**Before a Board of Inquiry**
**Northern Corridor Improvements Project**

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|---|---|
| Under | the Resource Management Act 1991 ('the Act') |
| In the matter of | a Board of Inquiry appointed under section 149J of the Act to consider notices of requirement for designations and resource consent applications by the New Zealand Transport Agency for the Northern Corridor Improvements Project |

# Statement of evidence of Terry Philip Church for the New Zealand Transport Agency (Transportation - Design)

Dated 20 April 2017

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# STATEMENT OF EVIDENCE OF TERRY PHILIP CHURCH FOR THE NEW ZEALAND TRANSPORT AGENCY

## 1 Qualifications and experience

1.1 My full name is Terry Philip Church.

1.2 I am a Senior Associate at Flow Transportation Specialists Limited ('**Flow'**), a consultancy firm that specialises in traffic engineering and transportation planning. I have been employed by Flow for ten years and before that I was a Work Group Manager at Opus International Consultants, where I was employed for six years.

1.3 I hold a Bachelor of Engineering Technology (Civil) and a New Zealand Certificate in Engineering (Civil), both from Unitec in Auckland. I have specialised in the traffic engineering and transportation planning field in New Zealand and the United Kingdom. I am a Graduate member of the Institute of Professional Engineers New Zealand.

1.4 My work experience includes 17 years in transport planning, working in both New Zealand and the United Kingdom.

1.5 My experience in New Zealand includes being responsible for the transportation planning, including traffic modelling and economic evaluation, of numerous major transport schemes. I have managed the transport assessment of major transport related projects covering regionally significant infrastructure, structure planning, and integrated transport assessments, using a variety of meso and micro simulation traffic modelling suites.

1.6 My local experience of relevance to this Northern Corridor Improvements Project ('**Project**') includes the following:

a I was involved in the development of the Upper Harbour SATURN traffic model used to inform the design and assessment of effects of the Upper Harbour Highway ('**UHH**') from Albany Highway to Westgate in 2001, and subsequently managed the updates to this model in 2008, 2012 and 2015 for the purposes of ongoing

investigation stages associated with the Northern Corridor connection with State highway ('**SH**') 18;

b I was responsible for the traffic modelling, economic evaluation and transport assessment of the SH18 Greenhithe Deviation and Upper Harbour Bridge duplication (which opened in 2007), as well as the SH18 Hobsonville Deviation and SH16 Extension project (which opened in 2011);

c I was responsible for providing transport modelling advice to the Opus project team responsible for the North Harbour Strategic Scoping Study (SH1/SH18 Interchange Upgrade), in 2010/11;

d I was responsible for the transport modelling, economic evaluation and reporting management for three of Auckland's Accelerated Roading Projects, being the SH1 Southern Motorway, SH1 Northern Motorway and SH20A Kirkbride Upgrade, in 2013; and

e I have been involved in the Project, since 2013, providing transport modelling and economic evaluation to the Project Teams during the Indicative Business Case and Detailed Business Case, assessing the transport effects of a range of project options.

1.7 My evidence relates to notices of requirement and resource consent applications lodged by the New Zealand Transport Agency ('**Transport Agency**') with the Environmental Protection Authority on 14 December 2016 for the Project.

## 2 Involvement with the Project

2.1 I am familiar with the area that the Project covers and the State highway and local road network in the vicinity of the Project. As noted in paragraph 1.6 above, I was first engaged to undertake traffic assessments as part of the early planning phases of the Project. I was involved in the early assessment of options during 2010, and have remained involved in the Project since. Specifically, I have acted as the primary transport modeller and transport planner for the Transport Agency for preparation of the Strategic Case, Indicative Business Case, Detailed Business Case and, currently, the post Detailed Business Case phases.

2.2 I have assessed the detailed operational effects of the Project along the Northern Motorway and the UHH, and I have assessed the impacts of the Project on the local road network both during the construction stage and following completion of the Project.

2.3 I am the reviewer of the *Assessment of Transport Effects* (Technical Report) that formed part of the Assessment of Environmental Effects ('**AEE**') lodged in support of the Project.

## 3 Code of Conduct

3.1 I have read and am familiar with the Code of Conduct for Expert Witnesses in the current Environment Court Practice Note (2014), have complied with it in the preparation of this evidence, and will follow the Code when presenting evidence to the Board. I also confirm that the matters addressed in this statement of evidence are within my area of expertise, except where I rely on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

## 4 Scope of evidence

4.1 This evidence addresses the following matters:

a The assessment methodology;

b The transport assessment of Project elements;

c Comments on submissions lodged in relation to the Project; and

d Conclusions.

4.2 In preparing this evidence, I have reviewed the following evidence:

a Mr Glucina, Transport Agency;

b Mr Moore, Project Design;

c Mr Hale, Construction;

d Mr McGregor, Utilities;

e Mr Schofield, Alternatives;

f Mr Burn, Planning (designations);

g Mr McGahan, Planning (resource consents); and

h Mr Clark, assessment of transport effects.

## 5 Executive summary

5.1 My evidence assesses the methodology used to assess the design of the Project. I have been involved with the assessment of alternatives through each of the design phases, including the Strategic Study (2011), the Auckland Accelerated Projects Schematic Plan (2013), the Indicative Business Case (2015), and the preferred and alternative options considered in the Detailed Business Case (2015).

5.2 The assessment of alternative options, including the refinement of the Project design, has been assessed using a consistent platform, being the Upper Harbour SATURN traffic model. The model has been peer reviewed as being fit for purpose.

5.3 My evidence also responds to matters raised by submitters on design elements of the Project, specifically:

a SH18 to SH1 south facing motorway connections;

b Caribbean Drive/Paul Matthews Road Intersection performance; and

c Greville Interchange SH17 to SH1 motorway connections.

5.4 With regards to the SH18 to SH1 (south) motorway connections, the Project does not preclude south facing connections from being constructed. The timing of the southbound connection is dependent on the receiving environment being able to cater for current and forecast traffic volumes.

5.5 The implementation of the northbound connection is less reliant on the receiving environment, and as such may be implemented sooner, subject to further investigation, funding and obtaining the necessary consents.

Even though the Project does not provide these ramp connections, it will provide some benefits for these traffic movements.

5.6 The exclusion of south facing connections between SH18 and SH1 (south) requires traffic on this route to remain on UHH and use the SH1/Upper Harbour Interchange, as required today. The Caribbean Intersection, while increasing in size and phasing sequences, will have reduced traffic volumes and is predicted to operate satisfactorily with an overall intersection Level of Service ('**LOS**') D. Further, travel times for motorists travelling between SH18 to SH1 (south) and vice versa are predicted to generally reduce with the Project.

5.7 The Project does not provide direct motorway connections between SH17 and SH1 at the Greville Interchange. While these connections do not form part of the Project, improvements to the Greville Interchange are proposed. Improvements in performance of the Greville Interchange are predicted through the following upgrades:

a Widening of SH1 through Greville Interchange (from two lanes to three lanes southbound);

b Widening of the section of SH1 between Greville Interchange and the downstream interchange (from 2 lanes to 4 lanes); and

c Signalising the eastern intersection of Greville Interchange.

5.8 These improvements will increase southbound traffic capacity and will assist in improving the performance of the Greville Interchange which currently requires meter signals to operate on the on ramp as a means to manage SH1 southbound throughput. While the meter signals will remain, their operation will likely alter as a result of the improved southbound capacity on SH1.

