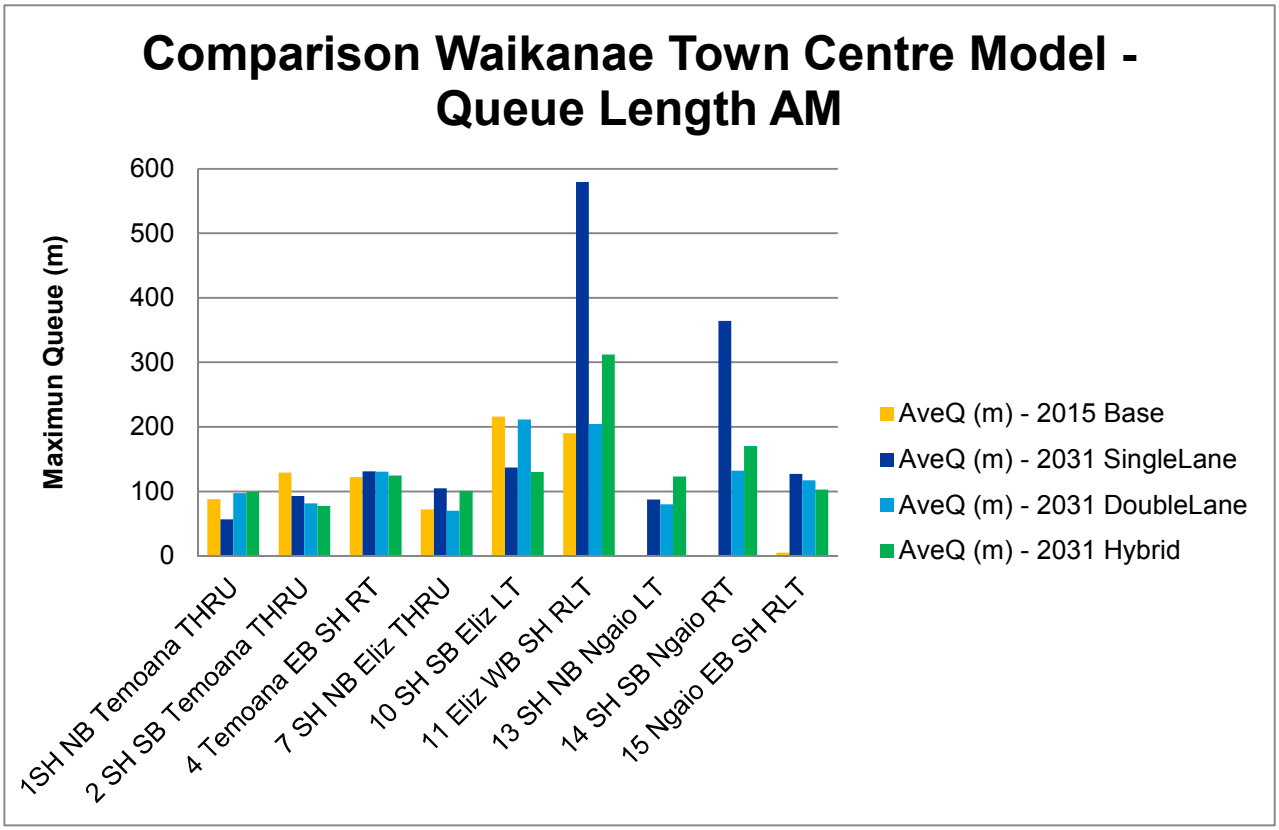
A pedestrian phase has been allowed for at both Elizabeth Street and Ngaio Road which allows for a pedestrian movement across all arms of the intersection. It has also been allowed to run in each cycle to obtain a 'worst case' scenario expected. The pedestrian phase at Te Moana Road has been omitted from the S-Paramics modelling due to the low impact on the modelled peak periods. It will be included in the detailed civil design layouts. A common cycle time has been used for all 3 intersections and manually adjusted offsets have been used to co-ordinate all 3 sets of signals along the corridor.

5.6 Results & Comparisons

The results from the Paramics models have been directly compared to the 2015 Base scenario to allow a comparison to be made between the three options against the base scenario.

Queue length and travel time graphs have been plotted to show the Paramics results on each of the main links through the Waikanae Town Centre area as shown in Figures 5.2.4 to 5.2.16 below.

