NZ TRANSPORT AGENCY
WAKA KOTAHI

Additional Waitemata Harbour Crossing

Final Transport and Traffic Model Report

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Quality Assurance Statement

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Revision Schedule

Rev. No	Date	Description	Prepared by	Reviewed by	Approved by
A	11/10/2010	Draft for comment	David Young & Ian Clark	David Ashley	
B	22/10/2010	Final Draft	David Young & Ian Clark	Richard Hancy	Richard Hancy

NZ Transport Agency

Contents

1. Executive Summary

This report sets out the work undertaken for the transport and toll modelling contract for the Additional Waitemata Harbour Crossing. The contract is one of three relating to the study and significant interactions were required between this contract and those relating to planning and engineering and development of the economic business case. Reference should be made, as necessary, to the reports arising from these workstreams.

The modelling approach has been to develop a transport modelling system which uses the Auckland Regional Transport (ART3) regional model, a more detailed SATURN traffic model, and a multi-user class assignment model based on the ART3 road assignment.

These models have the capability to:

- Analyse the impacts of crossing options on transport demands and mode choice sufficient for undertaking economic analysis in accordance with the Economic Evaluation Manual
- Provide transport network information sufficient to support an analysis of wider regional and local economic benefits (and this will be agreed with the business case team)
- Provide information on the operational traffic effects of the crossing options
- Forecast the impacts of tolling of cross harbour movements on total travel demand, route choice and mode switch
- Forecast levels of demand under various tolling scenarios sufficient for utilisation in an initial analysis of the viability of tolling to support a business case.

2. Introduction

Sinclair Knight Merz (SKM) and Flow Transportation Specialists (Flow) were appointed by the New Zealand Transport Agency (NZTA) to undertake the transport and toll modelling required for the assessment of the Additional Waitemata Harbour Crossing Project. This is one of three concurrent contracts, with the others being planning and engineering services, being undertaken by Beca/Aecom and economics advisory services, being undertaken by Price Waterhouse Cooper/NZIER.

2.1 Study Objectives

The NZTA's particular objectives for the Additional Waitemata Harbour Crossing project (i.e. the three contracts combined) are:

> *'To contribute to an affordable, integrated, safe, responsive and sustainable land transport system within the Auckland region by providing a cross-harbour motorway route between the Central Motorway Junction and Esmonde Road that will:*
>
> - *Encourage economic development and facilitate growth in line with the strategic land use objectives of the Auckland Regional Growth Strategy (ARGS);*
> - *Improve cross-harbour accessibility and reduce the barrier effect of the Waitemata Harbour;*
> - *Provide an additional transport route to the existing Auckland Harbour Bridge (AHB) to provide a more resilient network and reduce risks associated with concentrating a high proportion of cross-harbour capacity on a single route; and*
> - *In conjunction with other harbour crossings, improve opportunities for cross-harbour accessibility for all modes, including commercial and general road traffic, passenger and rapid transport, walking and cycling.*

KiwiRail's particular objectives for the Additional Waitemata Harbour Crossing project are:

> *'To encourage and maintain safe and efficient rail passenger transport services within the Auckland region by providing a cross-harbour rail route between Gaunt Street and Akoranga Station that will:*
>
> - *Encourage economic development and facilitate growth in line with the strategic land use objectives of the Auckland Regional Growth Strategy;*
> - *Provide for improved cross-harbour accessibility and reduce the barrier effect of the Waitemata Harbour;*
> - *Provide greater opportunity for the development of a rail network on the North Shore connecting with the Auckland Isthmus;*

- *Allow for stations which are easily accessible and serve the needs for existing and future communities; and*
- *Contribute to providing a more resilient cross-harbour transport network and reduce risks associated with concentrating a high proportion of cross-harbour capacity on a single route.'*

2.2 Modelling Purposes

The purposes of the transport and toll modelling contract were defined in the request for tenders (RFT) as to provide detailed information in the following areas:

- An analysis of the impacts of crossing options on transport demands and mode choice sufficient for undertaking economic analysis in accordance with the NZTA's Economic Evaluation Manual;
- Transport network analysis sufficient to support an analysis of wider regional and local regional benefits;
- The impact of tolling of cross harbour movements on total travel demand, route choice and mode switch; and
- Levels of demand under various tolling scenarios, sufficient for utilisation in an initial analysis of the viability of tolling sufficient to support a business case.

It is relevant to note that the scope of the work undertaken for the three contracts was required to be completed within an unusually tight timeframe. Outputs from the transport and toll models were required by the consultants undertaking the other two contracts to allow the completion of the business case by the end of October 2010.

3. Modelling System

The modelling system set up for this study needed to encompass the capability to:

- Forecast with confidence and reliability overall travel demands by mode and their sensitivity to land use and a range of other demand-influencing factors;
- Evaluate the operational impacts on the road system of the preferred crossings strategy;
- Evaluate the benefits of road tolling strategies and their contribution to project financing; and
- Forecast rail and bus service patronage and the relationship of demand to capacity.

The overall structure of the modelling system is:

- ART3 for forecasting crossing harbour demands and passenger transport modelling, linked to
- A SATURN for the operational traffic assessments, and
- Adapting the ART3 road assignment with multi-user classes by willingness to pay segments for the toll modelling.

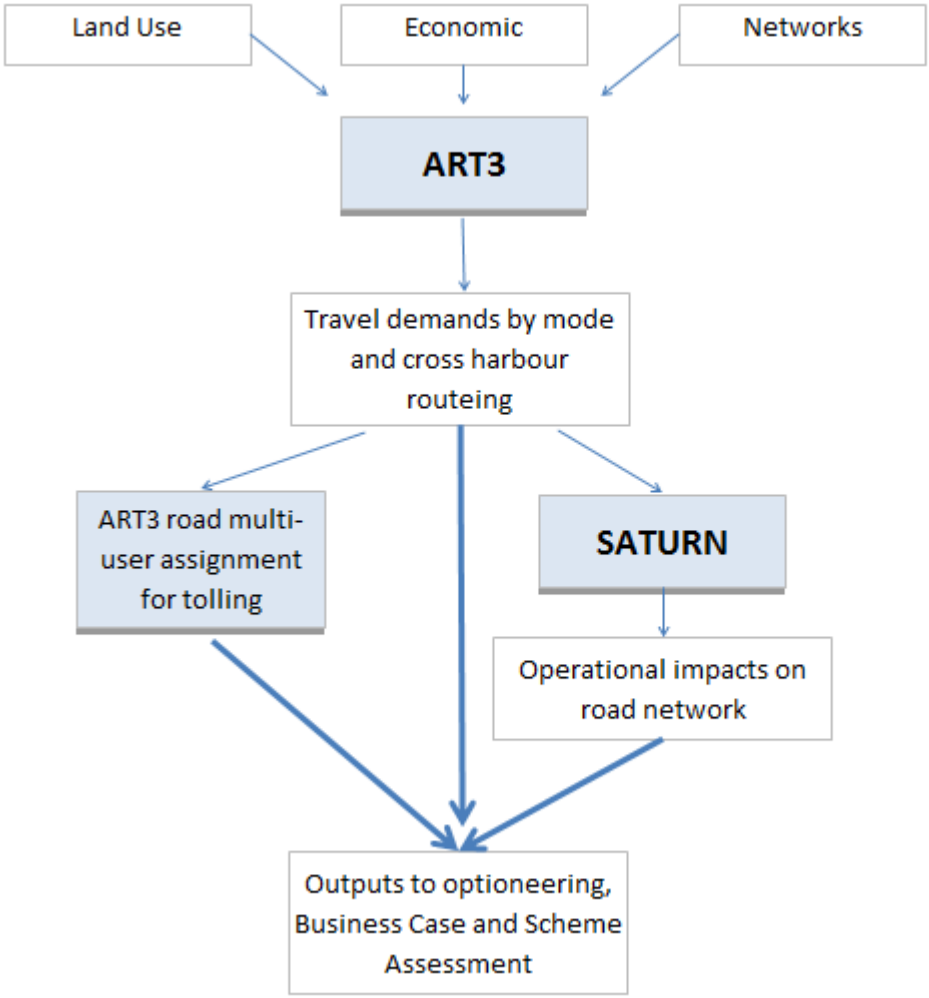
Hence ART3 was used for the first and last of the above points, the SATURN model for the second point, and for the tolling tests, the third point, the ART3 road assignment was adapted by introducing multi-user classes and differential values of time representing the willingness to pay of each class.

A key part of our approach was to review the inputs to ART3 and then propose a set of inputs for sign-off with NZTA. As part of this, three future land use scenarios and three sets of economic and strategy inputs have been modelled with the Do Minimum forecasts.

ART3 vehicle trip matrices were passed to the SATURN model with the ART3 2-hour matrices converted to peak 1-hour SATURN matrices using profiles of count data within the study corridor.

The modelling system is illustrated in **Figure 3-1** along with the inputs to and outputs of the models.

Figure 3-1 Modelling Procedures



4. Model Development

4.1 ART3 Model

The performance of the base year 2006 ART3 model and the 2011 forecast were reviewed, particularly in terms of travel across the Waitemata Harbour for both traffic and passenger transport.

A key purpose for the 2011 review was to ascertain the performance of the model where there have been changes to the network of relevance to the project since 2006. These are the Northern Busway and the completion of motorway links within CMJ.

As part of the review a range of adjustments to ART3 were investigated aimed at achieving the best possible comparisons with observed data, the outcome of which was to retain the model as received from the ARC, that is, with no modifications. Given the set project timeframe this investigation process was constrained to the time available within the overall programme. The adjustments considered were largely minor intersection and motorway adjustments.

The outcome of this is documented in the report "WS3.3 ART3 Model Validation Report Final", dated 10 August 2010, which concluded with the following:

> *In conclusion, the original ART3 validation in 2006 for the whole of Auckland and for the cross-harbour context demonstrates that the model provides a sound basis for forecasting cross-harbour demands and the project appraisal. The further update of this validation on the most recent data demonstrates also reassuring outcomes in terms of its sensitivity to the growth in Auckland and the network changes made since 2006.*
>
> *Nevertheless, as with any model of this nature, the strengths and weaknesses of the validation and verification – particularly on specific links - should be recognised and corresponding care taken in its use and when interpreting specific model outputs.*
>
> *As such the model is considered fit for purpose for this study, that is, for the modelling purposes set out in the study brief, and that it is capable of undertaking the modelling tasks it has been designed for.*

The peer review of this report concluded:

> *Overall, we concur with the conclusion that the model is acceptable, that it generally forecasts increases/decreases in flow for 2011 in line with observed, and that as with any strategic model, the strengths and weaknesses (particularly for individual links) should be considered when interpreting and applying model outputs.*

4.2 SATURN Model

The development and validation of the base SATURN models are documented in the report "WS3.3 SATURN Model Validation Report Final", dated 20 August 2010.

The model was originally developed in 2001 to evaluate the Upper Harbour projects along State Highway 18. It was updated by Flow in late 2009, early 2010 for the purposes of the SH18 Strategic Transport Improvements Study and also for the evaluation of proposals along State Highway 1 between Greville Road and Oteha Valley Road. For this study it was expanded to include

- The Southern Motorway, from CMJ south to the Newmarket Viaduct;
- Grafton Gully, from CMJ east to the Parnell Rise/Stanley Street/Beach Road/The Strand intersection
- Takapuna and Milford.

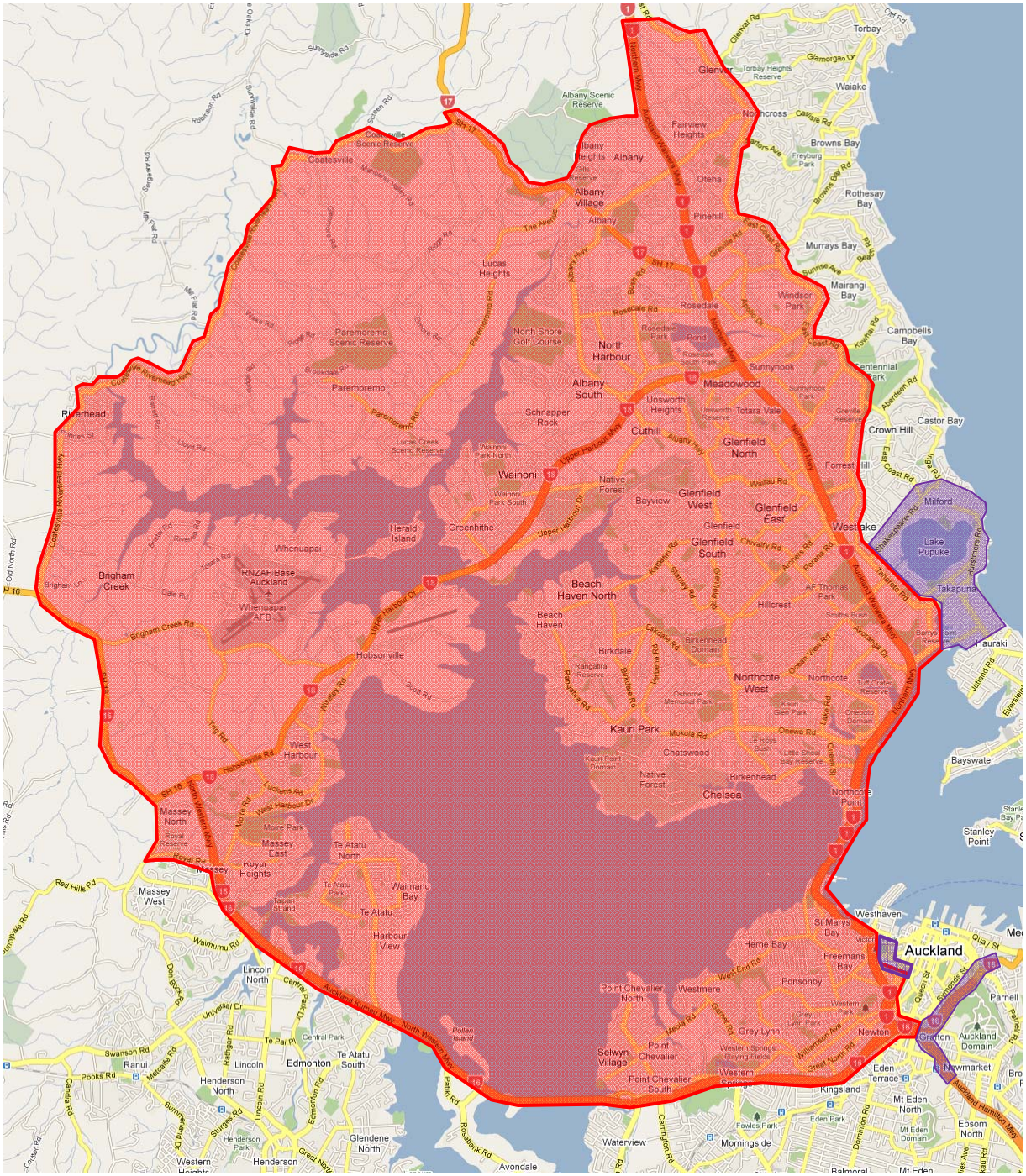
The full model extent is shown in Figure 4-1.

The prior demands have been taken from the ART3 model and subject to matrix estimation, in order to improve the level of validation.

The validation report concludes with:

> *The report has demonstrated that the model meets the guidelines and requirements set in the New Zealand New Zealand Economic Evaluation Manual (EEM). Link count and journey time validation results show that the model performs satisfactorily, compared with conditions observed on site. In conclusion, this report has demonstrated that the model developed gives a sufficiently accurate representation of the areas of the road network likely to be most directly and immediately affected by the proposed Additional Harbour Crossing. The model is therefore considered to be able to be taken forward to be used to assess the operational performance of the options under consideration.*

- **Figure 4-1 SATURN Model Extent with Extensions Highlighted**



4.3 ART3 Multi-User Class Assignment Model for Tolling

As tolling of the road crossing(s) influences both overall cross-harbour traffic demands and car users' choices of cross-harbour route, ART3 has been used to estimate the effects on traffic demands, while the detailed impacts of the tolling options on route choice have been determined with a multi-user class assignment model. Hence, ART3, which has a single-class assignment for the demand-supply iterations, was run with tolls included, to produce the vehicle demands, which were then passed to the toll model for the multi-class assignment.

This multi-class assignment toll model was developed by adapting the ART3 road assignment model with the introduction of multi-user classes and differential values of time (VoT) representing the willingness to pay (WTP) of each class. This has made use of the ART3 car and HCV demands by purpose creating appropriate market segments.

As noted in the toll modelling scoping note (refer Section 7.1) the WTP segments and their VoT used are based on those developed for NZTA's toll modelling for the Transmission Gully project in Wellington. A total of 12 segments were created and implemented in the model.

5. Do Minimum Forecasting

5.1 Introduction

The future years modelled were 2026 and 2041. Year 2026 is close to the possible opening year of a new crossing and year 2041 is about 30 years from now, and there are 15 years between each. Additionally the ARC had previously modelled in these years, either for specific projects or for the Regional Transport Strategy (2041 was the main model year for this).

5.2 Inputs to Forecasting

A range of inputs are required for the forecasting which are considered under the following four categories. In each case these were reviewed and agreed with the ARC, the other workstreams and NZTA as appropriate.

5.2.1 Transport networks

The future Do Minimum transport networks are documented in Appendix A.

5.2.2 Land Use

The process for developing the future land use inputs is documented in Appendix B and a summary of the outcomes is in Appendix C.

5.2.3 Economic and Strategy Inputs

The economic and strategy inputs to ART3 were reviewed and recommendations made for the forecasting for the study. These are documented in Appendix D.

5.3 ART3 Do Minimum Forecasting

The outcomes of the ART3 Do Minimum forecasts are documented in Appendix E. This records the modelling undertaken for the Do Minimum forecasts and provides some summary and specific statistics for the region, relevant screenlines and cross-harbour travel. The reasons for the differences between the results of the model runs are discussed, followed by conclusions and a recommendation in respect of the option forecasting.

5.4 SATURN Do Minimum Forecasting

The operation of the future Do Minimum SATURN models for the years 2026 and 2041 are set out in Appendix F. This sets out the predicted changes in demand flows and the locations where congestion is forecast in these future years, for a scenario without the AWHC.

6. Option Forecasting

6.1 Options Modelled

Three options were modelled in both ART3 and SATURN and the third was chosen as the basis for evaluation purposes. Descriptions of the three options are documented in Appendix G. Note that for transport modelling there is no difference between a bridge or a tunnel.

6.2 ART3 Option Forecasts

The outcomes of modelling the final option (bridge or tunnel) are documented in Appendix H.

It presents key results from the modelling of the Option for the region, relevant screenlines and cross-harbour travel making comparisons between the Option case and the Do Minimum case.

6.3 SATURN Option Forecasts

The operation of the future networks in 2026 and 2041, with the AWHC, was set out in Appendix I.

This summarises the changes in traffic demands across the Harbour, without and with the project, and the increases in traffic able to cross the Harbour per hour as a result of the AWHC. It also sets out the predicted journey times along the motorway, without and with the project, demonstrating the bottlenecks that can be expected to occur for both scenarios.

7. Toll Modelling

7.1 Toll Modelling Scope

The agreed scope of the toll modelling is documented in Appendix J. This covers the purpose and objectives of tolling, the overall approach to the toll modelling, the tolling strategies considered and the model outputs to be provided.

Three toll strategies were modelled:

- Tolling the new crossing (WHC) only,
- Tolling the existing bridge (AHB) only, and
- Tolling both the new crossing and the existing bridge.

Each was modelled in years 2026 and 2041 with toll levels of $0, $2, $4, $6, and $8 (all-day in each direction).

7.2 Toll Modelling Results

Results of the toll modelling are given in Appendix K. They cover flows and revenues, cross-harbour vehicle and PT flows, screenline flows, vehicle demands by sector and travel times.

8. Model Outputs

8.1 Outputs for the Design Team

Traffic flows and queues were provided from the SATURN model to assist with option refinement.

8.2 Outputs for the Option Assessment and Scheme Assessment Report

Information on traffic flows, patronage, and network performance have been provided for the option assessment and Scheme Assessment Report.

8.3 Outputs for the Business Case

For the business case these have included:

- Outputs from the benefit cost analysis (see below);
- Outputs for the agglomeration benefits, including:
  - 24-hour trip and cost matrices, and
  - zonal employment data;
- Outputs for the assessment of land use effects:
  - The standard trips and costs provided from ART3 to the land use model (ASP3.2);
- Outputs related to network performance, including:
  - Road times, speeds and LOS on specified routes,
  - Car, HCV and PT flows on cross-harbour links, and
  - Average speeds between specified sectors and economic centres.

8.4 Benefit Cost Analysis

Benefit cost ratios (BCRs) have been calculated using the procedures in the Economic Evaluation Manual (EEM) as far as possible, but in a simplified manner in order to fit with the project timelines. A variable demand matrix-based approach has been used, encompassing both roading and passenger transport, using the ART3 model outputs.

The details of this are given in Appendix L and the results of the analysis are in Appendix M. The analysis has used the 100% costs with the construction period for both bridge and tunnel assumed to be 6 years.

Appendix A Future Do Minimum Transport Networks

This file note sets out the proposed assumptions for the two forecast years for the transport models to be used for this project for the future Do Minimum Scenario. The more detailed projects will only need to be included within the SATURN traffic model and not the ART model.

The assessment of which projects should be included in 2026 and 2041 has been based on the Regional Land Transport Strategy discussions with NZTA. The assumptions for road projects are generally consistent with those used for the SH20 Waterview Extension.

The tables below relate to infrastructure projects and passenger transport services and improvements. Assumptions regarding all the other inputs set out in our Scoping Report, including investment in travel demand management (non pricing) and future land use inputs, will be addressed separately by the modelling team. Separate papers have been prepared on the proposed future land use inputs and the other inputs for issue to NZTA for sign-off.

Table 1: State Highway Projects

Project	2026	2041	Comment
SH1 Warkworth-Wellsford expressway	Yes	Yes	
SH1 Puhoi-Warkworth motorway extension	Yes	Yes	
SH1 Wainui Interchange	Yes	Yes	
SH1-SH18 Rosedale Link	Yes	Yes	
SH1 Constellation to Greville 6 laning	Yes	Yes	
SH1 Greville Interchange upgrade	Yes	Yes	
SH1 widening Northcote to Sunnynook Rd 4L,3L(NB)	Yes	Yes	Completed
SH1: HOVs on Busway	No	Yes	Busway assumed to be full by 2041, according to page 91 of RLTS, so HOVs excluded
SH1: Truck restrictions on Harbour Bridge	No	No	Would affect SATURN model only
SH1 Victoria Park Tunnel	Yes	Yes	Under construction
SH1 Newmarket Viaduct	Yes	Yes	Under construction
SH1 widening Main-Ellerslie to Greenlane 4L(NB)	Yes	Yes	
SH1 Papakura Interchange improvements	Yes	Yes	
SH1 widening Hill Rd to Hingaia Rd 3L	No	No	
SH16 Grafton Gully Stage 3	Yes	Yes	
SH16 widening Waterview to Rosebank	Yes	Yes	
SH16 widening Rosebank to Te Atatu 8L	Yes	Yes	
SH16 widening Te Atatu to Royal Road 6L	Yes	Yes	

SH16 Te Atatu junction Improvements	Yes	Yes	
SH16 Brigham Creek Extension	Yes	Yes	Under construction
SH20 Manukau Extension	Yes	Yes	Under construction
SH20 Mangere to Puhinui 6 laning	Yes	Yes	
SH20 Manukau Harbour Crossing	Yes	Yes	Under construction
SH20 Waterview Extension	Yes	Yes	
SH20 A Kirkbride Interchange	Yes	Yes	
SH20 B widening	Yes	Yes	
Sth Western to East Tamaki Stage 1	Yes	Yes	
Sth Western to East Tamaki Stage 2	No	Yes	
Sth Western to East Tamaki Stage 3	No	No	
Sth Western to East Tamaki Stage 4	No	No	

Table 2: Major Local Roads

Project	2026	2041	Comment
Penlink to SH1	Yes	Yes	Tolled route
Whau River crossing	Yes	Yes	
AMETI Stage 1: Northern section up to 2016	Yes	Yes	
AMETI Stage 2: Central / Southern sections up to 2021	No	Yes	
Redoubt Rd 4-laning SH1-Mill Rd	Yes	Yes	
Mill Rd Corridor 1	Yes	Yes	
Mill Rd Corridor 2	No	Yes	
Drury to Ararimu (East)	No	No	
Karaka-Weymouth Link	No	No	
Pukekohe Eastern Corridor by-pass	Yes	Yes	

Table 3: Local Roads

Project	2026	2041	Comment
Westgate Centre Improvements	Yes	Yes	
Massey North	Yes	Yes	
Tiverton Wolverton St Upgrade (widening)	Yes	Yes	
RARP Priority 1	Yes	Yes	
RARP Priority 2	No	Yes	
Fanshawe Street Widening	Yes	Yes	As per Wynyard Quarter plans. SATURN model only
HOVs on Esmonde Road	Perhaps	Perhaps	Check with NSCC
Lake Road Widening (south to Jutland Rd)	Yes	Yes	SATURN model only

Anzac Street Widening (including westbound bus lane)	Yes	Yes	SATURN model only
Direct access from Smales Farm to Northcote Rd	Yes	Yes	SATURN model only
Burns Avenue Upgrade	No	Yes	SATURN model only
Akoranga/Northcote intersection upgrade	Yes	Yes	SATURN model only

Table 4: Rail

Project	2026	2041	Comment
Parnell Station, Panmure moved, Tamaki deleted	Yes	Yes	
Helensville extension	No	No	
Onehunga Branch line	Yes	Yes	Under construction
Manukau Link	Yes	Yes	Under construction
Western Frequencies	Yes	Yes	
CBD Loop	Yes	Yes	Based on page 89 of RLTS
Airport link (Stage 1)	No	Yes	Based on pages 90-91 of RLTS
Airport to Manukau (Stage 2)	No	Yes	Based on pages 90-91 of RLTS
Avondale to Southdown	No	Yes	Based on page 91 of RLTS
Botany extension	No	No	Based on page 91 of RLTS
Westgate spur	No	No	
Rail Electrification	Yes	Yes	
Integrated ticketing and fares	Yes	Yes	

Table 5: Passenger Transport

Project	2026	2041	Comment
Ferries			
Future ferry links: Waitemata Harbour, East Coast Bays	Yes	Yes	
Bus services			
2016 PTNP with frequencies increased in later years to match demands	Yes	Yes	
Rapid Transit			
Northern Busway Stage 2 Constellation to Silverdale	Yes	Yes	Based on page 90 of RLTS
Northern Busway Stage 3 Silverdale to Orewa	No	Yes	Based on page 91 of RLTS
Panmure-Botany	Yes	Yes	Based on page 91 of RLTS
Botany - Manukau	No	Yes	Based on page 91 of RLTS
Henderson-Westgate-Albany	Yes as QTN	Yes as QTN	Based on page 91 of RLTS
Bus Lanes			
Lincoln Rd Corridor	Yes	Yes	

Akoranga Corridor	Yes	Yes	Completed
Lake Road Corridor	No	Yes	
Onewa Road Corridor	Yes	Yes	Include westbound transit lane
Glenfield Road Corridor	Yes	Yes	
Te Atatu Road Corridor	Yes	Yes	
Great North Road Corridor	Yes	Yes	
Changes in Auckland CBD	Yes	Yes	Details to be discussed with ACC – with input from CBD PT study

Ian Clark

Appendix B Development of Future Land Use Inputs

1 Introduction

This note sets out:

- the land use forecasts to be used as inputs into the transport modelling forecasts for the Additional Waitemata Harbour Crossing (AWHC) study (refer Section 4),
- the processes for developing the proposed two variants to the existing Auckland Regional Growth Strategy (RGS) land use forecasts (refer Section 5), and
- the proposed process to be used by the Business Case for assessing the land use effects of an additional Waitemata Harbour crossing (refer Section 6).

The note covers the land use forecasts to be used for all components of the study:

- Transport and Toll Modelling,
- The Business Case, and
- The Network Plan.

It is for distributing to NZTA and the Peer Reviewer for sign-off of the proposed approaches and is one of three notes on inputs to the transport modelling; the other two consider:

- the do minimum transport networks, and
- other inputs to ART3 (e.g. future fuel prices, PT fares, parking costs, etc).

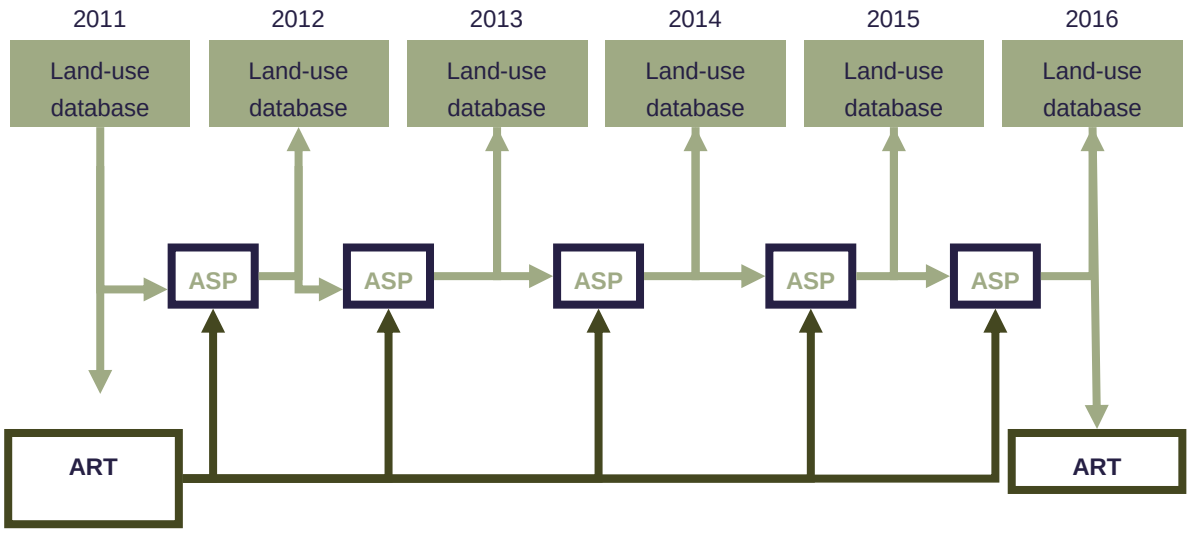
2 Auckland Regional Modelling System

The Auckland regional modelling system consists of:

- the Auckland Strategic Planning model (ASP3),
- the Auckland Regional Transport model (ART3), and
- the interfaces between them.

The two models are designed to run interactively between the base year (2006) and year 2051 with ASP3 run in each year and ART3 run every 5th year. ART3 uses the ASP3 land use outputs (population, households, employment, education rolls) as inputs, and ASP3 uses the travel costs output by ART3 as one of the inputs to determine where future development is allocated.

Part of this sequence - from 2011 to 2016 - is shown diagrammatically in the following figure[1].



3 Existing Land Use Forecasts

A number of sets of land use forecasts presently exist, however none have been formally accepted within the region. The capacity inputs (or permitted activity) under district plans which form part of any future land use forecast, have been finalised via the Auckland Regional Council's (ARC's) 2010 Capacity for Growth study/report which is reflected in the outputs of ASP3.

The existing land use forecasts used for the Auckland Regional Land Transport Strategy (RLTS) and from the latest round of modelling for the ARC's Future Land Use and Transport Planning Project (effectively a review of the RGS[2]) are presently available.

3.1 Forecasts used for RLTS

The forecasts used for the RLTS modelling are based on an earlier version of an ASP-ART run for RGS review, with manual adjustments in year 2041 to fit better with the growth strategy and the land use contained in Schedule 1[3] of the Regional Policy Statement as amended by Change 6.

The RLTS modelling was undertaken in year 2041 only, and land use forecasts were developed for other years, before and after 2041, incorporating the 2041 adjustments. It is acknowledged that there is

[1] Extracted from the ART3 User Manual

[2] The RGS review is also known as the RPS review work.

[3] Schedule 1 lists all the agreed regional growth areas and growth centres and corridors. Schedule 1 is derived from the RGS.

considerable uncertainty in some aspects in the forecasts for these other years. Hence these land use forecasts in years 2011 to 2051 are available for ART3 in 5 year increments.

For the RLTS transport modelling two further sets of land use inputs were developed manually from the above for year 2041. These had much higher intensification in centres, including alignment with future rail on the North Shore, and were labelled as "extreme".

3.2 Latest RGS Forecasts

Since the RLTS modelling was undertaken in 2009 a further round of ASP-ART runs have been undertaken as part of the future land use and transport planning work the for the RGS review (with no manual adjustments made). Three land use scenarios were modelled:

- the current RGS,
- a more intensified version (labelled Compact City), and
- a scenario with considerable urban expansion beyond the current Metropolitan Urban Limit (MUL)

The outcomes and evaluation of this modelling has become available recently as it is now in the public domain. Land use forecasts in years 2011 to 2051 are available for ART3 in 5 year increments.

4 Approach to Land Use Forecasts for This Study

Future land use estimates are a key input into ART3 and will be a key influence on cross-harbour demands and travel patterns. Given the scale of this project it is proposed that the transport forecasting be based on three differing future land use scenarios. At this time decisions have yet to made on whether all three will be modelled with all AWHC options and with the alternative sets of ART3 other inputs[4].

Following discussions with the ARC modellers, the latest version of the land use forecasts from the RGS review will be used (refer 3.2 above). This provides the best representation of the current RGS with intensification in the CBD, sub-regional and town centres, and general adherence to the MUL boundaries[5].

Two alternatives to this will be developed, both of which will be variants of the RGS land use:

- Variant 1: a modification to the RGS land use with lower levels of intensification, more general intensification of suburban areas (infill[6]) and some further extensions to the MUL. This land use will be informed by ARC land use capacity assessments and the urban expansion land use scenario from the RGS review modelling (refer 3.2 above).

[4] Refer to note "WHC - ART3 Inputs"

[5] This includes future greenfield growth areas such as Hingaia, Takanini, Massey North and Kumeu.

[6] The current RGS land use utilises a conservative capacity for urban infill development i.e. general infill (additional house on front or back where possible) as opposed to single site redevelopment where existing house is removed and site redeveloped to the maximum number permitted under the district plan.

- Variant 2: again a modification of the RGS land use with more intensification along the corridor served by cross-harbour bus and/or rail passenger transport. This option will be informed by work which has already been undertaken regionally including the North Shore City Plan work[7], the "extreme" RLTS land use (refer 3.1) and the more intensified RGS scenario (refer 3.2).

Hence ART3 will not be run in conjunction with the land use model (ASP3), but the existing RGS land use and the alternative(s) will be standalone inputs to ART3. The decision not to use ASP3, following discussions with the ARC modellers, was due to:

- It takes considerable resource and time for the ARC to develop alternative land use scenarios (inputs or capacities for the land use model), which does not fit with project timeframe;
- The resulting land use forecasts for ART3 are not certain;
- Land use inputs are required for years 2026 and 2041 only, whereas the ASP-ART system is usually run from 2006 to 2051 producing input data for ART3 every 5th year;
- The ARC modellers recommended that ASP-ART runs not be done.

The RGS and Variant 2 forecasts will be used for the Network Plan modelling: the RGS land use with the Northern Busway, and Variant 2 with rail on the North Shore.

5 Development of Alternative Forecasts

As stated above two variants land use forecasts will be developed, one with less intensification than the RGS forecasts, and the other with more intensification focussed on the harbour crossing corridor aligned with rail on the North Shore.

Each variant will retain the same regional total population, employment and education rolls as the RGS forecasts. Starting with the existing 2026 and 2041 RGS forecasts, modifications will be made to zonal data, beginning with specifically identified zones, followed by adjustments in other areas to achieve the same regional totals.

For Variant 1 the process will involve:

- Assessment of growth in intensified areas (growth centres) from 2006 to 2026 and 2041;
- Modification (reduction) of the growth in these areas, considering the percentage of available capacity in the RGS, on the basis that full take up is unlikely;
- Determine where to allocate the excess growth, such as infill within the MUL, some limited expansion outside the MUL, additional growth in other smaller centres:
    - Additional infill growth can be allocated based on the existing lower and higher capacity figures for each zone; the lower figure only has been used to date, and

[7] This land use is reflected in an earlier ASP-ART run for the RGS review known as Scenario 3 (the TA Scenario).