## 6 Assessment Methodology

6.1 The evidence of **Mr Clark**[1] summarises the use of transport models to assist in the assessment of effects. The assessment of a number of alternatives also used the outputs from these transport models.

6.2 The traffic models that I have developed align with regional land use projections available at the time of the assessment and include network upgrades as agreed with the Transport Agency and Auckland Transport. The forecast models build on the updated 2015 base model for the purposes of informing the Detailed Business Case, which has been peer reviewed.[2]

6.3 The years represented in the traffic model, and the purpose of each forecast year are summarised as follows:

a 2015 – Base Year. Model calibration and Validation;

b 2018 – Construction Temporary Traffic Management Evaluation;

c 2021 – Opening Year Assessment, covering matters such as local road impacts. This forecast year has been used for the economic evaluation;

d 2031 – Design Year, based on 10 years post construction. This forecast year also informed the economic evaluation; and

e 2041 - This long term forecast also informed the economic evaluation.

6.4 Weekday morning commuter peak (average peak hour between 7:00am and 9:00am), inter peak (average hour between 12:00pm and 2:00pm), and evening commuter peak (average peak hour between 4:00pm and 6:00pm) models have been developed for each of the above years.

6.5 The forecast regional land use is based on Auckland Council's "Scenario I9" Medium Growth. The network assumptions for 2031 (being the design forecast year) generally align with what is termed "the Common Elements

[1] Paragraphs 6.1 – 6.3 of Mr Clark's evidence in chief (Transportation – General overview).
[2] Letter to Flow Transportation Specialists, from Traffic Design Group, Northern Corridor Improvements Peer Review Summary, dated 25 September 2015.

Enhanced 2" network upgrades across the wider area, and they include the following:

a The completion of the Albany Highway (north) project, i.e. north from Bush Road, as construction of this project was completed in October 2016;

b The completion of the SH20 Waterview Connection (currently under construction);

c The completion of the associated upgrades to the SH16 Northwestern Motorway, between the St Lukes Interchange and Lincoln Road (currently under construction);

d Widening of SH16 from Lincoln Road to Westgate (expected to be completed by the Transport Agency in 2018);

e Changes to the intersection controls at Rosedale Road/Tawa Drive, Rosedale Road/Apollo Drive, and Don McKinnon Drive/Mercari Way, from roundabouts to traffic signals;

f The Long Bay Transport Improvements along Glenvar Road and East Coast Road, including widening of East Coast Road to two traffic lanes per direction between Glenvar Road and Oteha Valley Road, the installation of a roundabout at East Coast Road/Glenvar Road/Lonely Track Road and traffic signals at East Coast Road/Glamorgan Drive;

g Spencer Road Realignment, including a roundabout at McClymonts Road;

h Additional capacity on Albany Highway South;

i The provision of a new link from Oteha Valley Road to Gills Road; and

j The proposed new Medallion Drive link, which will extend north from Oteha Valley Road to connect into Fairview Avenue.

6.6 The Upper Harbour SATURN traffic model has been updated for various phases of the Project, and the model has been realigned with regional land use and infrastructure improvements.

## 7 Assessment of Options

7.1 I note that the range of options assessed is summarised in the evidence of **Mr Schofield.**[3]

7.2 The transport assessment of options associated with the Project is recorded in schematic plans tabled in the Strategic Study (2011), the Auckland Accelerated Projects Schematic Plan (2013), the concepts put forward during the Indicative Business Case (2015), and the preferred and alternative options considered in the Detailed Business Case (2015). These have been informed by the Upper Harbour SATURN traffic model. This traffic model in turn is based on changes in traffic demands forecast by the Auckland Regional Transport ('**ART**') model. The ART model has been run with and without the Project.

7.3 As such, each alternative option has been assessed using a consistent platform. While the Upper Harbour SATURN traffic model has been updated through each phase of work, the predicted outputs and analysis completed to determine the benefits of each option have been consistent throughout.

## 8 Response to Submissions

8.1 I have read the submissions of Mr Stephen Broadbent (Submission 126154), Mr Peter Fogarty (Submission 126267), and Mr David Willmott (Centre for Urban and Transport Studies) (Submission 126516). My evidence responds to the following transport matters raised in these submissions:

a The exclusion of motorway connections between SH18 and SH1 (south) – Mr Willmott[4], Mr Broadbent[5], Mr Fogarty;[6]

[3] Paragraphs 6.1 – 6.6 and 7.1 – 7.17 of Mr Schofield's evidence in chief (Alternatives).
[4] Mr Willmott's Submission (Submission 126516), Paragraph 2 headed Complete non-consideration of Auckland's internal inter-accessibility needs.
[5] Mr Broadbent's Submission (Submission 126154), Last sentence to the Continued Bad Planning paragraph and overall Summary.
[6] Mr Fogarty's Submission (Submission 126267), In Summary Bullet 2.

b The impacts associated with excluding south facing connections on the local road network - specifically the performance of the Caribbean Drive/Paul Matthews Road/UHH Intersection – Mr Fogarty;[7] and

c Greville Road Interchange performance – referring to the future proofing of connections between Albany Expressway (SH17) and SH1 (south) – Mr Willmott.[8]

8.2 I also respond to Auckland Council's (Submission 126345) submission separately, with the evidence of **Mr Clark** addressing matters raised by both Auckland Council and Auckland Transport.[9]

## 9 SH18 to SH1 South Facing Connections

9.1 Submissions received from Mr Willmott, Mr Broadbent and Mr Fogarty all raise concerns relating to the exclusion of south facing ramps between SH18 and SH1 (south).

9.2 The Project objectives are stated in the *Assessment of Transport Effects* report, at Section 4.1. With regards to the connections that are included, the Project objectives discuss connectivity between SH1 and SH18 Interchange, with the focus being on improvements that:

a Facilitate inter-regional travel between Auckland and Northland;

b Complete the Western Ring Route; and

c Improve safety, efficiency, reliability and capacity of SH1 between SH18 and Albany, and SH18 between SH1 and Albany Highway.

9.3 The Project completes the Western Ring Route and therefore provides a motorway standard connection between SH18 and SH1 northbound. Further, the north facing connections improve safety, efficiency, reliability and capacity of SH1 between SH18 and Albany, and SH18 between SH1 and Albany Highway. As such, the Project, which includes the construction of north facing connections meets these Project objectives.

[7] Mr Fogarty's Submission (Submission 126267), In Summary Bullet 3.
[8] Mr Willmott's Submission (Submission126516), Paragraph 6 headed At Greville: No improvement is offered for the currently congested west to south movement.
[9] Paragraphs 14.13 – 14.16 of Mr Clark's evidence in chief (Transportation – General overview).

9.4 In noting the above, the design of the north facing connections does not preclude the ability to construct the SH18 to SH1 (south) south facing connections, which may be delivered through separate projects at a later date. This is discussed in the evidence of **Mr Moore**.[10]

9.5 While acknowledging that the design of the Project does not preclude constructing south facing connections, and noting that the Project scope for which designations are being sought excludes the south facing connections, my evidence below discusses the transport planning issues associated with providing south facing connections at this time.