Figure 5.2.4 & 5 - Queue Lengths in AM Peak



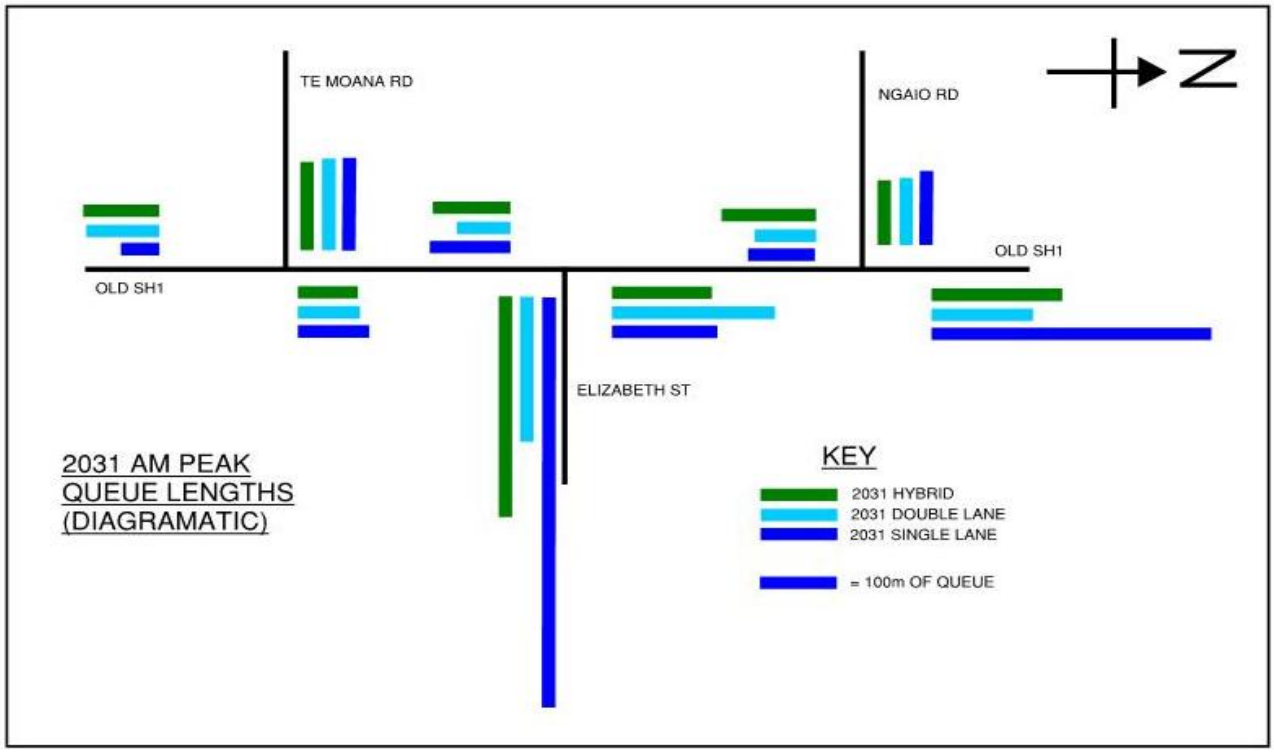
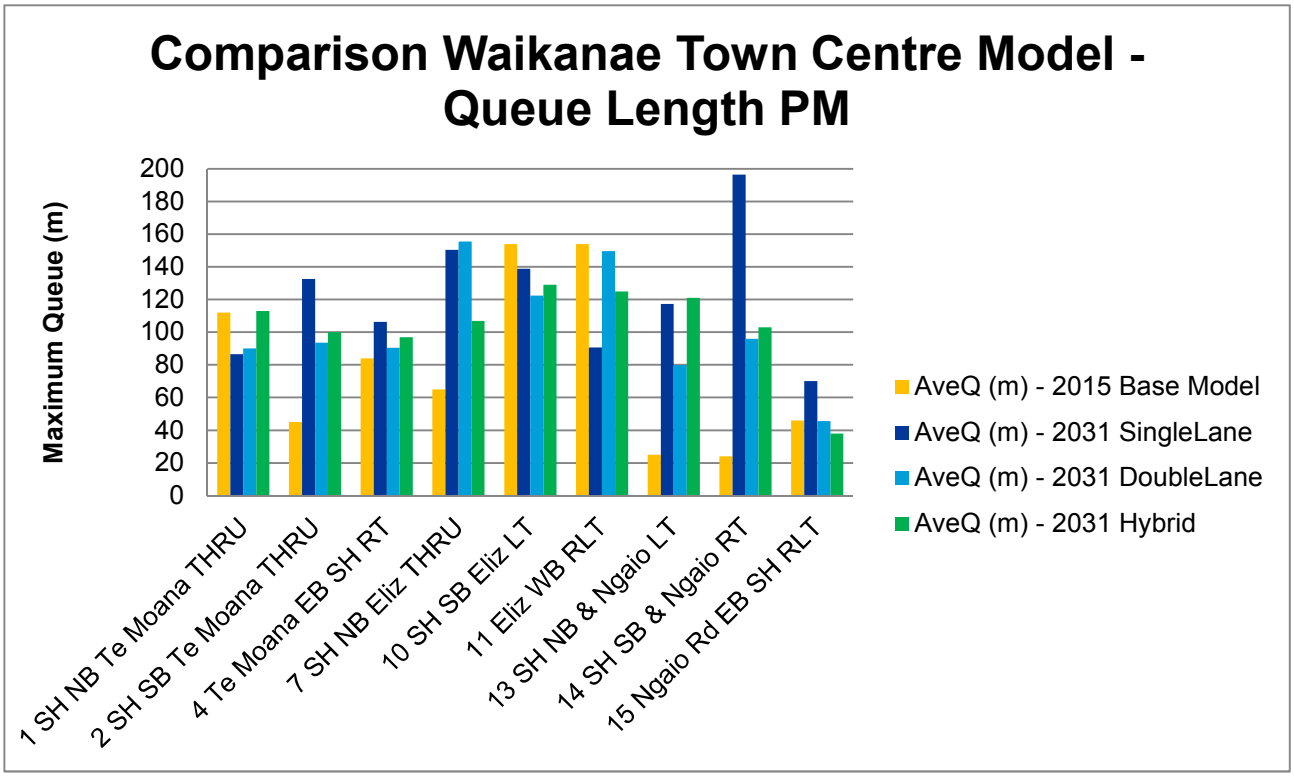
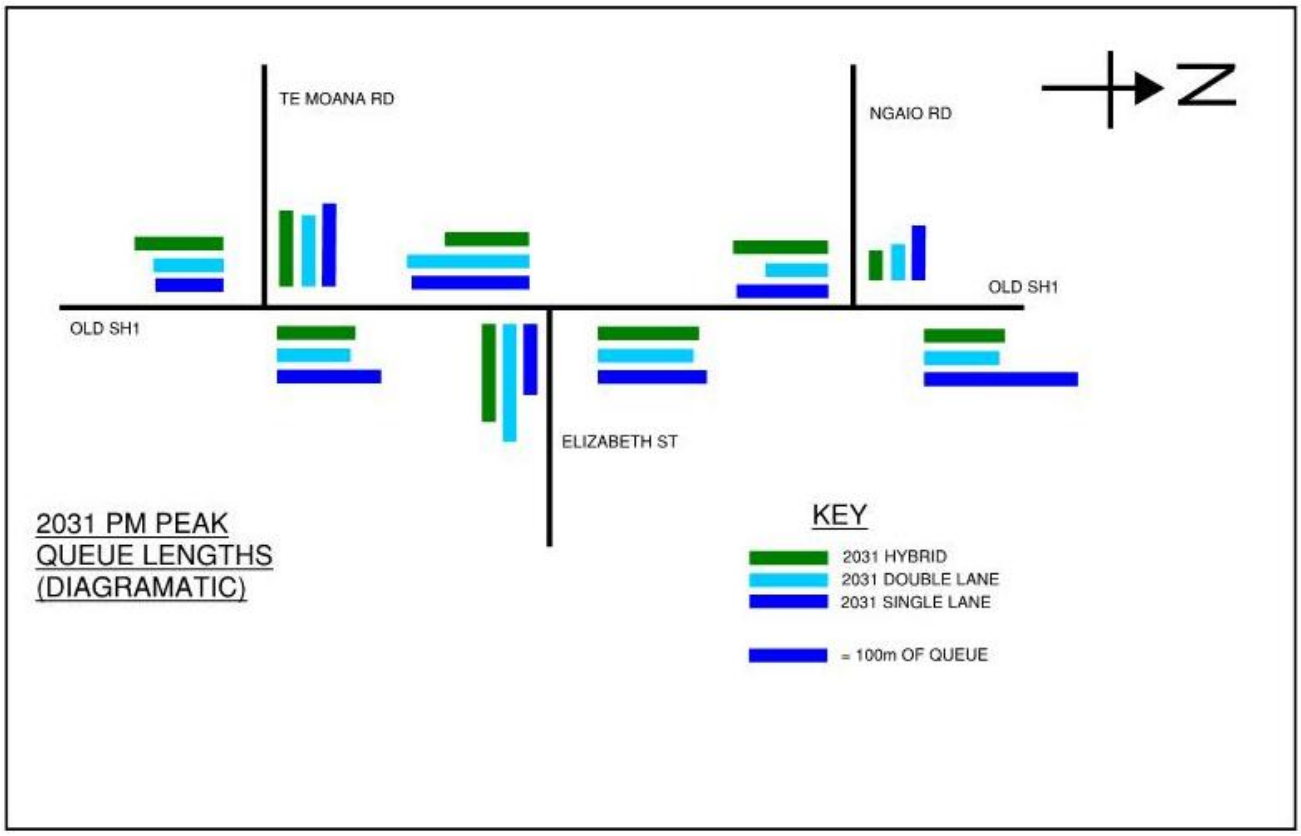


Figure 5.2.6 & 7 - Queue Lengths in PM Peak





Journey times through the main routes through the town centre area have also been plotted and these are provided below.