- Expansion beyond the MUL can be determined on the basis of TA or private sector proposals, for example, at Whenuapai, Puhinui, Drury South, and Silverdale.

For Variant 2 the process will be similar in concept to that for Variant 1, but involve:

- Assessment of growth in the harbour crossing corridor, focussing on the possible alignment of rail between Albany and the Auckland CBD; at this time our understanding is this would include Takapuna (Barry's Point Road, Smales Farm, Wairau Valley, and possibly the employment area to the south of Albany;
- Modification (increase) of the growth in the above areas;
- Determine where reductions in growth should occur in order to achieve the RGS regional totals, considering:
  - Growth in North Shore centres not on the possible rail alignment, and
  - Growth in other centres elsewhere in the region.

6 Assessment of Land Use Effects of an Additional Harbour Crossing

The following is the Business Case proposed approach to assessing the land use effects of an additional harbour crossing.

The land use modelling for the study will provide insight into the following questions:

- Is the AWHC likely to have a material impact on land use patterns?
- What are the principal changes that an AWHC may prompt in household location, property developments & firm location?
- Do these changes aid or hinder the Regional Growth Strategy's desire for urban intensification within identified areas, centres and corridors?

The intention is that the modelling provides indicative answers on these questions.

The land use model uses a variety of inputs most of which remained unchanged (e.g. demographic, economic) between model runs. It is intended to utilise the standard ARC demographic and economic inputs, but create a different development scenario for the purposes of this project. This is to enable testing the potential land use effects of an additional Waitemata Harbour Crossing, which is a different question from those that previous uses of the ASP3 model have been asked to answer.

The intention is to model one development scenario with travel costs (or accessibilities) from ART model runs with and without the AWHC. This may mean more than two model runs as it is likely that the capacities will be adjusted to see how this changes the way the model responds. While tolling is going to be considered as part of this study, we don't intend to model such variants.

The results reported will focus on the differences between with and without the AWHC as the absolute numbers that come out of the scenario runs are not regarded as being significant in themselves; it is the differences that will give insight into the questions listed above. For this reason complete compatibility is not required between the land use scenarios that the transport modelling team are using and those for the land use modelling. However there does need to be general compatibility as the travel costs from the transport modelling will be used as inputs to the land use modelling.

Starting with the capacities[8] from the current RGS scenario, these will be added to as appropriate to create a suitable scenario. For example, the RGS scenario has the ratio of floorspace per household remaining constant or dropping between 2006 and 2051. This implies - that since all the permitted floorspace has been developed - that the scenario inputs effectively determine where households live as there is not enough spare capacity in the system to allow the model a choice over where to locate households. For this reason extra capacity will be introduced so that the model can show spatial differences in development patterns without and with the AWHC. The main changes are likely to be in the area near the AWHC, especially the North Shore. In developing our scenario we will review the three land use scenarios used with the transport modelling and use elements from them.

As outlined in Section 2, ART3 is designed to be run in an iterative fashion with ASP3 with ART3 taking its land use inputs from the outputs of ASP3, and the latter using travel costs output by ART3 as one of the inputs it uses to decide where to locate population, households & employment.

In this project the two models will not be run iteratively due to time constraints (a full ART3/ASP3 run takes at least five days). Instead the land use model run will be started from the opening date of the new crossing using 2026 travel costs supplied by ART3. The land use model will then be run until 2051 with the final years using the 2041 travel costs from ART3.

David Young, Brian Waddell (Transport Modelling), and Russell Jones (Business Case)

[8] These are called permissible development in the DELTA software which ASP3 uses, but the term capacities is used in this document as that is the term in widespread use in Auckland.

Appendix C Future Land Use Inputs

1 Introduction

This note summarises the land use forecasts used as inputs into the transport modelling forecasts for the Additional Waitemata Harbour Crossing (AWHC) study. It follows from the note which set out the process for developing the land use forecasts: "WHC - Land Use Forecasts v3".

The purpose of this note is to record the outcomes of developing the land use forecasts for the study, so that it can then be included in the reporting on the forecasting. As such it:

- describes the changes made to the RGS land use inputs to create the two variants (refer section 2, and
- gives historic and forecasts statistics of population and employment for the region, sectors and specific areas relevant to the study.

This note is draft and may remain that way, as the intention is to incorporate it into AWHC reporting.

2 Three Sets of Land Use Inputs

As described in the previous note, three sets of future land use inputs are being used with the ART3 forecasting for the study:

RGS Land Use:

- the current RGS, arising from the latest round of ASP-ART modelling undertaken as part of the ARC's future land use and transport planning project;

Variant 1 Land Use:

- a modification to the RGS land use with lower levels of intensification, more general intensification of suburban areas and some further extensions to the MUL.

Variant 2 Land Use:

- a modification of the RGS land use with more intensification along the corridor served by cross-harbour bus and/or rail passenger transport.

The two variants have been developed manually starting with the RGS land use as described in the previous note.

3 Development of the Two Variants

3.1 Variant 1

Variation 1 Land Use is a scenario which recognises that the RGS has some ambitious growth allocations within many of its growth centres. This Variation seeks to spread development more widely by removing some capacity from key RGS centres and reallocating it within the same sector as more infill development[9] or via new greenfield development.

This means that existing suburban areas increase their populations through additional infill and existing business areas (largely those developed for industrial or warehousing purposes) continue to redevelop for a variety of business activities including offices and retailing.

Variation 1 makes the following amendments to the RGS land use.

- Remove between 25-60% of population and employment from high density centres including Orewa, Westgate, Albany, Brown's Bay, Birkenhead, Glenfield, Milford and Takapuna.
- Reduce an otherwise very high regional town centre population at Manukau City Centre (down to 25,000 from 44,000).
- Add approximately 25,000 population as additional infill development to already established North Shore residential suburbs as further infill development.
- Add approximately 25,000 population as additional infill development to already established Auckland Isthmus residential suburbs as further infill development.
- Add new greenfield residential development areas at Dairy Flat/Silverdale South (20,000 population), Riverhead (10,000), Coatesville (10,000) and Kumeu / Huapai (10,000), Beachlands (10,000)
- Add new greenfield employment areas at Silverdale South (10,000), Whenuapai (10,000), Puhinui (7,500) and Drury South (7,500).
- Redevelopment of already existing developed business zones including Rosedale, North Harbour Estate, Wairau Valley and Link Drive, Penrose, Carbine Road and Otahuhu. These areas are assumed to redevelop into a mix of uses including office and retailing.
- The CBD contains a 2041 employment count of 125,000 as opposed to an RGS employment count of 148,000. Additional employment is allocated to the CBD fringe (an additional 12,000) which has the effect of spreading the wider CBD employment rather than concentrating it.

3.2 Variant 2

Variant 2 Land Use is a scenario which recognises that while the RGS provides for a future with a lot of centre intensification it does not provide a lot of intensification along the North Shore's central transport spine served by cross-harbour bus and/or rail passenger transport. This variation seeks to consolidate

[9] Based on numbers for residential infill redevelopment provided from the 2010 ARC Capacity For Growth study.

development along the central spine and reduce the amount of intensification within centres not directly located on the RTN.

Variation 2 makes the following amendments to the RGS land use:

- Removing between 20-50% of population and employment from high density centres such as Orewa, Brown's Bay, Mairangi Bay, Milford, Highbury and Westgate
- Increasing the population and employment at new centres based on possible rail station locations at Wairau, Sunnynook, East Coast Bay Road (Model zone 50).
- Small increase to 30,000 population at 2041 for Albany centre with employment maintained at around 28,000.
- Shifting the focus of Takapuna from Hurstmere Road to Barry's Point Road i.e. reallocating population and employment from those parts of Takapuna removed from a possible rail station at Barry's Point Road to model zones closer to the station. The greater Takapuna centre has a population of 37,000 with 33,000 employment
- Little modification to the CBD numbers in terms of population i.e. a 2041 population of 71,000 but increasing employment to 168,000 at 2041.
- Adjusting the southern growth areas of Hingaia and Takanini by having them fully developed by 2026 to maintain balanced regional totals.

4 Historic and Forecast Data

4.1 Introduction

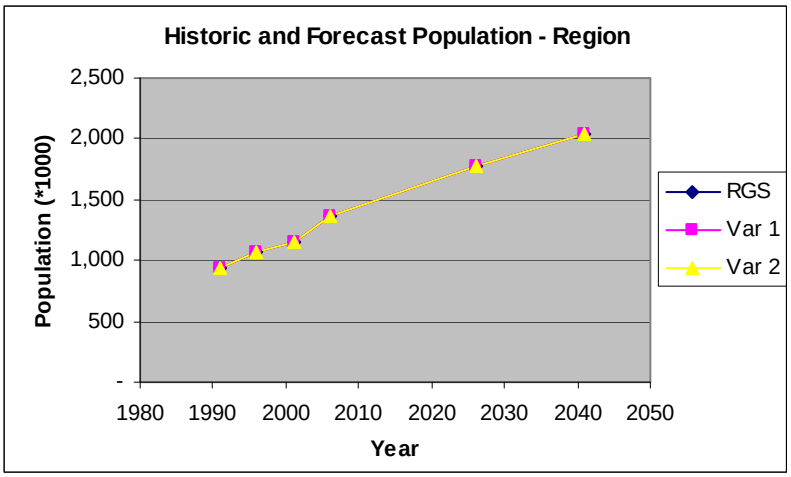
The following documents historic and forecast population and employment for the region, sectors of the region, and specific areas of relevance to the study.

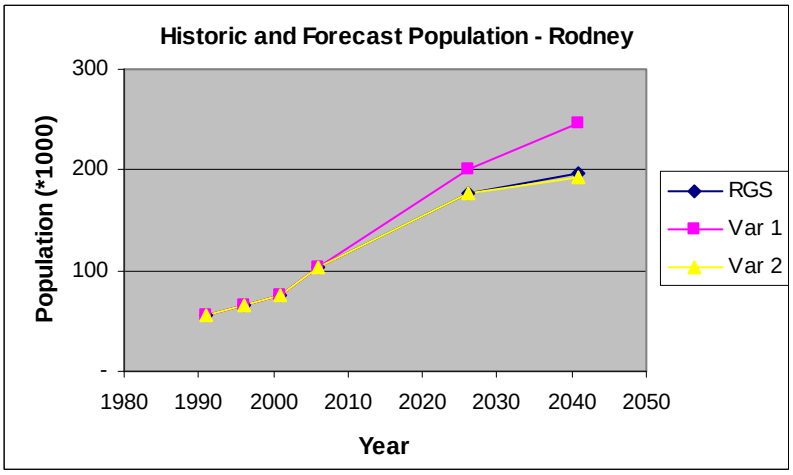
4.2 Population

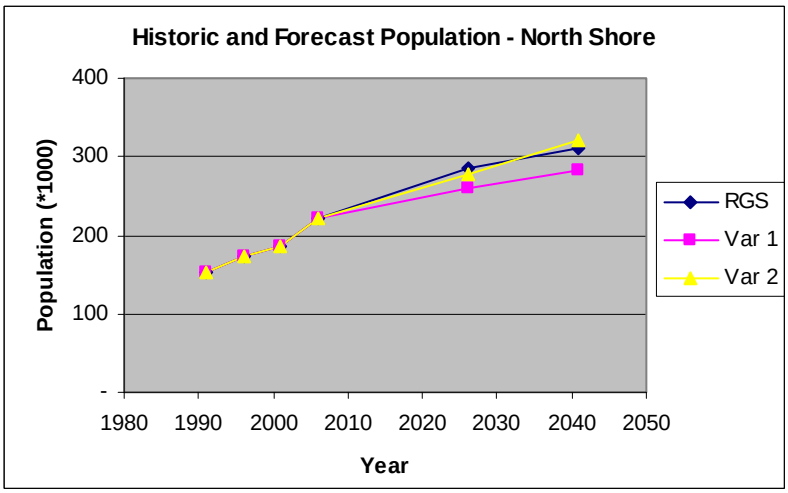
The following table gives historic population at 5-year intervals 1991 to 2006, and 2026 and 2041 forecasts for each of the three land use scenarios for the region and sectors. For the region the forecast scenarios are the same, hence only one is given. The table also gives the percentage per annum (%p.a.) increase for each successive year of data.

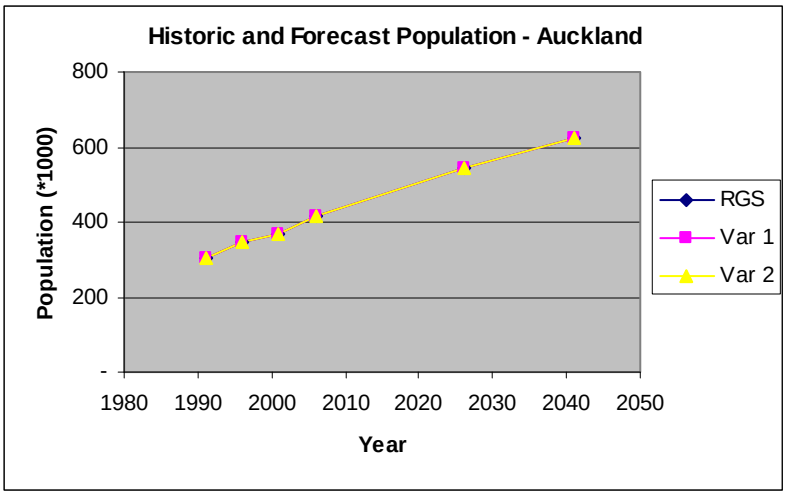
The historic and forecast populations are also shown graphically in the figures following the table.

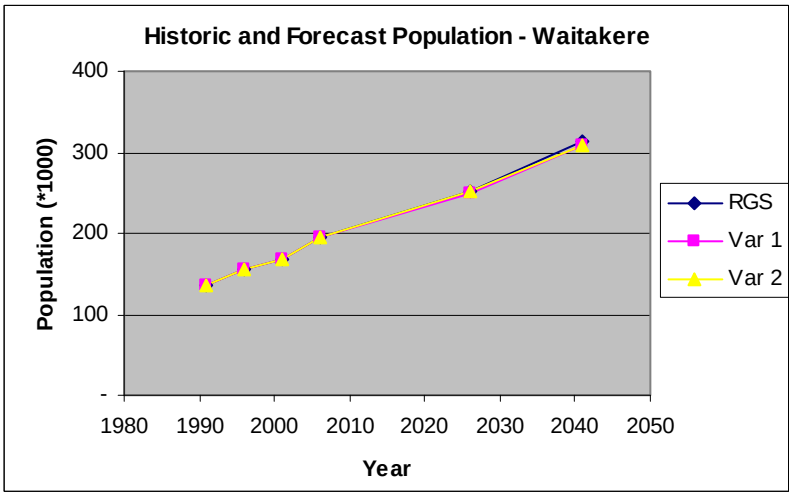
Area	Scenario	1991	1996	2001	2006	2026	2041
Region	All	944	1,069	1,159	1,367	1,771	2,037
			2.5%	1.6%	3.4%	1.3%	0.9%
Rodney	RGS	55	66	76	102	176	196
			3.9%	2.8%	6.1%	2.7%	0.7%
	Var1				102	202	246
						3.4%	1.3%
	Var2				102	177	192
						2.8%	0.5%
North Shore	RGS	153	172	185	223	286	312
			2.4%	1.4%	3.8%	1.3%	0.6%
	Var1				223	259	283
						0.8%	0.6%
	Var2				223	279	321
						1.1%	0.9%
Auckland	RGS	306	346	368	416	544	624
			2.5%	1.2%	2.5%	1.3%	0.9%
	Var1				416	544	622
						1.3%	0.9%
	Var2				416	544	624
						1.3%	0.9%
Waitakere	RGS	137	156	169	194	252	313
			2.6%	1.6%	2.9%	1.3%	1.5%
	Var1				194	250	308
						1.3%	1.4%
	Var2				194	252	308
						1.3%	1.3%
South	RGS	293	329	361	431	513	591
			2.3%	1.9%	3.6%	0.9%	1.0%
	Var1				431	516	577
						0.9%	0.8%
	Var2				431	518	591
						0.9%	0.9%

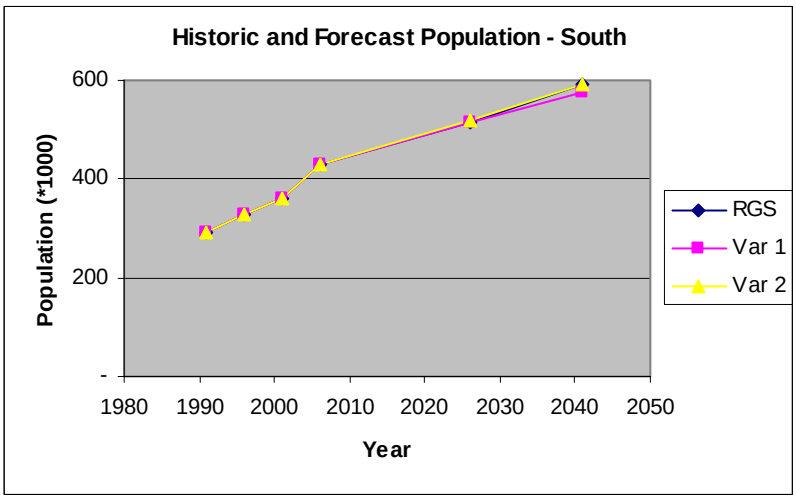

Historic and Forecast Population - Region
Population (*1000)
2,500
2,000
1,500
1,000
500
-
1980
1990
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Population - Rodney
Population (*1000)
300
200
100
-
1980
1990
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Population - North Shore
Population (*1000)
400
300
200
100
-
1980
1990
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2



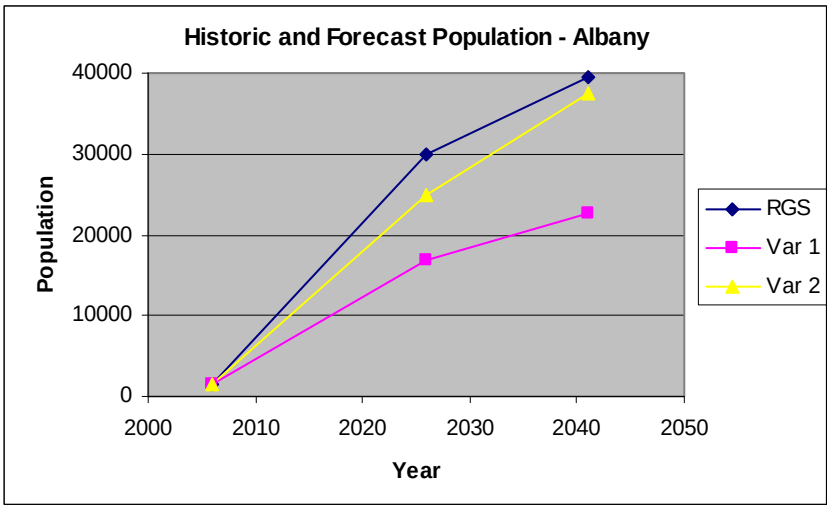


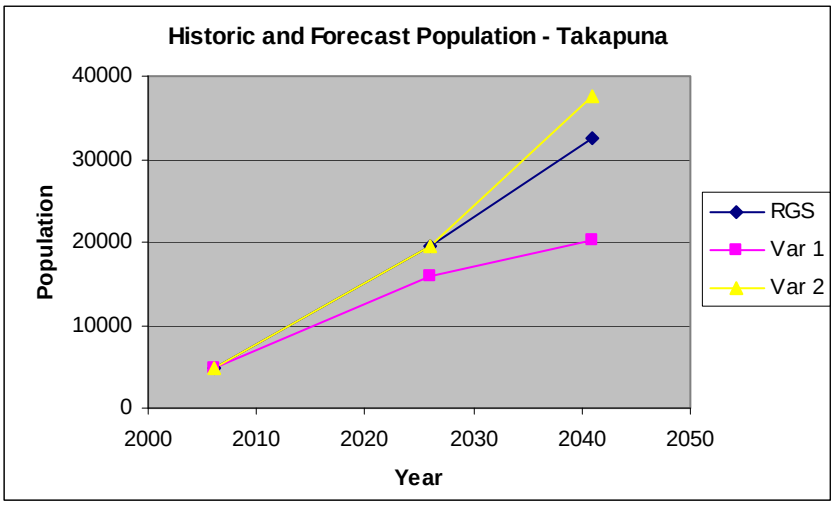


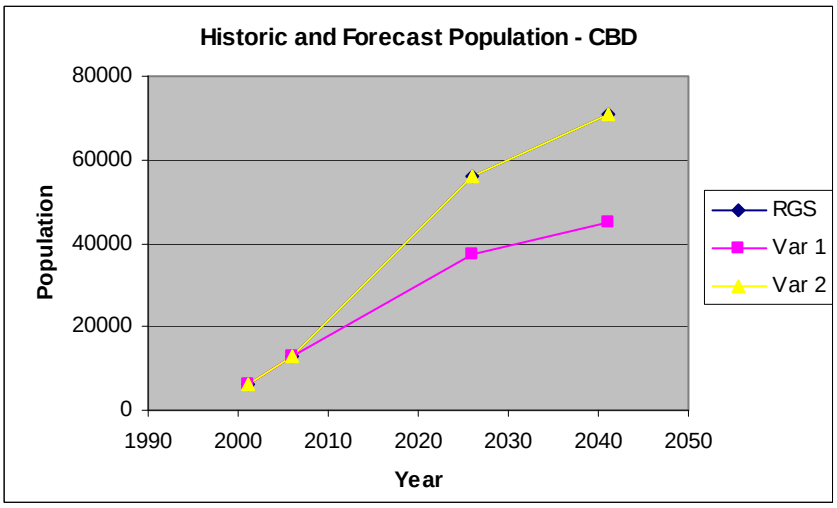
The following table gives historic population at 5-year intervals 1991 to 2006, and 2026 and 2041 forecasts for each of the three land use scenarios for specific locations of relevance to the study: Albany, Takapuna, Auckland CBD and the CBD fringes. The table also gives the percentage per annum (%p.a.) increase for each successive year of data.

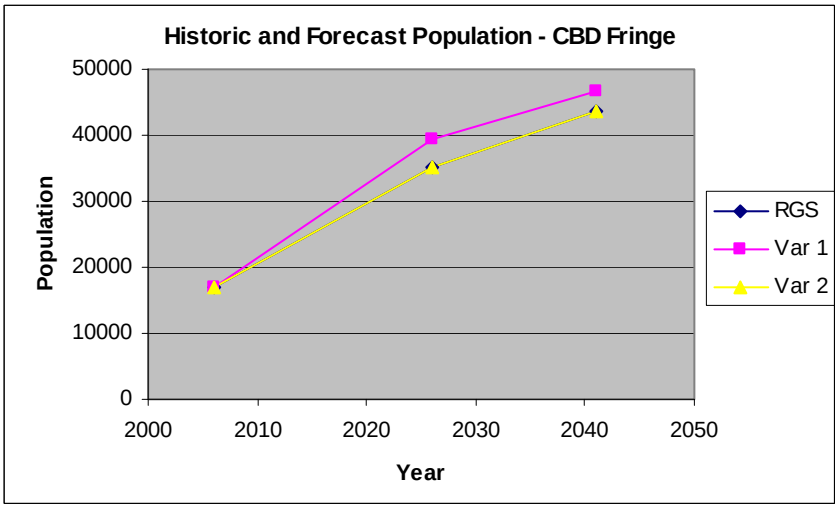
The historic and forecast populations are also shown graphically in the figures following the table.

Area	Scenario	1991	1996	2001	2006	2026	2041
Albany	RGS				1,435	29,897	39,464
						16.4%	1.9%
	Var1				1,435	16,750	22,707
						13.1%	2.0%
	Var2				1,435	25,000	37,500
						15.4%	2.7%
Takapuna	RGS				4,760	19,417	32,453
						7.3%	3.5%
	Var1				4,760	15,827	20,273
						6.2%	1.7%
	Var2				4,760	19,493	37,500
						7.3%	4.5%
CBD	RGS			6,456	13,170	55,926	71,023
					15.3%	7.5%	1.6%
	Var1			6,456	13,170	37,315	45,134
					15.3%	5.3%	1.3%
	Var2			6,456	13,170	55,926	71,023
					15.3%	7.5%	1.6%
CBD Fringe	RGS				17,103	35,238	43,685
						3.7%	1.4%
	Var1				17,103	39,311	46,657
						4.2%	1.1%
	Var2				17,103	35,238	43,685
						3.7%	1.4%







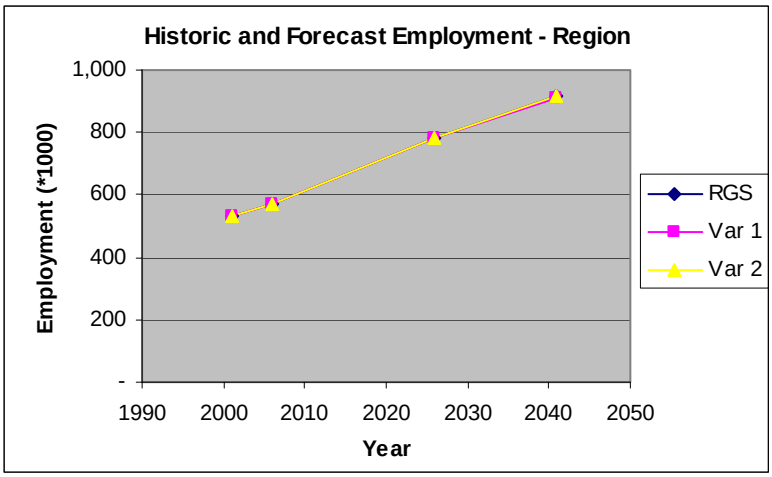


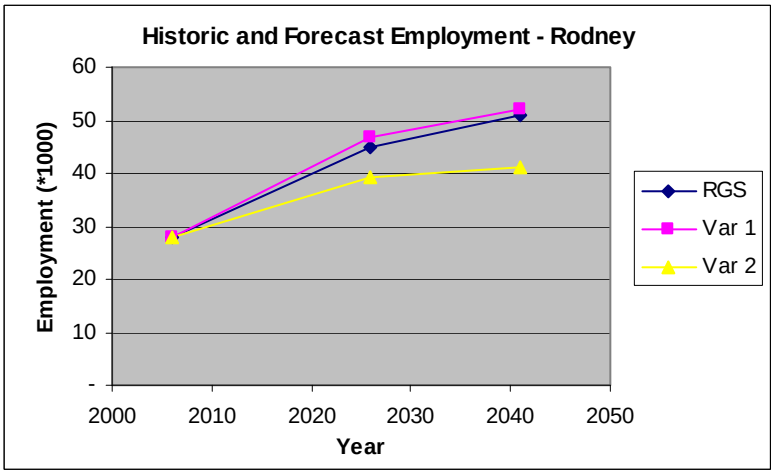
4.3 Employment

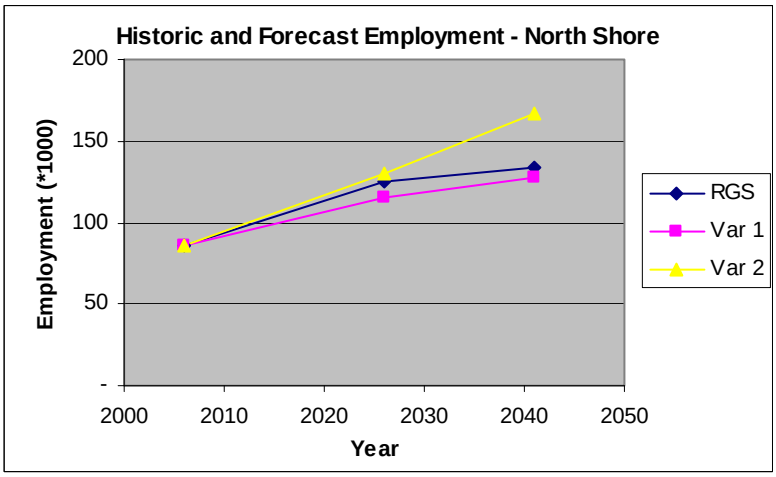
The following table gives historic employment at 5-year intervals 1991 to 2006, and 2026 and 2041 forecasts for each of the three land use scenarios for the region and sectors. For the region the forecast scenarios are the same, hence only one is given. The table also gives the percentage per annum (%p.a.) increase for each successive year of data.

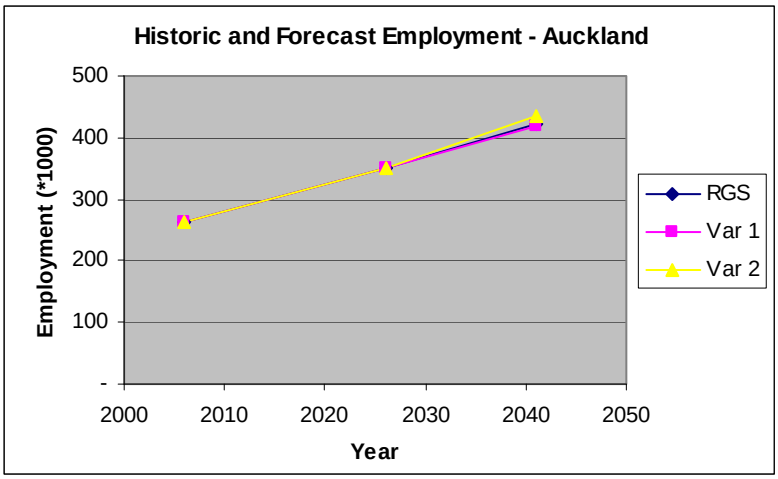
The historic and forecast employment is also shown graphically in the figures following the table.

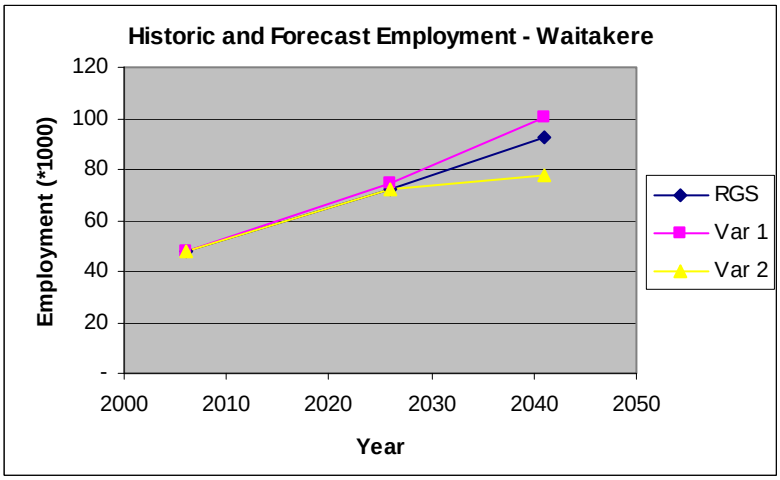
Area	Scenario	1991	1996	2001	2006	2026	2041
Region	All			534	571	781	914
					1.4%	1.6%	1.0%
Rodney	RGS				28	45	51
						2.4%	0.8%
	Var1				28	47	52
						2.7%	0.7%
	Var2				28	39	41
						1.7%	0.3%
North Shore	RGS				86	125	134
						1.9%	0.5%
	Var1				86	115	128
						1.4%	0.7%
	Var2				86	130	167
						2.1%	1.7%
Auckland	RGS				263	349	423
						1.4%	1.3%
	Var1				263	349	420
						1.4%	1.2%
	Var2				263	349	436
						1.4%	1.5%
Waitakere	RGS				48	72	93
						2.1%	1.7%
	Var1				48	75	101
						2.3%	2.0%
	Var2				48	72	78
						2.1%	0.5%
South	RGS				147	190	213
						1.3%	0.7%
	Var1				147	195	212
						1.4%	0.6%
	Var2				147	190	191
						1.3%	0.0%

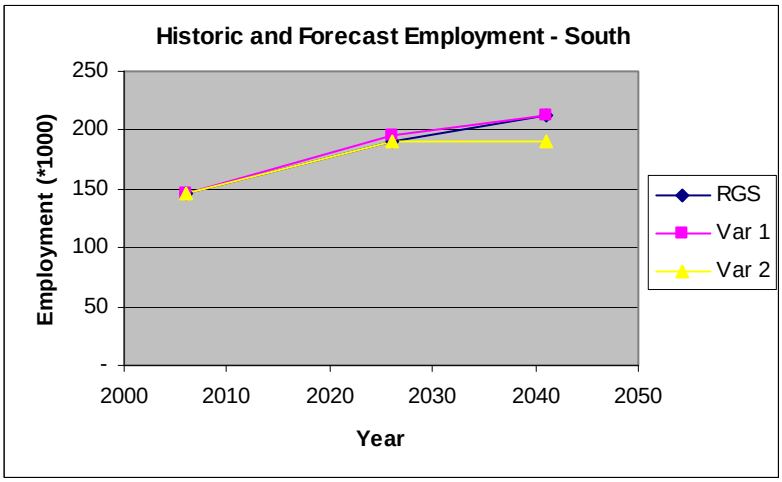

Historic and Forecast Employment - Region
Employment (*1000)
1,000
800
600
400
200
-
1990
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Employment - Rodney
Employment (*1000)
60
50
40
30
20
10
-
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Employment - North Shore
Employment (*1000)
200
150
100
50
-
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Employment - Auckland
Employment (*1000)
500
400
300
200
100
-
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2

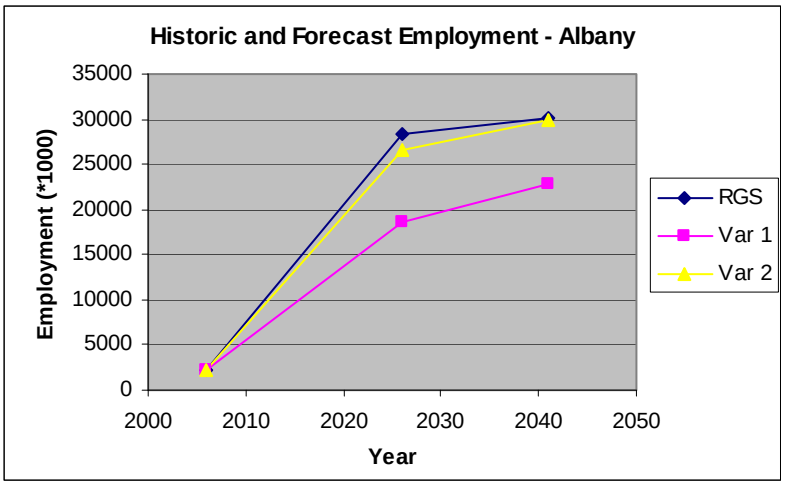

Historic and Forecast Employment - Waitakere
Employment (*1000)
120
100
80
60
40
20
-
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2

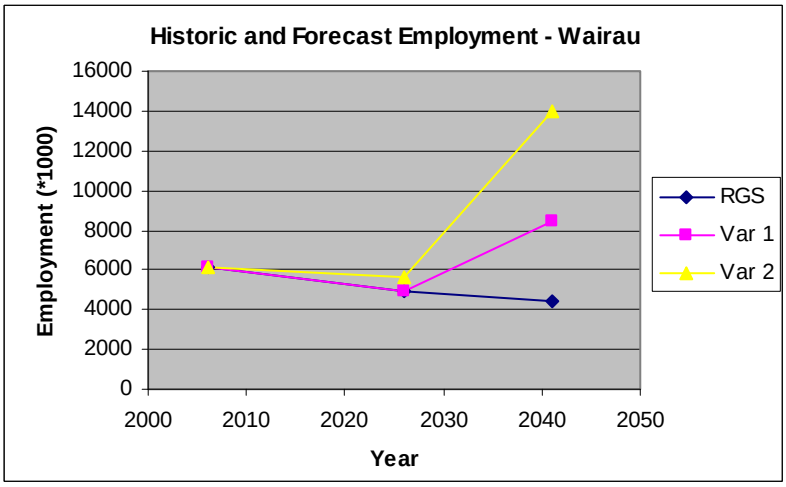

Historic and Forecast Employment - South
Employment (*1000)
250
200
150
100
50
-
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2

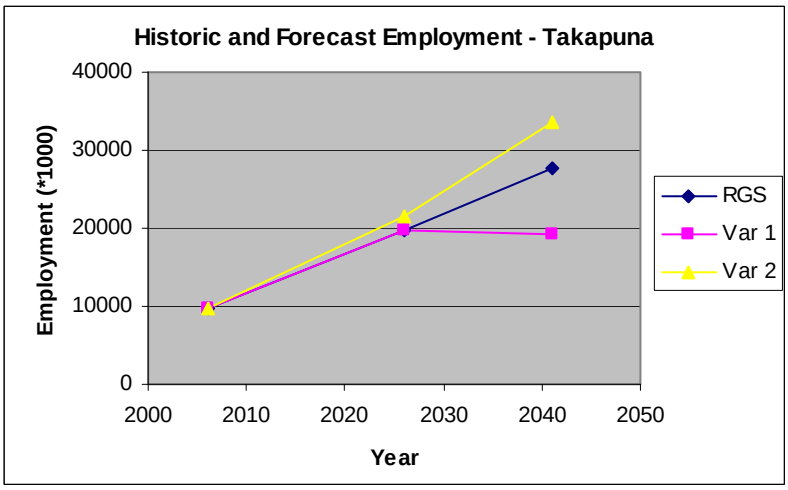
The following table gives, where available, historic and current (2006) employment at 5-year intervals, and 2026 and 2041 forecasts for each of the three land use scenarios for specific locations of relevance to the study: Albany, Wairau, Takapuna, Auckland CBD and the CBD fringes. The table also gives the percentage per annum (%p.a.) increase for each successive year of data.