*SH18 to SH1 Southbound Connection*

9.6 During the morning commuter peak, significant queues exist on the Northern Motorway southbound which are primarily caused by the performance of the SH1/Esmonde Road interchange. The Additional Waitemata Harbour Crossing ('**AWHC**') project is currently progressing through an investigation phase, leading to a notice of requirement to designate the necessary land to protect planning certainty. A benefit of the AWHC project is to *"ease congestion and improve travel times for motorists and freight"*[11] whilst providing greater transport options.

9.7 Currently, morning peak congestion regularly extends back along the Northern Motorway as far as Greville Interchange as a result of the Esmonde Interchange capacity constraint. As a result, minimal benefits would be gained by introducing the southbound connection until this downstream bottleneck and resulting congestion is eased.

9.8 During the inter peak, evening peak and weekend peak periods, congestion currently occurs southbound at the Upper Harbour Interchange where two southbound traffic lanes exist. Observed traffic counts sourced from the Transport Agency's automatic traffic count system has existing southbound traffic volumes for the inter peak, evening peak and weekend peak as 3,900, 3,650 and 4,200 vehicles per hour respectively, between UHH and Tristram Avenue Interchanges. The practicable capacity of the motorway about this section of motorway would

[10] Paragraphs 9.2 and 9.24 of Mr Moore's evidence in chief (Project design).
[11] New Zealand Transport Agency, *SH1 Additional Waitemata Harbour Crossing Project,* https://www.nzta.govt.nz/projects/awhc/.

sit at about 3,800 vehicles per hour,[12] when considering merging and weaving conflicts, the motorway is at (or exceeding) capacity.

9.9 The inclusion of a southbound connection at this time would require widening of the Northern Motorway (SH1) (to three lanes as a minimum) southbound between Upper Harbour Interchange and Tristram Interchange, including the widening of the Tristram Avenue overpass, amongst other upgrades. Without these works, the current congestion that occurs at the Upper Harbour Interchange throughout the day will merely be shifted to the section of motorway where two traffic lanes form. However, not even these works would address the congestion that occurs during the morning commuter peak (because of the constraint posed by Esmonde Interchange, north of the Harbour Bridge).

9.10 As such, a southbound connection would not provide any benefits until such time as downstream improvements are implemented.

9.11 Even though the Project does not provide a southbound connection, it is still predicted to lead to southbound travel time savings between SH18 and SH1 (south) of approximately 2 minutes, 1 minute and 1.5 minutes for the morning, inter and evening peak periods respectively.[13] Therefore, the Project will improve, if not retain, travel times for motorists travelling between SH18 and SH1 (south), whilst not precluding the southbound connection to be constructed in the future once the receiving environment is able to cater for current and future southbound traffic volumes.

*Northbound Connection*

9.12 **Mr Moore's** evidence explains that the Project does not preclude the SH1 to SH18 northbound connection.[14] However, even without providing that connection, the Project is predicted to improve the performance and safety of motorists travelling between SH1 and SH18 through the following:

[12] Assuming 2,000 vehicles per lane per hour for the outside lane, and some 1,800 vehicles per lane per lane for the kerbside lane.
[13] Assessment of Transport Effects, *Table 20 Predicted Forecast 2031 Reference Case and Project Journey Times (mm:ss)*.
[14] Paragraph 9.4 of Mr Moore's evidence in chief (Project design).

a Removing SH1 (north) to SH18 traffic from the UHH, therefore providing improved operation of the Upper Harbour Interchange through revised signal settings;

b Upgrading SH18 to motorway standard west of the Caribbean Drive Intersection, which includes removing one intersection (Paul Matthews Road) and widening SH18 westbound, which currently has a one lane section west of Paul Matthews Road; and

c Providing two left turn lanes (signalised) at the Upper Harbour Interchange off ramp, providing improved safety for all transport modes.

9.13 Predicted travel times between SH1 (from Tristram Avenue) and SH18 (Albany Highway) with and without the Project are summarised in Table 20 of the *Assessment of Transport Effects* report. Through the above improvements, the Project is predicted to improve the northbound travel time by 2 minutes, 1 minute and some 7 minutes for the morning, inter and evening peak periods respectively.[15]

*Summary*

9.14 The Project does not preclude south facing connections from being constructed. The timing of the southbound connection is dependent on the receiving environment being able to cater for current and forecast traffic volumes. The implementation of the northbound connection is less reliant on the receiving environment, and as such may be implemented sooner, subject to further investigation, funding and obtaining the necessary consents. Even though the Project does not provide these ramp connections, it will provide some benefits for these traffic movements.

## 10 Caribbean Drive Intersection Performance

10.1 Mr Fogarty (Submission 126267) raises concerns over the local connection performance between SH18, Paul Matthews Road and Caribbean Drive as a result of excluding the south facing motorway

[15] Assessment of Transport Effect, *Table 20 Predicted Forecast 2031 Reference Case and Project Journey Times (mm:ss).*

connections. He specifically questions the predicted performance of the Caribbean Drive/Paul Matthews Road/UHH Intersection[16] and suggests that the impacts of the Waterview Connection will negate any reduction predicted on the local road network.

10.2 Firstly, the assessment of the Project is based on forecast traffic demands obtained from the Auckland Regional Transport model. The traffic demands used in the assessment assume that the Waterview Connection is complete, as covered in Section 6.2.2 of the *Assessment of Transport Effects* report. As such, the impacts predicted on the local road network already consider changes to network wide traffic volumes associated with the Waterview project.

10.3 In considering the performance of local connections between Paul Matthews Road, SH18 and Caribbean Drive, the Project will:

a Reduce the number of signalised intersections along the SH18 corridor from two to one signalised intersection, with a roundabout being introduced on the SH18 eastbound off ramp;

b Improve the operating speed of SH18 (west of Caribbean Drive) to motorway standard, being 100km/hr; and

c Widen the SH18 westbound corridor, west of Paul Matthews Road to two lanes.

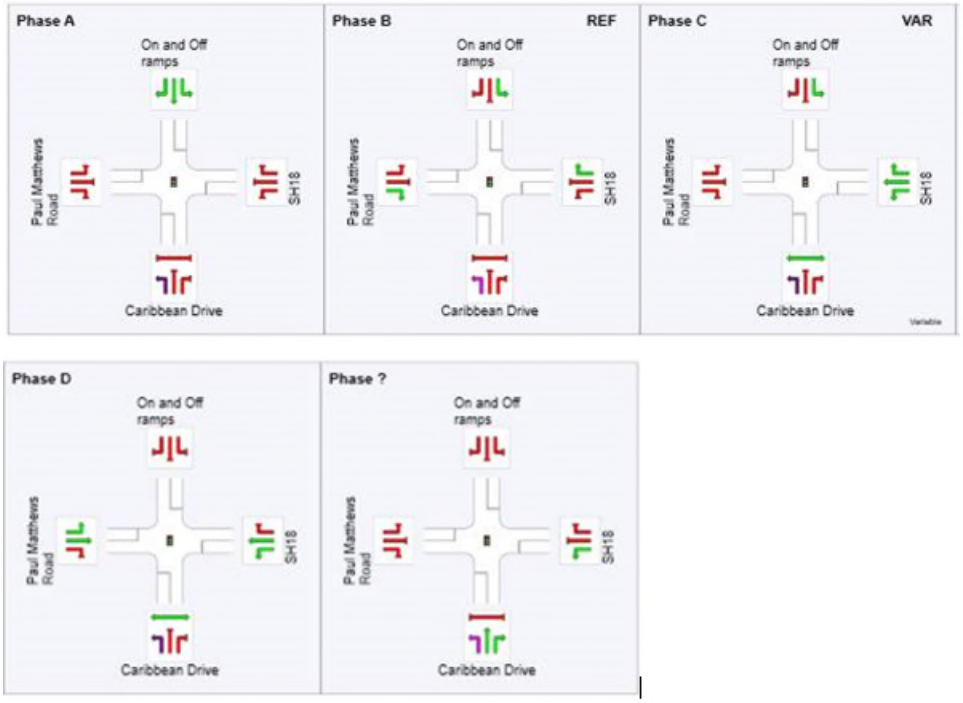
10.4 Mr Fogarty has assessed the delays between connections between Paul Matthews Road and the surrounding road network. When considering delays to motorists in the immediate area, it is important to consider the motorist's whole journey, rather than the impact at a particular segment of a journey.