5.6.1 AM Peak

Figure 5.2.8 - Route 1 SH1 Northbound AM Peak Journey Time Graph

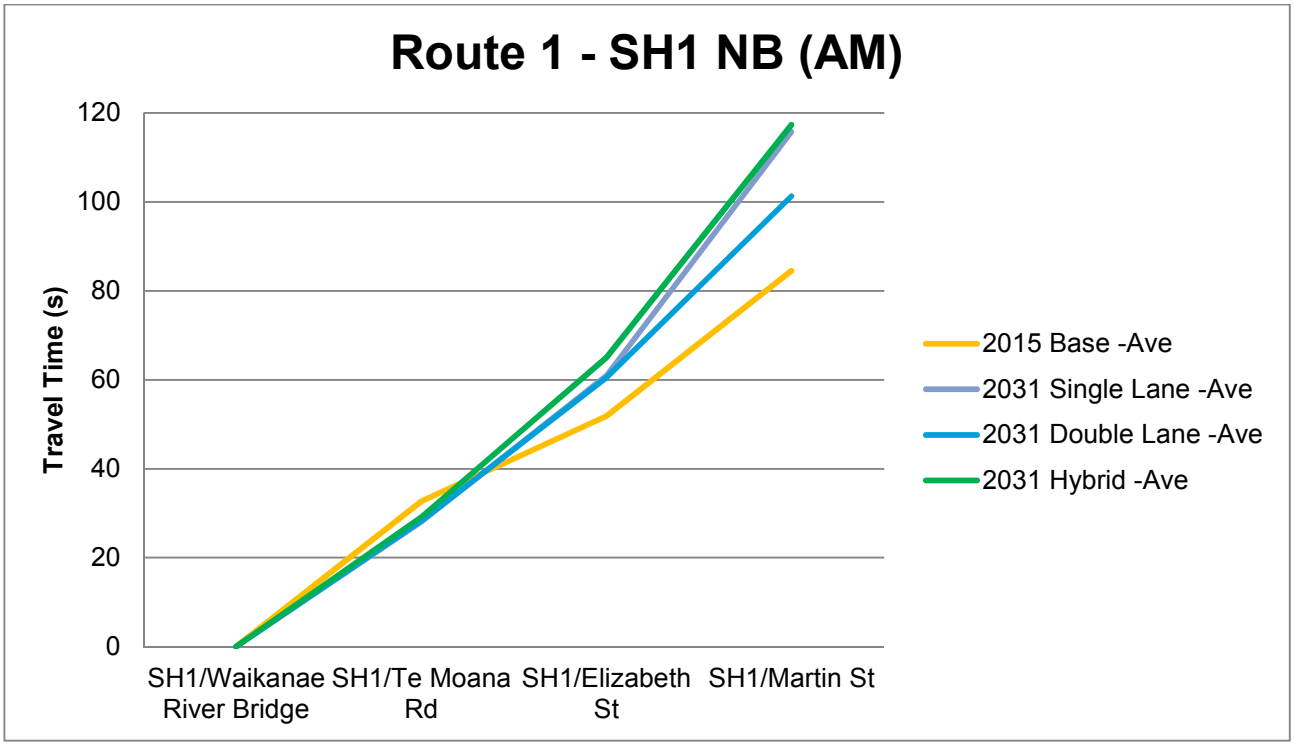


Figure 5.2.9 - Route 1 SH1 Southbound AM Peak Journey Time Graph

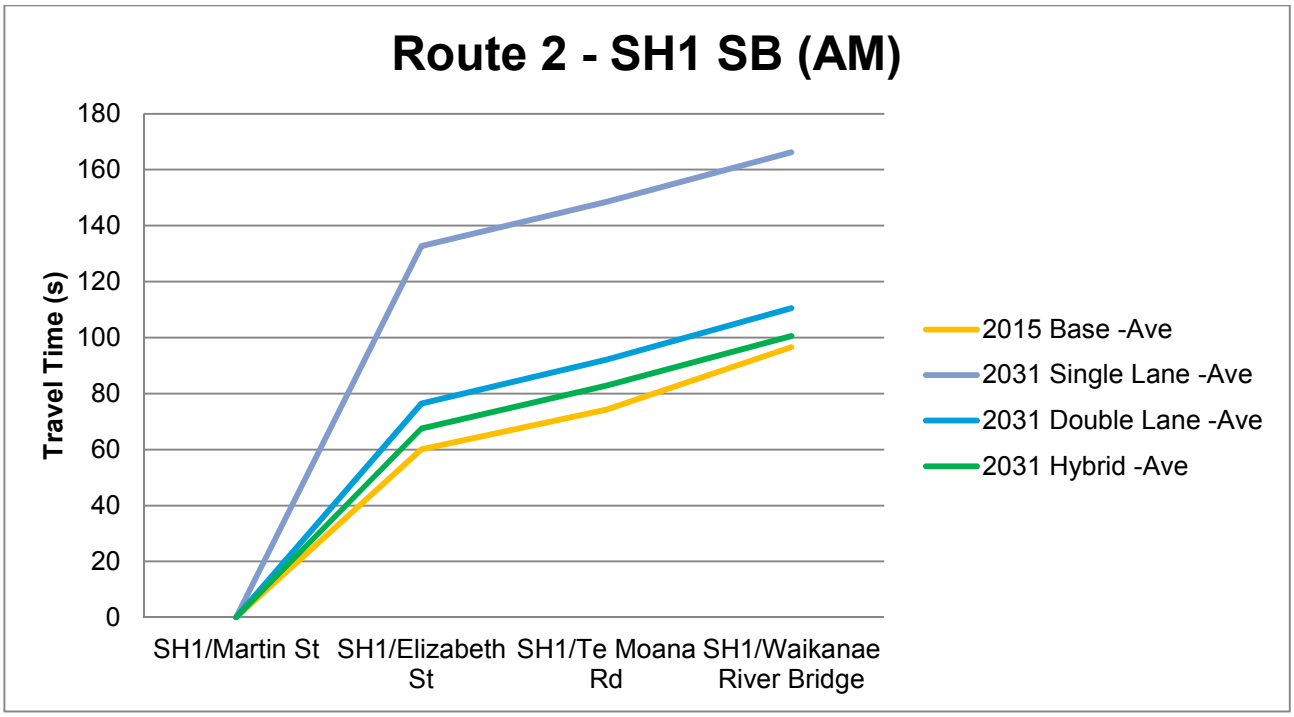


Figure 5.2.10 - Route 3 Te Moana Road to Elizabeth Street AM Peak Journey Time Graph

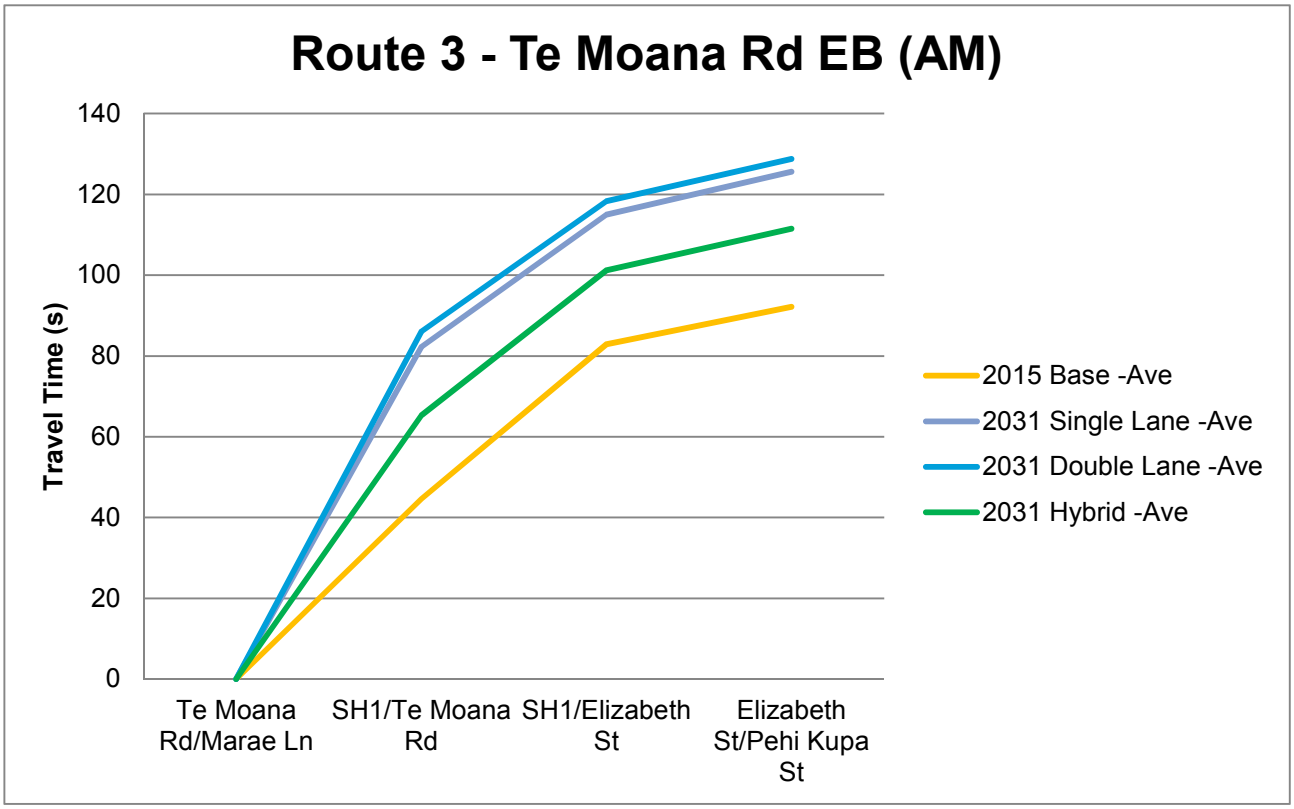
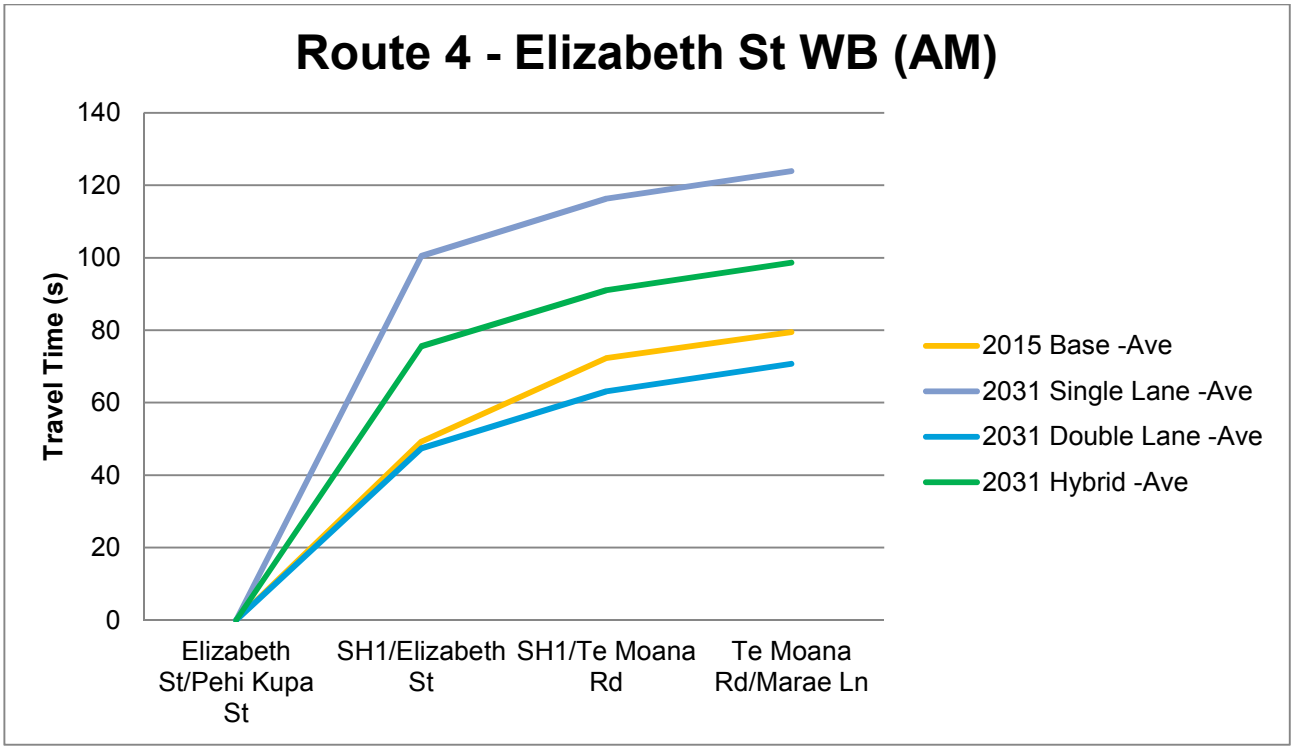