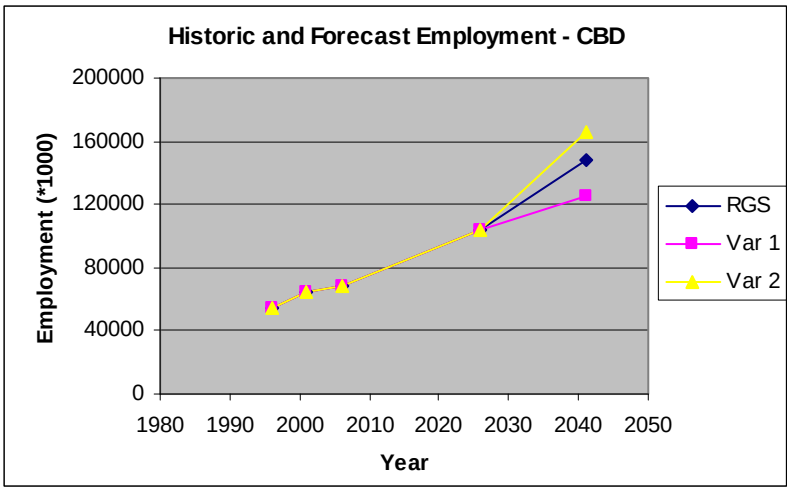
The employment figures are also shown graphically in the figures following the table.

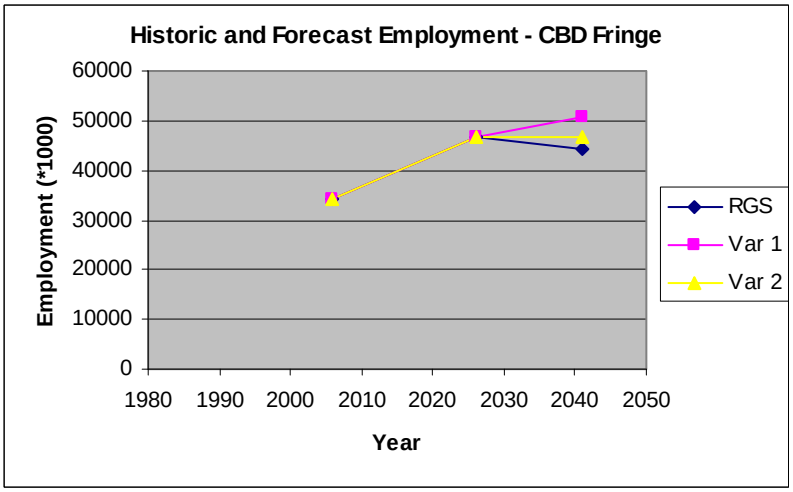
Area	Scenario	1991	1996	2001	2006	2026	2041
Albany	RGS				2,128	28,357	30,063
						13.8%	0.4%
	Var1				2,128	18,516	22,755
						11.4%	1.4%
	Var2				2,128	26,516	29,829
						13.4%	0.8%
Wairau	RGS				6,095	4,921	4,474
						-1.1%	-0.6%
	Var1				6,095	4,921	8,500
						-1.1%	3.7%
	Var2				6,095	5,658	14,000
						-0.4%	6.2%
Takapuna	RGS				9,679	19,645	27,601
						3.6%	2.3%
	Var1				9,679	19,645	19,285
						3.6%	-0.1%
	Var2				9,679	21,500	33,500
						4.1%	3.0%
CBD	RGS		54,612	64,259	68,986	104,392	148,205
				3.3%	1.4%	2.1%	2.4%
	Var1		54,612	64,259	68,986	104,392	125,000
				3.3%	1.4%	2.1%	1.2%
	Var2		54,612	64,259	68,986	104,392	166,269
				3.3%	1.4%	2.1%	3.2%
CBD Fringe	RGS				34,034	46,766	44,458
						1.6%	-0.3%
	Var1				34,034	46,766	50,712
						1.6%	0.5%
	Var2				34,034	46,766	46,843
						1.6%	0.0%


Historic and Forecast Employment - Albany
Employment (*1000)
35000
30000
25000
20000
15000
10000
5000
0
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Employment - Wairau
Employment (*1000)
16000
14000
12000
10000
8000
6000
4000
2000
0
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2


Historic and Forecast Employment - Takapuna
Employment (*1000)
40000
30000
20000
10000
0
2000
2010
2020
2030
2040
2050
Year
RGS
Var 1
Var 2





David Young, Brian Waddell

Appendix D Economic and Strategy Inputs

1 Introduction

This note sets out the proposed inputs to ART3 in forecasting (excluding land use inputs and transport networks which are considered separately) for the purposes of NZTA and peer review sign-off prior to the forecasting commencing.

This is the final version of the note following peer review comments and subsequent modifications. A final section has been added to the note which sets out how the inputs have been used in the ART3 Do Minimum forecasts for the study.

2 Background

The ARC for their RLTS and RGS modelling have used a set of inputs designed to represent their policies and initiatives. These were recently reviewed and a revised set used in ART3 model runs to produce traffic demands for the WRR economic evaluation.

For the AWHC transport modelling it is proposed to use the RLTS/RGS inputs as well as an alternative set. This alternative has been derived following a review of the RLTS/RGS inputs and consideration of the revisions made for the WRR economic evaluation, and some test forecasts undertaken by the ARC with initial revised inputs.

Additionally, given concerns expressed by the ARC over the growth in HCV trips we have also reviewed the HCV model in forecasting, and a proposed revised model is outlined. This would be used in all WHC forecasts.

A range of inputs are required for the ART3 forecasting which are considered under the categories of economic inputs and strategy inputs. In each case the RLTS/RGS inputs are described as are those for the proposed alternative.

3 Economic Inputs

3.1 Introduction

The following economic inputs for the future scenarios have been reviewed:

- Growth in GDP/capita (this is presently set at 1.8% p.a. based on historical growth)
- Levels of car ownership, which are influenced by GDP/capita growth
- Growth in heavy commercial vehicles, which is related to both employment growth and GDP/capita growth
- Values of time
- Vehicle operating costs, both fuel prices and vehicle efficiency

- Parking costs and their location
- Passenger transport fare levels
- Growth in flight passengers at Auckland Airport, which impacts on growth in flight-related traffic to/from the airport
- Growth in traffic into and out of the region (external traffic), which is presently based on historic count data

3.2 GDP Growth, HCV Trips and Car Ownership

We have reviewed the basis of the currently used GDP/capita growth of 1.8% p.a. and this rate will continue to be used in the model and which impacts on the growth in HCV trips and levels of car ownership.

We have also reviewed the ART3 HCV model following concerns about high growth in HCV trips from both the ARC and the WRR modelling. The current model was developed using historic HCV traffic growth and GDP growth to year 2006. The trends shown in the latter years of this data proved to be inconclusive as to whether they continued similar to earlier data, hence the model was based on the earlier data.

Our review suggests that the model should be reformulated as follows.

The distribution of HCV demand should be adjusted to accord with the changed distribution of employment and households (based on the HCV trip end calculations, as in the present model) and the overall growth in HCV trips will be controlled by the growth in GDP (with GDP/head assumed to grow at 1.8% p.a. and population by 49% to 2041, this implies a GDP growth assumption of 3%pa). The historic overall national elasticity of HCV vkt to GDP (real) appears to be about 1.0, but this may be too high in urban areas – this would result in a 20% lower forecast HCV growth to 2041 compared with the present forecasts. In other studies a value of around 0.6 has proved to be more appropriate in this context, and this would almost halve the present forecasts of HCV growth.

Our proposal is to generally use the 0.6 elasticity in the cross-harbour forecasts but to include the 1.0 elasticity as a sensitivity test (probably as part of the RLTS case).

3.3 Values of Time

When costs are changed in forecasting so should the willingness to pay these costs, which relates to increases in earnings. This has not occurred to date in the ART3 forecasts.

International views appear to be an elasticity of about +1.0, and the UK advises +0.8 for non-work travel and +1.0 for business/CV trips. The elasticity is to earnings, for which GDP/capita can be substituted.

Applying the GDP/capita growth of 1.8% p.a. and the UK elasticities, gives the ART3 values of time given in Table 1.

- **Table 1 Values of Time ($/hr)**

	2006	2026	2041
HBW	10.40	13.84	17.14
EB	33.10	47.29	61.80
Other	8.70	11.57	14.34

3.4 Vehicle Operating Costs (VOC)

These include both fuel price and vehicle efficiency.

The ARC modelling has included increased future fuel prices based on a report by MRC prepared for the ARC's RLTS review: "***Price Forecasts for Transport Fuels and other Delivered Energy Forms, ARC, January 2009***". This has fuel prices of $2.75/litre in 2026 and $3.71/litre in 2041 (in 2006 dollar terms). Vehicle efficiency was not modified.

The WRR modelling used the ARC fuel prices, but also included assumed vehicle efficiency improvements. The latter came from MoT advice based on their Vehicle Fleet Emissions Model (VFEM), which for 2026 was an improvement over 2006 of 1.1% p.a.

We have obtained updated advice from the MoT based on revised assumptions, including fleet projections. This is for a 13% improvement by year 2026 and 31% by year 2041. In our alternative inputs, we propose to use the ARC's fuel prices, and the above improvements for vehicle efficiency (Table 2).

- **Table 2 Vehicle Operating Costs**

	2006	2026	2041
Fuel Price ($/litre)	1.55	2.75	3.71
Vehicle Efficiency (litres/100km)	10.0	8.7	6.9

3.5 Parking Costs

Commuting parking costs in ART3 are, for each zone, the product of the average cost paid and the proportion of vehicle trips that pay.

In the ARC's recent RGS modelling, both components of the 2006 observed costs were increased and the location of paying parking costs widened from the CBD, Newmarket, Takapuna, and Henderson to include Albany, more of Takapuna and Henderson, New Lynn, Manukau City Centre, and the CBD Fringe (Parnell, Grafton, Newton, Ponsonby). These changes appear to be based on both increased earnings and policy changes.

In the 2006 model the average cost paid in the CBD zones is $2.83, and in the RGS modelling this is $6.28 in 2026 and $7.72 in 2041. Given that the above costs do not increase uniformly over time (the increase to 2026 is greater than that to 2041), we have related the parking cost increases to earnings (GDP/capita). Using the historic GDP/capita growth of 1.8% p.a. and adjusting the elasticity to achieve the 2041 average CBD cost results in a 2026 average CBD cost of $5.26.

Hence, based on the above, we propose to use the parking costs by ART3 zone in Table 3.

- **Table 3 Average Parking Costs**

Location	Zone	2006	2026	2041
Albany	57		4.19	6.50
Takapuna	108	0.54	4.19	6.50
Takapuna	111		4.61	6.50
Henderson	158	0.09	2.52	4.00
Henderson	159		2.52	4.00
Henderson	161	0.09	2.52	4.00
CBD	191	2.70	5.02	7.38
CBD	192	2.70	5.02	7.38
CBD	193	3.00	5.57	8.20
CBD	194	3.00	5.57	8.20
CBD	195	3.00	5.57	8.20
CBD	196	3.00	5.57	8.20
CBD	197	3.00	5.57	8.20
CBD	198	2.55	4.74	6.97
CBD	199	2.55	4.74	6.97
Newmarket	233	2.00	3.71	7.25
Newmarket	232	2.00	3.71	7.25
Manukau	450		3.77	5.25
Manukau	451		3.77	5.25
New Lynn	187		2.93	4.00
CBD Fringe	230		4.19	6.50
CBD Fringe	229		4.19	6.50
CBD Fringe	200		4.19	6.50
CBD Fringe	201		4.19	6.50
CBD Fringe	202		4.19	6.50
CBD Fringe	204		4.19	6.50
CBD Fringe	210		4.19	6.50
CBD Fringe	211		4.19	6.50
CBD Fringe	212		4.19	6.50
CBD Fringe	214		4.19	6.50

3.6 PT Fares

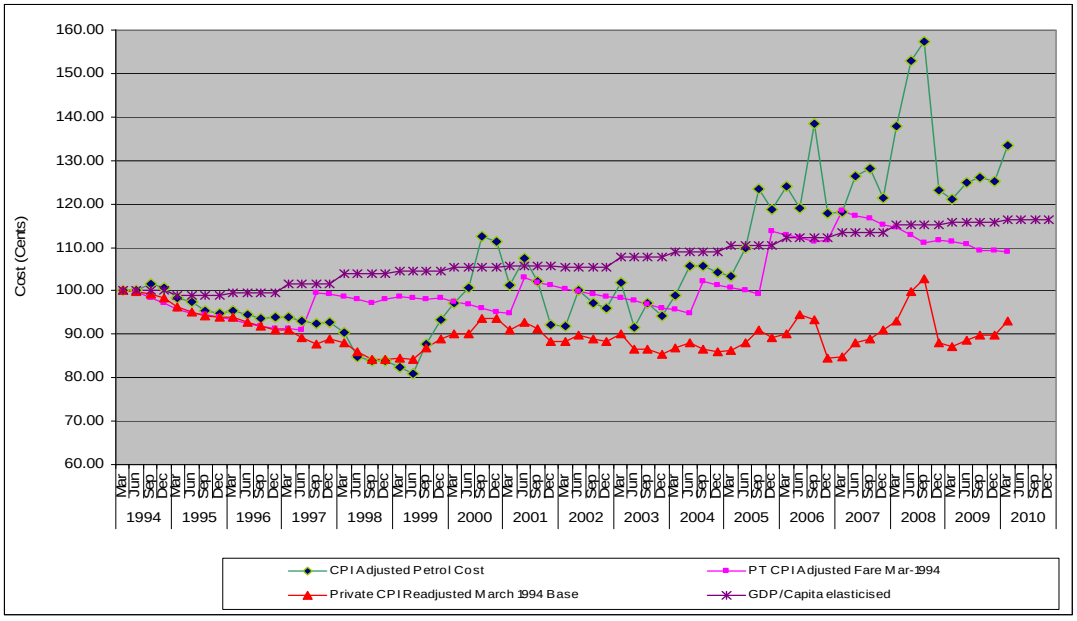
PT fares have remained constant in the ARC's RLTS and RGS forecasting. For the WRR modelling the historic relationship between fares and fuel price was considered, using graphical data given in an ARC RLTS paper.

The general principle is clear that future PT fares need to be considered in light of future increases in real fuel costs and in real earnings, and that the costs of public transport provision may be expected to increase faster than inflation and thus be reflected in growing real fares.

To the ARC data we have added GDP/capita, applying an elasticity and adjusting it until the trend best matches PT fares (Figure 2). An elasticity of 0.5 gave the best fit.

Based on the trend in GDP/capita we propose to increase the 2006 PT fares by 20% in year 2026 and 37% in 2041.

- **Figure 2 PT Fares, Fuel Price and GDP/Capita**



3.7 Flight Passengers

The growth in flight passengers at Auckland Airport impacts on the growth in flight-related traffic to/from the airport. This is currently set at 4.5% p.a. for international flights and 3.5% p.a. for domestic flights based on historic and forecast data from AIAL provided in 2007.

There is no reason to alter these growth rates but the effect on cross-harbour travel will be monitored during forecasting.

3.8 Trips External to the Region

The growth in traffic into and out of the region (external traffic) is based on historic count data and presently set at 3% p.a. This growth rate seems reasonable and these trips will be a minor proportion of cross harbour travel.

4 Strategy Inputs

A component of the Auckland Regional Transport Strategy is a series of travel demand management (TDM) initiatives known as "TDM non-pricing":

- Workplace travel planning
- Working from home initiatives
- Education travel planning
- Community-based travel initiatives

The impacts of these are estimated external to the model and the effects inserted into the model as reductions in car trips and increases in passenger transport and active (walk and cycle) trips.

These are included in the RLTS/RGS inputs, and, given that there is little or no substantive independent documented evidence on the effects of such plans, we propose to exclude all from the alternative set of inputs.

5 Inputs Used in ART3 Do Minimum Forecasts

Following the above review and development of alternative inputs two alternative sets of inputs: labelled Alt1 and Alt2. These, along with the RGS inputs, will be used in the forecasting.

The table records where the change in each of the input variables is included in each set of inputs. Hence the difference between Alt1 and Alt 2 is the inclusion of the TDM effects.

Input	Change	Alt1	Alt2	RGS
Fuel Price	**Increased**	√	√	√
Vehicle Efficiency	**Improved**	√	√	
Values of Time	**Increased**	√	√	
Parking Costs	**Increased**	√	√	√
PT Fares	**Increased**	√	√	
TDM Effects	**Included**		√	√

David Young

Appendix E ART3 Do Minimum Forecasts

1 Introduction

This note records the modelling undertaken for the Do Minimum forecasts and provides some summary and specific statistics. The forecast years are 2026 and 2041, while the ART3 base year is 2006.

This is for the purposes of facilitating internal sign-off of the Do Minimum forecasts. A shortened version was for communicating with NZTA and the wider project team (an initial version was presented to the Team Leader meeting of 06/08/2010),

The note outlines the various inputs to ART3, the Do Minimum model runs undertaken, and then presents a sample of key results for the region, relevant screenlines and cross-harbour travel. The reasons for the differences between the results of the model runs are discussed, followed by conclusions and a recommendation.

2 Inputs to ART3

2.1 Transport Networks

The Do Minimum transport networks for the wider network, covering the Auckland region, were agreed and documented in a separate note. The AHB operates in 2026 and 2041 as is does today.

2.2 Land Use Inputs

Three sets of future land use inputs have been used:

- RGS Land Use: the current RGS (known as Plan Change 6), arising from the latest round of ASP-ART modelling undertaken as part of the ARC's future land use and transport planning project;
- Variant 1 Land Use: a modification to the RGS land use with lower levels of intensification, more general intensification of suburban areas and some further extensions to the MUL.
- Variant 2 Land Use: a modification of the RGS land use with more intensification along the corridor served by cross-harbour bus and/or rail passenger transport.

The two variants have been developed manually starting with the RGS land use, with locational differences largely in North Shore, Rodney, Auckland CBD and fringes, while keeping the regional totals constant. The process and outcomes of this are documented in separate notes.

2.3 Other Inputs

We have reviewed other inputs to ART3 used by the ARC in their RGS/RLTS modelling and developed alternative inputs which have now been peer reviewed, from which we have created two alternative sets of inputs: Alt1 and Alt2. These, along with the RGS inputs, have been used in these forecasts.

The input variables are listed below and the following table records where the change in each is included in each set of inputs:

- Vehicle operating costs: made up of fuel price and vehicle efficiency
- Values of time
- Parking costs
- PT fares
- The effects of TDM non-pricing initiatives.

Input	Change	Alt1	Alt2	RGS
Fuel Price	**Increased**	√	√	√
Vehicle Efficiency	**Improved**	√	√	
Values of Time	**Increased**	√	√	
Parking Costs	**Increased**	√	√	√
PT Fares	**Increased**	√	√	
TDM Effects	**Included**		√	√

3 Model Runs Undertaken

ART3 has been run in the two forecast years, 2026 and 2041, for 5 do minimum scenarios using the do minimum transport networks with different land use and other inputs as set out in the following table.

This has enabled the effects of the different inputs, both land use and other inputs, to be independently determined and understood.

Land Use Inputs	RGS	Var1	Var2
Alt1	√	√	√
Alt2	√		
RGS	√		

4 Results

4.1 Regional

Population, Employment and Trip Growth

The table gives the 2006 regional population, employment, vehicle trips and PT trips and the percentage growth between 2006 and each forecast year, 2026 and 2041:

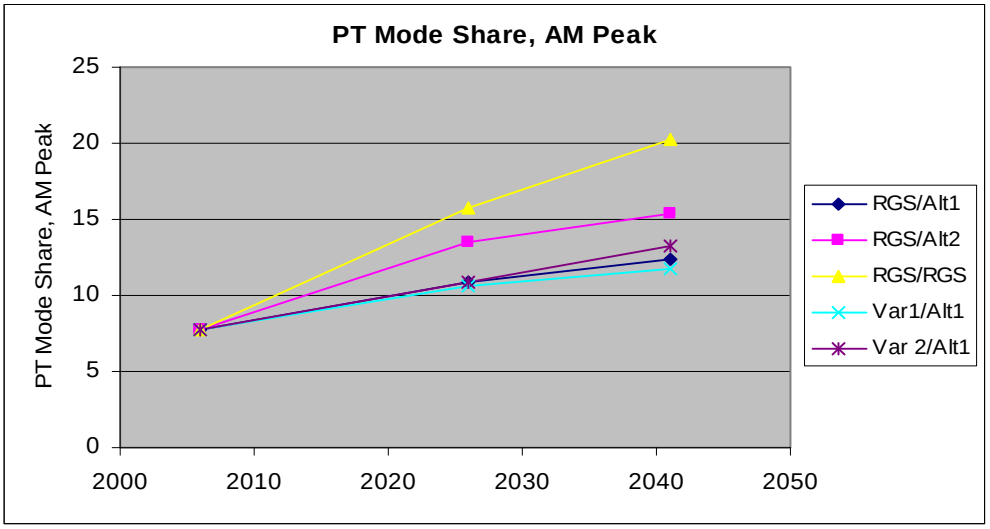
- The growth in population is 30% and 50%; employment growth is higher
- The growth in trips varies between scenarios; depending on the land use and other inputs:
  - The variation with land use inputs (RGS, Var1, Var2) is small,
  - The variation with other inputs (Alt1, Alt2, RGS) is significant.
- Growth in vehicle trips:
  - With the Alt1 inputs the growth is in line with population growth,
  - With the RGS inputs the growth is half the population growth,
  - With the Alt2 inputs the growth is in-between these two.
- Growth in PT trips:
  - The Alt1 inputs gives the lowest growth, 2-3 times the population growth,
  - The RGS inputs gives the highest growth, 5 times the population growth,
  - The Alt2 inputs give growth in-between these two, 3-4 times the population growth.

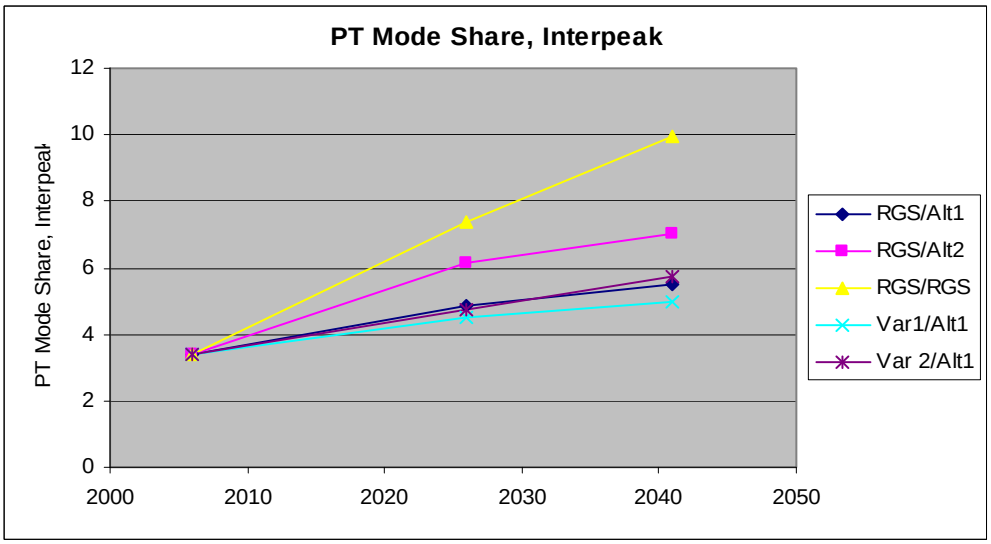
	2006	2026					2041				
Land Use		**RGS**	**RGS**	**RGS**	**Var1**	**Var2**	**RGS**	**RGS**	**RGS**	**Var1**	**Var2**
Other Inputs		**Alt1**	**Alt2**	**RGS**	**Alt1**	**Alt1**	**Alt1**	**Alt2**	**RGS**	**Alt1**	**Alt1**
Population	1,347,377					30%					50%
Employment	520,251					40%					66%
AM Peak											
Vehicle Trips	489,255	29%	18%	15%	29%	28%	45%	27%	20%	46%	43%
PT Trips	47,241	84%	113%	150%	78%	83%	138%	164%	249%	124%	153%
Interpeak											
Vehicle Trips	460,209	35%	25%	20%	36%	35%	58%	39%	29%	59%	56%
PT Trips	18,214	96%	130%	170%	81%	91%	158%	193%	295%	134%	167%
PM Peak											
Vehicle Trips	528,337	29%	18%	15%	30%	29%	46%	28%	21%	47%	44%
PT Trips	38,735	89%	121%	163%	82%	88%	153%	178%	276%	137%	168%

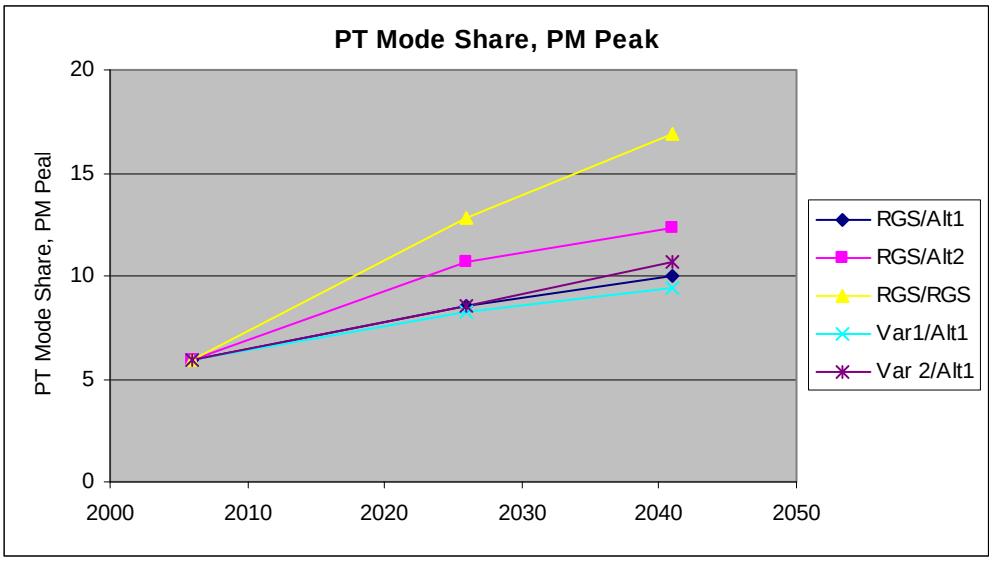
Mode shares

The figures give the regional average PT mode shares, defined as PT trips/(vehicle trips x 1.2 + PT trips). The figures show that:

- All scenarios in all three periods show increased PT mode share over time, but with variation in the increases,
- There is small variation between the scenarios due to the land use inputs,
- There is significant variation between the scenarios due to the other inputs:
    - The Alt1 inputs result in the lowest PT mode shares - in 2041 60-70% higher than today,
    - The RGS inputs give significantly higher PT mode share - in 2041 160-200% higher than today,
    - The Alt2 inputs give PT mode shares in-between the other two scenarios - in 2041 twice that of today.



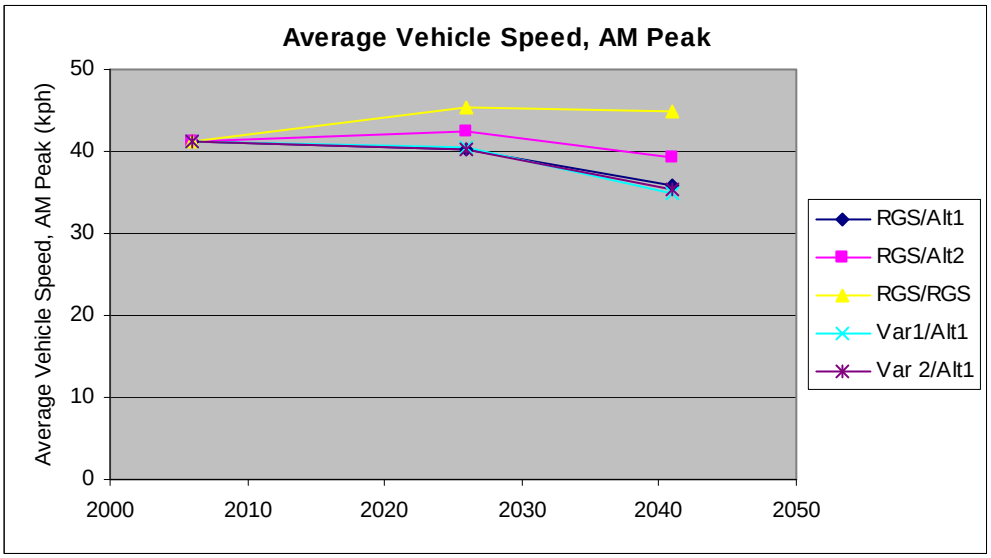


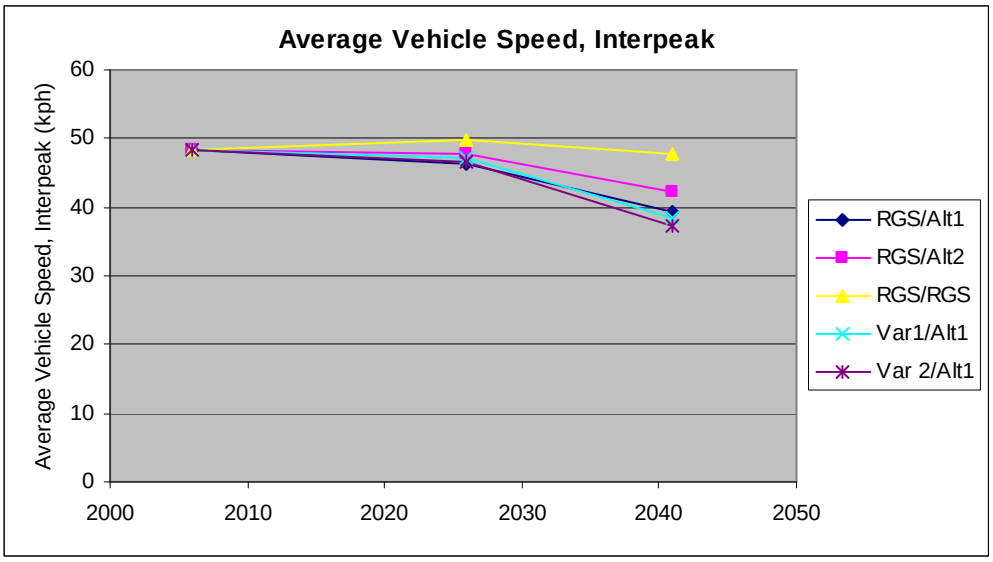


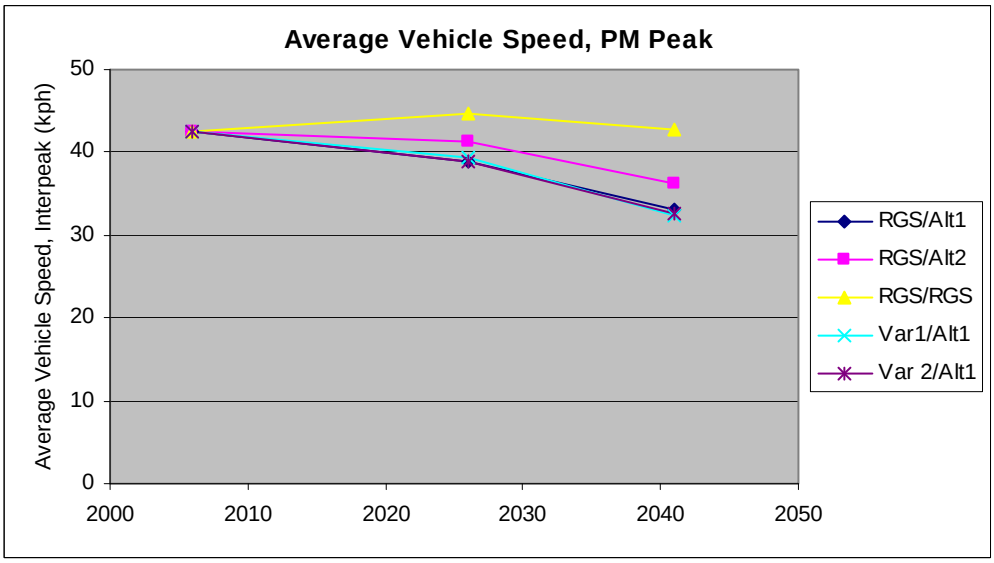
Vehicle Speeds

The figures give the average vehicle speeds in each modelled period, showing:

- Little variation in average speeds between the three sets of land use inputs,
- Significant variation in average speeds between the other inputs, with:
  - The Alt1 and Alt2 inputs giving lower speeds than today,
  - The RGS inputs resulting in average speeds higher than today in the AM peak and about the same as today in the Interpeak and PM peak.







4.2 Screenline Statistics

The following table gives the 2006 AM peak vehicle and PT flows across the 5 screenlines of particular relevance to the study, and the percentage growth between 2006 and each of the forecast years.