10.5 In his assessment, Mr Fogarty has incorrectly assumed that the new Paul Matthews Road/Caribbean Drive Intersection will require "6-7 traffic light phases, possibly 8". Up to five signal phases are assumed in the traffic modelling for the Paul Matthews Road/Caribbean Drive Intersection as

[16] Mr Fogarty's Submission (Submission 126267), In Summary Bullet 3.

shown in **Figure 1**. These may be refined to introduce split phasing[17] which may occur between the core four phases, with any split phases (being Phase C) further optimising the performance of the intersection.

**Figure 1: Paul Matthews Road/Caribbean Drive Intersection Phasing**




10.6 Pedestrian crossing movements will likely operate on parallel phases, with partial protection. Where full protection is provided (subject to detailed design), the left turn phase (on the UHH eastbound for example) will be delayed to provide pedestrians sufficient time to cross.

10.7 The Caribbean Drive Intersection configuration will change from a three arm intersection to a four arm intersection (Paul Matthews Road approach), with additional stop line capacity being provided to Caribbean Drive. While the intersection has been made larger, the number of vehicles passing through the intersection is predicted to reduce as a result of SH18 to SH1 (north) and SH1 (north) to SH18 traffic being removed from the intersection. The predicted changes in total intersection volumes are presented in **Table 1** for 2031.

[17] Split phases are phases introduced as a means to efficiently change from one light sequence to another, whereby a lighter trafficked movement can be stopped earlier to allow an opposing movement to start earlier.

**Table 1: 2031 Predicted Total Intersection Volumes: Caribbean Drive/Upper Harbour Highway**

| | Morning Peak Hour | Interpeak Hour | Evening Peak Hour |
|---|---|---|---|
| Without the Project | 5,050 | 4,380 | 5,300 |
| With the Project | 4,280 (-770) | 3,420 (-960) | 4,700 (-600) |

10.8 The summary shows a reduction of some 600 to 960 vehicles per hour for the periods assessed. Using the predicted traffic volumes included in the Project SATURN traffic model, I have completed a SIDRA[18] assessment to analyse the predicted performance of the intersection during the busier morning and evening commuter periods.

10.9 The performance of the Caribbean Drive/Paul Matthews Intersection in 2031 (with the Project) is predicted to operate at an acceptable LOS[19] D, on the basis that the average delay to all vehicles is less than 55 seconds (being some 39 seconds for the morning peak and 41 seconds for the evening peak). The performance of each approach is summarised as follows:

a Caribbean Drive – LOS D for the morning and evening peak periods, with 95$^{th}$ percentile queues predicted to be some 120 metres (16 vehicles) for the right turn movement. This is the distance to the roundabout with Barbados Drive. 95$^{th}$ percentile queues are not predicted to pass through the Barbados Drive roundabout (as currently occurs) and, as such, the Project is predicted to lead to an improvement when compared to today's operation;

b UHH – LOS C for the morning and evening peak periods. 95$^{th}$ percentile queues are predicted to be up to 190 metres (26 vehicles)

[18] SIDRA is an Intersection Design Tool used to assess the performance of isolated intersections or a small network of intersections. SIDRA is commonly used for intersection design through Australasia.

[19] Level of Service (LOS) is a measure of performance for intersections. The LOS ranges (being A to F) applied in the assessment are based on average intersection delays, with LOS A performance being very good (delays less than 10 seconds per vehicle) and LOS F being poor (delays being greater than 80 seconds per vehicle for signalised intersections).

on this approach, with the available storage length being some 350 metres to the SH1 Upper Harbour Interchange;

c SH18 off ramp – LOS C (morning) and LOS D (evening). 95th percentile queues are predicted to be some 105 metres long (14 vehicles); and

d Paul Matthews Road - LOS E for the morning and evening peak periods. The through and right turn movements are predicted to operate at LOS E, with relatively short queues predicted in the morning peak (10 vehicles), and larger 95th percentile queues, 220 metres (30 vehicles) predicted for the evening peak.

10.10 Overall, the intersection is considered to operate satisfactorily in 2031, being the forecast design year. The SIDRA model outputs are included in **Annexure A**.

10.11 It is recognised that some movements which currently do not pass through the Caribbean Drive Intersection, such as SH18 eastbound to Paul Matthews Road and vice versa will experience a slightly longer travel distance and travel time. Using the Project SATURN traffic model, I have extracted the predicted travel times for the other routes discussed in Mr Fogarty's submission.

**Table 2: 2031 Predicted Travel Times – Local Connections (Morning and Evening Peak)**

| | Morning Peak | | Evening Peak | |
|---|---|---|---|---|
| | **Without Project** | **With Project** | **Without Project** | **With Project** |
| Paul Matthews Road to Unsworth Drive | 7:30 | 3:30 | 7:00 | 5:10 |
| SH18 EB to Constellation Drive Industrial Area | 6:20 | 4:30 | 5:30 | 4:00 |

10.12 The Project SATURN traffic model predicts an improved travel time for the Project, when compared to the Reference Case, which predicts high delays for traffic exiting Paul Matthews Road and at the one lane

westbound section of SH18. While a slightly longer travel distance is required for those travelling to Unsworth Drive, the new route is predicted to be quicker. With regards to SH18 eastbound motorists, the travel times are also predicted to be quicker with the Project during the busier commuter peak periods, when compared against the Reference Case.

10.13 Mr Southall (Bike Auckland) (Submission 126313) proposes design options to improve the safety of shared path users crossing Caribbean Drive at the Caribbean Drive/Paul Matthews Road Intersection.[20] He suggests the removal of the slip lane and adding a left turn arrow to the kerbside straight through lane.

10.14 I have tested this layout in the SIDRA traffic model. If the slip lane is removed, with left turning vehicles sharing with through movement vehicles, the performance of the intersection reduces significantly. Queues on Caribbean Drive are predicted to extend to some 250 m, with the overall intersection performance reducing to LOS E and LOS F for the morning and evening peaks respectively. SIDRA traffic model results are included in Annexure A for this test.

10.15 As a result, I support the lane layout of the Caribbean Drive Intersection as per the design lodged. However, I support the alterations that can be considered to this approach as covered in the evidence of **Mr Moore**.