Figure 5.2.11 - Route 4 Elizabeth Street to Te Moana Road AM Peak Journey Time Graph



5.6.2 PM Peak

Figure 5.2.12 - Route 1 SH1 Northbound PM Peak Journey Time Graph

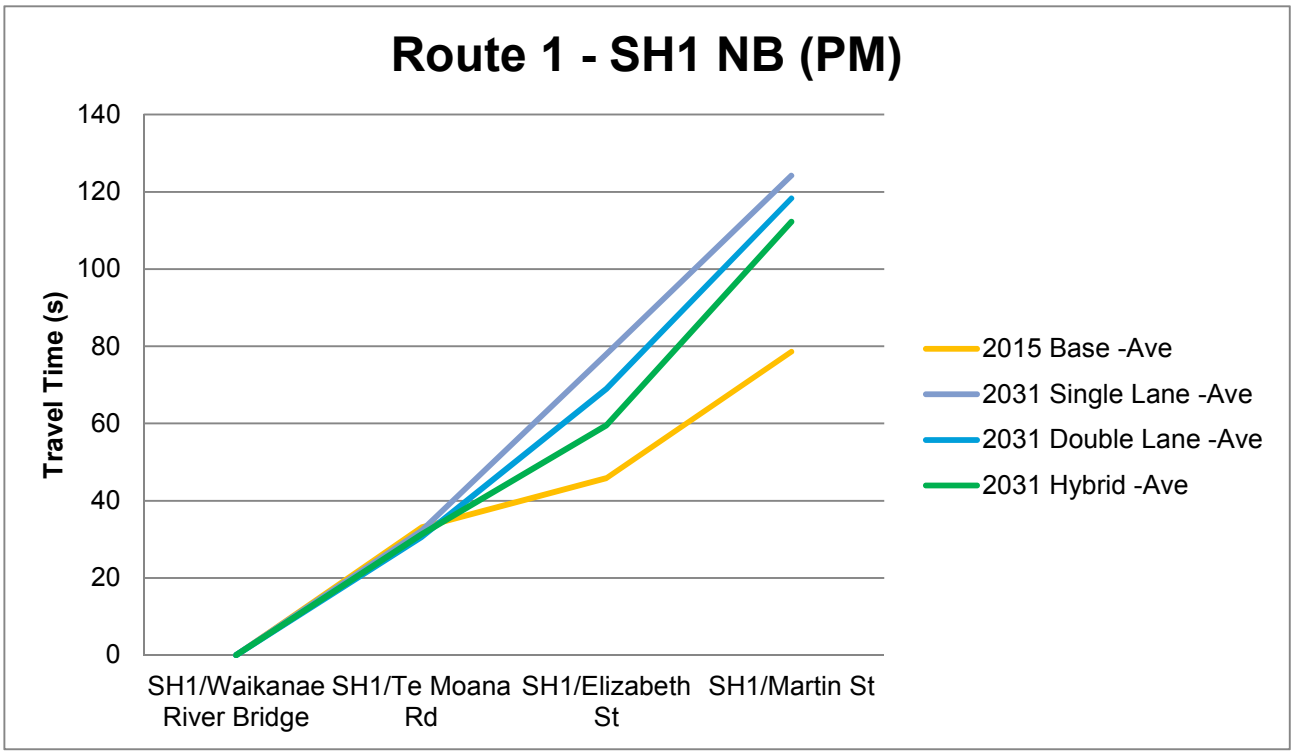


Figure 5.2.13 - Route 1 SH1 Southbound PM Peak Journey Time Graph

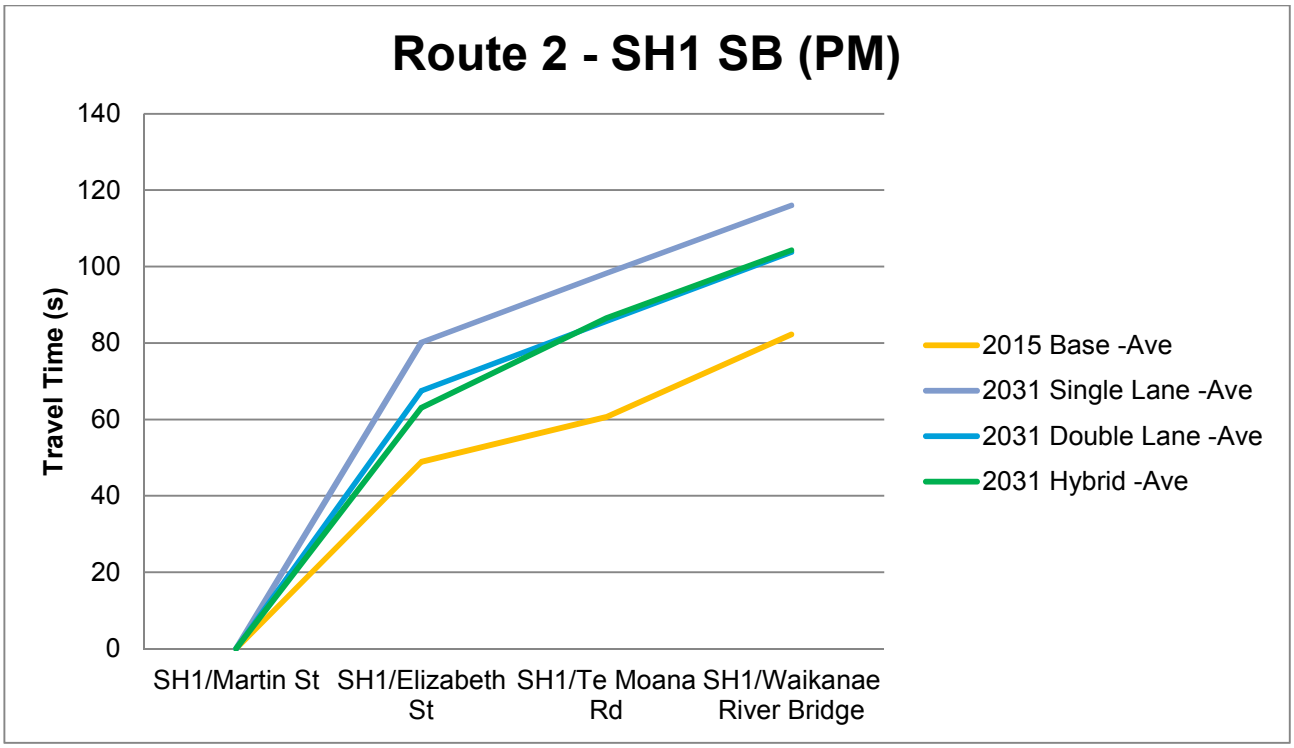


Figure 5.2.14 - Route 3 Te Moana Road to Elizabeth Street PM Peak Journey Time Graph