The data show:

- The growth varies between screenlines according to their location; for example higher growth on the Hibiscus screenline and generally lower on screenlines closer to the CBD;
- The growth in PT flows is much higher than for vehicle flows, often from a low 2006 base; this resulted in extremely high percentage growth for the Hibiscus screenline so this has been removed from the table for readability purposes;

- The growth in vehicle flows from 2006 to 2026 (20 years) is more than half the growth from 2006 to 2041 (35 years), implying a slowing of growth between 2026 and 2041; this is not unexpected given that the network capacity is not increased after 2026;
- Considering the relative growth by direction across each screenline:
    - for vehicles this varies; on the CBD screenline the outbound growth is much higher than the inbound, whereas on the Harbour screenline the growth is more even, though the northbound direction tends to be slightly higher (from a lower base),
    - for PT the outbound growth (i.e. away from the CBD) is higher than the inbound, but is from a lower base;
- There are generally relatively small variations between the scenarios due to the land use inputs;
- There are some significant variations between the scenarios due to the other inputs:
    - The growth in vehicle flows is highest with the Alt1 inputs, lower with the Alt2 inputs, and lowest with the RGS inputs,
    - In some cases there is negative growth in vehicle flows with the RGS and, to a lesser extent, Alt2 inputs

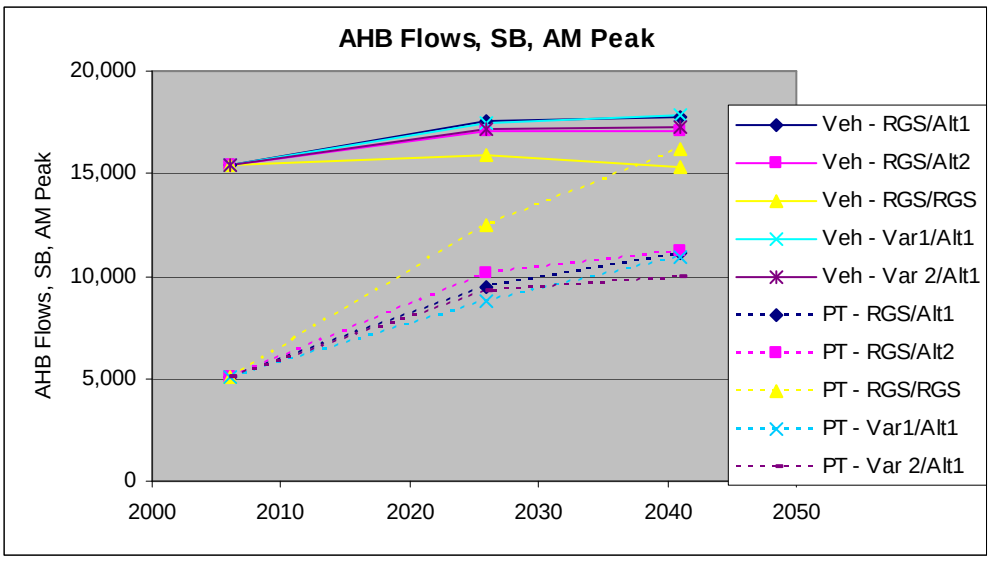
	2006	2026					2041				
Land Use		**RGS**	**RGS**	**RGS**	**Var1**	**Var2**	**RGS**	**RGS**	**RGS**	**Var1**	**Var2**
Other Inputs		**Alt1**	**Alt2**	**RGS**	**Alt1**	**Alt1**	**Alt1**	**Alt2**	**RGS**	**Alt1**	**Alt1**
AM Peak Vehicle											
Hibiscus NB	3,735	66%	58%	37%	70%	53%	95%	84%	40%	100%	77%
Hibiscus SB	6,448	71%	66%	52%	82%	74%	77%	72%	39%	100%	86%
North Shore NB	11,813	25%	18%	4%	14%	16%	29%	21%	-8%	30%	20%
North Shore SB	14,037	18%	14%	4%	21%	24%	23%	17%	-2%	28%	37%
Harbour NB	15,302	35%	35%	30%	34%	34%	36%	35%	26%	36%	37%
Harbour SB	18,615	33%	29%	18%	33%	31%	38%	33%	9%	42%	31%
Central Isthmus NB	55,491	3%	-4%	-12%	4%	4%	8%	0%	-17%	8%	11%
Central Isthmus SB	34,619	11%	7%	-2%	11%	11%	28%	21%	2%	29%	23%
CBD IN	33,593	11%	-2%	-16%	13%	11%	29%	17%	-13%	22%	36%
CBD OUT	22,230	36%	21%	10%	26%	36%	58%	43%	17%	44%	61%
AM Peak PT											
Hibiscus NB	24										
Hibiscus SB	366										
North Shore NB	458	585%	661%	800%	266%	422%	588%	648%	994%	404%	613%
North Shore SB	2,470	159%	173%	235%	141%	169%	198%	195%	326%	223%	204%
Harbour NB	1,196	281%	333%	414%	188%	259%	321%	366%	615%	261%	437%
Harbour SB	7,183	70%	82%	115%	63%	69%	112%	108%	180%	112%	96%
Central Isthmus NB	18,792	58%	75%	101%	61%	60%	99%	103%	164%	82%	144%
Central Isthmus SB	2,658	144%	188%	224%	139%	145%	155%	206%	286%	159%	132%
CBD IN	23,025	40%	53%	77%	41%	40%	71%	76%	129%	56%	98%
CBD OUT	3,298	219%	291%	359%	182%	213%	242%	305%	461%	235%	260%

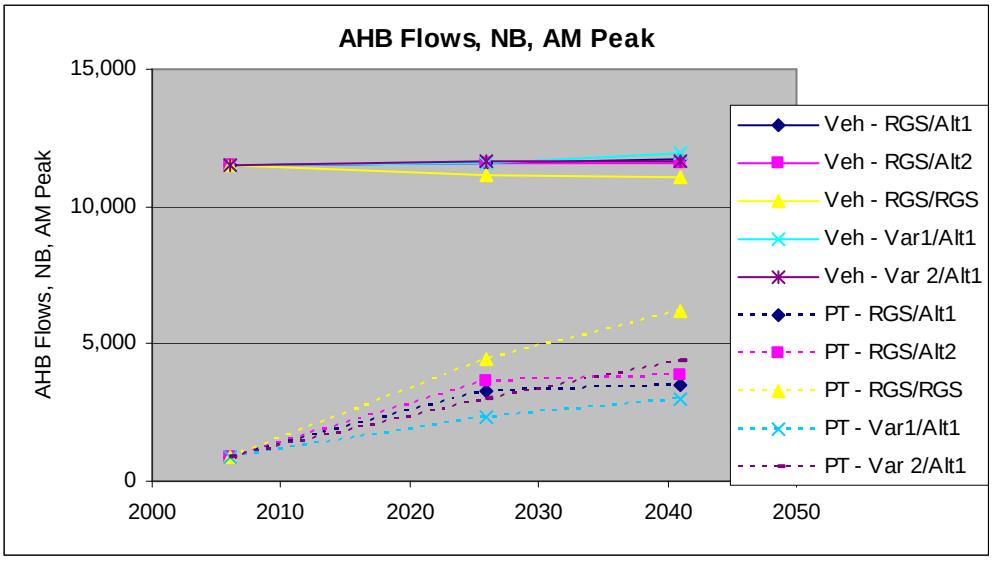
4.3 Cross-Harbour Travel

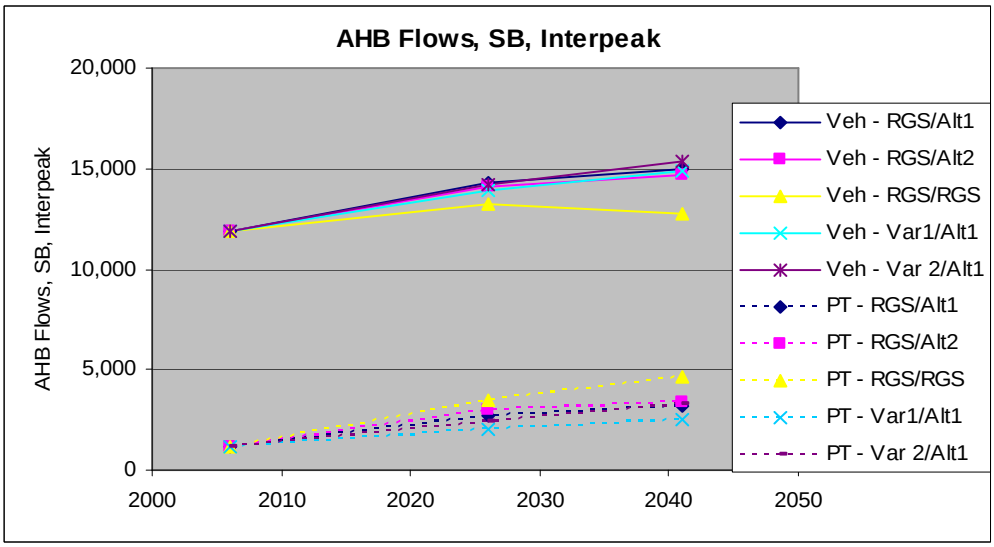
Trips

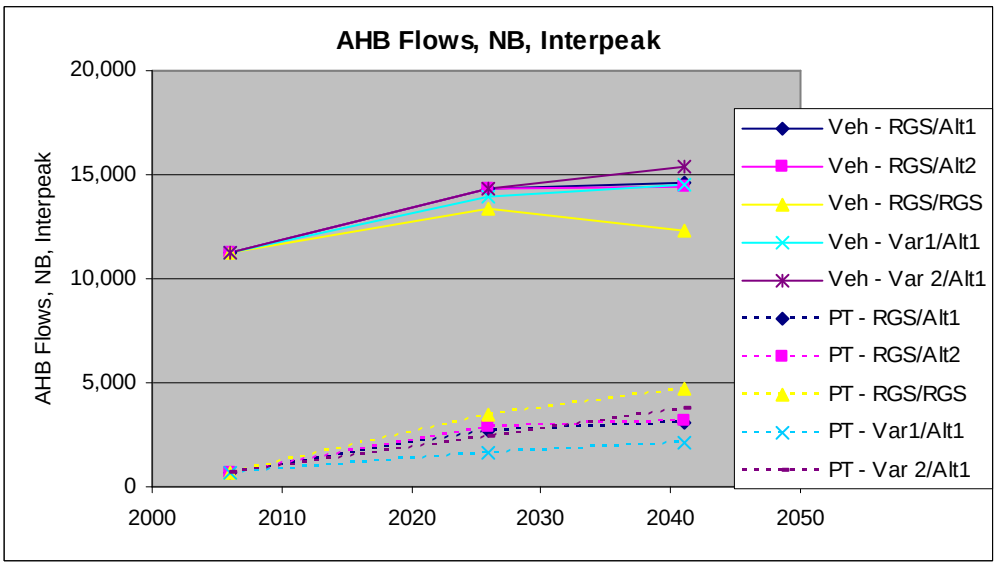
The following figures give the vehicle trips and PT patronage on AHB southbound (SB) and northbound (NB) in the three modelled periods, showing:

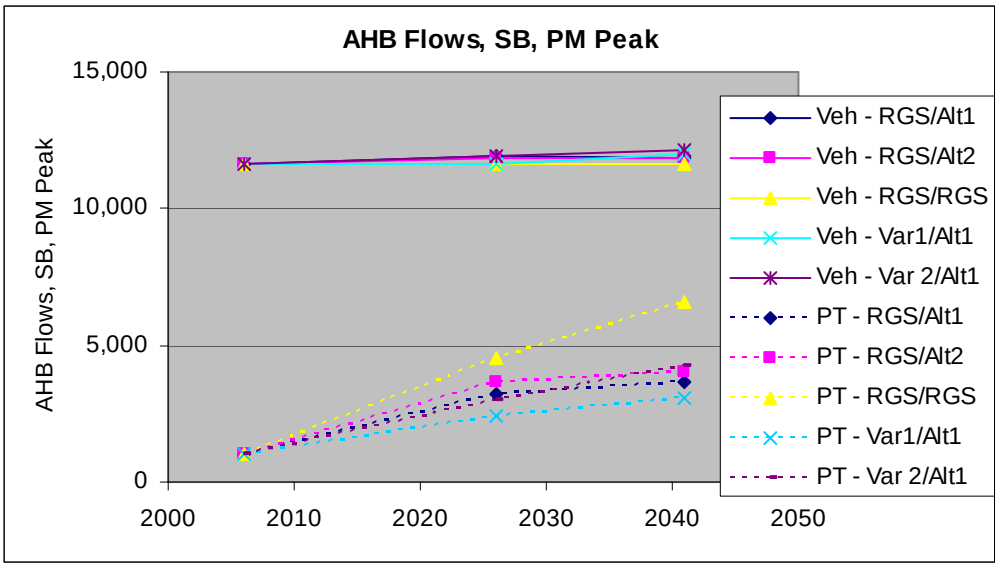
- Lower growth in vehicle trips compared with PT trip growth
- Little variation between land use inputs,
- Significant variation between the alternative (Alt1, Alt2) and RGS inputs, with one exception:
    - Vehicle flows:
        - Alt1 and Alt2 inputs give increased peak period vehicle flows over today in the peak directions (AM SB and PM NB), and in the Interpeak period both directions, whereas
        - the corresponding flows using the RGS inputs are similar to today;
        - In the non-peak directions (AM NB and PM SB) the flows in all scenarios are similar and all show little growth over today; this is due to the capacity constraint on AHB of 3 lanes in the non-peak direction.
    - PT patronage:
        - Alt1 and Alt2 inputs result peak period PT patronage in the peak directions that is twice that of today, whereas
        - the corresponding patronages using the RGS inputs are over 3 times that of today;
        - in the non-peak directions and the Interpeak period there are large patronage increases in all scenarios, but these are from very low bases in 2006; as with the peak directions, the RGS inputs give higher increases than the alternative inputs.

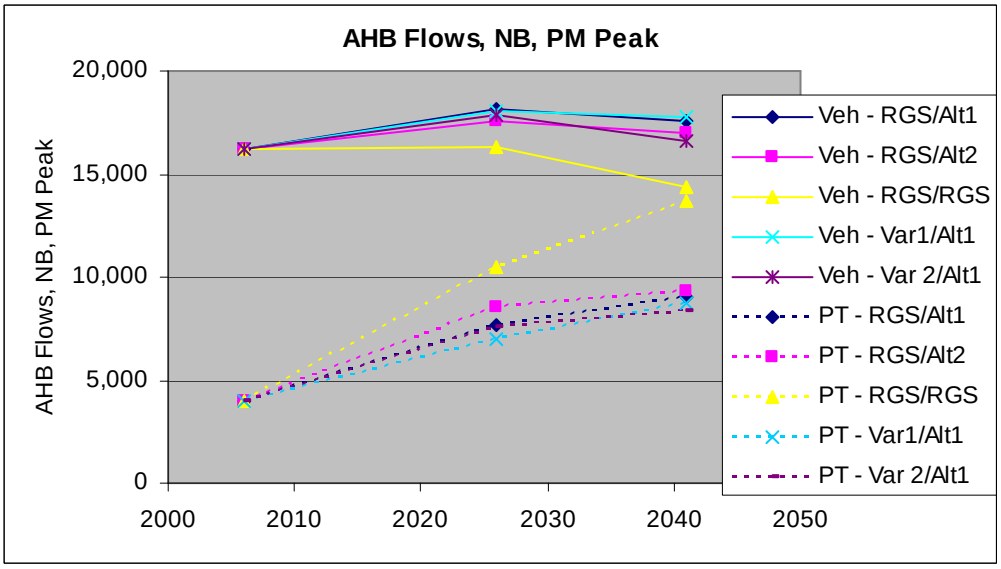



AHB Flows, NB, AM Peak
AHB Flows, NB, AM Peak
15,000
10,000
5,000
0
2000
2010
2020
2030
2040
2050
Veh - RGS/Alt1
Veh - RGS/Alt2
Veh - RGS/RGS
Veh - Var1/Alt1
Veh - Var 2/Alt1
PT - RGS/Alt1
PT - RGS/Alt2
PT - RGS/RGS
PT - Var1/Alt1
PT - Var 2/Alt1


AHB Flows, SB, Interpeak
AHB Flows, SB, Interpeak
20,000
15,000
10,000
5,000
0
2000
2010
2020
2030
2040
2050
Veh - RGS/Alt1
Veh - RGS/Alt2
Veh - RGS/RGS
Veh - Var1/Alt1
Veh - Var 2/Alt1
PT - RGS/Alt1
PT - RGS/Alt2
PT - RGS/RGS
PT - Var1/Alt1
PT - Var 2/Alt1


AHB Flows, NB, Interpeak
AHB Flows, NB, Interpeak
20,000
15,000
10,000
5,000
0
2000
2010
2020
2030
2040
2050
Veh - RGS/Alt1
Veh - RGS/Alt2
Veh - RGS/RGS
Veh - Var1/Alt1
Veh - Var 2/Alt1
PT - RGS/Alt1
PT - RGS/Alt2
PT - RGS/RGS
PT - Var1/Alt1
PT - Var 2/Alt1





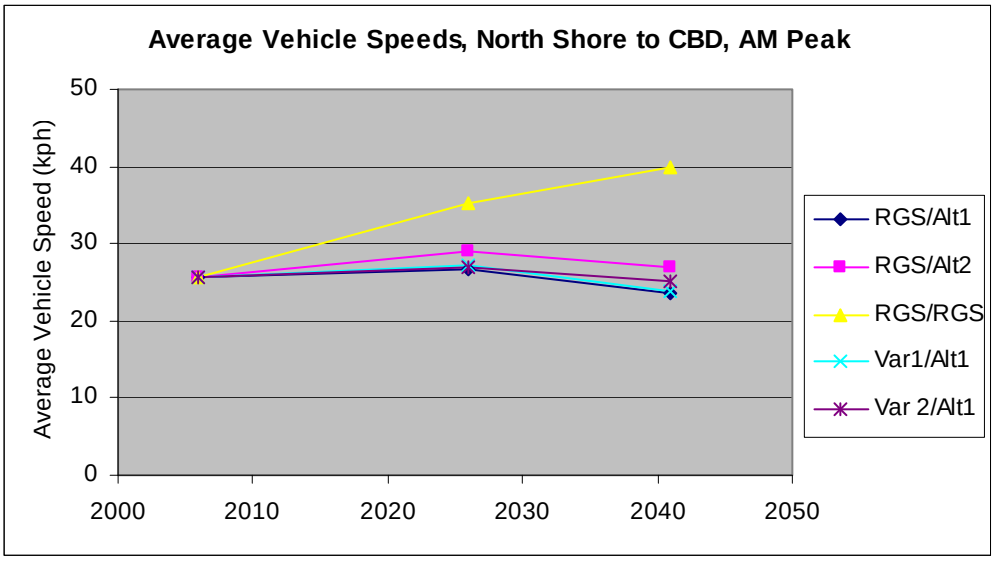
Average Vehicle Speeds, North Shore to CBD

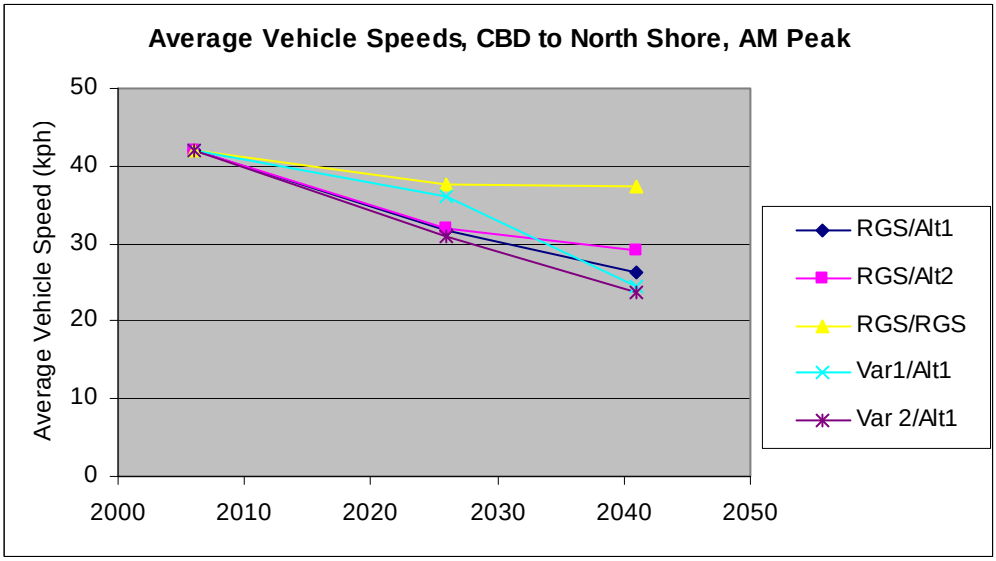
The following figures give the average vehicle speeds between North Shore and the CBD in both directions in the three modelled periods. The average speeds between the North Shore and the Isthmus were also examined, and as they showed the same trends are not included in this note. The figures show:

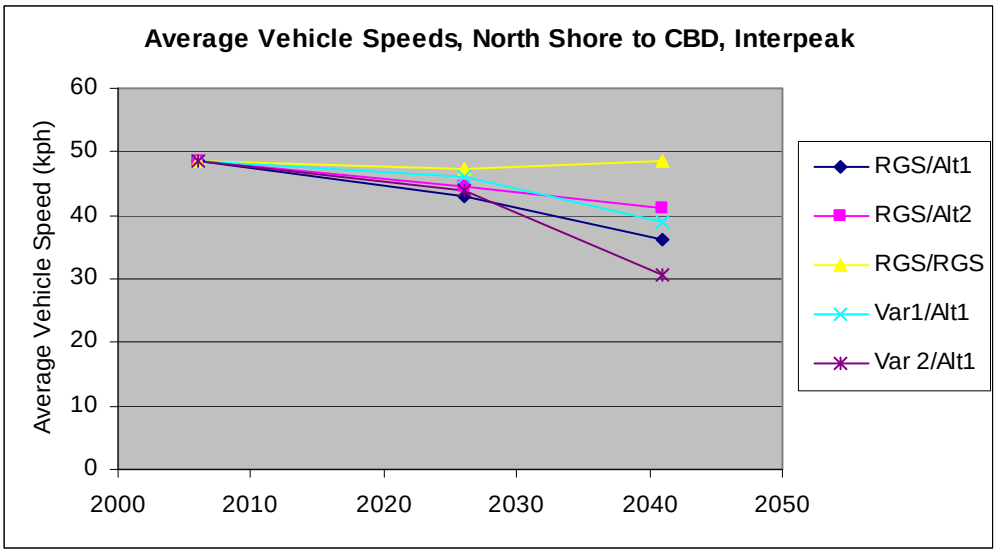
- Small variation in average speeds between the land use inputs,
- Significant variation in average speeds between the alternative (Alt1, Alt2) and RGS inputs:
    - In the peak directions in the peaks (i.e. North Shore to CBD in the AM peak and the reverse in the PM peak) the Alt1 and Alt2 inputs give similar speeds to today, whereas the RGS inputs result in higher average speeds (+50% in the AM peak in 2041);

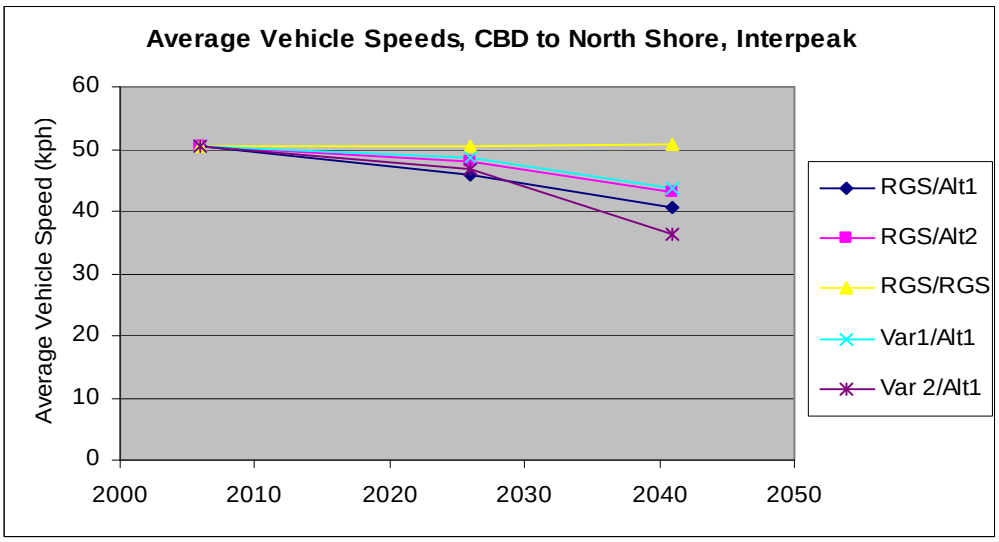
- In the contra-peak directions and in the Interpeak the average speeds with the RGS inputs are similar to today, whereas those with the alternative inputs are lower than today.

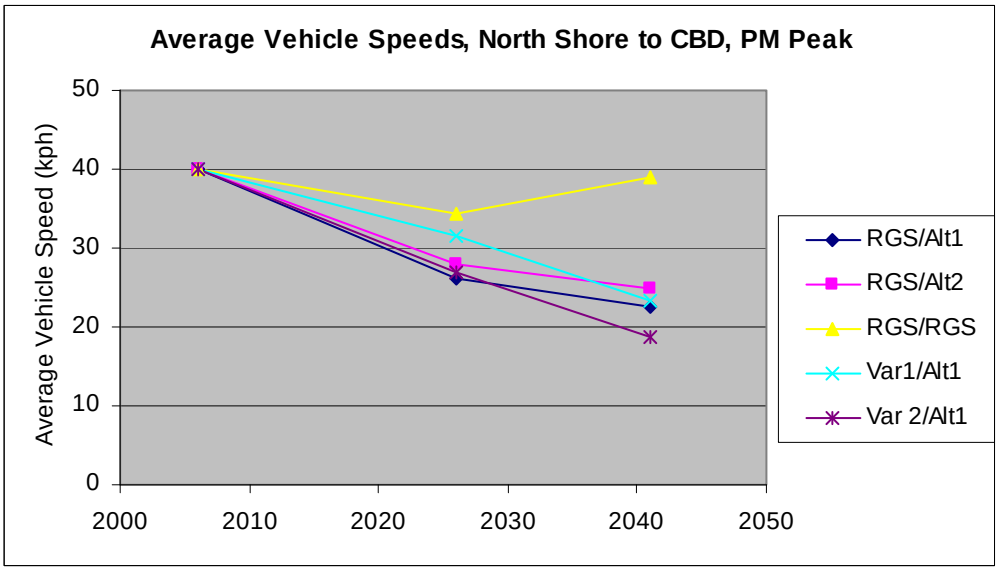
- These temporal changes in speed are a reflection of the changes in flows over time; the higher the traffic flows the lower the speeds; for example, the scenario with the RGS inputs shows no growth in traffic on AHB in the AM peak southbound and the corresponding average speed between the North Shore and CBD increases over time; on the other hand, the other scenarios all show growth in traffic and speeds which are significantly lower than in the RGS inputs scenario.

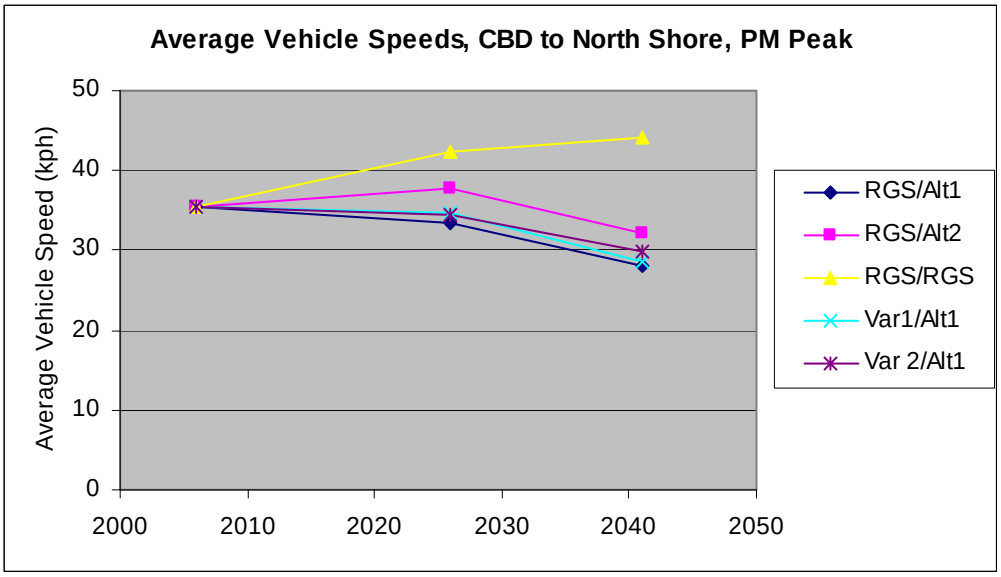





Average Vehicle Speeds, North Shore to CBD, Interpeak
Average Vehicle Speed (kph)
60
50
40
30
20
10
0
2000
2010
2020
2030
2040
2050
RGS/Alt1
RGS/Alt2
RGS/RGS
Var1/Alt1
Var 2/Alt1


Average Vehicle Speeds, CBD to North Shore, Interpeak
Average Vehicle Speed (kph)
60
50
40
30
20
10
0
2000
2010
2020
2030
2040
2050
RGS/Alt1
RGS/Alt2
RGS/RGS
Var1/Alt1
Var 2/Alt1


Average Vehicle Speeds, North Shore to CBD, PM Peak
Average Vehicle Speed (kph)
50
40
30
20
10
0
2000
2010
2020
2030
2040
2050
RGS/Alt1
RGS/Alt2
RGS/RGS
Var1/Alt1
Var 2/Alt1



5 Commentary

With all the data and statistics there are clear patterns between the Do Minimum scenarios which relate to the inputs.

The variations in land use have, at most, small effects on both regional and cross harbour travel.

With land use constant, the differences due to the other inputs are generally significant, with the RGS set of inputs giving different results regionally and across the harbour. This is due to the unchanged values of time, vehicle efficiency and PT fares, and the inclusion of TDM effects.

The differences between the Alt1 and Alt2 inputs is that the latter includes the TDM effects. The results show that the TDM has a significant impact on regional statistics (trips, mode shares, average speeds), but much less of an effect on cross harbour travel.

The RGS inputs result in regional vehicle trip growth lower than population growth and PT trip growth which is much higher. With the Alt1 inputs vehicle growth matches population growth and PT growth is lower, but still 2-3 times population growth. Including the TDM effects (Alt1 -> Alt2) reduces the vehicle trip growth by about a third and increases PT growth by about the same proportion. The same trends are apparent with regional mode shares and average vehicle speeds. In 2041 the average AM peak speed is higher than today's with the RGS inputs, whereas it is lower with the Alt1 inputs.

The same patterns are evident with flows across screenlines and cross harbour flows and speeds.

6 Conclusions and Recommendation

- Our review of the 5 Do Minimum model runs indicates that we are comfortable with the outputs. The results are consistent with previous modelling.
- The forecasts do not vary greatly between the three sets of land use inputs used.
- The forecasts do vary between the other inputs, notably between the alternative sets of inputs (Alt1 and Alt2) and those used for the RLTS/RGS modelling (RGS inputs).
- The latter gives quite different traffic and PT flows regionally and across the harbour; for example, it gives no growth in AM peak southbound traffic and very high growth in PT patronage.
- Our recommendation is that for the modelling and testing of the options and for the toll modelling we use:
    - the RGS land use and
    - one of the alternative sets of inputs, preferably Alt1, and then
    - at the end of the option testing the variant land use inputs and RGS set of inputs be used to understand the differences arising.

David Young

Appendix F Do Minimum SATURN Models

This file note sets out the details regarding the future Do Minimum SATURN models for 2026 and 2041.

1 OVERALL DEMANDS

The modelled demands have been derived from the ART model runs undertaken for this project, details of which have been set out in a File Note from SKM dated 6 September 2010. The SATURN demands have used the Regional Growth Strategy land use and with other inputs as included within what the SKM File Note termed Alternative 1. The network changes have previously been agreed with NZTA.

It is important that the changes to the demands that were applied to the base SATURN models are retained within the future forecasts. Therefore, the ART matrices have been used to determine the differences between the base and forecast demands. These differences have then been applied using the multiplicative approach (ie the ratios of changes to the base model are applied to the future matrices). This is consistent with the approach taken for the SH18 Strategic Improvements Study.

Issues were encountered in terms of the demands predicted by ART for the Wynyard Quarter area and the demands were modified to reflect those predicted by the Wynyard Quarter Transport Assessment. Details of these changes were set out in the Flow File Note dated 6 September 2010.

The total traffic demands in the SATURN model are set out in Table 1.

Table 4:Total Traffic Demands in Saturn Model

Scenario	AM	Inter Peak	PM Peak
2008 Base	95,520	85,330	106,280
2026 Do Minimum	119,820	114,100	131,270
2041 Do Minimum	127,070	124,830	139,850

The table indicates that the overall demands are predicted to increase by 24-26% in the peak hours, between 2008 and 2026, and by 34% in the inter peak. 2041 demands are expected to be 32-33% above 2008 flows in the peak hours, and 46% higher in the inter peak.

We have rerun the 2026 Do Minimum AM peak matrices using the additive method (where the absolute trip numbers in 2008 are added to the ART model differences). This leads to 121,380 trips/hour, which is within 1.5% of the figure given in Table 1, indicating that the total flows are consistent using either approach.

2 CROSS HARBOUR DEMANDS

The arrival flows and demand flows across Waitemata Harbour are set out in the following tables. These are based on the average hours for the three modelled periods and the models have been run without a preload for this purpose, so as not to influence the predicted demands.

The tables give information firstly for the 2008 base year, for the two existing bridges across the Waitemata Harbour, then the two forecast years. Daily flows have been derived from the demand flows by assuming two AM hours, two PM hours and 10.5 inter peak hours per day. These are the default values that we have derived for a number of studies in this area.

The directions on the Upper Harbour Bridge are described as northbound and southbound, but should more accurately be northeastbound and southwestbound

Table 5: 2008 Flows on Upper Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Base	Northbound	1,630	1,610	770	770	1,310	1,220	14,010
	Southbound	1,080	1,070	780	780	1,420	1,390	13,160
	Total	**2,710**	**2,680**	**1,550**	**1,550**	**2,730**	**2,610**	**27,160**

Table 6: 2008 Flows on Auckland Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Base	Northbound	5,010	4,800	5,170	5,170	9,280	8,020	82,890
	Southbound	8,980	7,640	5,210	5,210	6,290	5,950	85,260
	Total	**13,990**	**12,450**	**10,380**	**10,380**	**15,570**	**13,970**	**168,150**

Table 7: 2026 Flows on Upper Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Do Min	Northbound	3,080	3,030	2,470	2,450	3,100	2,990	38,340
	Southbound	3,320	3,280	2,540	2,530	3,320	3,260	39,930
	Total	**6,400**	**6,310**	**5,010**	**4,980**	**6,420**	**6,250**	**78,260**

Table 8: 2026 Flows on Auckland Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		
		Demand	Actual	Demand	Actual	Demand	Actual	AADT
Do Min	Northbound	5,270	5,050	6,600	6,580	9,850	9,370	99,530
	Southbound	9,860	7,750	6,380	6,300	5,810	5,630	98,300
	Total	**15,120**	**12,800**	**12,980**	**12,880**	**15,660**	**15,010**	**197,830**

Table 9: 2041 Flows on Upper Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Do Min	Northbound	3,080	3,020	2,600	2,570	2,920	2,780	39,280
	Southbound	3,390	3,350	2,670	2,660	3,180	3,110	41,220
	Total	**6,470**	**6,370**	**5,270**	**5,230**	**6,100**	**5,890**	**80,500**

Table 10: 2041 Flows on Auckland Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Do Min	Northbound	5,290	5,110	6,870	6,790	9,260	8,670	101,210
	Southbound	9,990	7,820	6,890	6,700	5,850	5,640	103,990
	Total	**15,280**	**12,930**	**13,760**	**13,490**	**15,110**	**14,310**	**205,200**

Tables 8 to 10 below set out the total predicted flows across the screenline (vehicles/day).

Table 11: 2008 Daily Flows across Harbour (vehicles/day)

	Northbound	Southbound	Total
Upper Harbour Bridge	14,010	13,160	27,160
Auckland Harbour Bridge	82,890	85,260	168,150
Total	96,890	98,420	195,310

Table 12: 2026 Daily Flows across Harbour (vehicles/day)

	Northbound	Southbound	Total
Upper Harbour Bridge	38,340	39,930	78,260
Auckland Harbour Bridge	99,530	98,300	197,830
Total	137,870	138,230	276,100

Table 13: 2041 Daily Flows across Harbour (vehicles/day)

	Northbound	Southbound	Total
Upper Harbour Bridge	39,280	41,220	80,500
Auckland Harbour Bridge	101,210	103,990	205,200
Total	140,490	145,210	285,700

The tables indicate that the total daily flows across the Harbour are predicted to increase by 41% between 2008 and 2026, with the majority of this growth on the Upper Harbour Bridge. Demands across the Auckland Harbour Bridge are only predicted to increase by 18% over this period.

Modest growth is predicted between 2026 and 2041, with the 2041 flows predicted to be around 46% above the 2008 flows.

The differences between the demand flows and the arrival flows are discussed in Section 3 below.

3 PREDICTED OPERATION

The following figures show the queue plots for the AM Peak, the interpeak and the PM Peak for 2008, 2026 and 2041. For each time period, plots are provided firstly for the whole modelled area, then for the Auckland CBD and Takapuna areas (ie the areas either side of the future Harbour Crossing).