*Summary*

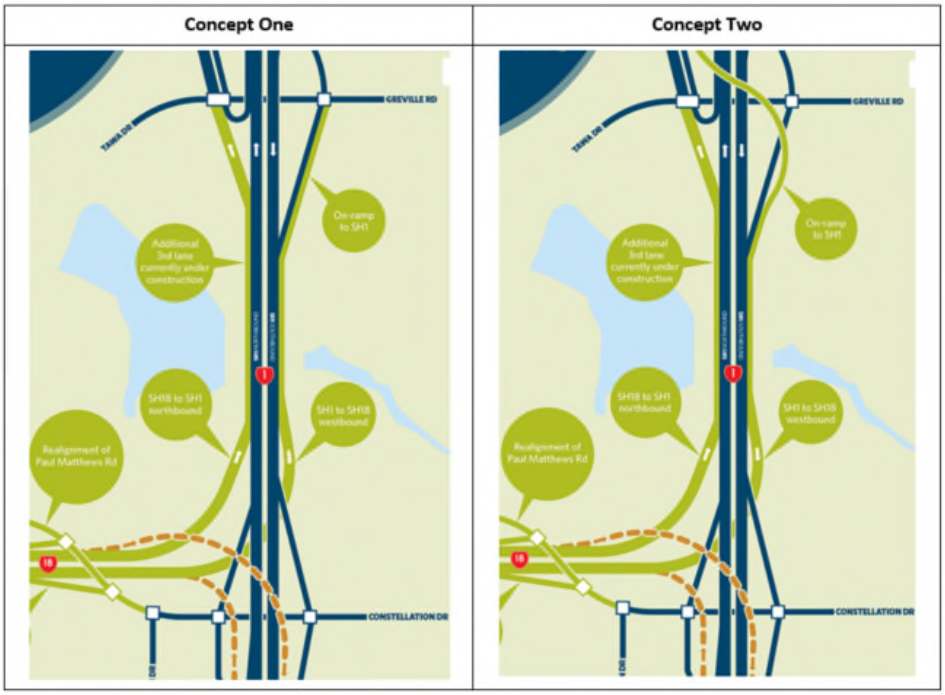
10.16 The exclusion of south facing connections between SH18 and SH1 (south) does require traffic on this route to use the UHH and Upper Harbour Interchange, as required today. The Caribbean Intersection, while increasing in size and phasing sequences, is predicted to be used by reduced traffic volumes and is predicted to operate satisfactorily with an overall intersection LOS D. Further, travel times for motorists travelling between SH18 to SH1 (south) and vice versa are predicted to generally reduce with the Project.

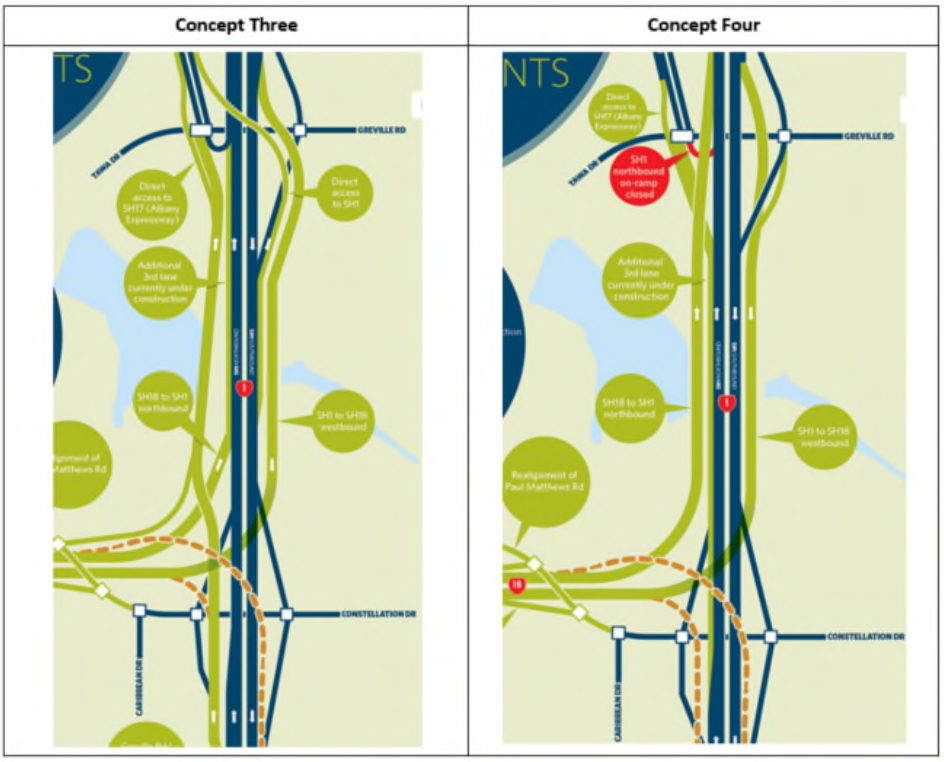
[20] Mr Southall's Submission (Submission 126313), Paragraph 2, Page 5.

## 11 Albany Interchange – SH17 to SH1 Connections

11.1 Mr Willmott (Submission 126516) queries the future proofing of direct connections between SH1 (south) and Albany Expressway. These possible connections were considered in designs during the Indicative and Detailed Business Case phases of the Project. Indicative Business Case concepts are shown below in **Figure 2**.

**Figure 2: Indicative Business Case Concepts**






**SH1 to SH17 Northbound Connection**

11.2 Concept 3 of the Indicative Business Case considered a northbound flyover from SH1 (south) to SH17.

11.3 The northbound flyover design of Concept 3 required the exit for SH17 and Greville Road to be before the Upper Harbour Drive off ramp. While I understand that safety and sign posting issues exist for this concept, along with substantial structures (with 4 levels of connections in the same location), the Project design now being progressed does not preclude the northbound layout of Concept 3. It can be seen that the northbound flyover design has the northbound infrastructure located to the western side of the carriageway.

11.4 While Concept 4 provided a northbound flyover, this Concept 4 also required all motorists travelling between SH18 and Albany Highway/Greville Road to use Upper Harbour Interchange to reroute using local routes about North Harbour, as the SH18/SH1 north facing connections connected to the north of Greville Interchange. Concept 4 also required the closure of the Greville Interchange northbound on ramp. This option was not considered to be acceptable because of the

importance of this connection to immediately adjacent commercial and retail areas. These impacts did not align with the Project objectives.

11.5 In noting the above, travel time predictions for the Project in 2031, for motorists travelling between SH1 (Tristram Avenue) to SH17 (Oteha Valley Road) are predicted to improve with travel time savings of 1 minute and 7 minutes for the morning and evening peak periods respectively. The travel time for the inter peak period is predicted to remain the same.

**SH17 to SH1 Southbound Connection**

11.6 With regards to southbound, Concept 2 and Concept 3 included a flyover between SH17 (Albany Expressway) and SH1. Concept 2 was taken through to the Detailed Business Case as the Incremental Option while Concept 3 was dropped, as the design did not allow connectivity between Greville Road and the new SH18 Motorway Connection.

11.7 Concept 2 was further assessed in the Detailed Business Case, as the Incremental Option. However, I understand the option could not work geometrically when considering design standards and land requirements. This is discussed in the evidence of **Mr Moore.**[21]

11.8 In noting the above, improvements to the Greville Interchange are expected as a result of the Project. Improvements in the performance are predicted through the following upgrades:

a Widening of SH1 through Greville Interchange (from two lanes to three lanes southbound);

b Widening of the section of SH1 between Greville Interchange and the downstream interchange (from 2 lanes to 4 lanes); and

c Signalising the eastern intersection of Greville Interchange.