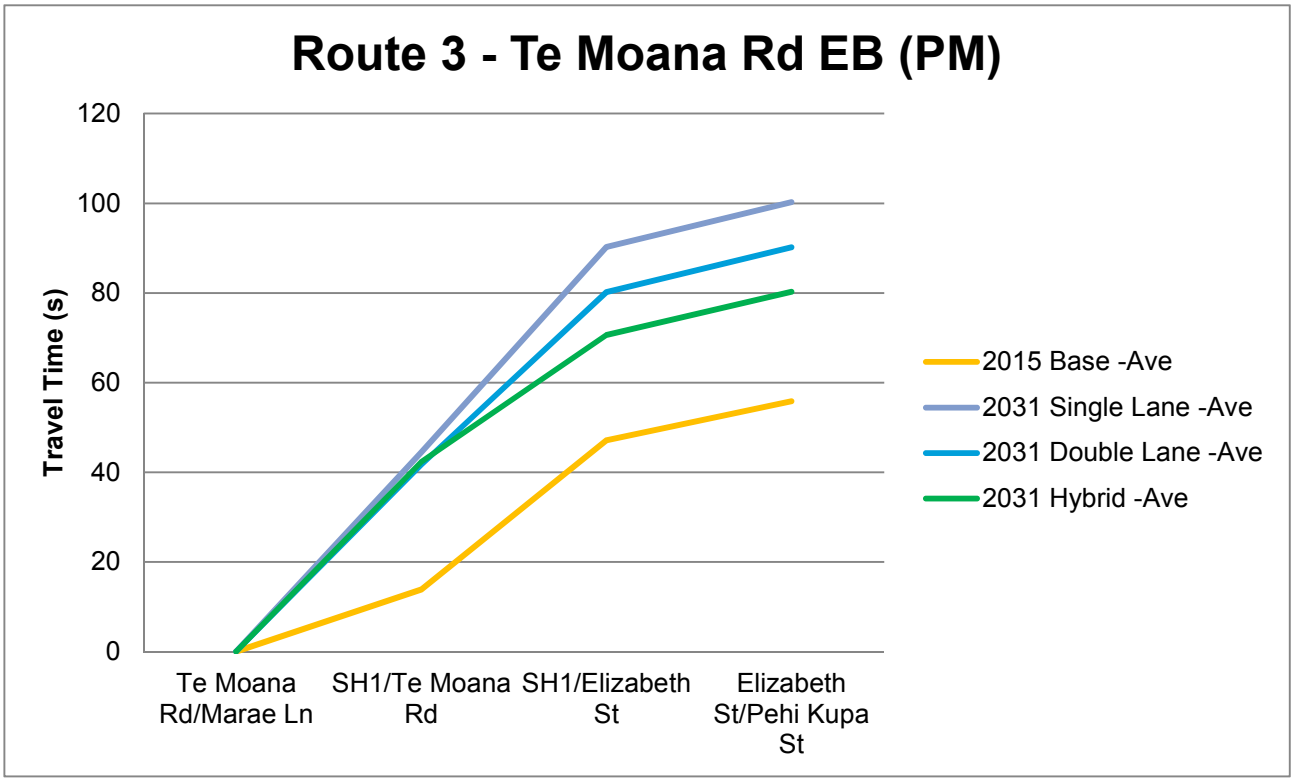
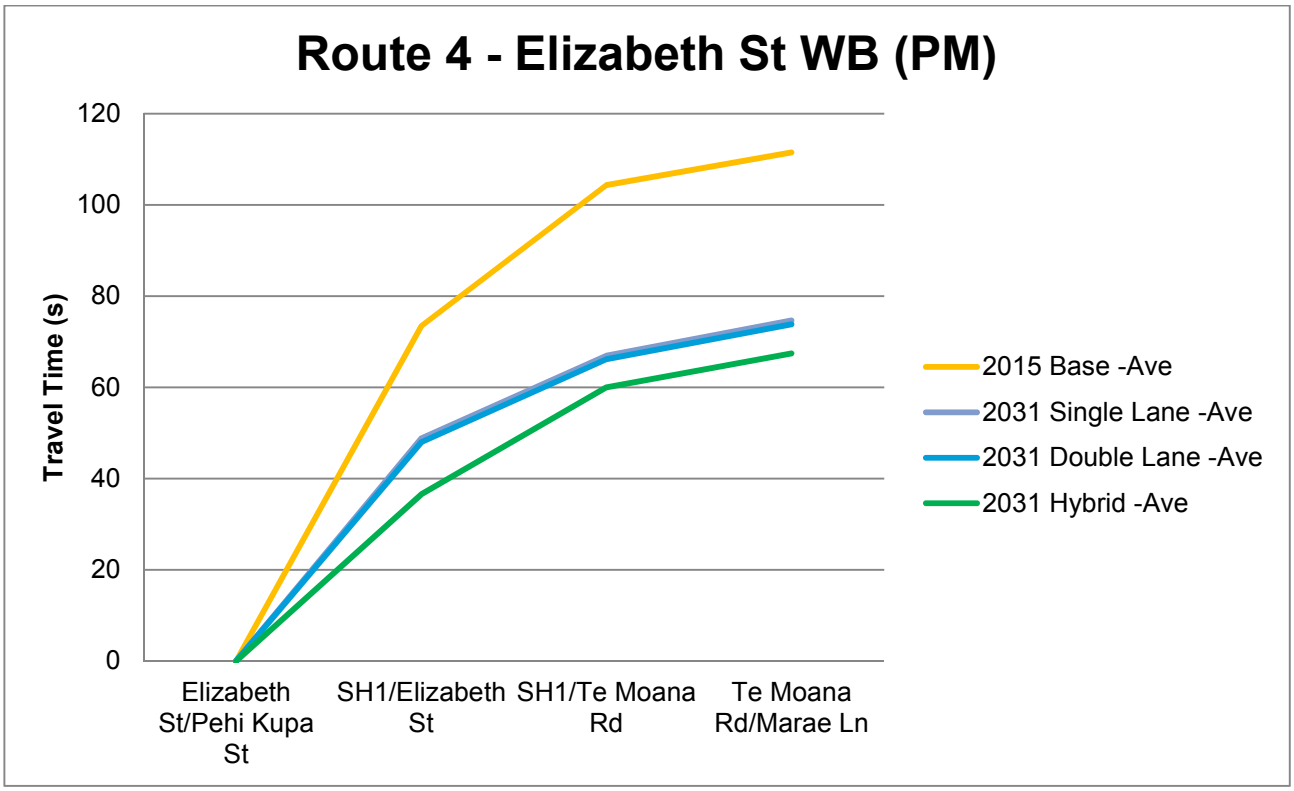


Figure 5.2.15 - Route 4 Elizabeth Street to Te Moana Road PM Peak Journey Time Graph



Levels of service for the three intersections have also been analysed for the 2031 design year and are contained in Table 5.2.14 below: -

Table 5.2.16 – Design Year 2031 Intersection Levels of Service

Intersection	AM Peak			PM Peak		
	Single Lane	Two Lane	Hybrid	Single Lane	Two Lane	Hybrid
Te Moana Road	C	B	C	C	B	C
SH1 Northbound	B	B	C	B	B	C
SH1 Southbound	A	A	C	A	A	B
Te Moana Road	D	D	D	E	D	D
Elizabeth Street	F	D	C	F	C	C
SH1 Northbound	C	B	B	D	B	B
SH1 Southbound	F	D	D	E	C	B
Elizabeth Street	F	E	D	F	E	E
Ngaio Road	C	A	C	B	A	B
SH1 Northbound	B	A	A	A	A	A
SH1 Southbound	B	A	B	A	A	A
Ngaio Road	F	F	E	F	F	F

Table 5.2.17 - Level of service bands

Level of Service	
Band	**Avg Delay (s/pcu)**
A	0-10
B	10-20
C	20-35
D	35-55
E	55-80
F	80+

Main areas of interest are as follows:

- Single lane option shows higher levels of queuing on Elizabeth Street & Ngaio Road in the AM Peak compared to both 2015 and the 2031 Two Lane & Hybrid arrangements.
- Single lane arrangement shows higher levels of queuing on the SH1 Southbound approach to the Ngaio Road intersection compared to the two lane & Hybrid option
- Single lane arrangement shows high levels of queuing on southbound SH1 between Elizabeth St & Te Moana intersections.
- Single lane arrangement shows increased journey times over the 2015 base on Southbound SH1 and Elizabeth Street to Te Moana Road routes in AM Peak even with improved optimisation
- Journey times in both single and two lane arrangement show increases in PM peak over 2015 base on most routes
- Levels of service show the expected improvements from the single lane to the two lane arrangement due to the extra lane capacity offered by that design.

- Level of service for the Hybrid design shows a reasonable compromise between then the single land and two lane options.

5.7 Increased Train Frequency

There is currently a proposal by GWRC in the Wellington Regional Rail Plan to increase the frequency of service on the Kapiti Rail line which will require analysis to determine the effects on the local road network due to the at grade crossing across Elizabeth Street as trains enter and exit from Waikanae Station.