These are what SATURN terms residual queues, at the end of the modelled periods.

3.1 2008 Scenario

Figure 3: 2008 AM Peak: Whole Model

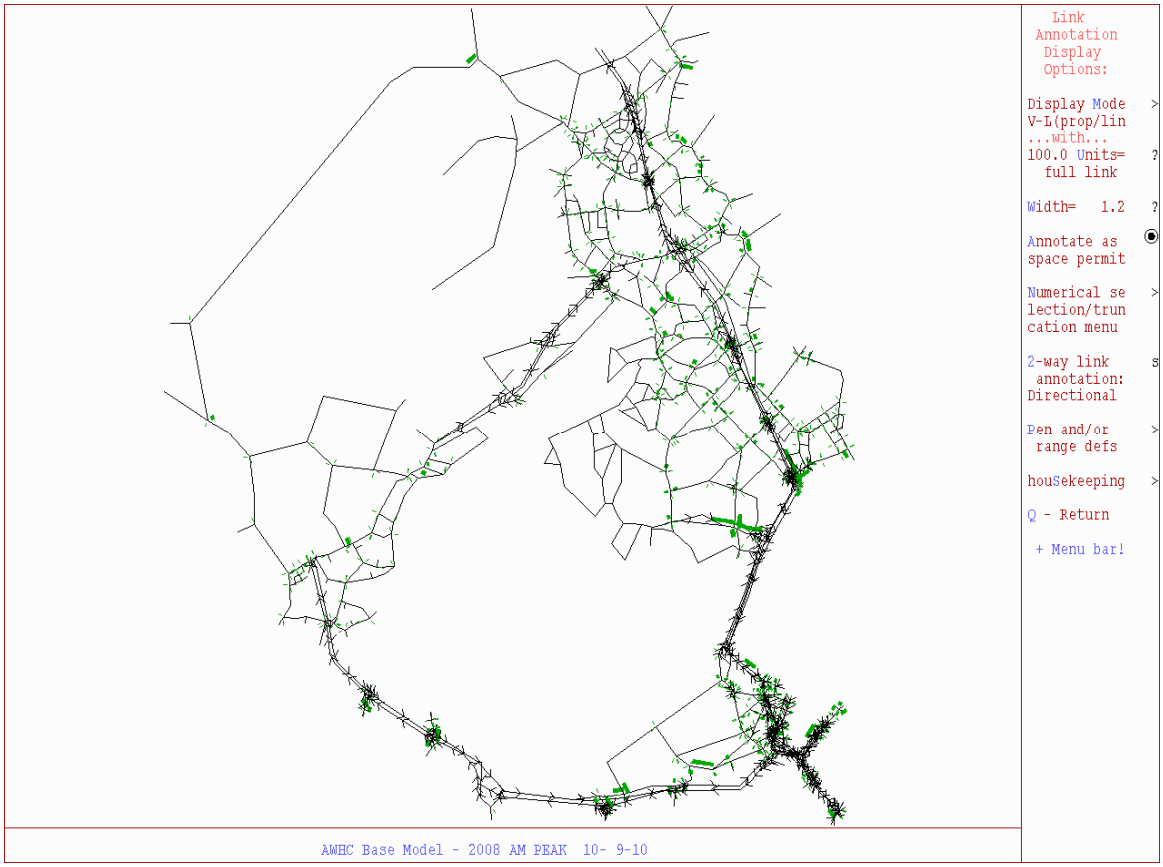


Figure 4: 2008 AM Peak: Auckland CBD

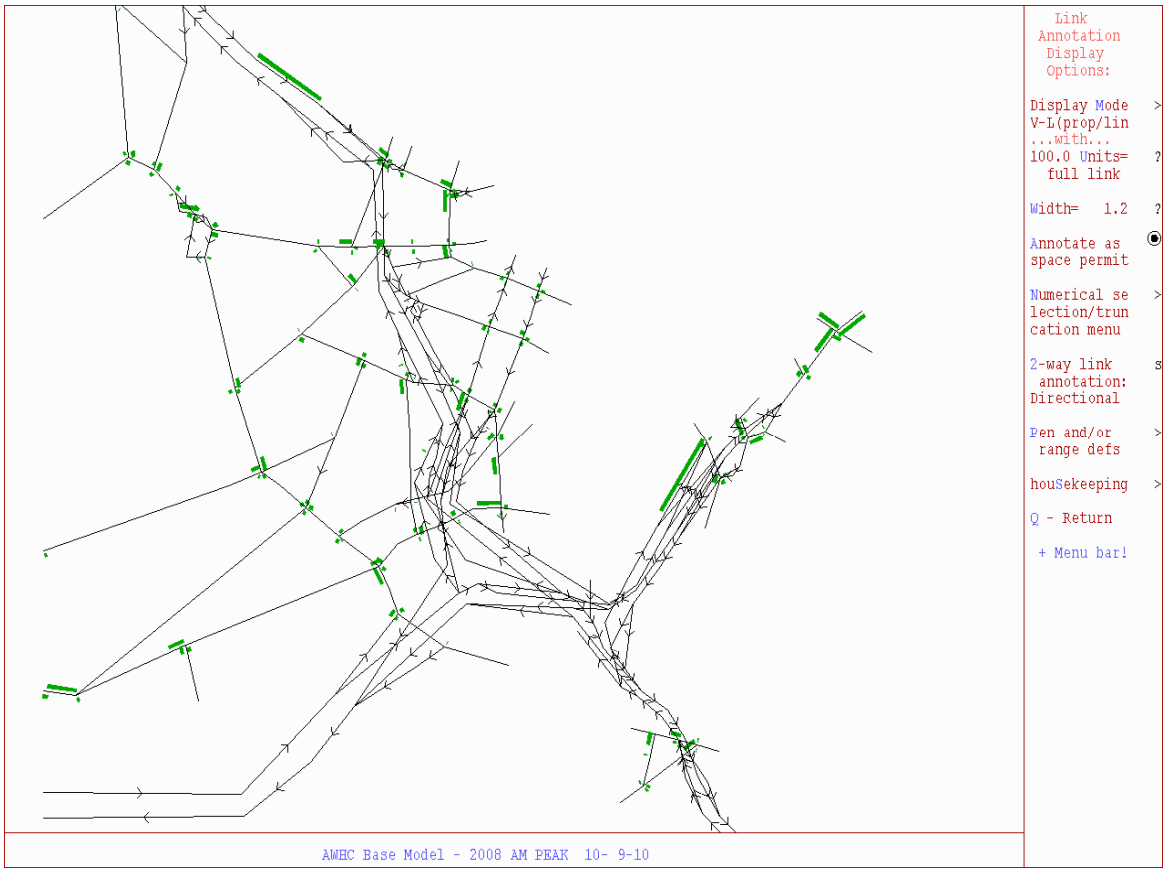


Figure 5: 2008 AM Peak: Takapuna

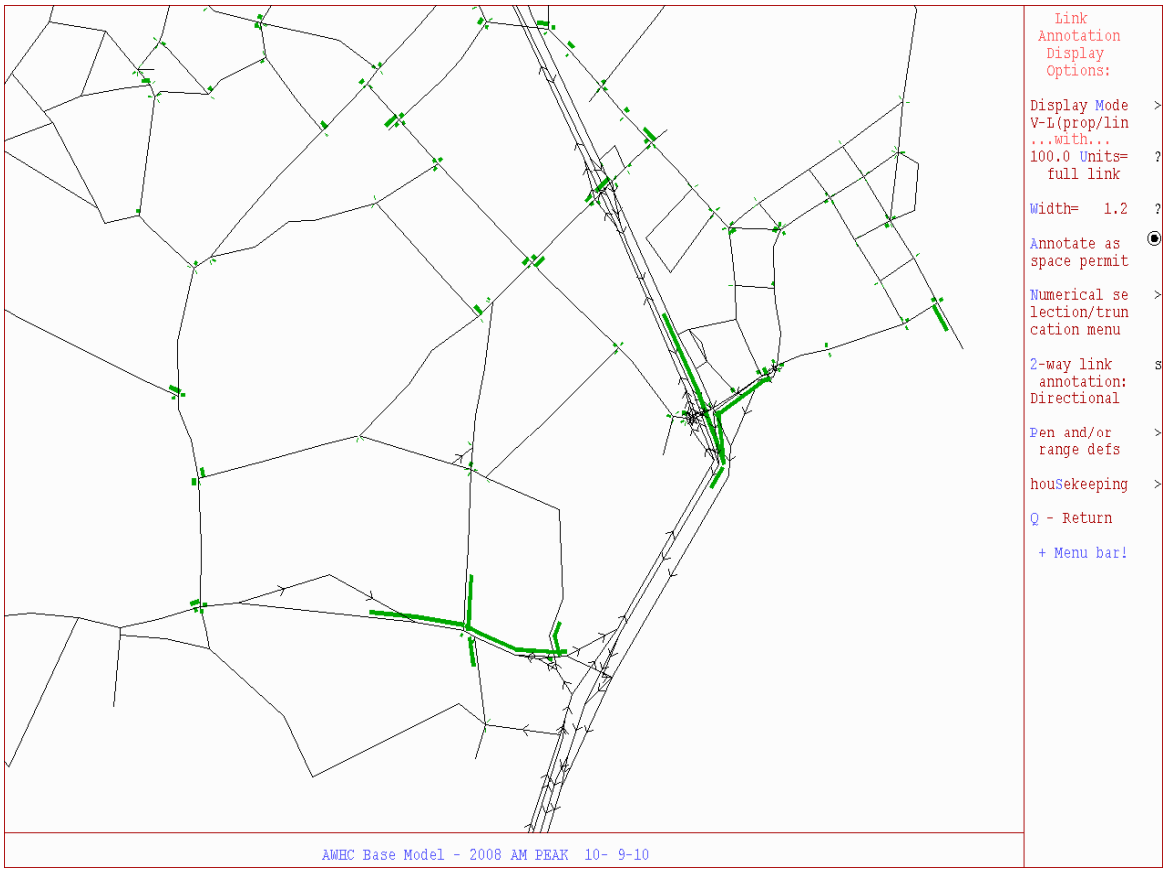


Figure 6: 2008 Inter Peak: Whole Model

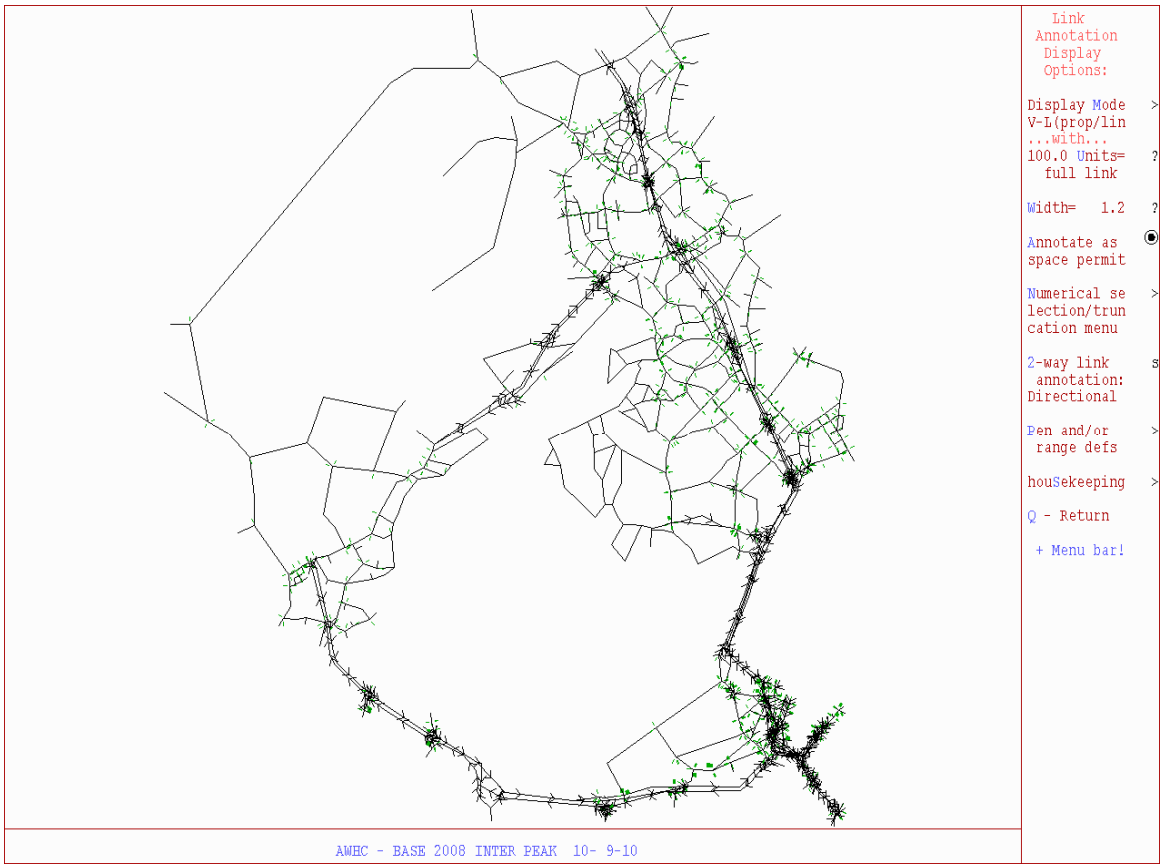


Figure 7: 2008 Inter Peak: Auckland CBD

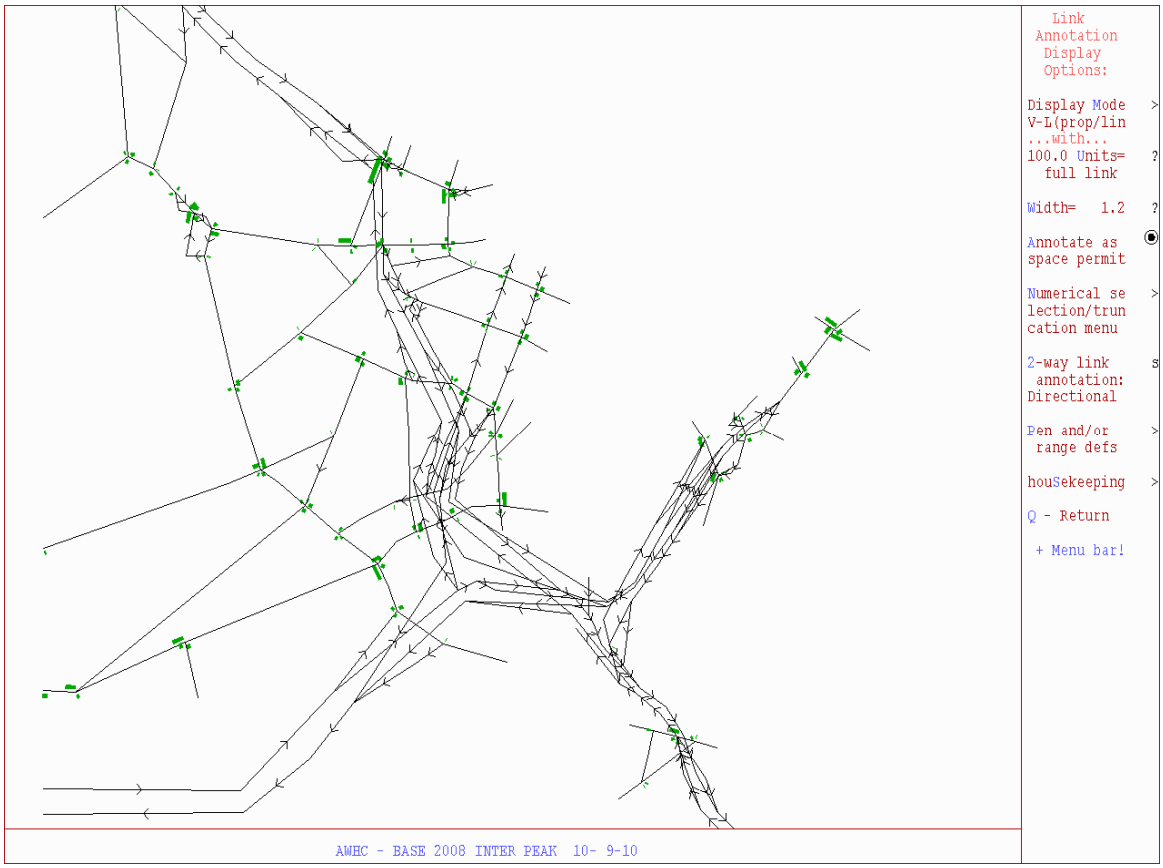


Figure 8: 2008 Inter Peak: Takapuna

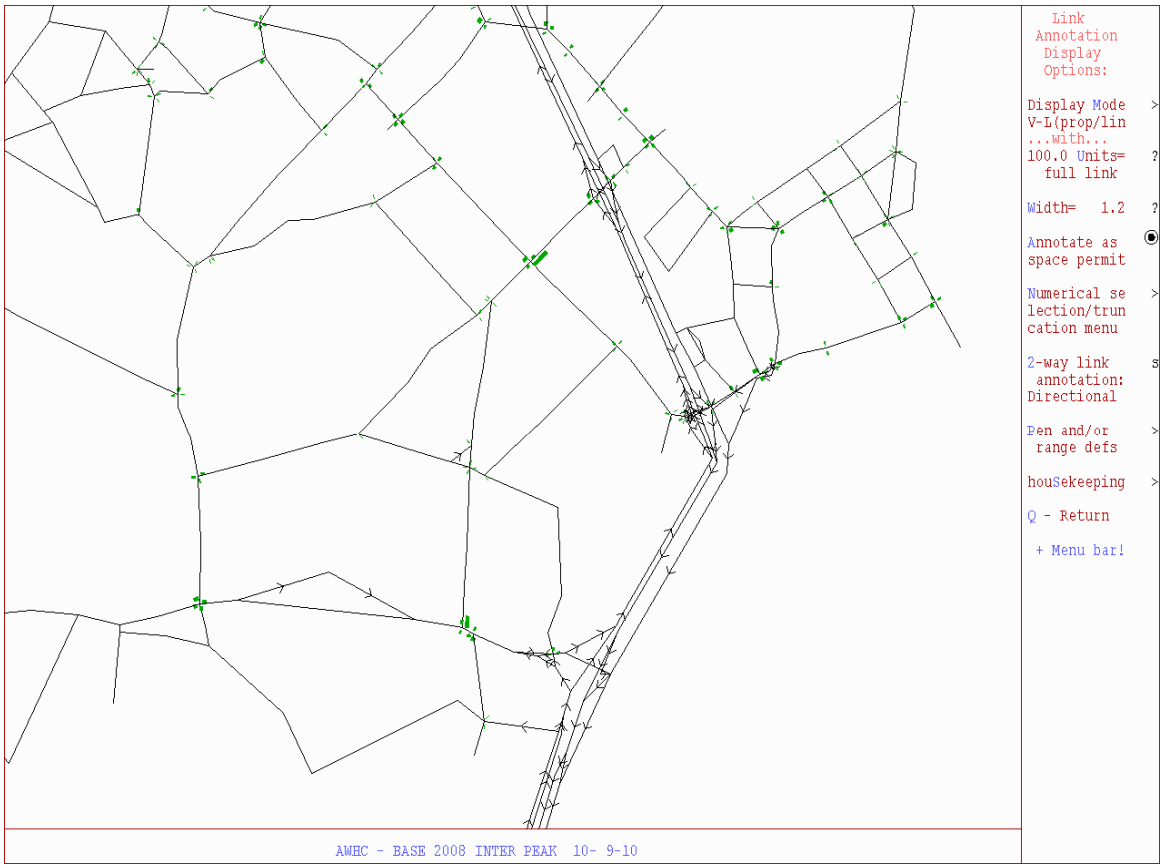


Figure 9: 2008 PM Peak: Whole Model

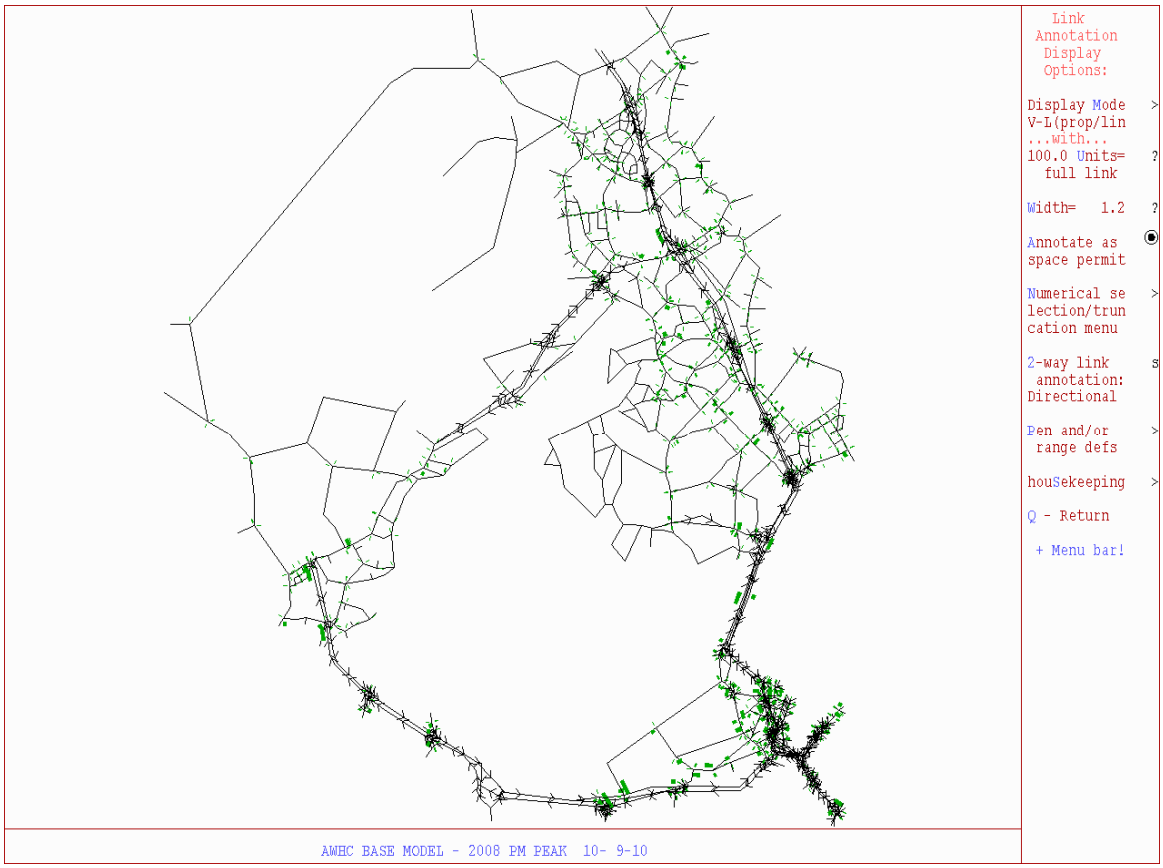


Figure 10: 2008 PM Peak: Auckland CBD

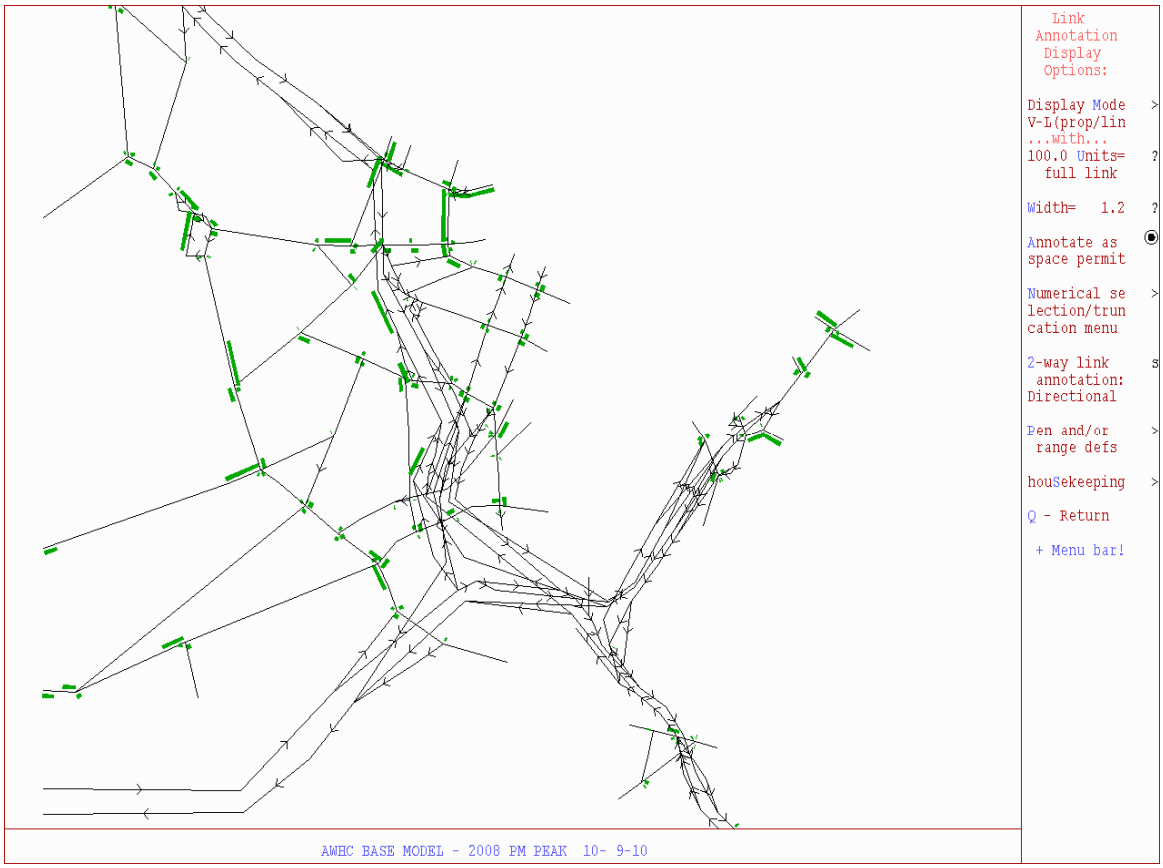
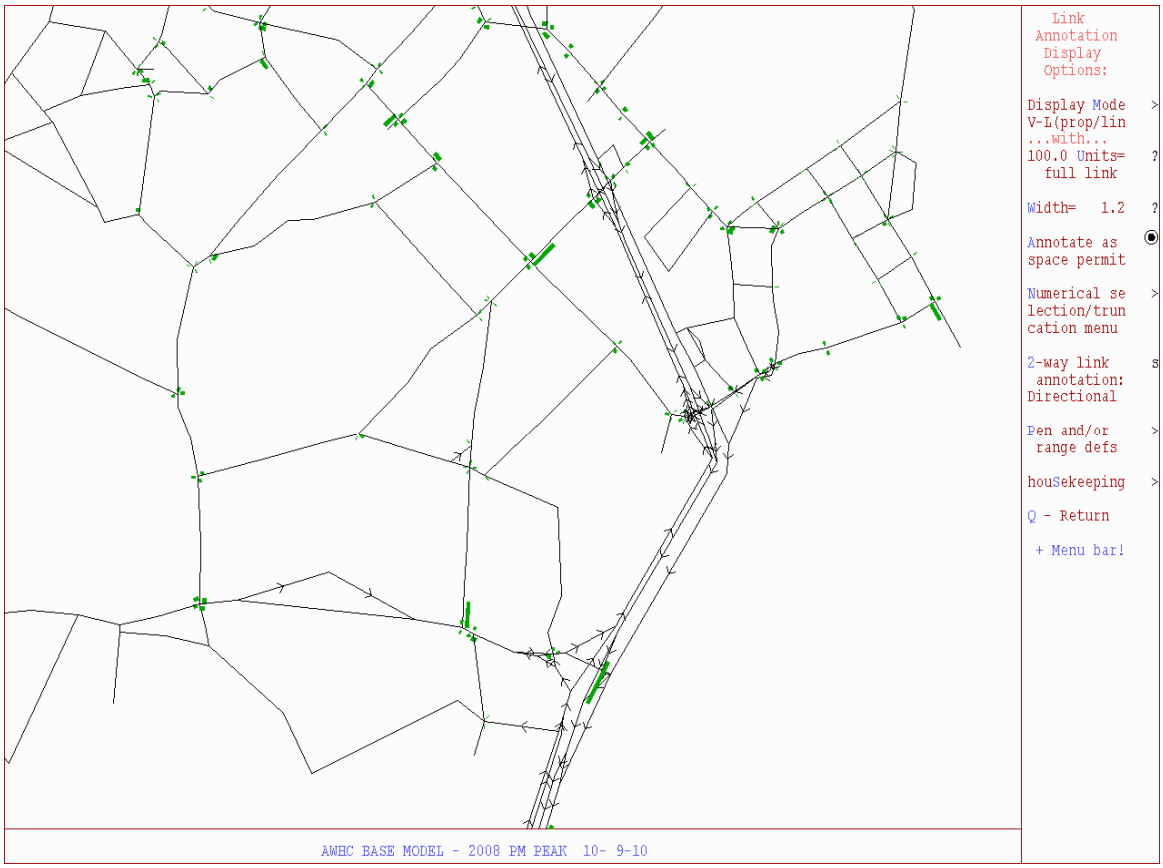


Figure 11: 2008 PM Peak: Takapuna



Queues are shown in the following locations:

- Significant queues are shown as occurring along Onewa Road, Esmonde Road and on the motorway, southbound, approaching Esmonde Road, in the AM peak. Queues are also shown on the motorway, southbound approaching the Victoria Park Viaduct
- No significant queues are shown in the inter peak
- Relatively modest queues are shown as occurring at a number of locations in the PM peak, including on the Victoria Park Viaduct, northbound, on either side of the Harbour Bridge, and at the Constellation northbound on ramp merge.