11.9 These improvements will increase southbound traffic capacity and will assist in improving the performance of the Greville Interchange which currently requires meter signals to operate on the on ramp as a means to manage SH1 southbound throughput. While the meter signals will

[21] Paragraph 9.27 of Mr Moore's evidence in chief (Project design) and AEE at page 124.

remain, how they operate will likely alter as a result of the improved southbound capacity on SH1.

11.10 Travel time predictions for 2031, for motorists travelling between SH17 (Oteha Valley Road) and SH1 (Tristram Avenue) are predicted to improve for the morning and inter peak period (3 minutes and 1 minute respectively) with the evening peak period predicted to increase by 30 seconds, if not remain the same.

*Summary*

11.11 I consider that the transport assessment of alternative options has given due consideration to the SH1 (south) to SH17 connections. In light of the traffic modelling predictions, the geometric constraints associated with the connections as defined through the Indicative and Detailed Business Cases has restricted these options from progressing.

## 12 Auckland Council Submission

12.1 The submission of Auckland Council (Submission 126345) indicates (at Section 3) that there are a number of outstanding matters on traffic and transport. A meeting was held with Council's transport advisor, Mr Duncan Tindall on 31 March 2017. Through this, points of clarification were discussed, with supporting information being provided to Mr Tindall for review.

12.2 **Mr Clark** addresses some of the issues raised, and ongoing discussions with Auckland Council will occur leading up to the inquiry. However, I note the following:

a The development of the Project traffic model was peer reviewed by Traffic Design Group, as well as the economic assessment methodology. A letter from Traffic Design Group capturing the salient points of the peer review is included in **Annexure B**.

b The Indicative and Detailed Business Case reports provide the predicted traffic impacts associated with Project concepts considered and discussed in the Assessment of Alternatives chapter, as covered also in the evidence of **Mr Schofield**.

c The assessment of the Paul Matthews Road/Caribbean Drive Intersection has been captured above, in Section 10, where it is assessed that the Caribbean Intersection, while increasing in size and phasing sequences, has reduced traffic volumes (as a result of the Project) and is predicted to operate satisfactorily with an overall intersection LOS D.

d The weaving of traffic between neighbouring interchanges was a key element of determining and confirming the Project design. The safety audit team considered various traffic characteristic elements, including:

i The number of one, two and three lane merges;

ii Total number of conflicts (weaves/merges) required between the SH18 motorway connection and Greville Interchange;

iii Weave distance;

iv Midblock capacity, and

v The predicted speed of traffic in the weave section.

e The outcome of the Safety Audit was that the Transport Agency safety and operations team supported the additional 5th lane between the SH18 motorway connection and the Greville Interchange northbound off ramp. The five lane layout is that included in the notice of requirement.

f As noted above, I will continue to discuss issues further with Auckland Council, prior to the inquiry.

## 13 Conclusions

13.1 The assessment of alternative options, including the refinement of the Project design has been assessed using a consistent platform, being the Upper Harbour SATURN traffic model. The model has been peer reviewed as being fit for purpose.

13.2 My evidence has provided responses to matters raised by submitters on design elements of the Project, specifically:

a SH18 to SH1 South Facing Motorway Connections;

b Caribbean Drive/Paul Matthews Road Intersection Performance; and

c Greville Interchange SH17 to SH1 Motorway Connections.

13.3 Auckland Council's submission indicates (at Section 3 – Transport and Traffic) that there are a number of outstanding matters on traffic and transport. A meeting was held with Council's transport advisor on 31 March 2017. I will continue to discuss issues further with Auckland Council, prior to the inquiry.

_____

**Terry Philip Church**

20 April 2017

# Annexure A – SIDRA Model Output – Caribbean Drive Intersection – 2031

## Specimen Design

### MOVEMENT SUMMARY

**Site: 101 [Paul Matthews Road AM_SATURN Flows]**

New Site
Signals - Fixed Time Coordinated Cycle Time = 120 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

**Movement Performance - Vehicles**

| Mov ID | OD Mov | Demand Flows Total veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Caribbean Drive | | | | | | | | | | | |
| 1 | L2 | 434 | 5.0 | 0.403 | 10.2 | LOS B | 8.9 | 65.1 | 0.44 | 0.66 | 44.0 |
| 2 | T1 | 127 | 5.0 | 0.323 | 43.7 | LOS D | 6.4 | 46.4 | 0.89 | 0.72 | 31.4 |
| 3 | R2 | 468 | 5.0 | 0.915 | 74.6 | LOS E | 16.2 | 118.0 | 0.97 | 1.08 | 24.7 |
| Approach | | 1029 | 5.0 | 0.915 | 43.6 | LOS D | 16.2 | 118.0 | 0.73 | 0.86 | 31.4 |
| East: SH18 | | | | | | | | | | | |
| 4 | L2 | 413 | 5.0 | 0.373 | 16.7 | LOS B | 11.8 | 86.3 | 0.54 | 0.72 | 40.3 |
| 5 | T1 | 645 | 5.0 | 0.763 | 38.5 | LOS D | 21.1 | 154.4 | 0.90 | 0.81 | 32.6 |
| 6 | R2 | 696 | 5.0 | 0.763 | 35.6 | LOS D | 25.6 | 187.1 | 0.85 | 0.84 | 33.7 |
| Approach | | 1754 | 5.0 | 0.763 | 32.2 | LOS C | 25.6 | 187.1 | 0.79 | 0.80 | 34.6 |
| North: On and Off ramps | | | | | | | | | | | |
| 7 | L2 | 758 | 5.0 | 0.362 | 18.6 | LOS B | 11.5 | 84.1 | 0.57 | 0.73 | 39.5 |
| 8 | T1 | 201 | 5.0 | 0.892 | 68.7 | LOS E | 14.1 | 103.0 | 1.00 | 1.09 | 25.8 |
| 9 | R2 | 9 | 5.0 | 0.892 | 73.2 | LOS E | 14.1 | 103.0 | 1.00 | 1.09 | 25.7 |
| Approach | | 968 | 5.0 | 0.892 | 29.5 | LOS C | 14.1 | 103.0 | 0.66 | 0.81 | 35.4 |
| West: Paul Matthews Road | | | | | | | | | | | |
| 10 | L2 | 9 | 5.0 | 0.929 | 82.5 | LOS F | 10.3 | 75.5 | 1.00 | 1.16 | 24.1 |
| 11 | T1 | 283 | 5.0 | 0.929 | 77.8 | LOS E | 10.4 | 75.8 | 1.00 | 1.16 | 24.2 |
| 12 | R2 | 171 | 5.0 | 0.715 | 61.4 | LOS E | 10.1 | 73.9 | 1.00 | 0.86 | 27.2 |
| Approach | | 463 | 5.0 | 0.929 | 71.9 | LOS E | 10.4 | 75.8 | 1.00 | 1.05 | 25.3 |
| All Vehicles | | 4214 | 5.0 | 0.929 | 38.7 | LOS D | 25.6 | 187.1 | 0.77 | 0.84 | 32.6 |

### MOVEMENT SUMMARY

**Site: 101 [Paul Matthews Road PM_SATURN Flows]**

New Site
Signals - Fixed Time Coordinated Cycle Time = 120 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