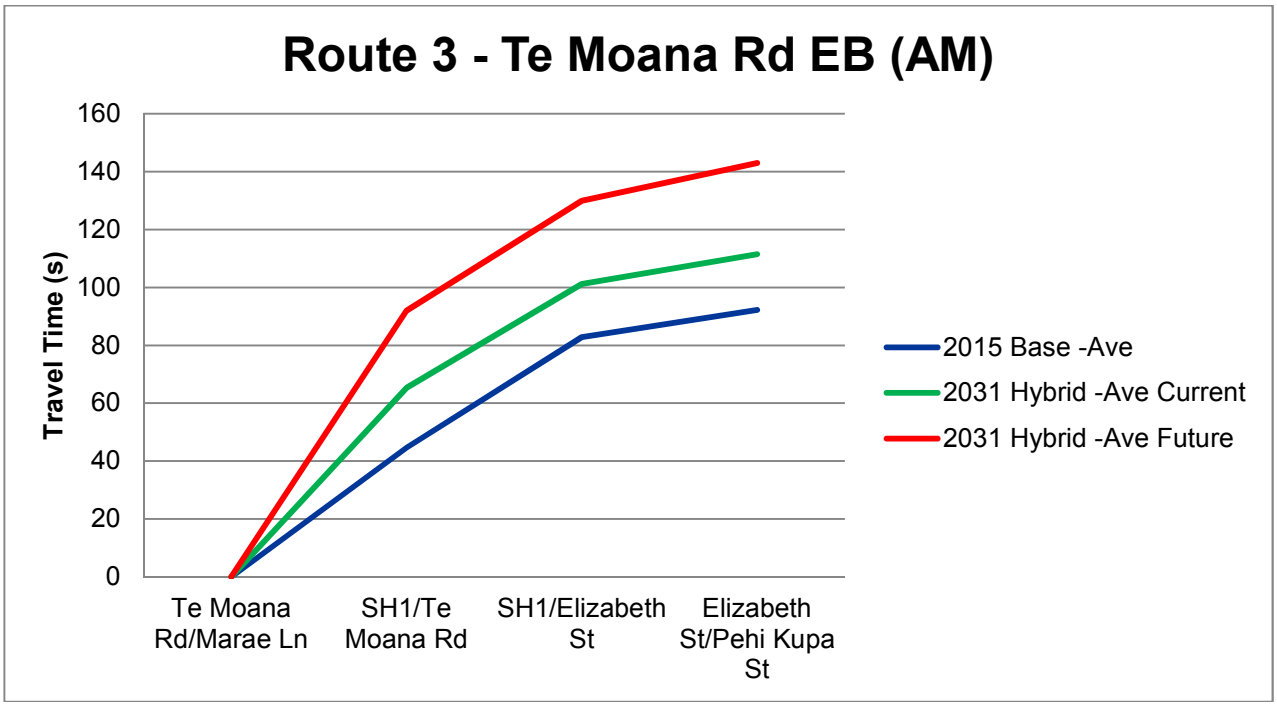
With the enhanced train frequency there will be additional delays due to more frequent train services that will affect the old SH1/Elizabeth Street intersection to the greatest degree.

The 2031 Design year has been run in the model with the enhanced train frequency (Future) and the results compared to the previous timetable (Current) with the Hybrid lane arrangement. This provides a reasonable assessment of the potential impacts the increased train service will have on the Waikanae town centre area.

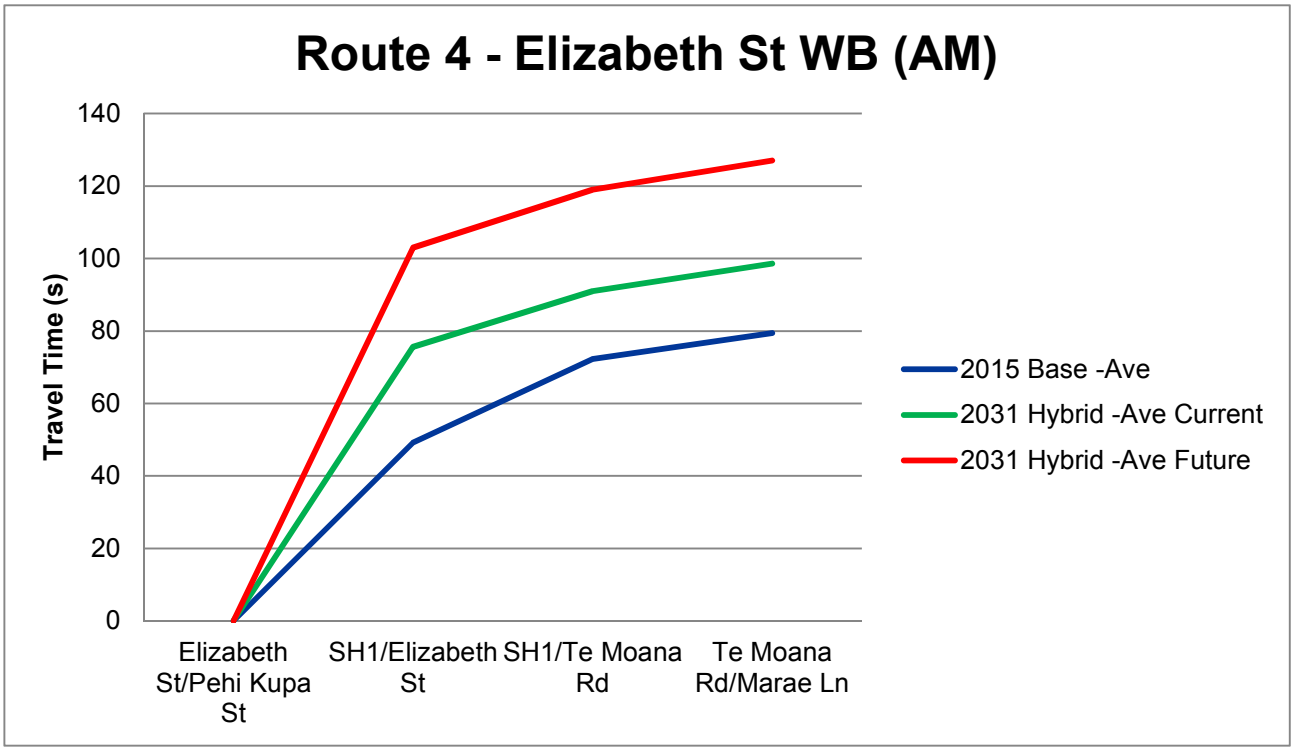
The analysis shows that there is an insignificant change to travel times on Routes 1 & 2 in both peak periods for the Hybrid arrangement. There is however an increase in travel times for Routes 3 & 4 which are the Eastbound and Westbound routes.

The resulting travel time graphs for both Routes 3 & 4 in the AM & PM Peaks are shown below in Figures 5.3.1 to 5.3.4 with queue length graphs shown in figures 5.3.6 & 7.

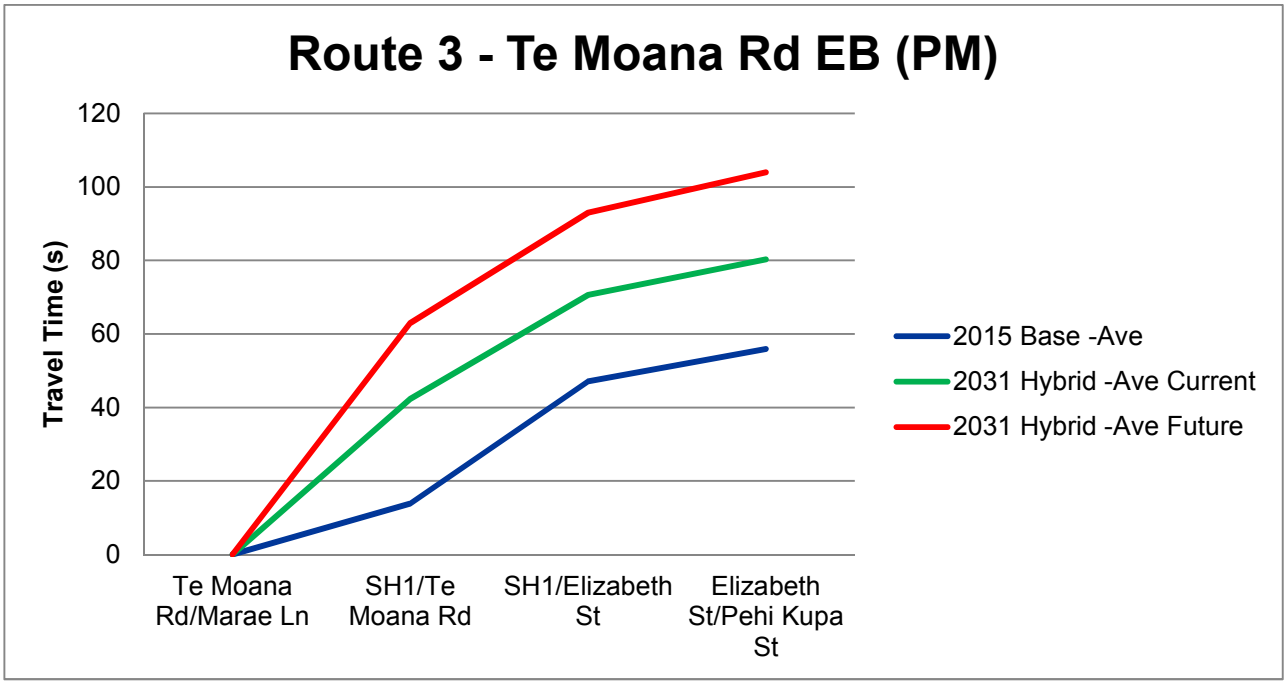
5.3.1 – Route 3 Te Moana Road to Elizabeth Street AM Peak Journey Time Graph (Current vs Future Train Timetable)