3.2 2026 Scenario

Figure 12: 2026 Do Minimum Scenario: AM Peak: Whole Model

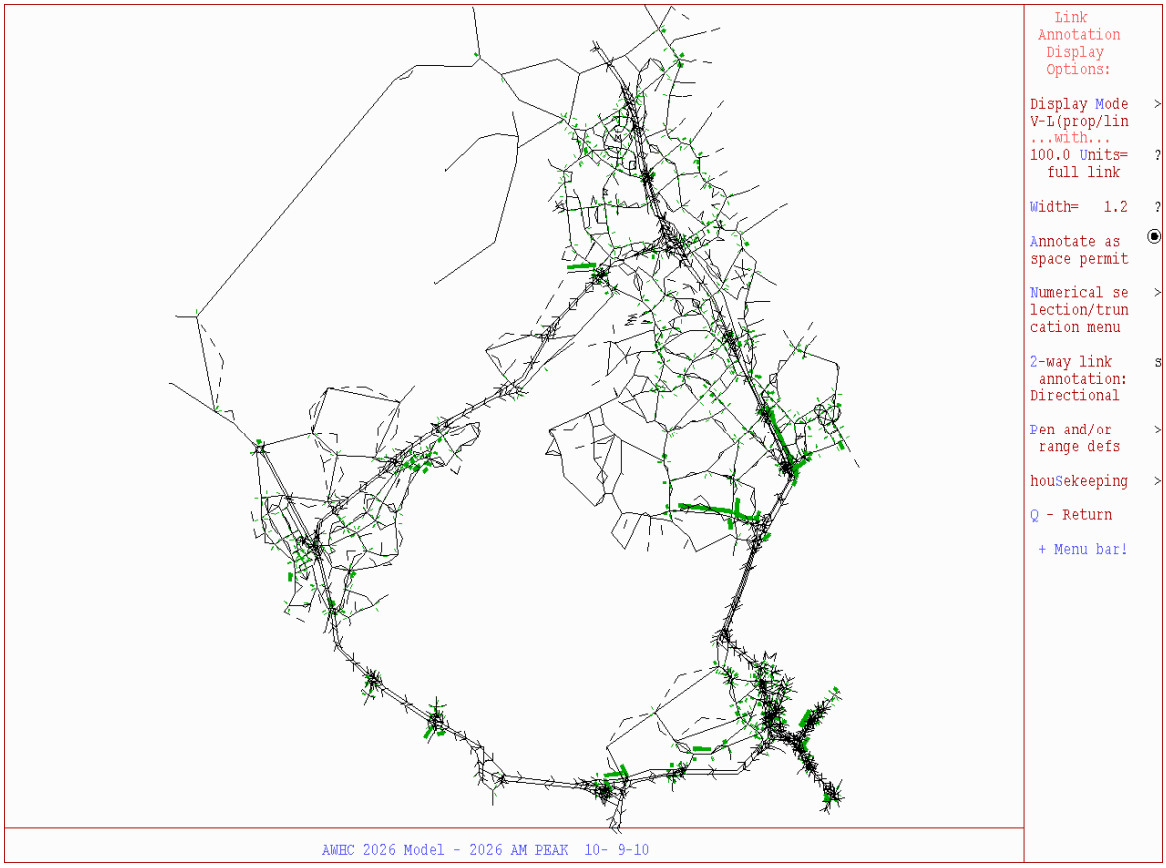


Figure 13: 2026 Do Minimum Scenario: AM Peak: Auckland CBD

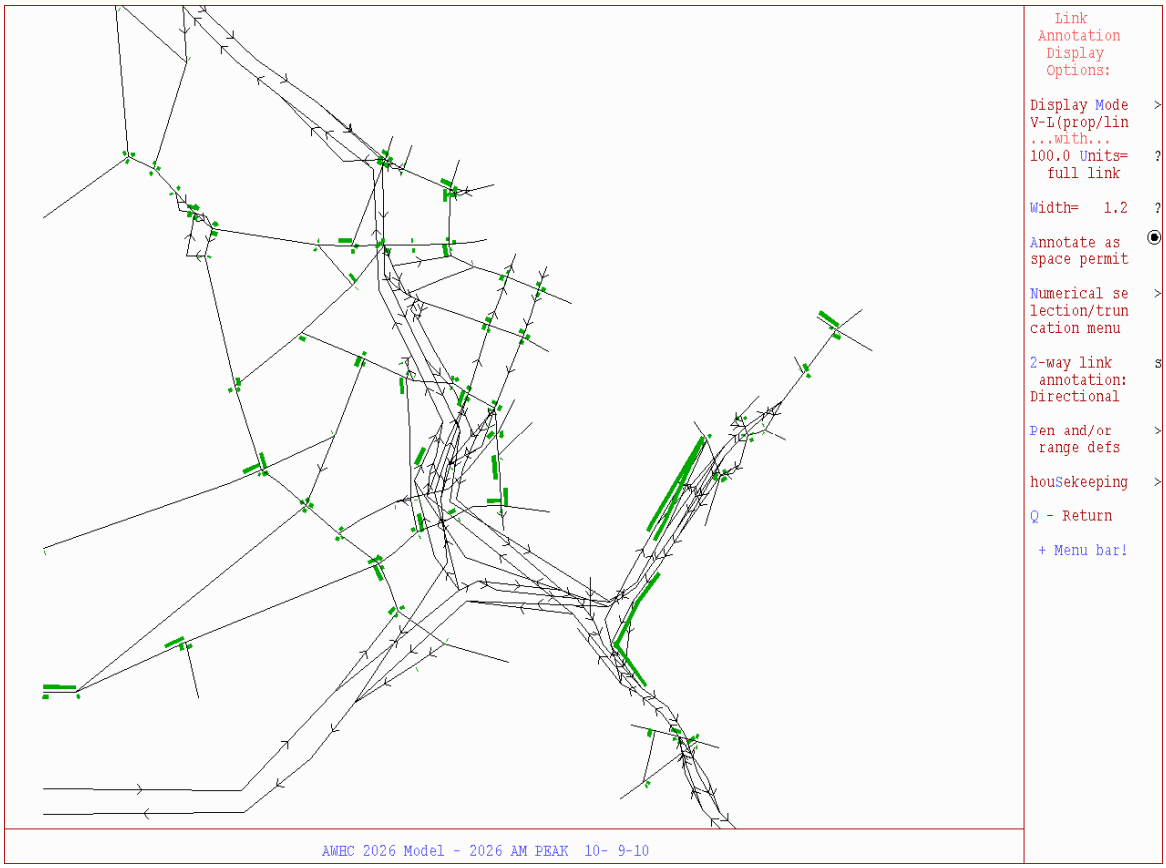


Figure 14: 2026 Do Minimum Scenario: AM Peak: Takapuna

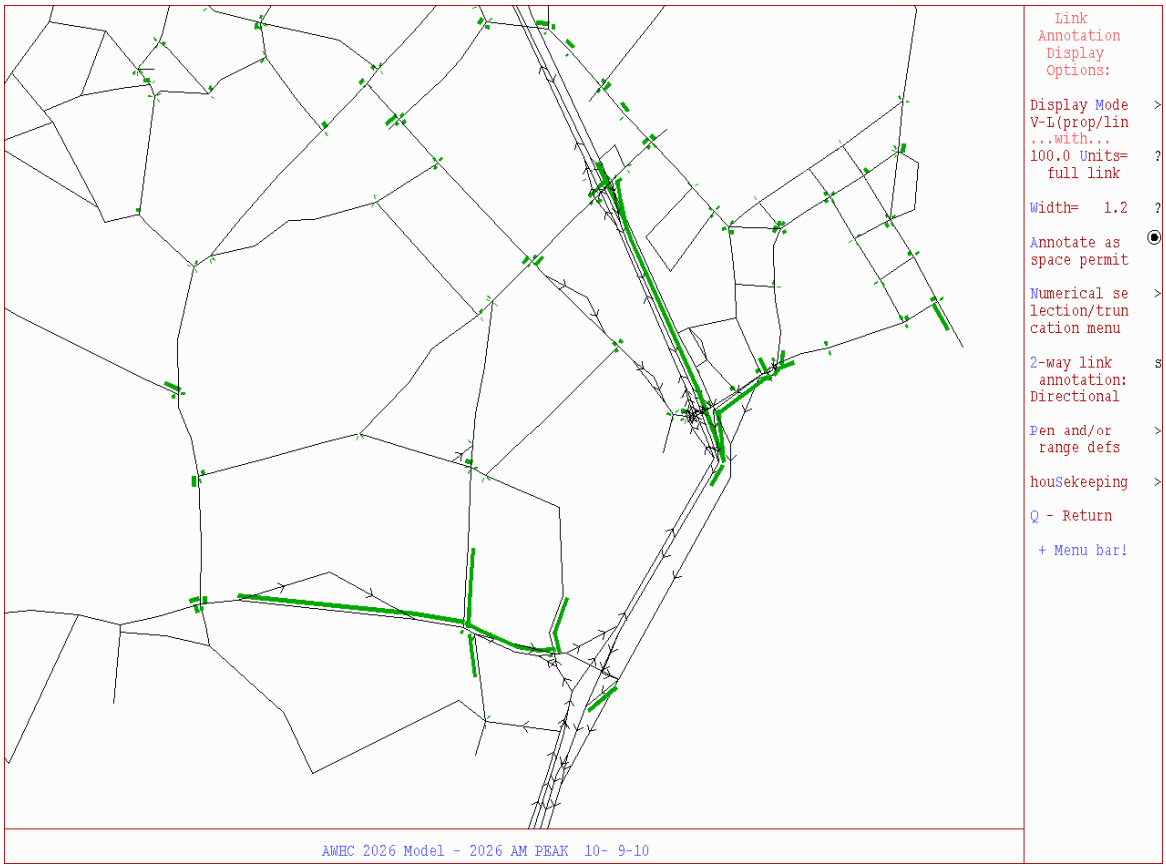


Figure 15: 2026 Do Minimum Scenario: Inter Peak: Whole Model

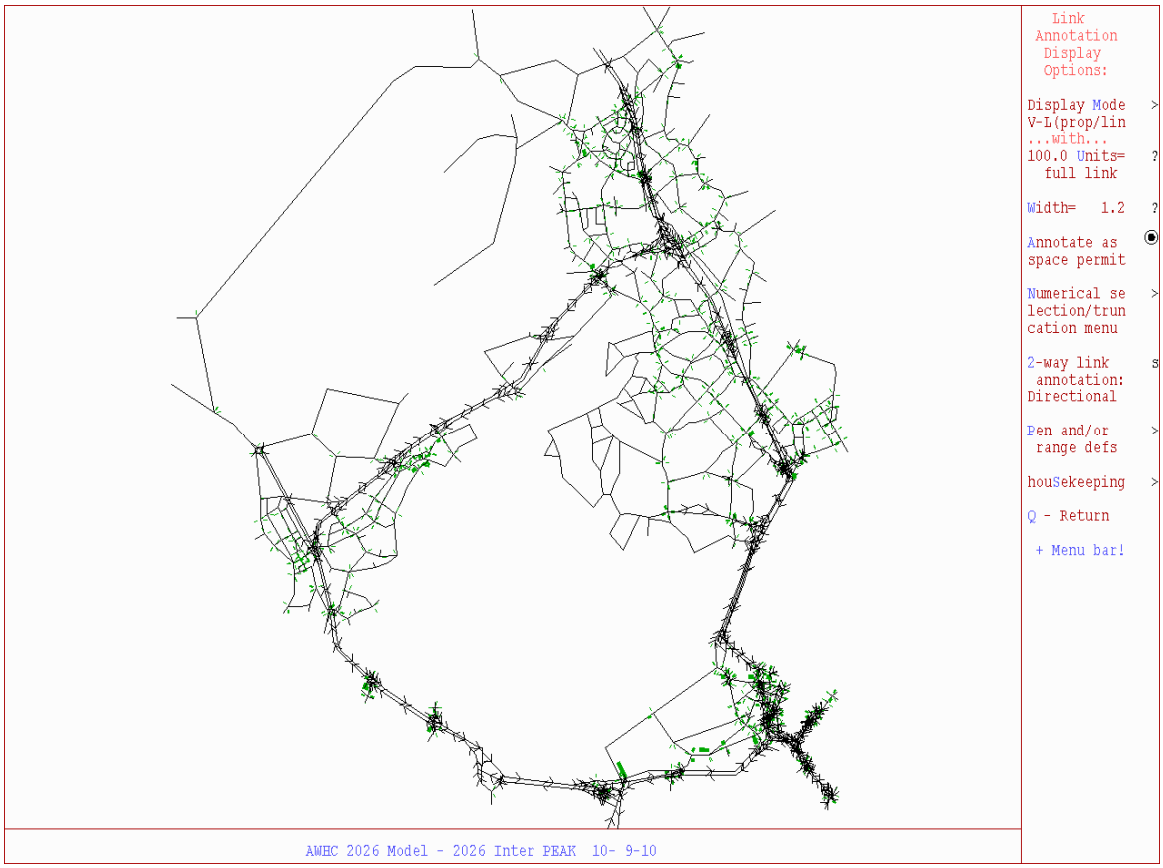


Figure 16: 2026 Do Minimum Scenario: Inter Peak: Auckland CBD

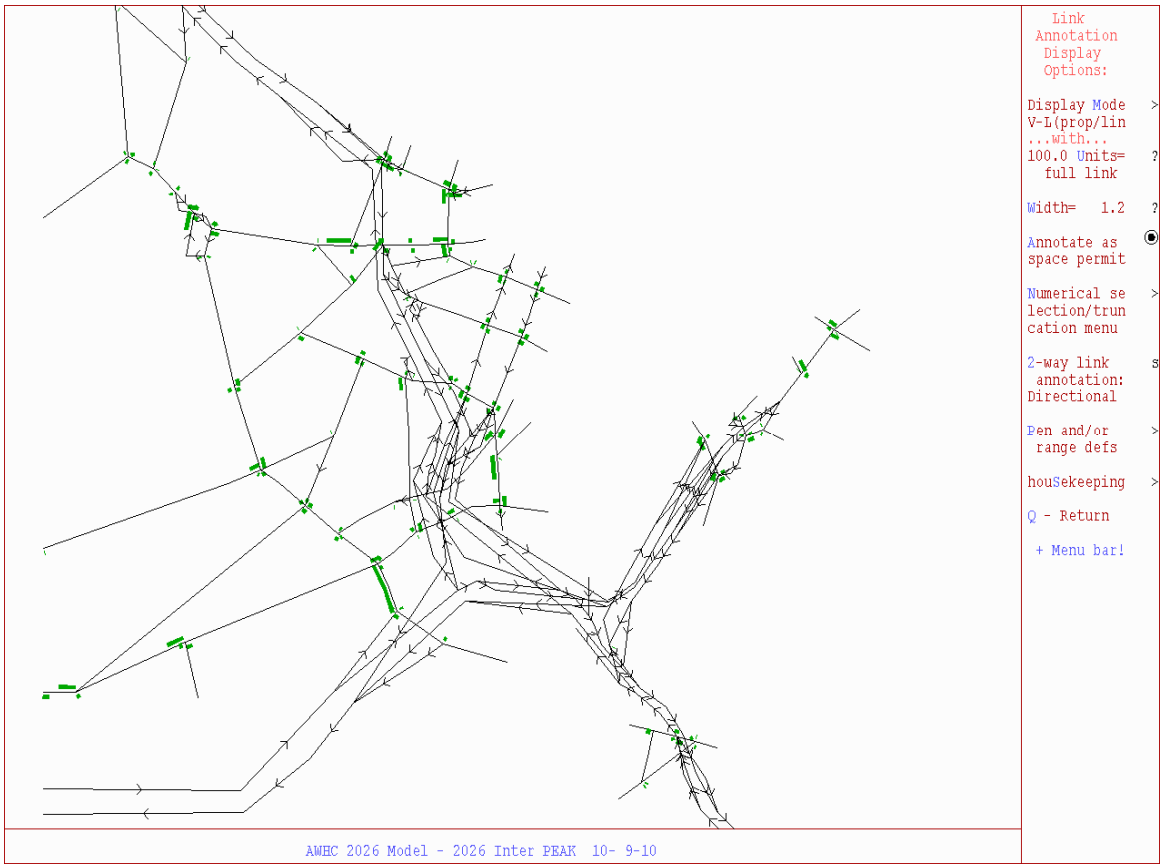


Figure 17: 2026 Do Minimum Scenario: Inter Peak: Takapuna

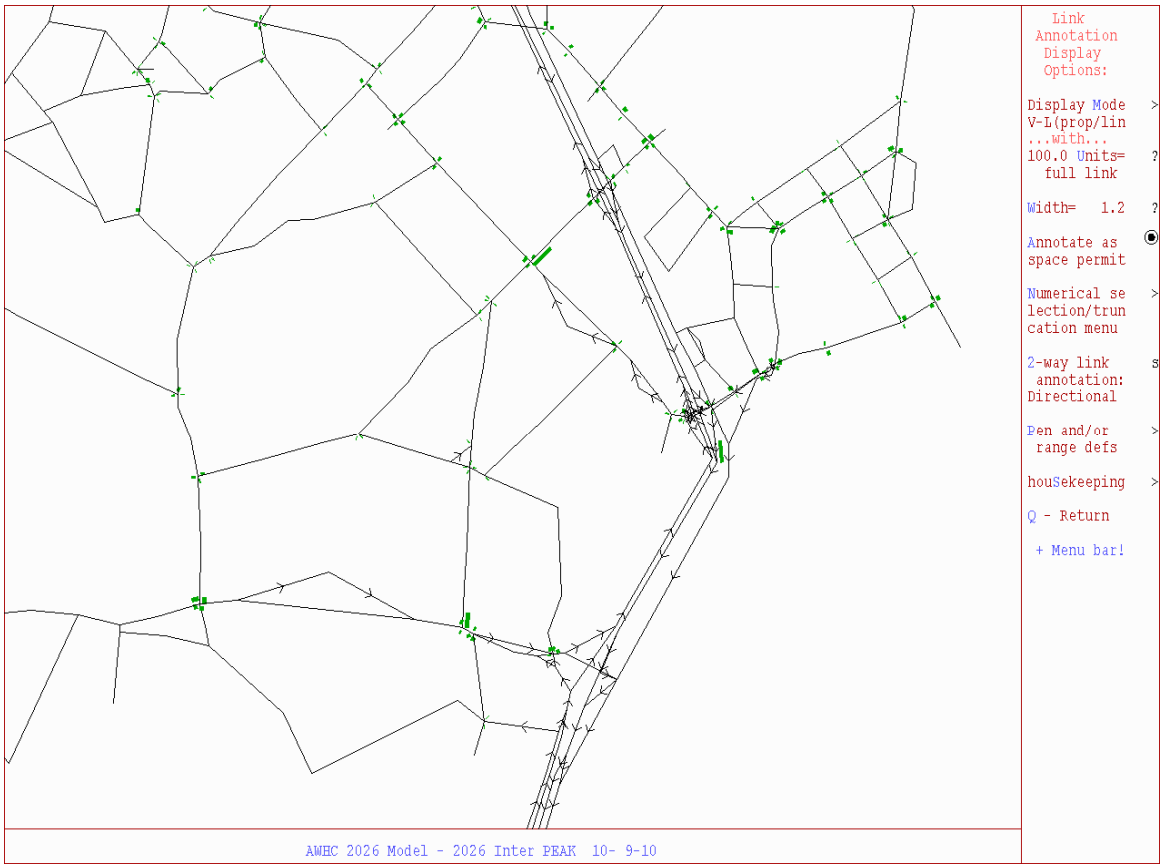


Figure 18: 2026 Do Minimum Scenario: PM Peak: Whole Model

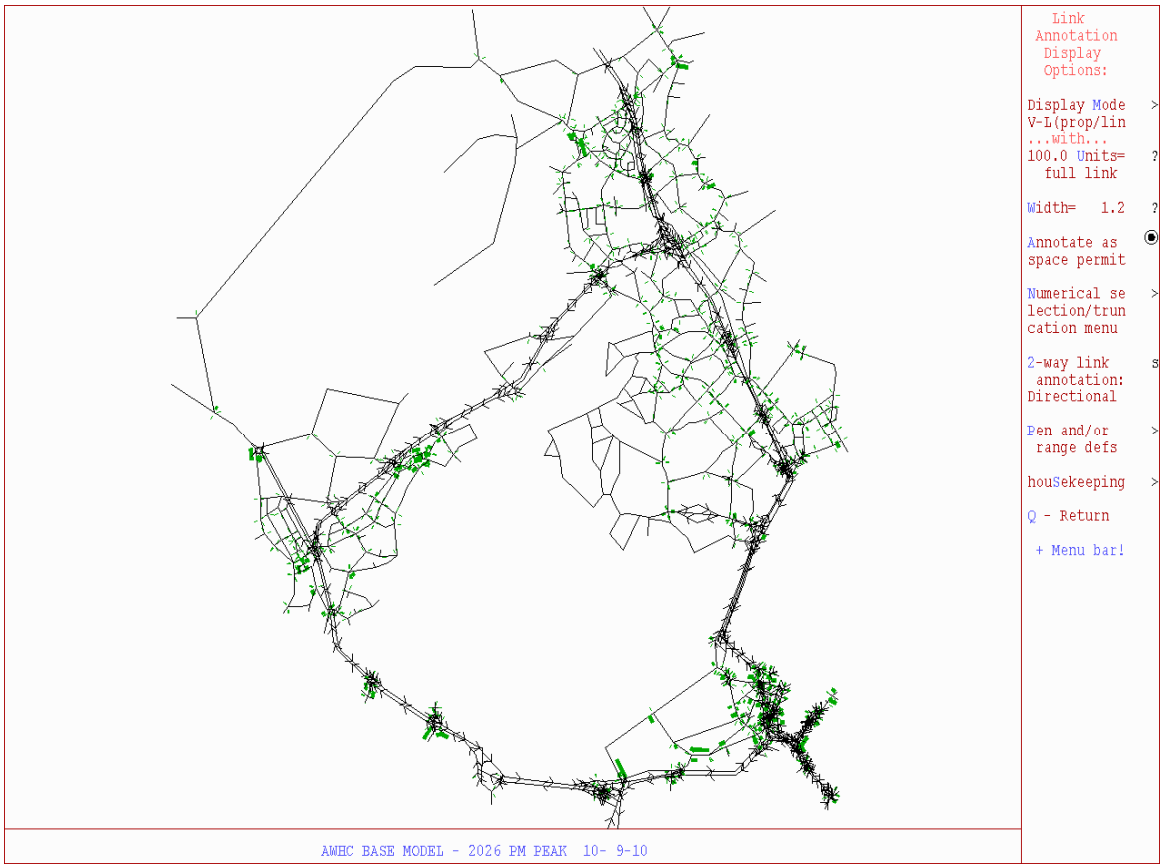


Figure 19: 2026 Do Minimum Scenario: PM Peak: Auckland CBD

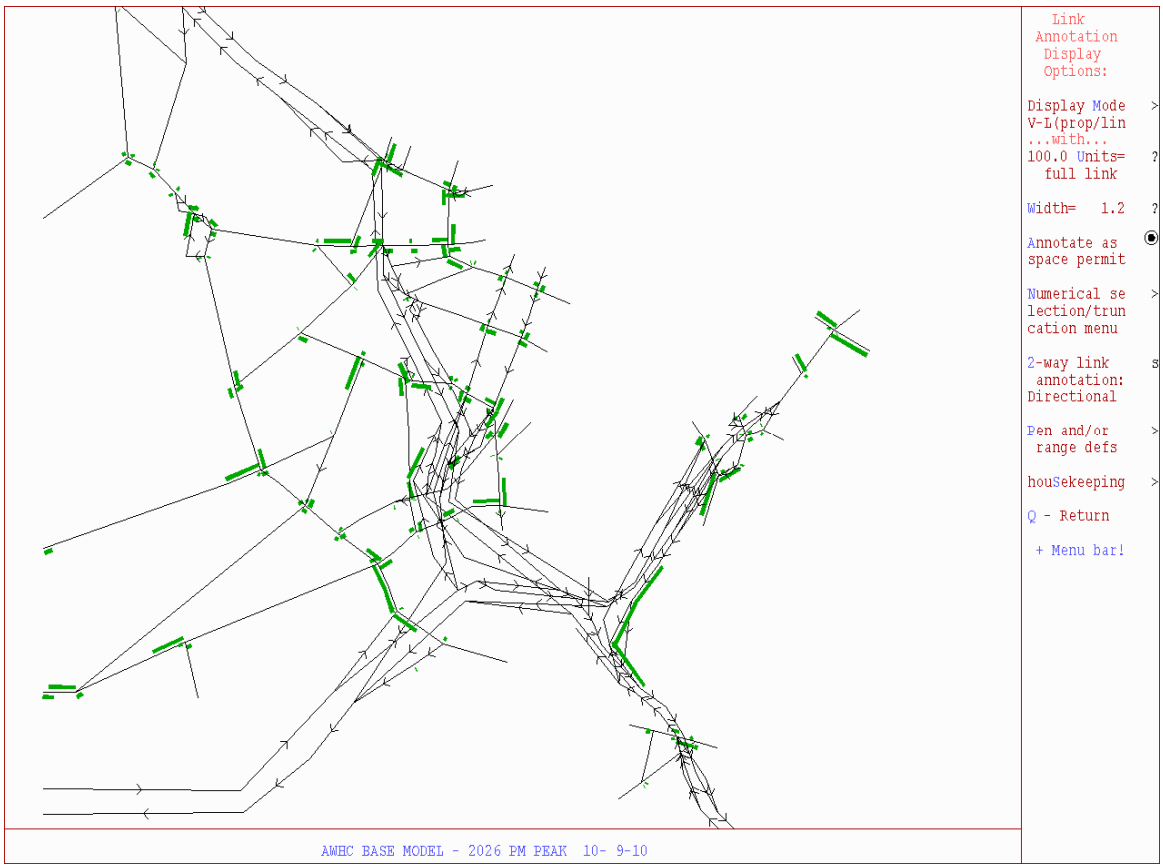
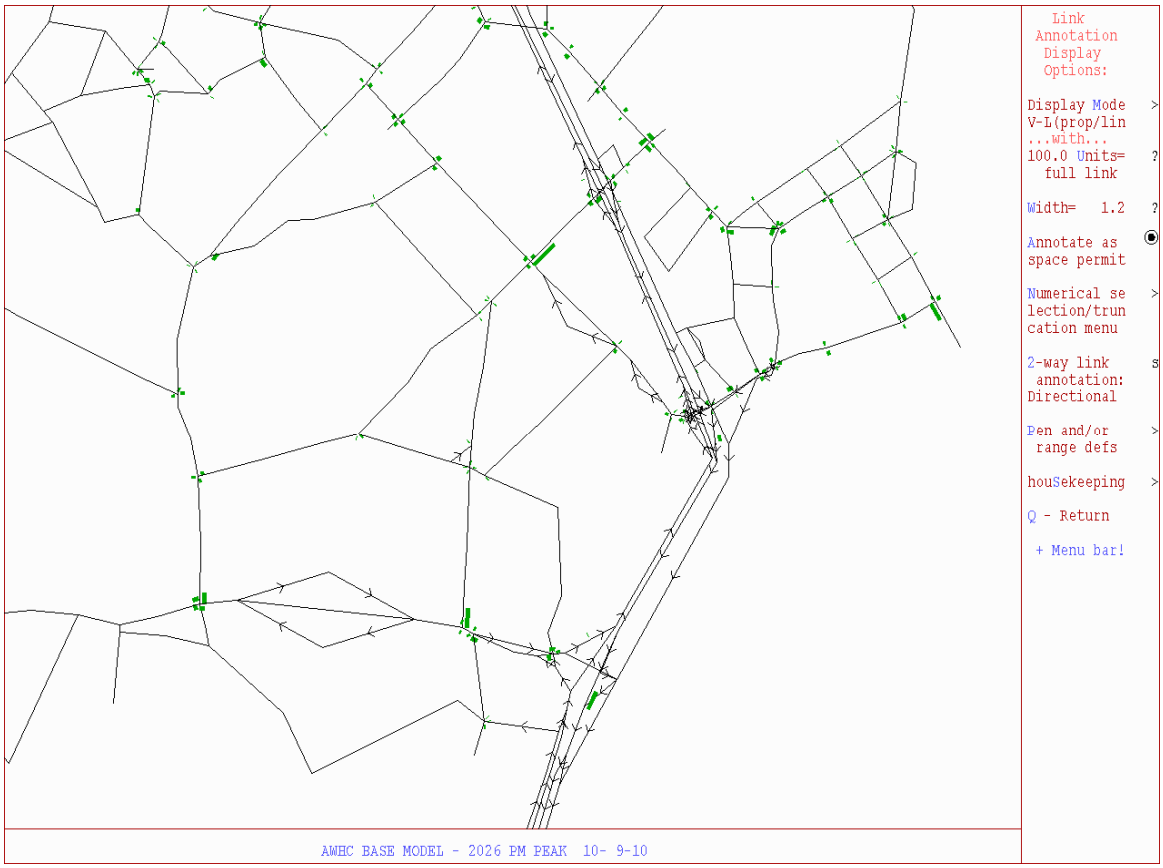


Figure 20: 2026 Do Minimum Scenario: PM Peak: Takapuna



Queues are shown in the following locations in the 2026 Do Minimum Scenario:

- Significant queues are shown as occurring along Onewa Road, Esmonde Road and on the motorway, southbound, approaching Esmonde Road, in the AM peak. No queues are shown around Victoria Park, due to the completion of the Victoria Park Tunnel, however queues are predicted within Grafton Gully
- No significant queues are shown in the inter peak
- Relatively modest queues are shown as occurring at a number of locations in the PM peak, due to the assumed completion of the Victoria Park Tunnel and SH1/18 interchange projects. However, reasonably significant queuing is predicted southbound up Grafton Gully, partly due to the assumed completion of Grafton Gully Stage 3.

The results of the queue plots are reflected in the differences between the demand and arrival flows in Tables 3 and 5. Greater differences (implying greater queues) are predicted in both directions across the Auckland Harbour Bridge in the AM peak (reflecting capacity constraints on the approaches rather than on the Bridge itself), particularly in the southbound direction. However, the tables indicate a reduction in the differences between the demand and the arrival flows northbound in the PM peak. This is a result of the completion of the Victoria Park Tunnel project, which will release the queues between the Central Motorway Junction and the southern foot of the Bridge.