**Movement Performance - Vehicles**

| Mov ID | OD Mov | Demand Flows Total veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Caribbean Drive | | | | | | | | | | | |
| 1 | L2 | 316 | 5.0 | 0.257 | 7.4 | LOS A | 4.2 | 30.8 | 0.30 | 0.60 | 45.5 |
| 2 | T1 | 160 | 5.0 | 0.508 | 49.9 | LOS D | 8.7 | 63.4 | 0.96 | 0.78 | 29.8 |
| 3 | R2 | 391 | 5.0 | 0.886 | 70.2 | LOS E | 12.8 | 93.6 | 0.99 | 1.04 | 25.5 |
| Approach | | 867 | 5.0 | 0.886 | 43.6 | LOS D | 12.8 | 93.6 | 0.73 | 0.83 | 31.4 |
| East: SH18 | | | | | | | | | | | |
| 4 | L2 | 637 | 5.0 | 0.801 | 23.8 | LOS C | 25.0 | 182.3 | 0.70 | 0.80 | 37.4 |
| 5 | T1 | 358 | 5.0 | 0.505 | 30.9 | LOS C | 16.1 | 117.3 | 0.82 | 0.72 | 35.2 |
| 6 | R2 | 896 | 5.0 | 0.769 | 43.7 | LOS D | 22.8 | 166.5 | 0.91 | 0.86 | 31.2 |
| Approach | | 1891 | 5.0 | 0.801 | 34.6 | LOS C | 25.0 | 182.3 | 0.82 | 0.81 | 33.8 |
| North: On and Off ramps | | | | | | | | | | | |
| 7 | L2 | 665 | 5.0 | 0.436 | 30.6 | LOS C | 13.6 | 99.5 | 0.75 | 0.78 | 35.0 |
| 8 | T1 | 96 | 5.0 | 0.881 | 72.0 | LOS E | 6.5 | 47.3 | 1.00 | 1.03 | 25.3 |
| 9 | R2 | 1 | 5.0 | 0.881 | 76.6 | LOS E | 6.5 | 47.3 | 1.00 | 1.03 | 25.2 |
| Approach | | 762 | 5.0 | 0.881 | 35.9 | LOS D | 13.6 | 99.5 | 0.79 | 0.81 | 33.3 |
| West: Paul Matthews Road | | | | | | | | | | | |
| 10 | L2 | 1 | 5.0 | 0.890 | 61.4 | LOS E | 29.7 | 217.1 | 1.00 | 1.07 | 28.0 |
| 11 | T1 | 830 | 5.0 | 0.890 | 56.8 | LOS E | 29.7 | 217.1 | 0.98 | 1.06 | 28.2 |
| 12 | R2 | 211 | 5.0 | 0.504 | 48.0 | LOS D | 10.8 | 79.1 | 0.92 | 0.81 | 30.2 |
| Approach | | 1042 | 5.0 | 0.890 | 55.1 | LOS E | 29.7 | 217.1 | 0.97 | 1.01 | 28.6 |
| All Vehicles | | 4562 | 5.0 | 0.890 | 41.2 | LOS D | 29.7 | 217.1 | 0.83 | 0.86 | 31.9 |

## Specimen Design – Caribbean Shared Left and Through Lane Test

### MOVEMENT SUMMARY

**Site: 101 [Paul Matthews Road AM_SATURN Flows_No Slip_LTTH]**

New Site
Signals - Fixed Time Coordinated Cycle Time = 120 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

**Movement Performance - Vehicles**

| Mov ID | OD Mov | Demand Flows Total veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Caribbean Drive | | | | | | | | | | | |
| 1 | L2 | 434 | 5.0 | 0.919 | 55.8 | LOS E | 34.4 | 250.8 | 1.00 | 1.07 | 28.4 |
| 2 | T1 | 127 | 5.0 | 0.919 | 51.2 | LOS D | 34.4 | 250.8 | 1.00 | 1.07 | 28.6 |
| 3 | R2 | 468 | 5.0 | 0.644 | 42.8 | LOS D | 11.3 | 82.7 | 0.88 | 0.80 | 31.5 |
| Approach | | 1029 | 5.0 | 0.919 | 49.3 | LOS D | 34.4 | 250.8 | 0.94 | 0.95 | 29.8 |
| East: SH18 | | | | | | | | | | | |
| 4 | L2 | 413 | 5.0 | 0.384 | 17.8 | LOS B | 12.3 | 90.1 | 0.56 | 0.73 | 39.9 |
| 5 | T1 | 645 | 5.0 | 0.920 | 66.9 | LOS E | 25.5 | 186.2 | 0.98 | 1.15 | 26.1 |
| 6 | R2 | 696 | 5.0 | 0.920 | 57.4 | LOS E | 40.6 | 296.7 | 1.00 | 1.02 | 28.0 |
| Approach | | 1754 | 5.0 | 0.920 | 51.6 | LOS D | 40.6 | 296.7 | 0.89 | 1.00 | 29.3 |
| North: On and Off ramps | | | | | | | | | | | |
| 7 | L2 | 758 | 5.0 | 0.409 | 23.5 | LOS C | 13.4 | 97.9 | 0.66 | 0.76 | 37.5 |
| 8 | T1 | 201 | 5.0 | 1.114 | 286.7 | LOS F | 32.7 | 238.4 | 1.00 | 2.06 | 10.2 |
| 9 | R2 | 9 | 5.0 | 1.114 | 291.3 | LOS F | 32.7 | 238.4 | 1.00 | 2.06 | 10.2 |
| Approach | | 968 | 5.0 | 1.114 | 80.6 | LOS F | 32.7 | 238.4 | 0.73 | 1.04 | 23.7 |
| West: Paul Matthews Road | | | | | | | | | | | |
| 10 | L2 | 9 | 5.0 | 1.032 | 159.6 | LOS F | 15.3 | 111.8 | 1.00 | 1.53 | 16.0 |
| 11 | T1 | 283 | 5.0 | 1.032 | 155.0 | LOS F | 15.4 | 112.1 | 1.00 | 1.53 | 16.1 |
| 12 | R2 | 171 | 5.0 | 0.545 | 54.1 | LOS D | 9.3 | 68.0 | 0.96 | 0.81 | 28.7 |
| Approach | | 463 | 5.0 | 1.032 | 117.8 | LOS F | 15.4 | 112.1 | 0.99 | 1.27 | 19.2 |
| All Vehicles | | 4214 | 5.0 | 1.114 | 65.0 | LOS E | 40.6 | 296.7 | 0.88 | 1.02 | 26.4 |

### MOVEMENT SUMMARY

**Site: 101 [Paul Matthews Road PM_SATURN Flows_No Slip_LTTH]**

New Site
Signals - Fixed Time Coordinated Cycle Time = 120 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