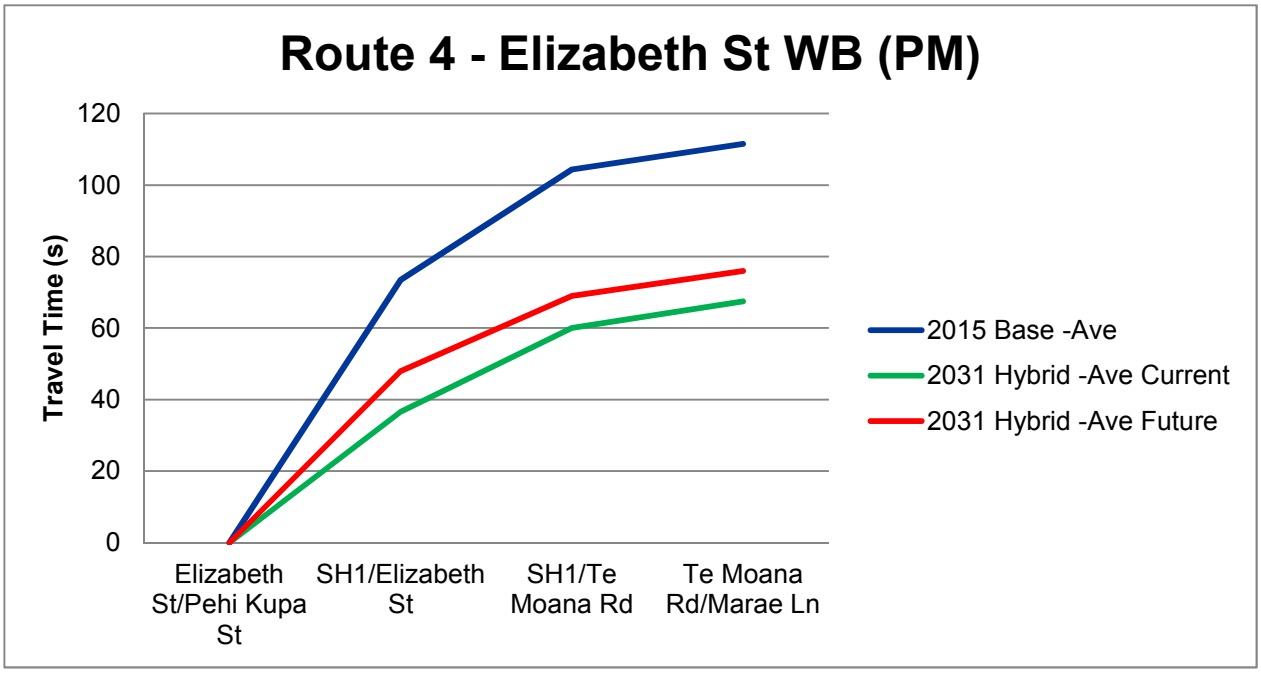
5.3.2 – Route 4 Elizabeth Street to Te Moana Road AM Peak Journey Time Graph (Current vs Future Train Timetable)



5.3.3 – Route 3 Te Moana Road to Elizabeth Street PM Peak Journey Time Graph (Current vs Future Train Timetable)



5.3.4 – Route 4 Elizabeth Street to Te Moana Road PM Peak Journey Time Graph (Current vs Future Train Timetable)



In summary the enhanced train frequency results in the following increases in journey time for the two routes:

Table 5.3.5 – Travel Time Increases due to higher frequency trains

Peak	Route	2031 Journey Time with Current Timetable (Seconds)	2031 Journey Time with High Frequency Timetable (Seconds)	Increase
AM	1 - Northbound	117	111	N/A
	2 - Southbound	101	100	N/A
	3 -Eastbound	112	143	**30%**
	4 - Westbound	99	127	**30%**
PM	1 – Northbound	112	113	N/A
	2 - Southbound	104	103	N/A
	3 - Eastbound	80	104	**20%**
	4 - Westbound	67	76	**10%**

Figure 5.3.6 – Queue Length Comparison Graph – 2031 AM Peak (Current vs Future Train Timetable)

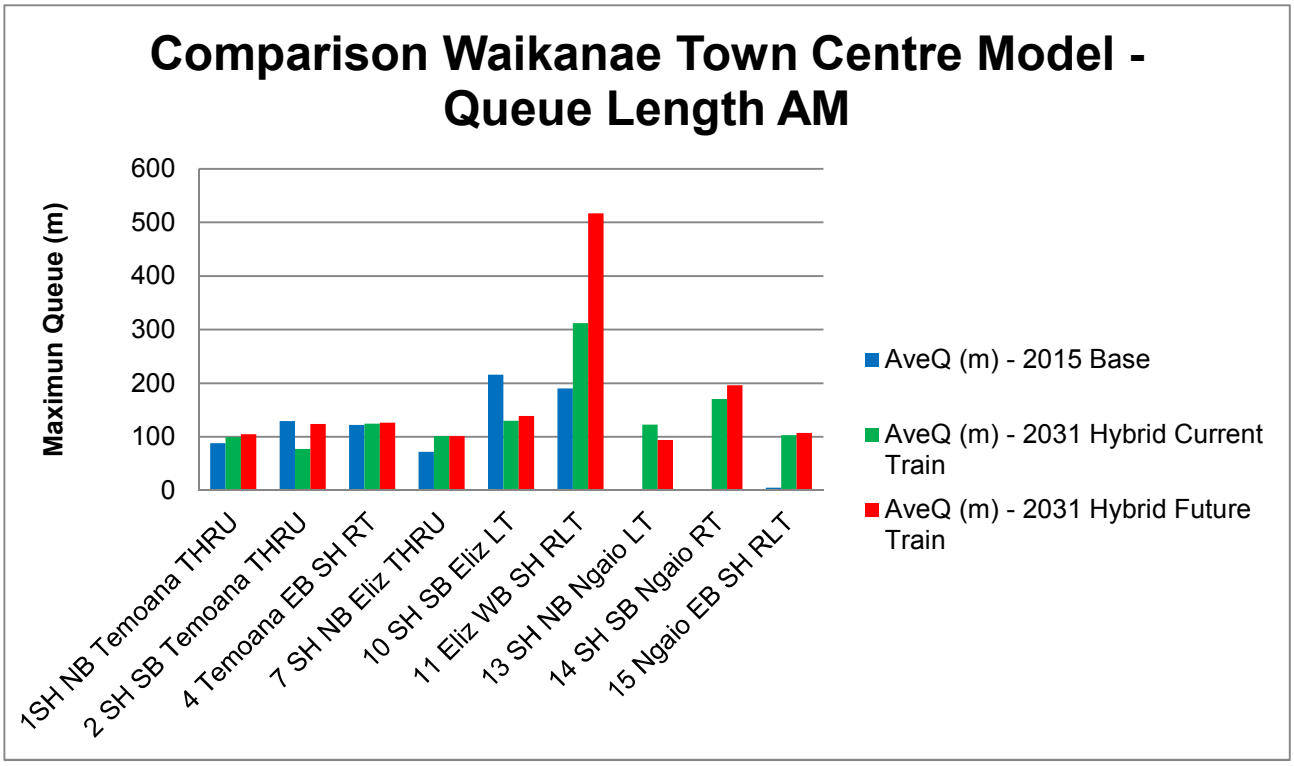
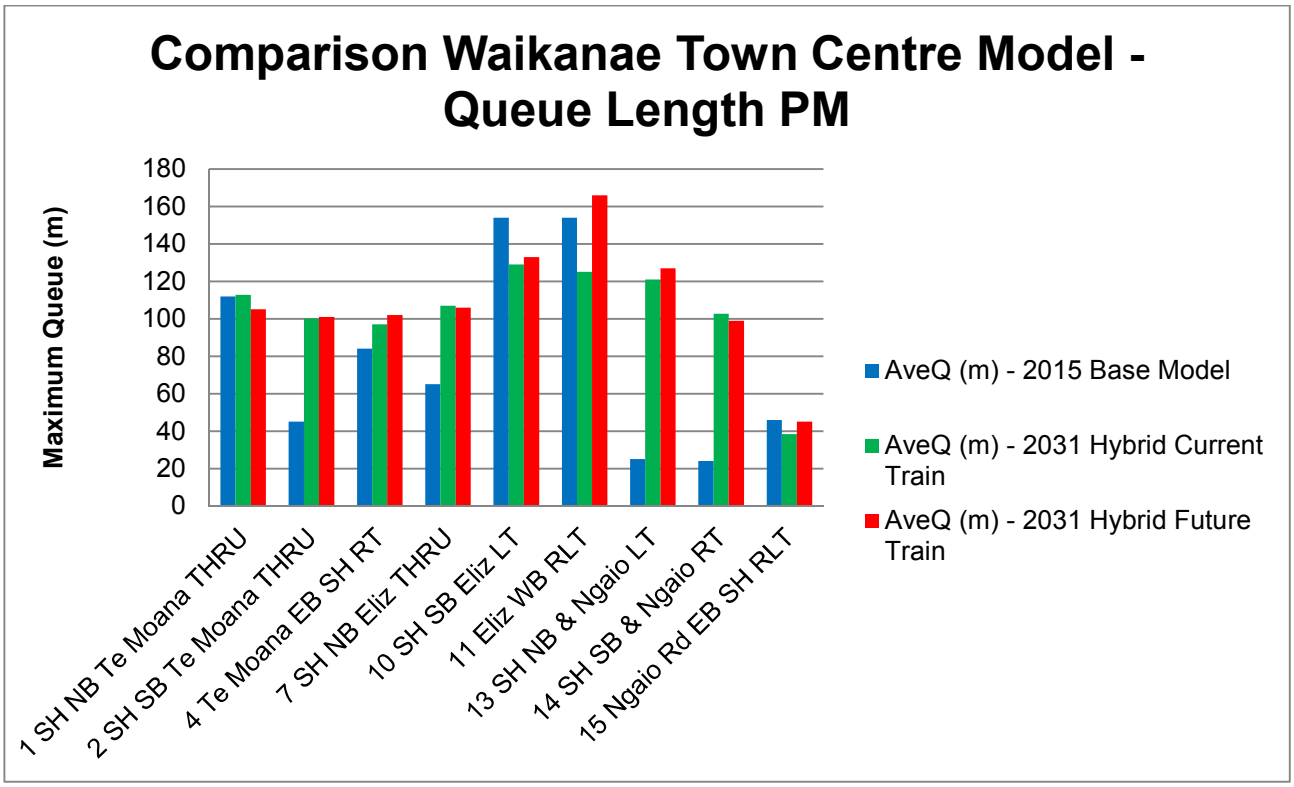