3.3 2041 Scenario

Figure 21: 2041 Do Minimum Scenario: AM Peak: Whole Model

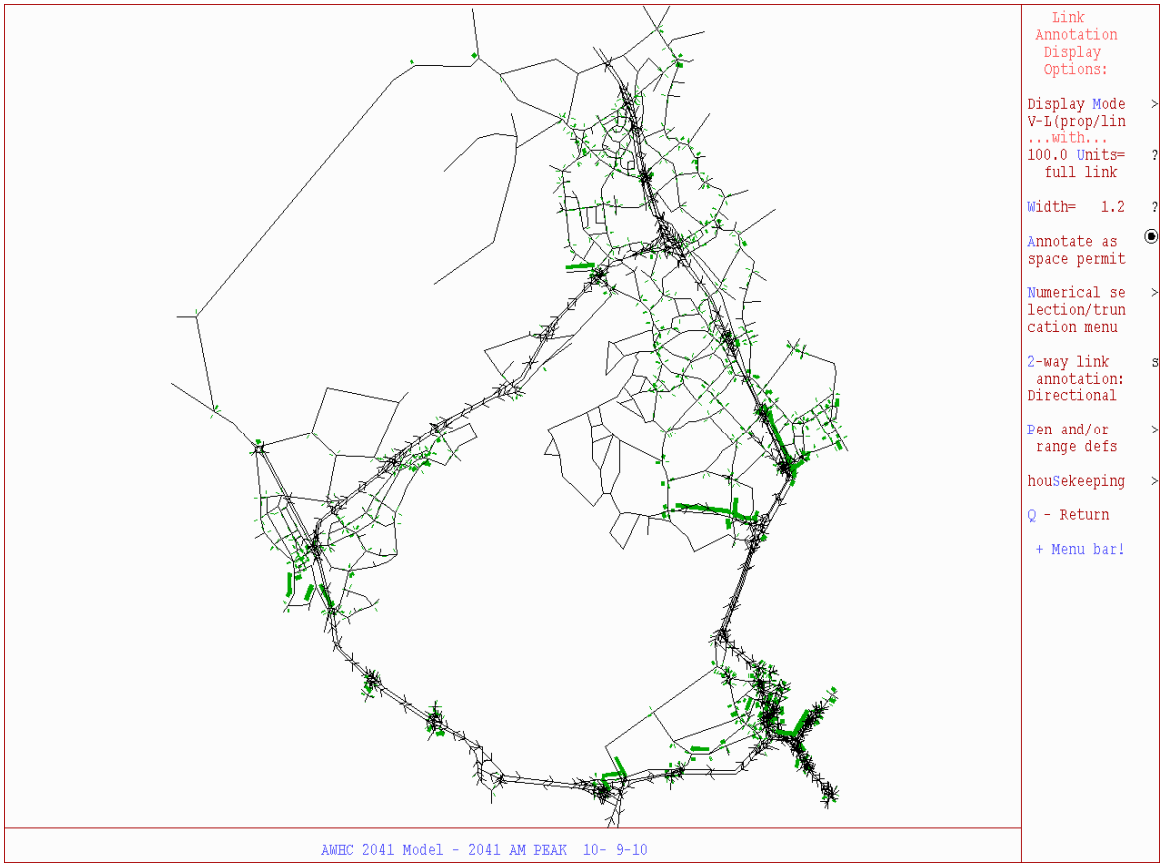


Figure 22: 2041 Do Minimum Scenario: AM Peak: Auckland CBD

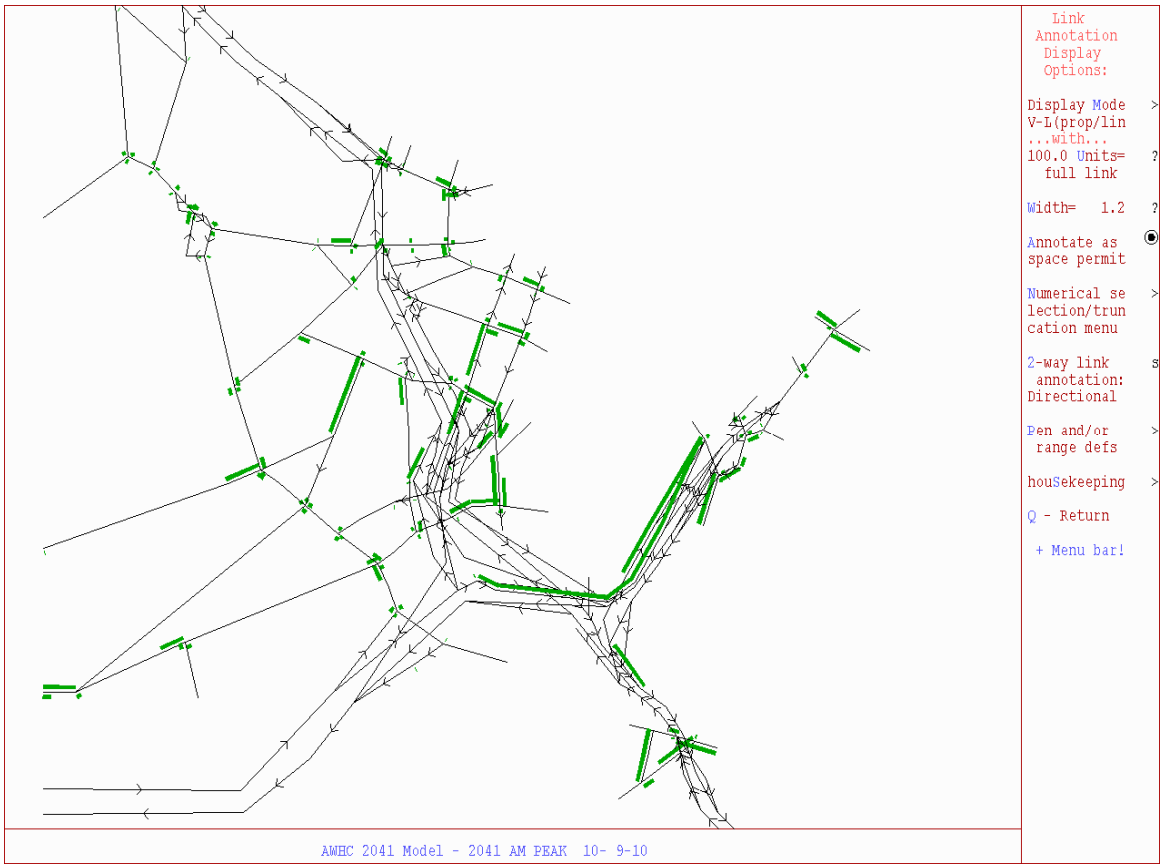


Figure 23: 2041 Do Minimum Scenario: AM Peak: Takapuna

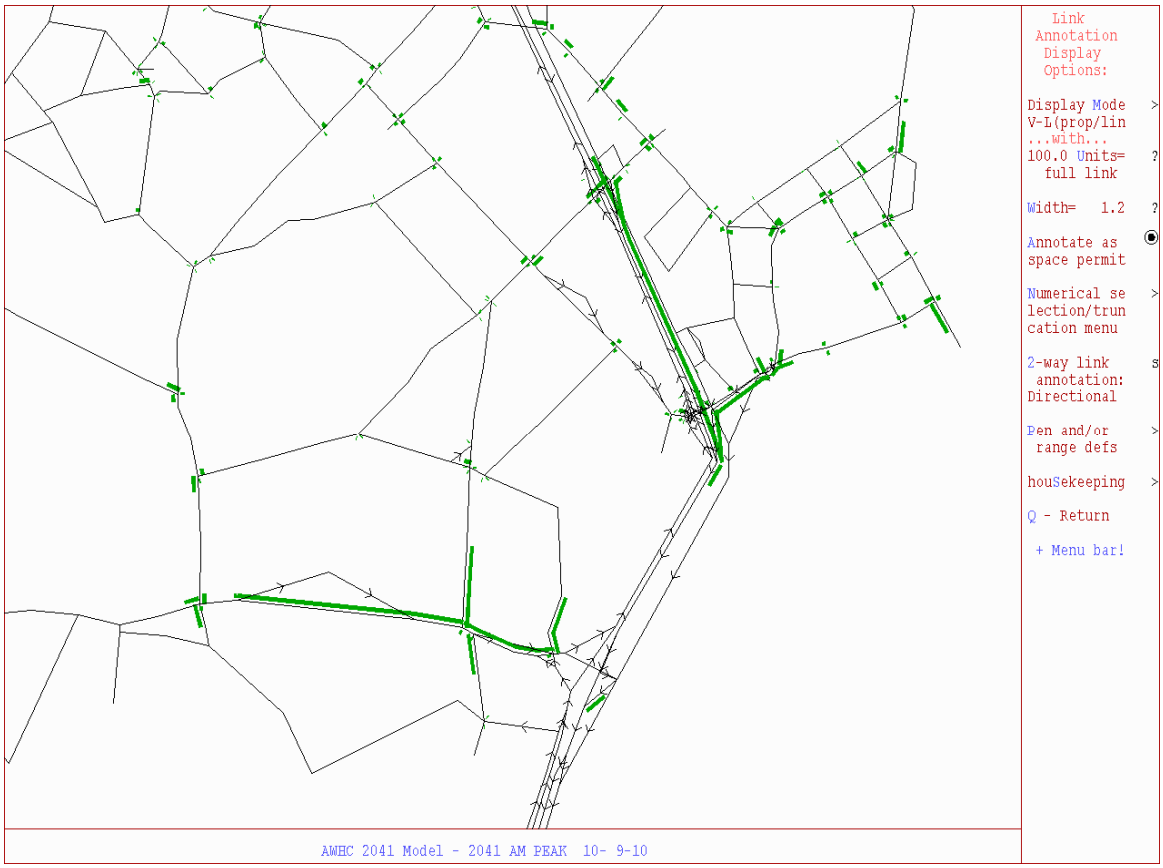


Figure 24: 2041 Do Minimum Scenario: Inter Peak: Whole Model

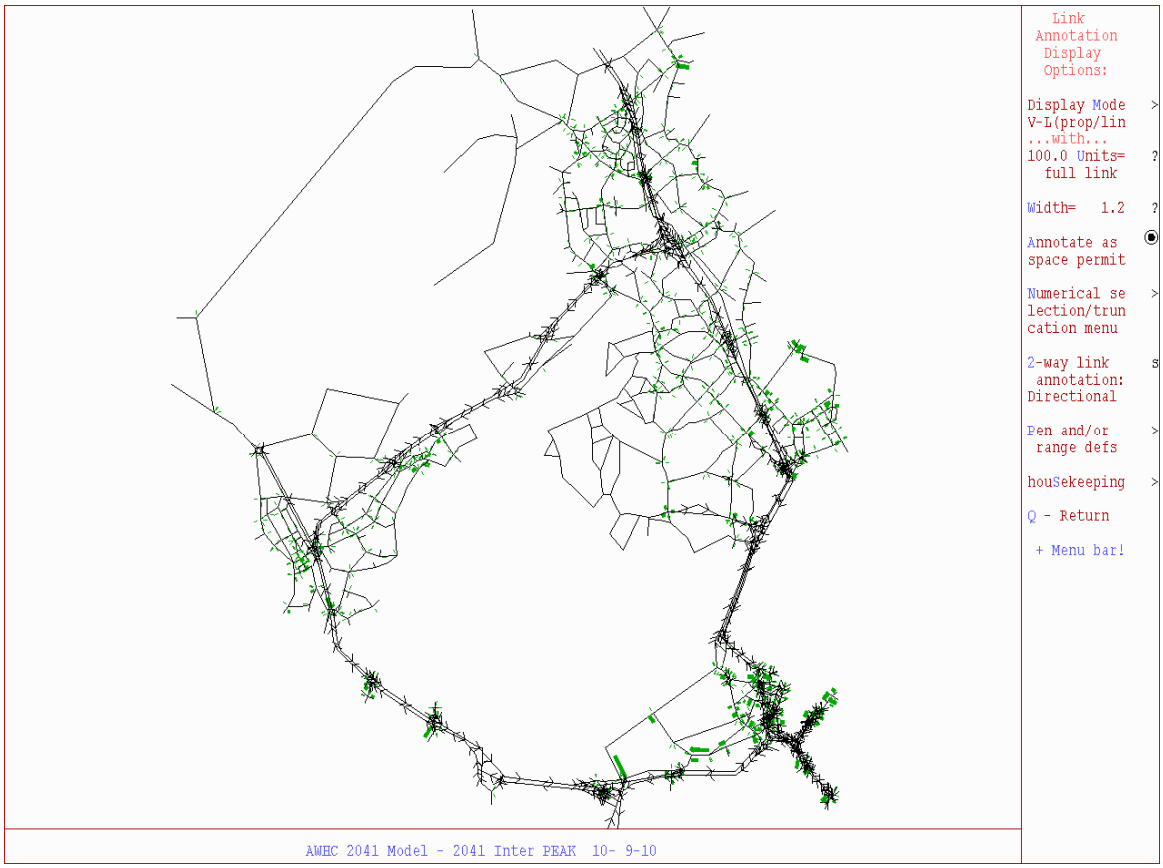


Figure 25: 2041 Do Minimum Scenario: Inter Peak: Auckland CBD

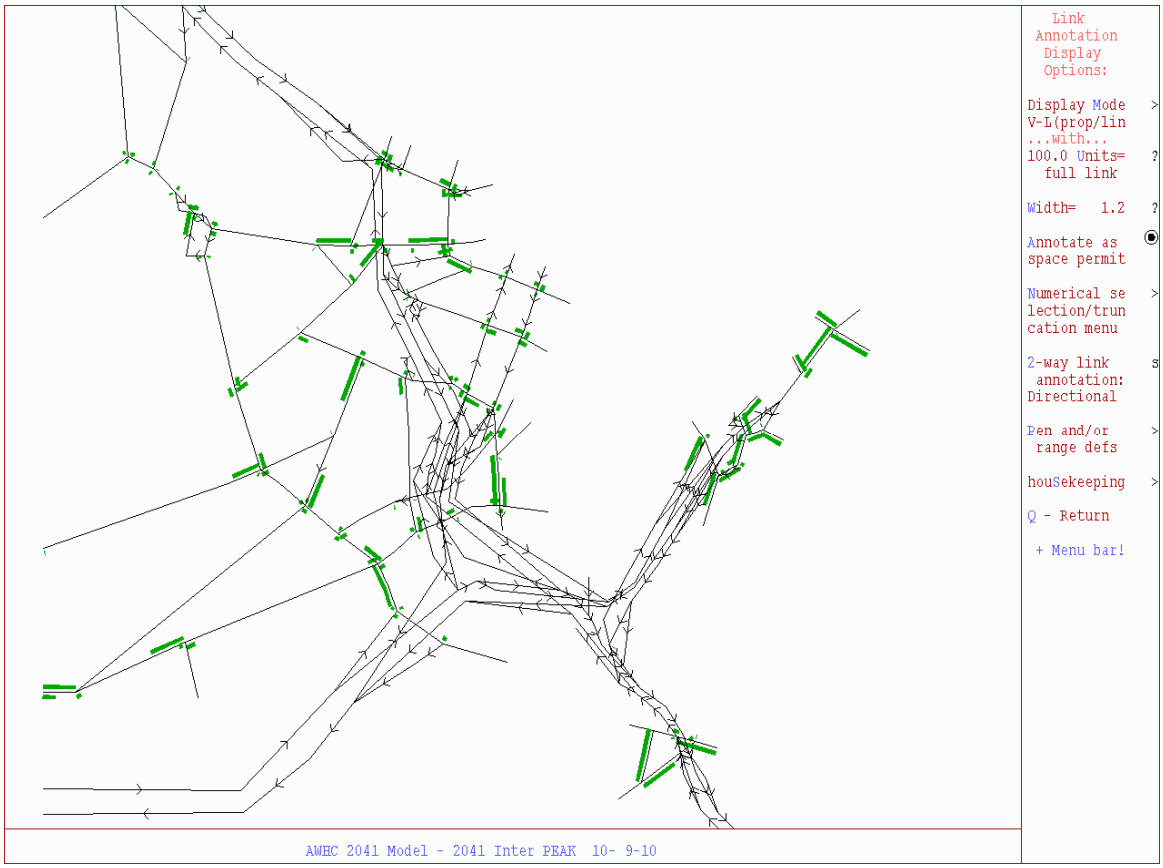


Figure 26: 2041 Do Minimum Scenario: Inter Peak: Takapuna

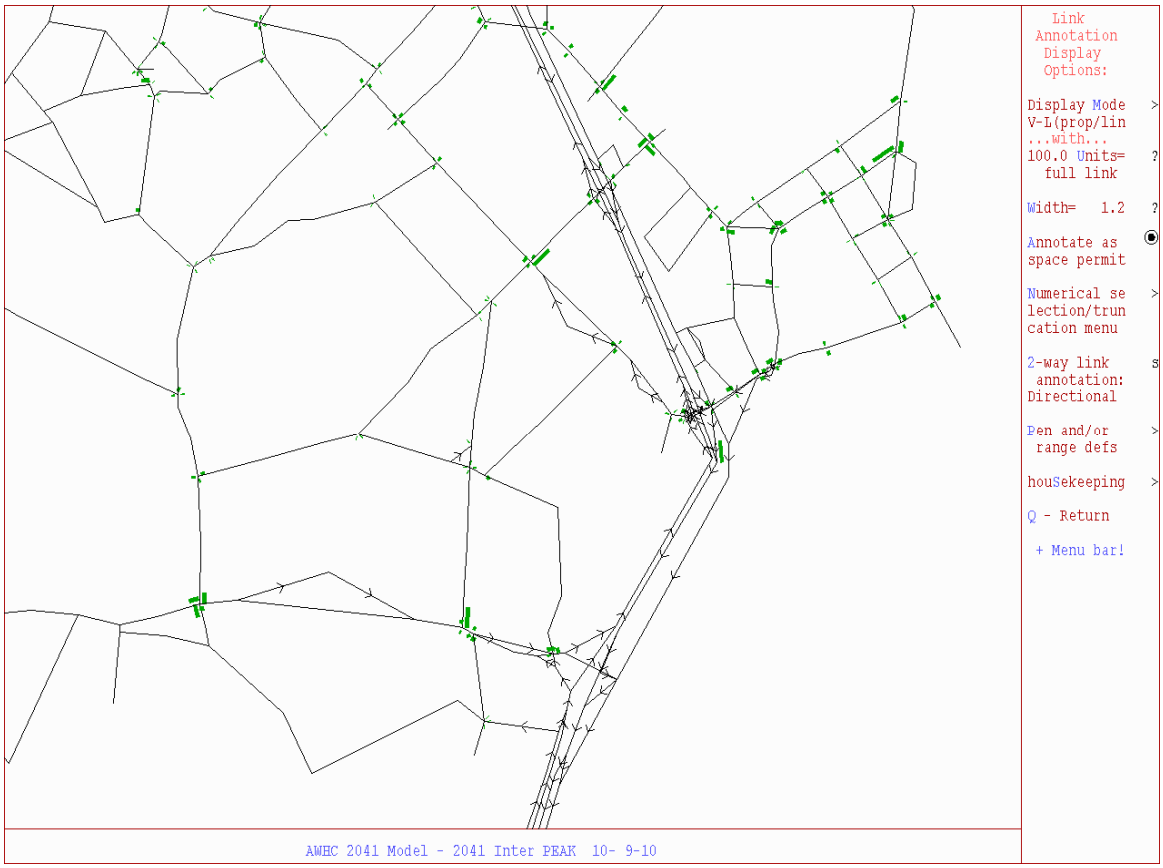


Figure 27: 2041 Do Minimum Scenario: PM Peak: Whole Model

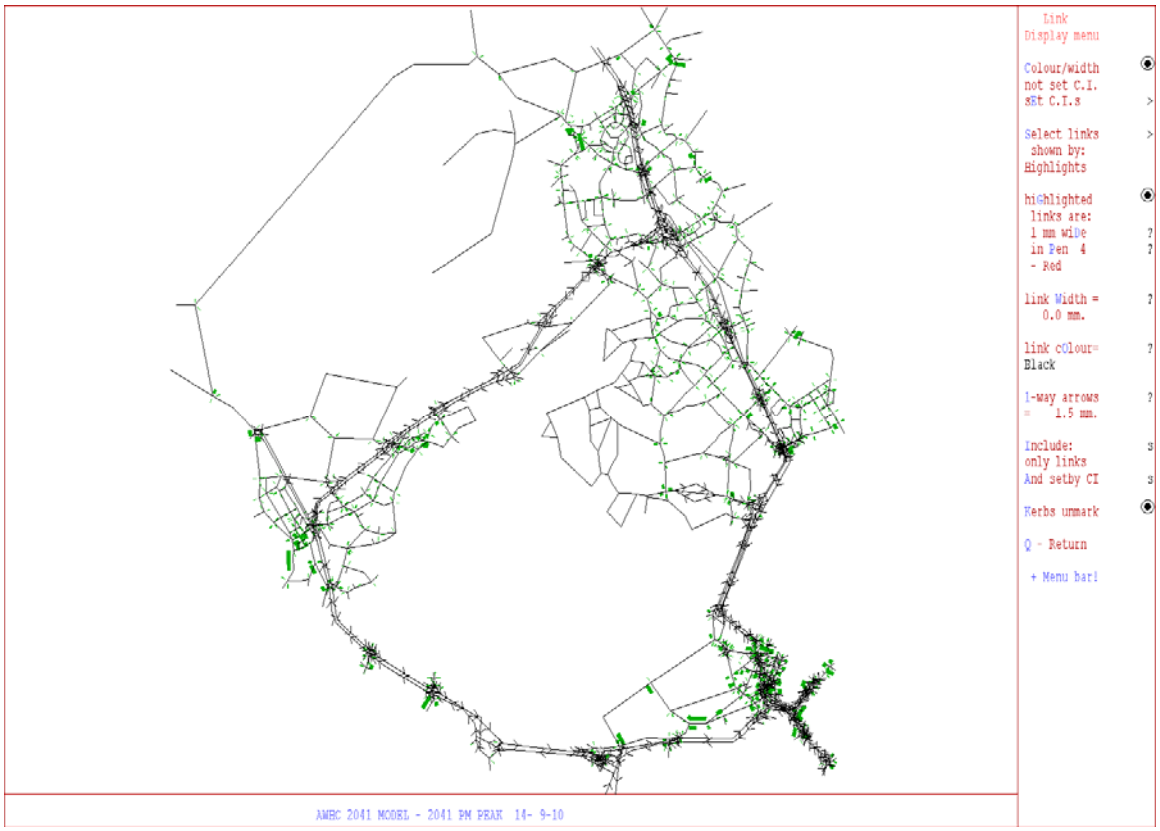


Figure 28: 2041 Do Minimum Scenario: PM Peak: Auckland CBD

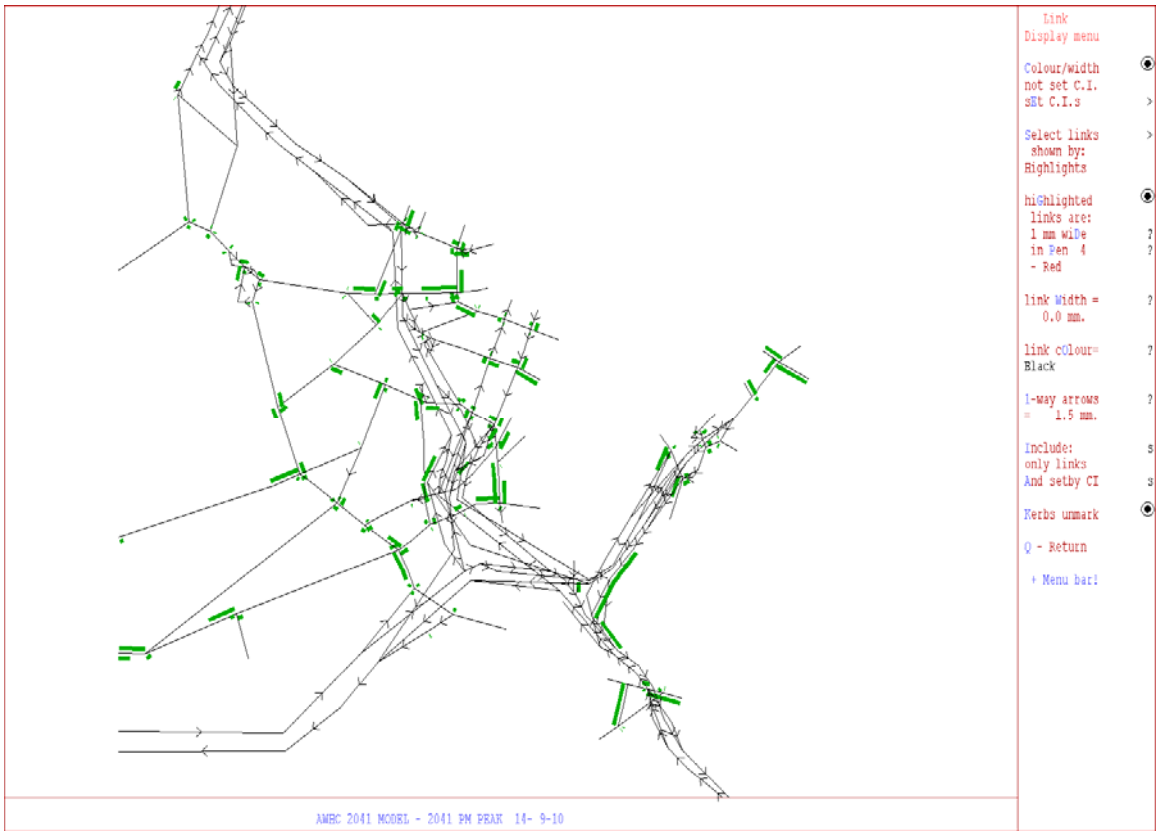
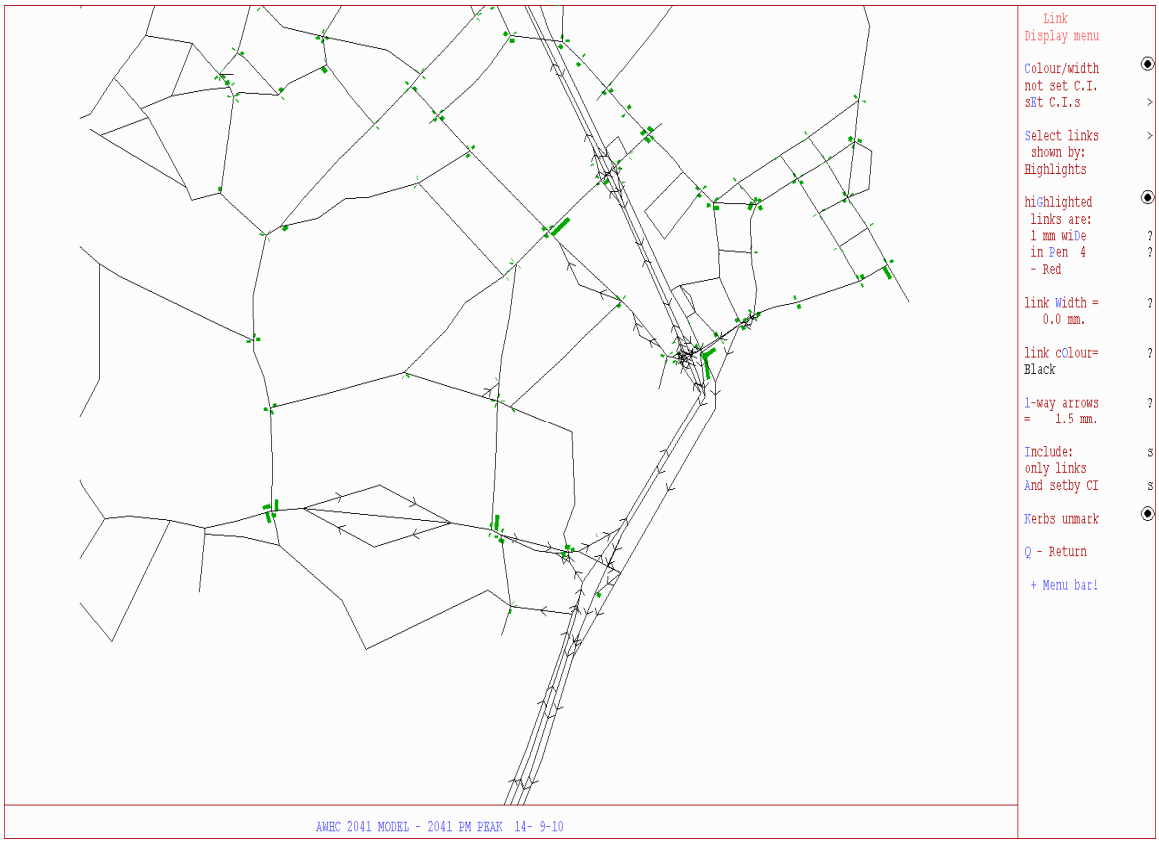


Figure 29: 2041 Do Minimum Scenario: PM Peak: Takapuna



The queues in 2041 are generally similar to those predicted for 2026, although increases in queues are predicted around the Auckland CBD in the AM peak, especially on the off ramps from Grafton Gully to Wellesley Street, where no improvements are included in the model.

This situation (with similar queues generally predicted in 2041) is to be expected, given that the overall growth is predicted to be quite modest after 2026 and the networks are assumed to be almost identical.

As noted earlier, the results of the queue plots are reflected in the differences between the demand and arrival flows in Tables 3 and 5. Slightly greater differences (implying greater queues) are predicted in 2041, compared with 2026, across the Auckland Harbour Bridge, southbound in the AM peak and northbound in the PM peak. This reflects capacity constraints on the approaches rather than on the Bridge itself, mainly from Onewa Road and Esmonde Road southbound in the AM peak and from Wellington Street and SH16 northbound in the PM peak. Also, by 2041, some modest differences are emerging in the inter peak period. Modest queues are predicted at a number of locations, with the main bottlenecks being on the Esmonde Road southbound on ramp and southbound along Albany Expressway, approaching the Greville Road interchange.

Ian Clark

Appendix G Option Definition for Modelling

This note sets out the definition of the options to be modelled for the study. It is to enable this to be confirmed by NZTA and the wider project team prior to the modelling commencing.

The modelled years are 2026 and 2041. The new road crossing and the changes to AHB are included in 2026, as are the changes to passenger transport. The only difference between 2026 and 2041 is the bus headways which increase to fit with PT demands.

Three options have been defined and modelled, labelled here as Options 1 to 3. Option 1 is defined fully and the changes for the other two described. Option 3 is being used for the evaluation, that is, for the outputs for the business case and the final operational modelling.

1. Option 1

New Road Crossing:

- Refer to:
  - Option Definition Report, final draft, dated 06 August 2010,
  - Lane configuration diagrams, pages 1 to 5.
- Form:
  - two options, bridge and tunnel;
  - no difference between these for the modelling as all lane configurations and connections are the same.
- Alignment:
  - same as the NOR between Esmonde and SH1 at the north end of CMJ, but
  - Esmonde/Akoranga southbound on-ramp onto separate 2 lane carriageway which merges with mainline in vicinity of Onewa Interchange,
  - Southbound traffic from north of Esmonde uses SH1 mainline (widened),
  - Decision about which crossing is used occurs in vicinity of Onewa Interchange
- Lanes: 3 lanes each direction across the harbour
- Speed limit: 80 kph along full length
- Mainline connections:
  - North end: in vicinity of Onewa Interchange,
  - South end: SH1 north of SH16/Port connections.

- Ramp Connections:
    - at Esmonde, Onewa,
    - all movements possible
    - Esmonde to Onewa movement via link to mainline Onewa off ramp just to the north of Onewa Interchange
    - lanes as per diagrams

- Same configuration for all modelled periods

AHB and St Mary's Bay:

- Refer to diagrams
- 8 lanes remain on AHB as per current bridge
- Allocation of lanes on AHB:
    - 1 for active modes; all day
    - 2 for bus only; 1 each direction; all day (effectively Busway)
    - 5 for general traffic:
        - AM peak: 3 southbound, 2 northbound
        - IP: 3 southbound, 2 northbound
        - PM peak: 2 southbound, 3 northbound
- Allocation of lanes on St Mary's Bay:
    - 3 traffic lanes each direction
    - 1 buslane each direction; all day (effectively Busway)
- Speed limit: 80 kph
- Mainline connections:
    - North end: in vicinity of Onewa Interchange,
    - South end: none
- Ramp Connections:
    - at Esmonde, Onewa, Fanshawe, Cook
    - Cook becomes both off and on ramps,
    - Wellington St on-ramp closed

SH1 North of Esmonde:

- 4 lanes each direction to Northcote;
- At Northcote: lane drop northbound, lane gain southbound

Local Road Network:

- No changes from today specified to date
- Some may arise from operational modelling
- Onewa buslane/HOV remains as per today

Passenger Transport:

- Bus remains, no rail to the North Shore
- Busway system as per Do Minimum retained
- Buslane (effectively a Busway) in each direction on AHB, St Mary's Bay, VPV/T, to/from Cook St ramps
- Same service patterns, headways, stations, park-and-ride sites as in the Do Minimum
- Only difference between the modelled years, 2026 and 2041, is increased headways in 2041 to cater for the increased demands
- Only change to Do Minimum routeing is at Cook St ramps:
    - Buses that use Cook off-ramp, rerouted to use Cook on-ramp (instead of Fanshawe on-ramp in Do Minimum).

2. Option 2

Option 2 is the same as Option 1 except for changes in the lane configuration on AHB.

Option 1 has 5 full general traffic lanes plus the southbound lane to Shelley Beach off-ramp shared with buses. The directional allocation of the 5 full lanes varies by time period during the day.

Option 2 has 4 full general traffic lanes plus the southbound lane to Shelley Beach off-ramp shared with buses. The 4 full lanes are allocated as 2 in each direction through the day.

The above is how this has been modelled in ART3, but there are two issues with northbound traffic:

- Curran on-ramp traffic cannot access the centre span lanes so in practice would need to share a clip-on lane with buses, and
- It may not be possible for Stafford off-ramp to be accessed from the centre span.

3. Option 3

Option 3 is the same as Option 1 except for the Esmonde southbound on-ramp where ramp signals are used to constrain the traffic entering to 1000 per hour per lane. This has been implemented in ART3 by reducing the capacities on the 2 links immediately south of Esmonde Road to this value.

David Young

Appendix H ART3 Option Forecasts

1 Introduction

This note records the modelling of the Option and provides summary and specific statistics making comparisons with the Do Minimum case. The forecast years are 2026 and 2041, while the ART3 base year is 2006.

Reference should be made to other notes as necessary, including:

- Do Minimum networks, "FN1A100617",
- ART3 inputs, "WHC - ART3 Inputs v2",
- land use inputs, "WHC - Land Use Forecasts v3" and "WHC - Outcomes of Land Use Forecasts v1"
- Do Minimum forecasts, "WHC - ART3 Do Min Forecasts v2 100906" and " WHC - ART3 Do Minimum Forecasts for Internal Review v2", and
- The Options for modelling, "Option Definition for Modelling".

This note presents a sample of key results from the modelling of the final Option for the region, relevant screenlines and cross-harbour travel.

2 ART3 Model Inputs

2.1 Transport Networks and Options

The Do Minimum transport networks for the wider network, covering the Auckland region, were agreed and are documented in a separate note. The AHB operates in 2026 and 2041 as is does today. The option modelled and reported here is described in the note "Option Definition for Modelling".

2.2 Land Use Inputs

The future land use inputs used in the Option modelling are the current RGS land use (known as Plan Change 6) arising from the latest round of ASP-ART modelling undertaken as part of the ARC's future land use and transport planning project.

2.3 Other Inputs

Our review of the other inputs to ART3 lead to the development a set of inputs known as Alternative 1 (Alt1), which was used in the Option modelling. This set of inputs has values of time, vehicle fuel price, parking costs and PT fares increasing over time, and vehicle efficiency improving. It does not include the effects of TDM non-pricing initiatives.

3 Regional Results

3.1 Vehicle and PT Trips

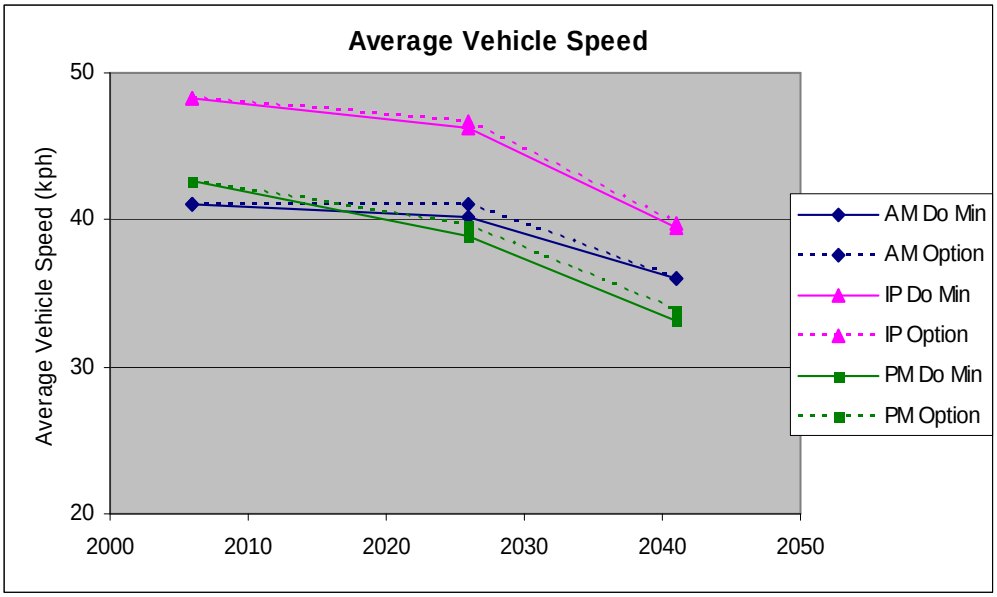
The effect of the new crossing on the region-wide total trip making is not significant (the growth in regional trips between 2006 and 2026 and 2041 are given in the note on the Do Minimum forecasts).

3.2 Average Vehicle Speeds

The table and figure give the average vehicle speeds in each modelled period for the Do Minimum and the Option, showing:

- That the Option results does not give rise to significantly improved network-wide average speeds:
  - At most this is 2% is the peaks in 2026, which is maintained in 2041 for the PM peak, but not the AM peak;
  - In the IP period the effect of the Option is less with the difference in average speed is less than 0.5kph in both forecast years;
- Given this small effect the option does not reverse the general decline over time in the network-wide average speeds.

	2006	2026				2041			
		Do Min	Option			Do Min	Option		
	Speed	Speed	Speed	Diff	% Diff	Speed	Speed	Diff	% Diff
AM Peak	41	40	41	1	2%	36	36	0	0%
Interpeak	48	46	47	0	1%	39	40	0	1%
PM Peak	43	39	40	1	2%	33	34	1	2%



4 Screenline Statistics

The following table gives, for each forecast year, the Do Minimum and Option AM peak vehicle and PT flows and the PT mode shares across the 5 screenlines of particular relevance to the study, and the differences between them.

The data show:

- The differences in vehicle and PT flows between the Do Minimum and the Option flows varies between screenlines according to their location, with, as expected, the largest increases on the Harbour and CBD screenlines;
- The differences in flows generally increase over time;
- The increases in vehicle flows are greater than those for PT flows, apart from the inbound CBD screenline in 2041;
- Considering the relative differences in flows by direction across each screenline:
    - for vehicles this is greater inbound to the CBD (peak direction) except for the Harbour screenline where the option results in a greater increase northbound (contra-peak direction) than southbound; this is due to the existing 3 lanes northbound becoming a capacity constraint in the future, which is released with the additional 2 northbound lanes provided by the Option;
    - for PT this is also the case for the Harbour screenline plus the North Shore screenline - which is related to the good PT accessibility to the large number of jobs in Albany - though these are from a relatively low base.
- Considering PT mode shares:
    - These are highest across the Harbour screenline southbound and the CBD screenline inbound;
    - the differences between Do Minimum and Option are relatively small and affected by both the increase in road capacity with the new crossing and the buslanes across AHB and into the city; this is evident on the Harbour screenline where the net effect is a slight reduction in the PT mode share;
    - the greatest increase in PT mode share occurs on the North Shore screenline northbound and is related to improved PT accessibility to the large employment at Albany.

	2026				2041			
	Do Min	Option			Do Min	Option		
	Trips	Trips	Diff	% Diff	Trips	Trips	Diff	% Diff
AM Peak Vehicle								
Hibiscus NB	6,188	6,432	244	4%	7,266	7,648	381	5%
Hibiscus SB	11,049	11,099	50	0%	11,410	11,406	-4	0%
North Shore NB	14,721	15,481	760	5%	15,266	15,929	663	4%
North Shore SB	16,545	17,603	1,058	6%	17,301	18,368	1,067	6%
Harbour NB	20,585	25,497	4,912	24%	20,843	27,103	6,259	30%
Harbour SB	24,839	28,617	3,778	15%	25,720	29,879	4,159	16%
Central Isthmus NB	57,382	58,588	1,206	2%	59,779	61,246	1,467	2%
Central Isthmus SB	38,464	39,438	974	3%	44,378	44,872	494	1%
CBD IN	37,338	42,382	5,044	14%	43,286	47,706	4,420	10%
CBD OUT	30,315	32,916	2,602	9%	35,107	37,621	2,514	7%
AM Peak PT								
Hibiscus NB	216	226	10	5%	429	581	152	36%
Hibiscus SB	2,103	2,161	58	3%	2,942	3,128	187	6%
North Shore NB	3,136	3,732	595	19%	3,154	3,971	817	26%
North Shore SB	6,395	6,582	187	3%	7,371	8,079	708	10%
Harbour NB	4,559	5,244	685	15%	5,036	6,353	1,318	26%
Harbour SB	12,204	12,517	313	3%	15,229	16,558	1,329	9%
Central Isthmus NB	29,743	29,822	79	0%	37,445	37,480	35	0%
Central Isthmus SB	6,487	6,465	-22	0%	6,787	6,859	71	1%
CBD IN	32,297	36,538	4,241	13%	39,269	45,859	6,590	17%
CBD OUT	10,508	11,289	782	7%	11,278	12,841	1,563	14%
PT Mode Share								
Hibiscus NB	3%	3%	0%		5%	6%	1%	
Hibiscus SB	14%	14%	0%		18%	19%	1%	
North Shore NB	15%	17%	2%		15%	17%	3%	
North Shore SB	24%	24%	-1%		26%	27%	1%	
Harbour NB	16%	15%	-1%		17%	16%	0%	
Harbour SB	29%	27%	-2%		33%	32%	-1%	
Central Isthmus NB	30%	30%	0%		34%	34%	-1%	
Central Isthmus SB	12%	12%	0%		11%	11%	0%	
CBD IN	42%	42%	0%		43%	44%	1%	
CBD OUT	22%	22%	0%		21%	22%	1%	

5 Cross-Harbour Travel

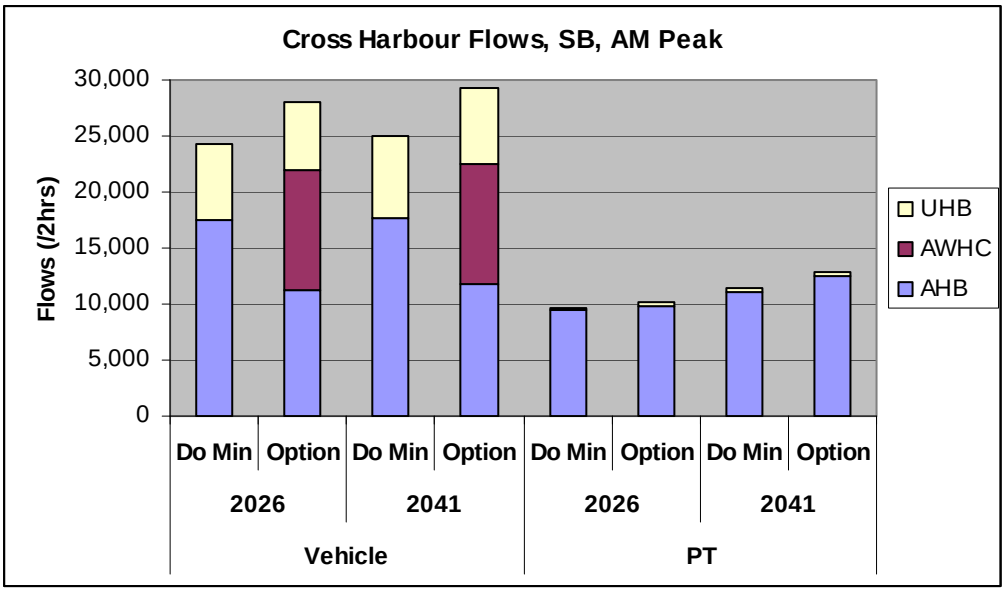
5.1 Trips

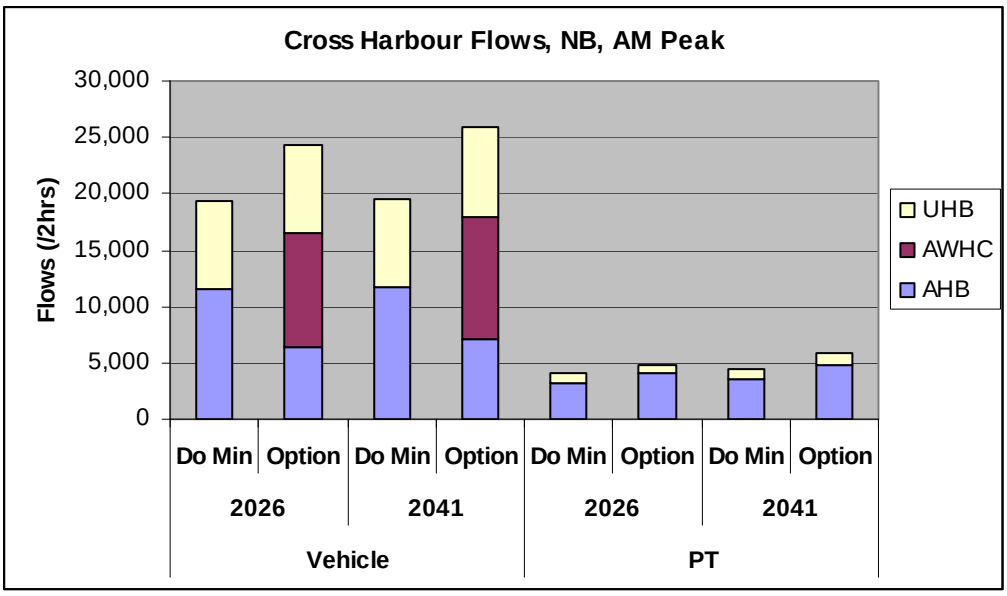
The following tables and figures give the vehicle trips and PT patronage on the three cross-harbour links: AHB, the new crossing (AWHC) and UHB. The tables also give the absolute and percentage differences for the sum of all three crossings.