**Movement Performance - Vehicles**

| Mov ID | OD Mov | Demand Flows Total veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Caribbean Drive | | | | | | | | | | | |
| 1 | L2 | 316 | 5.0 | 0.897 | 54.2 | LOS D | 28.6 | 209.0 | 1.00 | 1.03 | 28.9 |
| 2 | T1 | 160 | 5.0 | 0.897 | 49.6 | LOS D | 28.6 | 209.0 | 1.00 | 1.03 | 29.1 |
| 3 | R2 | 391 | 5.0 | 0.535 | 44.6 | LOS D | 9.6 | 69.9 | 0.88 | 0.79 | 31.0 |
| Approach | | 867 | 5.0 | 0.897 | 49.0 | LOS D | 28.6 | 209.0 | 0.95 | 0.92 | 29.9 |
| East: SH18 | | | | | | | | | | | |
| 4 | L2 | 637 | 5.0 | 0.843 | 31.4 | LOS C | 29.4 | 214.7 | 0.75 | 0.85 | 34.7 |
| 5 | T1 | 358 | 5.0 | 1.027 | 173.2 | LOS F | 40.5 | 295.3 | 1.00 | 1.75 | 14.9 |
| 6 | R2 | 896 | 5.0 | 1.124 | 310.3 | LOS F | 90.1 | 658.0 | 1.00 | 1.86 | 9.5 |
| Approach | | 1891 | 5.0 | 1.124 | 190.4 | LOS F | 90.1 | 658.0 | 0.92 | 1.50 | 13.9 |
| North: On and Off ramps | | | | | | | | | | | |
| 7 | L2 | 665 | 5.0 | 0.536 | 36.3 | LOS D | 15.1 | 110.1 | 0.83 | 0.81 | 33.2 |
| 8 | T1 | 96 | 5.0 | 1.028 | 146.6 | LOS F | 9.8 | 71.2 | 1.00 | 1.42 | 16.7 |
| 9 | R2 | 1 | 5.0 | 1.028 | 151.2 | LOS F | 9.8 | 71.2 | 1.00 | 1.42 | 16.7 |
| Approach | | 762 | 5.0 | 1.028 | 50.3 | LOS D | 15.1 | 110.1 | 0.85 | 0.88 | 29.5 |
| West: Paul Matthews Road | | | | | | | | | | | |
| 10 | L2 | 1 | 5.0 | 1.016 | 143.8 | LOS F | 47.4 | 346.1 | 1.00 | 1.65 | 17.2 |
| 11 | T1 | 830 | 5.0 | 1.016 | 145.5 | LOS F | 47.4 | 346.1 | 1.00 | 1.67 | 16.8 |
| 12 | R2 | 211 | 5.0 | 0.428 | 43.2 | LOS D | 10.2 | 74.3 | 0.87 | 0.80 | 31.3 |
| Approach | | 1042 | 5.0 | 1.016 | 124.8 | LOS F | 47.4 | 346.1 | 0.97 | 1.49 | 18.5 |
| All Vehicles | | 4562 | 5.0 | 1.124 | 125.1 | LOS F | 90.1 | 658.0 | 0.92 | 1.28 | 18.4 |

# Annexure B – Traffic Model and Economic Evaluation Methodology Peer Review Letter

Traffic Design Group Limited
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Mr Ian Clark
Director
Flow
Level 1, 11 Blake Street, Ponsonby
**Auckland**

TDG Ref: 13390
25 September 2015

**Issued via email:** **ian@flownz.com**

Dear Ian

**Northern Corridor Improvements**
**Peer Review Summary**

The Upper Harbour SATURN Traffic Model has been updated by Flow Transportation Specialists ("Flow") and applied to inform the Detailed Business Case for the Northern Corridor Improvement (NCI) project.

Our role in this project was to peer review the update of the transport model (i.e. base year update/validation), and the economic analysis arising from the subsequent application of the model.

This letter summarises the peer review as of today. The text below also lists the correspondence for the purpose of future referencing.

## 1. Base Model Update

The update of the model was documented in the report produced by Flow titled "Northern Corridor Improvements, Upper Harbour SATURN Model Update" dated July 2015 (status "B" dated 24 July 2015). Comments were provided in TDG's "Peer Review Report" dated August 2015 (title as per Flow report).

Key conclusions from the peer review of the update of the base model were:

- We concurred with adopting 2015 as a base year as this included the northbound auxiliary lane on the Northern Motorway, which is within the core study area.
- Because of the uncertainty of the impact of the roadworks and hence the models ability to replicate observed in the wider area, it would be advantageous to demonstrate that the majority of benefits produced from applying the model are from within the core study area that has been validated. This assessment was produced and reported, which is acknowledged in the next section of this letter.
- We suggested that prior to any further applications of the Upper Harbour SATURN model for other studies, that a review is undertaken particularly as the report on the base model update concluded that a model of this type cannot replicate long queues. At a minimum, recalibration will be required to move the model closer to the targets in the new guidelines. Alternatively, a new type of analysis tool may be warranted.
- The model was updated rather than recalibrated (demands sourced from ART with some minor manual intervention). It generally met the targets in the EEM, and mostly

achieved link based targets in the 2014 Model Development guidelines which are more stringent. It is considerably weaker in its ability to replicate observed turning movements. More caution should be applied if modelled turning movements are utilised specifically (i.e. for intersection design). The model could be applied incrementally (i.e. the change from the model) to observed turning movements for design purposes.

## 2. Model Application – Economic Analysis

A technical note titled "Economic Assessment Methodology" dated 17 August 2015 produced by Flow was supplied for comment. A letter response (TDG letter dated 31 August 2015) was provided.

Section 9 (only) extracted from the Detailed Business Case report was then provided by Flow on 4 September in conjunction with the spreadsheet calculating the variable demand benefits and economic assessment.

Following our review of the economic calculations, we queried, in particular, the methodology for the inclusion of the off-peak benefits (email from Julie to Ian, dated 14 September 2015). We received a response to this email in a letter from Flow dated 18 September 2015 accompanied by spreadsheets we had requested showing the flow profiles on state highways and local roads separately.

A reply to the letter from Flow was provided in our letter dated 22 September. In this, we acknowledged that our concerns and questions on the economic assessment had been addressed although there was one outstanding issue as to whether the weekend off-peak benefits were being included (the weekday off-peak benefits were excluded). An email from yourself on 23 September confirmed that both weekday and weekend off-peak benefits were now excluded from the benefit calculation.

We note that the spreadsheet with the economic analysis provided for our review did not contain the final benefit-cost ratios. The construction and benefit stream dates in the spreadsheet did not match the text in the report extract (Section 9 extract supplied on 4 September). Furthermore, the update factors incorporated were for the year 2012 and 2014/15 needed to be sourced and applied. Both of these points were acknowledged in the letter from Flow dated 18 September 2015.

We accept that these issues are relatively minor and they do not impact on our ability to review the methodology/approach adopted for the calculation of the variable demand benefits and the economic assessment.

Sensitivity tests on the benefits were carried out and reported. This included a sensitivity test we suggested to confirm that the majority of the benefits were derived from the core area of the model that had been validated. The reporting (Table 33 in the Section 9 extract supplied on 4 September) confirmed that the majority of benefits were derived from within the core area of the model.

## 3. Summary

We confirm that based on the information provided, the update of the base model generally met the targets in the EEM.

The calculation of project benefits from the road network[1] using a variable demand matrix approach is appropriate and follows the procedures in the EEM.

We had suggested certain sensitivity tests on the economic assessment to address potential issues, and these were conducted and the resulting benefits reported. In particular, the majority of scheme benefits are derived from with the core area of the model, which was the focus of the model validation.

We confirm that our requests for further information and sensitivity tests have been answered to our satisfaction. We also confirm that the approach adopted for the calculation of benefits and the economic analysis are in line with the EEM and are considered appropriate.

Yours sincerely
**Traffic Design Group Ltd**

Julie Ballantyne.

Julie Ballantyne
**Director**

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cc: Kenny See, NZTA, Kenny.See@nzta.govt.nz
Terry Church, Flow, terry@flownz.com
Qing Li, Flow, Qing@flownz.com

[1] We note that we have not reviewed any public transport benefits.