Figure 5.3.7 – Queue Length Comparison Graph – 2031 PM Peak (Current vs Future Train Timetable)



When the new train timetable is implemented on the Hybrid lane arrangement the AM Peak results show that there is:

- An increase in queue length (approximately 200m) on Elizabeth Street compared to the queues generated by the current rail timetable
- Journey times in both the Eastbound & Westbound directions increase in duration by around 30% compared to the journey times generated by the current rail timetable

The PM Peak results indicate that there is:

- Less impact on queue lengths on Elizabeth Street (approximately only an increase of 40m) compared to the queues generated by the current rail timetable
- Journey times are only increased by around 20% Eastbound and 10% Westbound compared to the journey times generated by the current rail timetable.

6 Conclusion

The key areas from the Paramics modelling that allow direct comparisons to the base 2015 model are the:

- Queue lengths found in the model for the three main options
- Travel times through the town centre area
- Existing train timetable has been used for consistency

The queue lengths for the main traffic links have been analysed and are presented below.

Table 6.1.1 – AM Peak Queue Lengths

No.	Link Description	AveQ (m) - 2031 Single Lane	AveQ (m) - 2031 Double Lane	AveQ (m) 2031 Hybrid	AveQ (m) - 2015 Base
1	SH NB Te Moana THRU	57	97	99	88
2	SH SB Te Moana THRU	93	81	78	129
4	Te Moana EB SH RT	131	130	125	122
7	SH NB Eliz THRU	105	70	101	72
10	SH SB Eliz LT	137	212	130	216
11	Eliz WB SH RLT	580	205	312	190
13	SH NB Ngaio LT	87	80	123	-
14	SH SB Ngaio RT	364	132	170	-
15	Ngaio EB SH RLT	127	117	103	-

Table 6.1.2 – PM Peak Queue Lengths

No.	Link Description	AveQ (m) - 2031 Single Lane	AveQ (m) - 2031 Double Lane	AveQ (m) 2031 Hybrid	AveQ (m) - 2015 Base
1	SH NB Te Moana THRU	87	90	113	112
2	SH SB Te Moana THRU	133	94	100	45
4	Te Moana EB SH RT	106	91	97	84
7	SH NB Eliz THRU	150	156	107	65
10	SH SB Eliz LT	139	122	129	154
11	Eliz WB RLT	91	150	125	154
13	SH NB & Ngaio LT	117	80	121	25
14	SH SB & Ngaio RT	196	96	103	24
15	Ngaio Rd EB SH RLT	70	46	38	46

The findings from the modelling are summarised below:

- Initial observations show that in the 2031 AM Peak the single lane arrangement performs noticeably worse than the two lane & hybrid option for Elizabeth Street. This is due to the reduced green time that can be offered to that approach due to the co-ordination between the 3 signalised intersections.
- The southbound existing SH1 also shows high levels of queuing in the AM Peak for the single lane arrangement. This is in excess of the current southbound SH1 queues on the approach to Elizabeth

Street which is where the current SH1 queues exist as the Ngaio Road intersection is free flowing in 2015.

- The 2031 PM peak is reasonably consistent for all options, although both single and two lane arrangements show excessive queues on the northbound approach to Elizabeth Street caused in part by the additional traffic from the Park and Ride site which allows a left turn only exit onto the northbound carriageway between the Te Moana & Elizabeth Street intersections. The right turn lanes for both the single and two lane options will in addition be compromised by excessive queues blocking the existing SH1. The Hybrid option provides the best result due to the additional capacity of the full length right turn lanes offered by minimising the amount of blocking that the right turning vehicles will have on the ahead (northbound) traffic.
- The journey times on the Eastbound route between Te Moana Road and Elizabeth Street are increased from the base model journey time in both peaks in all three lane arrangement options. In the AM Peak the hybrid arrangement results in only a 19 second increase compared to the other 2031 design options which produce a 33 and 36 second increase respectively. In the PM Peak the Hybrid arrangement results in a 25 second increase whereas the other two design options produce a 35 and 45 second increase.
- The journey times on the Westbound direction between Elizabeth Street and Te Moana Road are increased by the single land & hybrid arrangements in the 2031 AM peak over the base model. The hybrid arrangement increases the journey time by 18 seconds from the base, whereas the single lane arrangement increases the average journey time by 43 seconds.
- The journey times on the Westbound journeys between Elizabeth Street and Te Moana Road are reduced by all three design arrangements in the 2031 PM peak over the base model. The hybrid arrangement achieves the greatest reduction in journey time with a decrease from the base year by 44 seconds.
- Levels of service between the design options vary to the expected degree – the two lane arrangement provides significant additional capacity to the network which in turn will allow more vehicles to pass through the signals in similar green times. This in turn reduces queued vehicles and aids in the co-ordination of the signals as traffic can move through the network more easily and generally in shorter platoons. This increase in capacity and co-ordination improves the level of service to a significant degree The Hybrid design provides a more suitable lane arrangement maximising the available carriageway to achieve improved travel times whilst providing single through lanes through the Waikanae town centre area.
- The model has been run with a pedestrian phase running every cycle, which although possible around train departure times is unlikely throughout the hour. A less conservative approach would be to model a pedestrian phase every other cycle which would allow some additional green time to be reallocated to the traffic phases. The reality is somewhere in between the two scenarios, but additional green time however small will potentially reduce some queues and further enhance co-ordination.
- When the new train timetable is implemented on the Hybrid lane arrangement the AM Peak results show that there is an increase in queue length (approximately 200m) on Elizabeth Street compared to the queues generated by the current rail timetable. Journey times in both the Eastbound & Westbound directions increase in duration by around 30% compared to the journey times generated by the current rail timetable
- For the future proposed train timetable the PM Peak results indicate that there is less impact on queue lengths on Elizabeth Street (approximately only an increase of 40m) compared to the queues generated by the current rail timetable. Journey times are only increased by around 20% Eastbound and 10% Westbound compared to the journey times generated by the current rail timetable.

7 Recommendation:

Based on the traffic modelling the recommendation is to proceed with the Hybrid design option as it minimises journey times, lengths of queues and provides the best compromise based on the 2031 flows and levels of service provided at the signals.

If the Hybrid option is selected then the traffic signal phasing could be examined to determine if further efficiencies can be found to the signal timings to further optimise the East/West connectivity even if this has an effect on the North/South connectivity along the old SH1 corridor.