The data show:

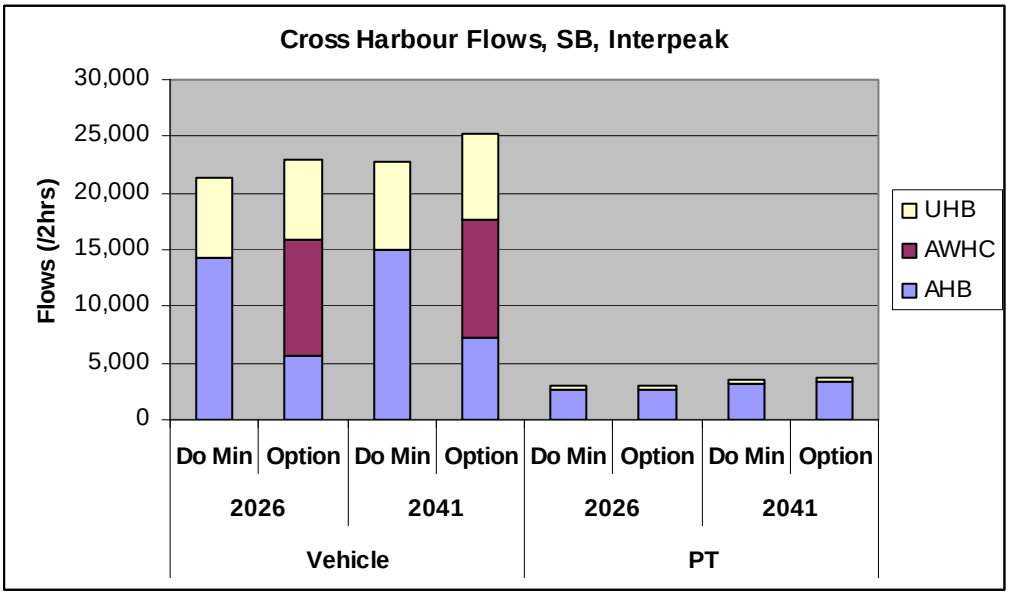
- That the percentage increases in vehicle trips across the harbour due to the new crossing are greater than for PT in 2026, but similar to PT in 2041;
- Vehicle flows:
  - Significant increases in vehicle trips across the harbour, with these being greater in the peak periods than in the Interpeak;
  - The new crossing and AHB have about equal peak direction traffic flows in the peak periods, but in the contra-peaks and the Interpeak the new crossing has at least 50% more than AHB;
  - The effect on UHB is small.
- PT patronage:
  - The increases, due to the new crossing and the provision of buslanes on AHB and into the CBD, are not significant the Interpeak period and in the peaks are relatively small in both absolute and percentage terms in 2026, but more significant in 2041;
  - The AM peak increases in 2041 are similar in absolute terms in each direction; the northbound increases relate to the improved accessibility to the large employment in Albany.

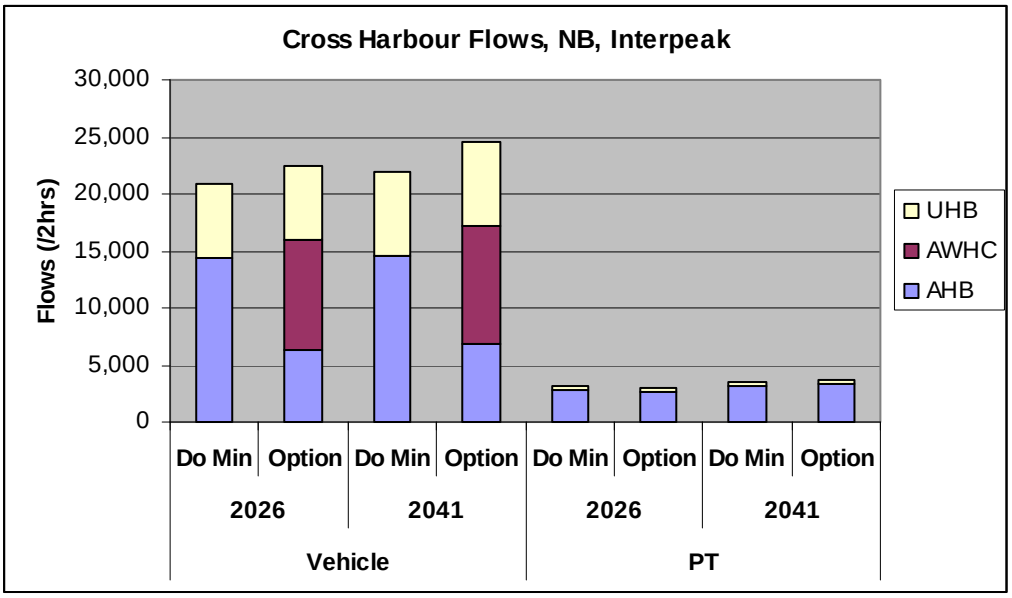
	Vehicle				PT			
	2026		2041		2026		2041	
	Do Min	Option	Do Min	Option	Do Min	Option	Do Min	Option
AM Southbound								
AHB	17,542	11,414	17,715	11,580	9,420	9,821	11,084	12,571
AWHC	0	10,592	0	10,777	0	0	0	0
UHB	6,671	6,006	7,256	6,845	273	274	289	298
Diff		3,798		4,232		402		1,496
% Diff		16%		17%		4%		13%
AM Northbound								
AHB	11,614	6,351	11,741	7,140	3,253	4,039	3,480	4,862
AWHC	0	10,149	0	10,945	0	0	0	0
UHB	7,737	7,827	7,794	7,750	773	700	949	911
Diff		4,975		6,300		713		1,346
% Diff		26%		32%		18%		30%


Cross Harbour Flows, SB, AM Peak
Flows (/2hrs)
30,000
25,000
20,000
15,000
10,000
5,000
0
UHB
AWHC
AHB
Do Min
Option
Do Min
Option
Do Min
Option
Do Min
Option
2026
2041
2026
2041
Vehicle
PT

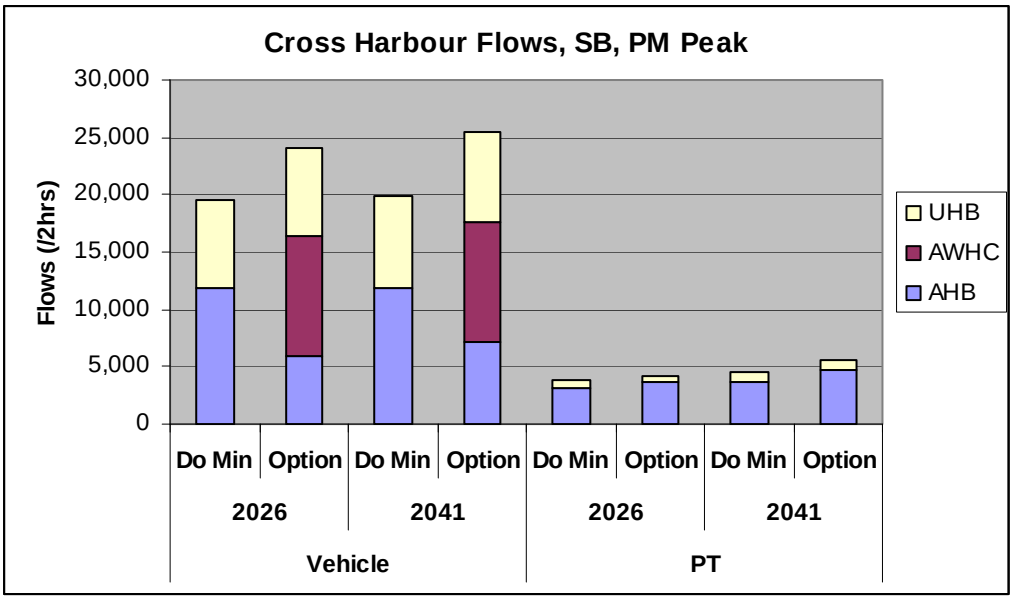

Cross Harbour Flows, NB, AM Peak
Flows (/2hrs)
30,000
25,000
20,000
15,000
10,000
5,000
0
UHB
AWHC
AHB
Do Min
Option
Do Min
Option
Do Min
Option
Do Min
Option
2026
2041
2026
2041
Vehicle
PT

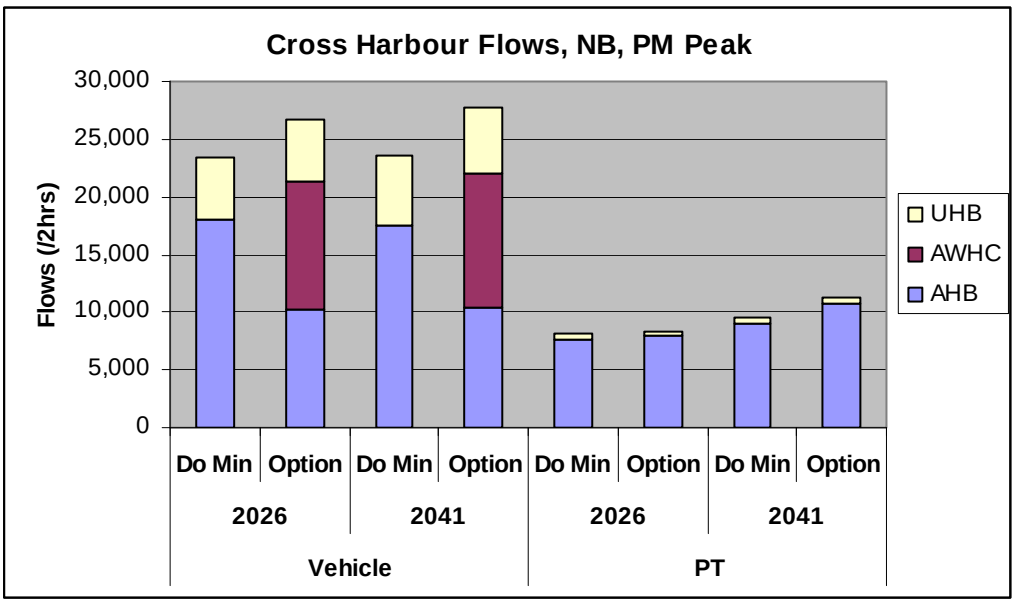
	Vehicle				PT			
	2026		2041		2026		2041	
	Do Min	Option	Do Min	Option	Do Min	Option	Do Min	Option
IP Southbound								
AHB	14,328	5,553	14,986	7,291	2,668	2,635	3,143	3,346
AWHC	0	10,215	0	10,461	0	0	0	0
UHB	6,937	7,096	7,715	7,564	272	278	302	320
Diff		1,598		2,616		-27		221
% Diff		8%		12%		-1%		6%
IP Northbound								
AHB	14,344	6,104	14,632	6,811	2,724	2,692	3,088	3,257
AWHC	0	9,629	0	10,372	0	0	0	0
UHB	6,477	6,703	7,349	7,308	353	335	418	398
Diff		1,615		2,509		-50		149
% Diff		8%		11%		-2%		4%





	Vehicle				PT			
	2026		2041		2026		2041	
	Do Min	Option	Do Min	Option	Do Min	Option	Do Min	Option
PM Southbound								
AHB	11,942	5,881	11,848	7,232	3,201	3,668	3,666	4,787
AWHC	0	10,354	0	10,471	0	0	0	0
UHB	7,674	7,833	7,959	7,819	565	565	810	767
Diff		4,452		5,716		467		1,078
% Diff		23%		29%		12%		24%
PM Northbound								
AHB	18,107	10,189	17,589	10,498	7,715	8,035	9,076	10,812
AWHC	0	11,128	0	11,523	0	0	0	0
UHB	5,257	5,326	6,018	5,754	378	365	446	404
Diff		3,279		4,168		306		1,694
% Diff		14%		18%		4%		18%


Cross Harbour Flows, SB, PM Peak
Flows (/2hrs)
30,000
25,000
20,000
15,000
10,000
5,000
0
UHB
AWHC
AHB
Do Min
Option
Do Min
Option
Do Min
Option
Do Min
Option
2026
2041
2026
2041
Vehicle
PT


Cross Harbour Flows, NB, PM Peak
Flows (/2hrs)
30,000
25,000
20,000
15,000
10,000
5,000
0
UHB
AWHC
AHB
Do Min
Option
Do Min
Option
Do Min
Option
Do Min
Option
2026
2041
2026
2041
Vehicle
PT

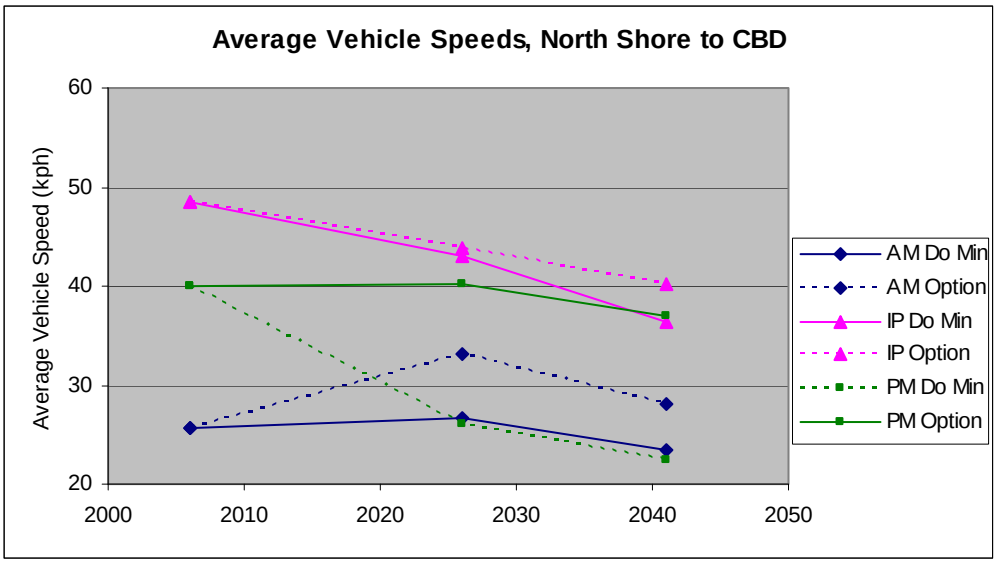
5.2 Average Vehicle Speeds Between Sectors

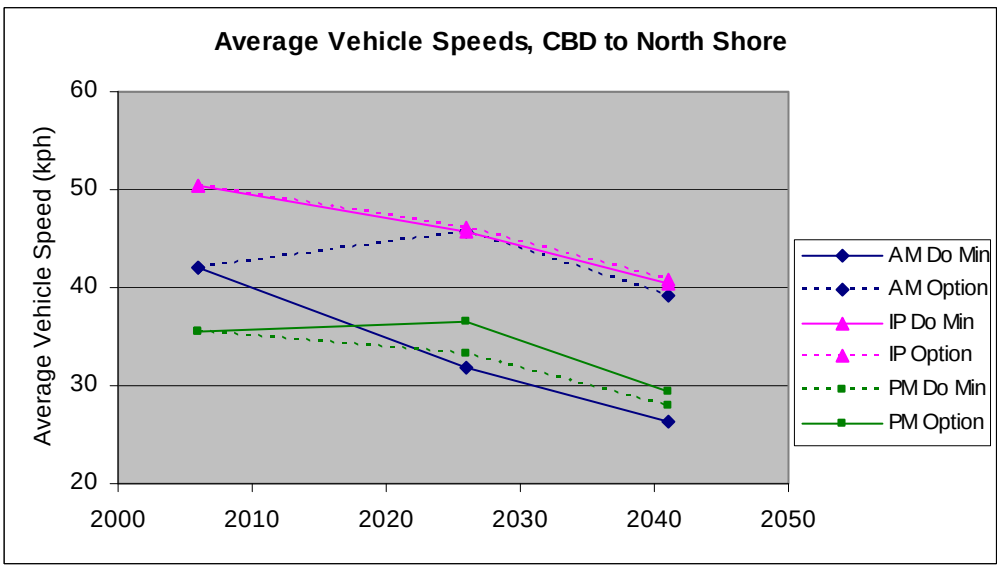
The following table and figures give the average vehicle speeds between North Shore and the CBD and the Isthmus in both directions in the three modelled periods.

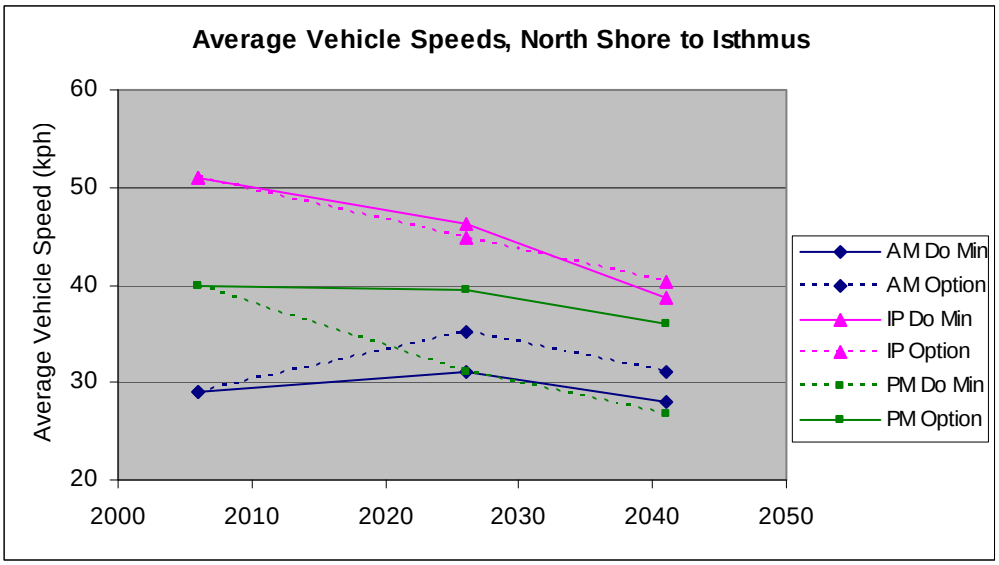
The data show that:

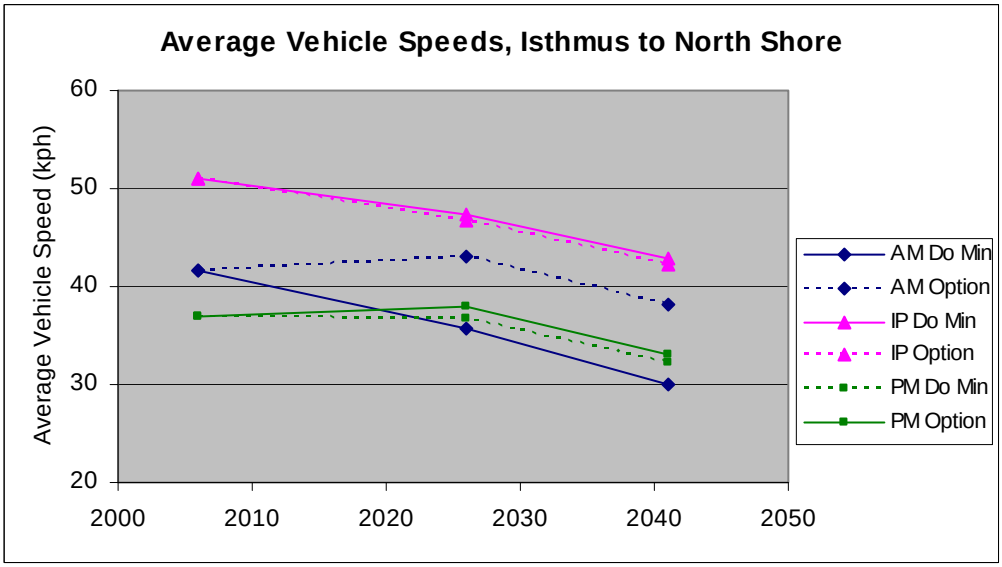
- The new crossing results in improved average speeds between the North Shore and the CBD/Isthmus in the peak periods, but has little effect on average speeds in the Interpeak period;
- The new crossing gives 2026 peak period average speeds which are similar to or better than in 2006, which are not sustained to 2041 when they are generally less than in 2006;
- The contra-peak speeds (northbound AM, southbound PM) in the forecast Do Minimum decline significantly from 2006 levels, and the Option provides significant improvements in both 2026 and 2041; these improvements will be due to the increased contra-peak capacity provided by the Option (3 additional lanes) releasing the constraint of the current 3 contra-peak lanes on AHB.

	2006	2026				2041			
		Do Min	Option			Do Min	Option		
	Speed	Speed	Speed	Diff	% Diff	Speed	Speed	Diff	% Diff
North Shore to CBD									
AM Peak	26	27	33	7	25%	23	28	5	16%
Interpeak	49	43	44	1	2%	36	40	5	10%
PM Peak	40	26	40	14	35%	23	37	14	39%
CBD to North Shore									
AM Peak	42	32	46	14	33%	26	39	13	33%
Interpeak	50	46	46	0	1%	40	41	0	1%
PM Peak	35	33	37	3	9%	28	29	1	5%
North Shore to Isthmus									
AM Peak	29	31	35	4	14%	28	31	3	9%
Interpeak	51	46	45	-1	-3%	39	40	2	4%
PM Peak	40	31	39	8	21%	27	36	9	25%
Isthmus to North Shore									
AM Peak	42	36	43	7	17%	30	38	8	21%
Interpeak	51	47	47	-1	-1%	43	42	-1	-1%
PM Peak	37	37	38	1	3%	32	33	1	2%


Average Vehicle Speeds, North Shore to CBD
Average Vehicle Speed (kph)
60
50
40
30
20
2000
2010
2020
2030
2040
2050
AM Do Min
AM Option
IP Do Min
IP Option
PM Do Min
PM Option


Average Vehicle Speeds, CBD to North Shore
Average Vehicle Speed (kph)
60
50
40
30
20
2000
2010
2020
2030
2040
2050
AM Do Min
AM Option
IP Do Min
IP Option
PM Do Min
PM Option


Average Vehicle Speeds, North Shore to Isthmus
Average Vehicle Speed (kph)
60
50
40
30
20
2000
2010
2020
2030
2040
2050
AM Do Min
AM Option
IP Do Min
IP Option
PM Do Min
PM Option


Average Vehicle Speeds, Isthmus to North Shore
Average Vehicle Speed (kph)
60
50
40
30
20
2000
2010
2020
2030
2040
2050
AM Do Min
AM Option
IP Do Min
IP Option
PM Do Min
PM Option

David Young

Appendix I SATURN Option Forecasts

This file note sets out the outputs from the base (2008) SATURN models and the future SATURN models for 2026 and 2041, both for the Do Minimum scenario and for the scenario with the Additional Waitemata Harbour Crossing (AWHC) Option.

The file note incorporates the following sections:

- Section 1 provides a comparison of journey times
- Section 2 sets out the operation of the 2008 model
- Section 3 sets out the operation of the 2026 Do Minimum and Option models
- Section 4 sets out the operation of the 2041 Do Minimum and Option models
- Section 5 provides details of the predicted flows along SH1 without and with the AWHC project

The following further details are provided in appendices:

- Appendix A details the overall demands within each year and option. It should be noted that these demands are set out for internal checking/peer review purposes. The traffic demands should properly be taken from the regional (ART) model. The results of the ART model are being provided separately
- Appendix B provides plots showing links with volume/capacity ratios greater than 95%, to supplement the information in the queue plots (ie to provide details of links close to capacity)
- Appendix C provides actual flow plots for the Option models for 2026 and 2041.

4 JOURNEY TIME COMPARISON

The following journey times have been taken from the SATURN models for the 2008 Base model and the future 2026 and 2041 models, both for the Do Minimum scenario and for the scenario with the AWHC Option.

Route 1 – State Highway 1 (SH1) southbound (SB)

A - Oteha Valley off ramp to the Northcote off ramp
B - Northcote off ramp to centre of the Harbour Bridge/AWHC
C - Centre of existing Harbour Bridge/AWHC to SH16 diverge
D - SH16 diverge to Gillies Ave off ramp

Route 2 – SH1 northbound (NB)

E - Gillies Ave on ramp to SH16 on ramp
F - SH16 on ramp to centre of Harbour Bridge/AWHC
G - Centre of existing Harbour Bridge/AWHC to Northcote on ramp
H - Northcote on ramp to Oteha Valley on ramp

Route 3 – Takapuna (Esmonde Road) to CBD (Fanshawe Street)

I - Esmonde Road (Burns Avenue) to centre of Harbour Bridge
J - Centre of existing Harbour Bridge to Fanshawe Street (east of Halsey Street)

Route 4 –CBD (Fanshawe Street) to Takapuna (Esmonde Road)

K - Fanshawe Street (east of Halsey Street) to centre of Harbour Bridge
L - Centre of existing Harbour Bridge to Esmonde Road (Burns Avenue)

Route 5 – Onewa Road to CBD (Cook Street)

M - Onewa Road (at Birkenhead Avenue) to centre of Harbour Bridge
N - Centre of existing Harbour Bridge to Cook Street

Route 6 – CBD (Wellington Street/Cook Street) to Onewa Road (Birkenhead Avenue)

O - Wellington Street (Do Minimum) or Cook Street (Option) to centre of existing Harbour Bridge
P - Centre of existing Harbour Bridge to Onewa Road (Birkenhead Avenue)

Tables 1, 2 and 3 set out the modelled times for the weekday morning peak, inter peak and PM peak respectively.

Table 14: Journey Times, AM Peak Period

		2008	2026		2041	
Route	**Route**	**Do Min**	**Do Min**	**Option**	**Do min**	**Option**
1	A. SH1 SB	23:47	18:51	24:47	19:33	26:09
	B. SH1 SB	15:54	19:16	5:40	19:30	5:38
	C. SH1 SB	5:19	2:11	4:20	2:14	4:24
	D. SH1 SB	2:46	3:11	6:19	3:20	6:09
	SH1 SB Total	47:46	43:29	41:05	44:37	42:20
2	E. SH1 NB	2:31	2:27	2:38	2:32	2:41
	F. SH1 NB	3:46	3:42	3:41	3:44	3:48
	G. SH1 NB	2:48	2:46	3:27	2:47	3:31
	H. SH1 NB	5:59	6:23	6:30	6:42	6:50
	SH1 NB Total	15:04	15:18	16:16	15:44	16:51
3	I. Takapuna – CBD	17:16	26:34	21:52	27:53	24:15
	J. Takapuna – CBD	2:57	3:13	3:48	3:30	8:35
	Takapuna – CBD Total	20:13	29:47	25:40	31:23	32:50
4	K. CBD – Takapuna	5:30	5:42	5:31	5:46	5:24
	L. CBD – Takapuna	4:32	4:44	5:23	4:52	5:58
	CBD – Takapuna Total	10:01	10:27	10:54	10:38	11:22
5	M. Onewa – CBD	26:17	37:08	35:57	36:33	37:39
	N. Onewa – CBD	6:22	3:34	3:44	3:21	5:00
	Onewa – CBD Total	32:40	40:42	39:41	39:54	42:39
6	O. CBD – Onewa	6:00	6:04	3:56	6:50	4:12
	P. CBD – Onewa	3:35	3:38	3:46	3:38	3:48
	CBD – Onewa Total	9:35	9:42	7:42	10:27	7:59

SH 1 southbound in the morning peak shows an improvement in the Do Minimum from 2008 to 2026 and as well as 2041. A number of schemes implemented in the Do Minimum scenarios are likely to have contributed to this, including SH1 six-laning between Constellation and Greville interchanges and the Victoria Park Tunnel.

Of note when comparing the future models is that the journey time for Route 1A is longer with the AWHC due to additional queuing south of the Constellation interchange, with additional traffic joining SH1 from SH18. Further south, Route 1B shows significant improvements with the AWHC on the approach to the

Crossing itself, as the AWHC will remove the existing bottleneck at the Esmonde Road on ramp. However, with the construction of the AWHC Route 1D in particular shows an increase relative to the Do Minimum, from three minutes to around six minutes. This is due to additional traffic being able to get across the Harbour and through to SH1 south of the Central Motorway Junction (CMJ).

Table 1 indicates overall travel time savings southbound on the motorway of around 2 minutes (in 2026 and 2041). However, Section 5 below notes that the flow able to cross the Harbour, southbound in the morning peak, is predicted to increase with the AWHC.

The route from Takapuna to the CBD (Route 3) initially shows a decrease for the Option over the Do Minimum in 2026, but in 2041 the Option travel time is slower, due to predicted congestion at the Fanshawe Street/Halsey Street intersection in the CBD.

A similar effect can be noticed with Route 4 where increases in journey times are predicted at the Esmonde Road/Akoranga Drive intersection with the Option, relative to the Do Minimum.

Table 15: Journey Times, Inter Peak Period

		2008	2026		2041	
Route	**Route**	**Do Min**	**Do Min**	**Option**	**Do min**	**Option**
1	A. SH1 SB	6:52	9:07	9:16	9:59	10:13
	B. SH1 SB	5:14	6:28	3:01	7:36	3:15
	C. SH1 SB	2:09	1:53	3:27	1:57	3:41
	D. SH1 SB	2:21	2:43	2:44	2:54	2:54
	SH1 SB Total	16:36	20:11	18:28	22:25	20:02
2	E. SH1 NB	2:15	2:14	2:18	2:17	2:23
	F. SH1 NB	3:35	3:55	3:57	3:59	4:11
	G. SH1 NB	2:36	2:46	3:12	2:50	3:20
	H. SH1 NB	5:50	6:05	6:08	6:21	6:20
	SH1 NB Total	14:15	15:00	15:36	15:26	16:13
3	I. Takapuna – CBD	6:08	8:48	6:41	11:18	10:54
	J. Takapuna – CBD	2:39	3:09	3:09	3:27	7:09
	Takapuna – CBD Total	8:46	11:58	9:50	14:45	18:02
4	K. CBD – Takapuna	5:08	6:02	5:19	6:05	5:07
	L. CBD – Takapuna	4:55	4:54	5:08	5:30	7:47
	CBD – Takapuna Total	10:02	10:56	10:27	11:35	12:54
5	M. Onewa – CBD	6:01	6:24	6:05	6:42	6:16
	N. Onewa – CBD	3:20	3:09	3:06	3:11	3:04

	Onewa – CBD Total	9:21	9:33	9:11	9:53	9:20
6	O. CBD – Onewa	5:32	5:46	3:49	7:31	4:21
	P. CBD – Onewa	3:40	3:44	3:51	3:45	3:56
	CBD – Onewa Total	9:12	9:30	7:39	11:16	8:17

Table 2 indicates that journey times are generally predicted to be similar between the Do Minimum and the AWHC in the inter peak. This reflects the prediction that the Do Minimum scenario will generally be operating satisfactorily. Reductions in journey times of almost 2 minutes are predicted on the motorway southbound. The table indicates increases of half a minute in the northbound direction, but this appears to be "model noise" resulting from differences in the modelled speed flow characteristics between the Esmonde and Onewa interchanges between the Do Minimum and the Option..

The model is also predicting an increase in journey times for traffic from the CBD to Takapuna again due to an increase in delay at the Esmonde Road/Akoranga Drive intersection which is predicted to be at capacity in 2041.

Table 16: Journey Times, PM Peak Period

		2008	2026		2041	
Route	**Route**	**Do Min**	**Do Min**	**Option**	**Do min**	**Option**
1	A. SH1 SB	9:27	9:55	11:00	10:47	11:24
	B. SH1 SB	10:20	8:55	3:33	8:54	3:43
	C. SH1 SB	2:54	2:33	3:40	2:33	3:51
	D. SH1 SB	2:53	3:27	4:02	3:27	4:18
	SH1 SB Total	25:34	24:50	22:15	25:42	23:15
2	E. SH1 NB	3:00	2:53	3:17	2:55	3:15
	F. SH1 NB	9:59	4:31	4:51	4:15	4:52
	G. SH1 NB	3:21	3:56	4:53	3:46	5:05
	H. SH1 NB	10:31	9:48	10:07	9:54	10:23
	SH1 NB Total	26:51	21:08	23:09	20:50	23:34
3	I. Takapuna – CBD	9:30	8:45	6:09	11:08	10:11
	J. Takapuna – CBD	2:49	2:44	2:36	2:51	2:48
	Takapuna – CBD Total	12:19	11:29	8:45	13:59	13:00
4	K. CBD – Takapuna	14:53	6:49	5:41	5:48	6:07
	L. CBD – Takapuna	4:38	5:15	6:25	5:04	7:12
	CBD – Takapuna Total	19:31	12:04	12:06	10:52	13:19

5	M. Onewa – CBD	7:32	6:55	5:58	6:55	6:02
	N. Onewa – CBD	3:47	3:23	2:47	3:22	2:47
	Onewa – CBD Total	11:19	10:18	8:45	10:18	8:49
6	O. CBD – Onewa	16:08	12:17	8:26	14:07	7:46
	P. CBD – Onewa	3:45	5:01	5:17	4:53	5:36
	CBD – Onewa Total	19:53	17:18	13:43	19:01	13:22

Northbound on SH1 (Routes A to D) in the evening peak shows an improvement in travel times in the Do Minimum from 2006 to 2026 and 2041. As is the case in the morning peak, there are a number of improvements on SH1, particularly the Victoria Park Tunnel, but also the widening assumed between the Constellation and Greville interchanges, that contribute to this reduction.

The AWHC is predicted to offer some improvement in travel times in 2026, southbound on the motorway, compared with the Do Minimum scenario, but increases are predicted in the northbound direction.

Decreases in travel times are predicted for Route 6 between the Do Minimum and Options, both in 2026 and 2041. These travel times are comparing Wellington Street on ramp to the proposed Cook Street on ramp for the future Option.

5 OPERATION OF 2008 MODEL

5.1 Queue Plots 2008 Scenario

The following figures show the queue plots for the AM Peak, the interpeak and the PM Peak for 2008. For each time period, plots are provided firstly for the whole modelled area, then for the Auckland CBD and Takapuna areas (ie the areas either side of the future Harbour Crossing.

These are what SATURN terms residual queues, at the end of the modelled periods.

Figure 30: 2008 AM Peak Queues: Whole Model

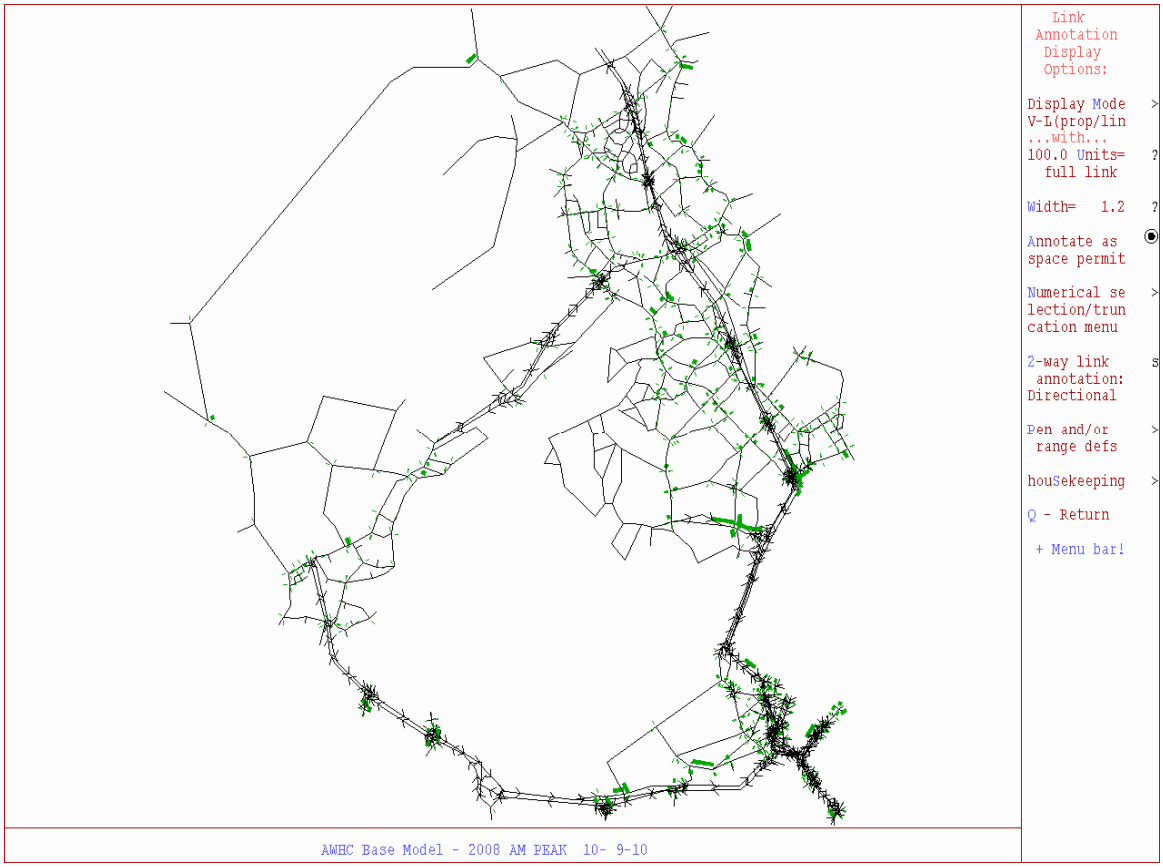


Figure 31: 2008 AM Peak Queues: Auckland CBD

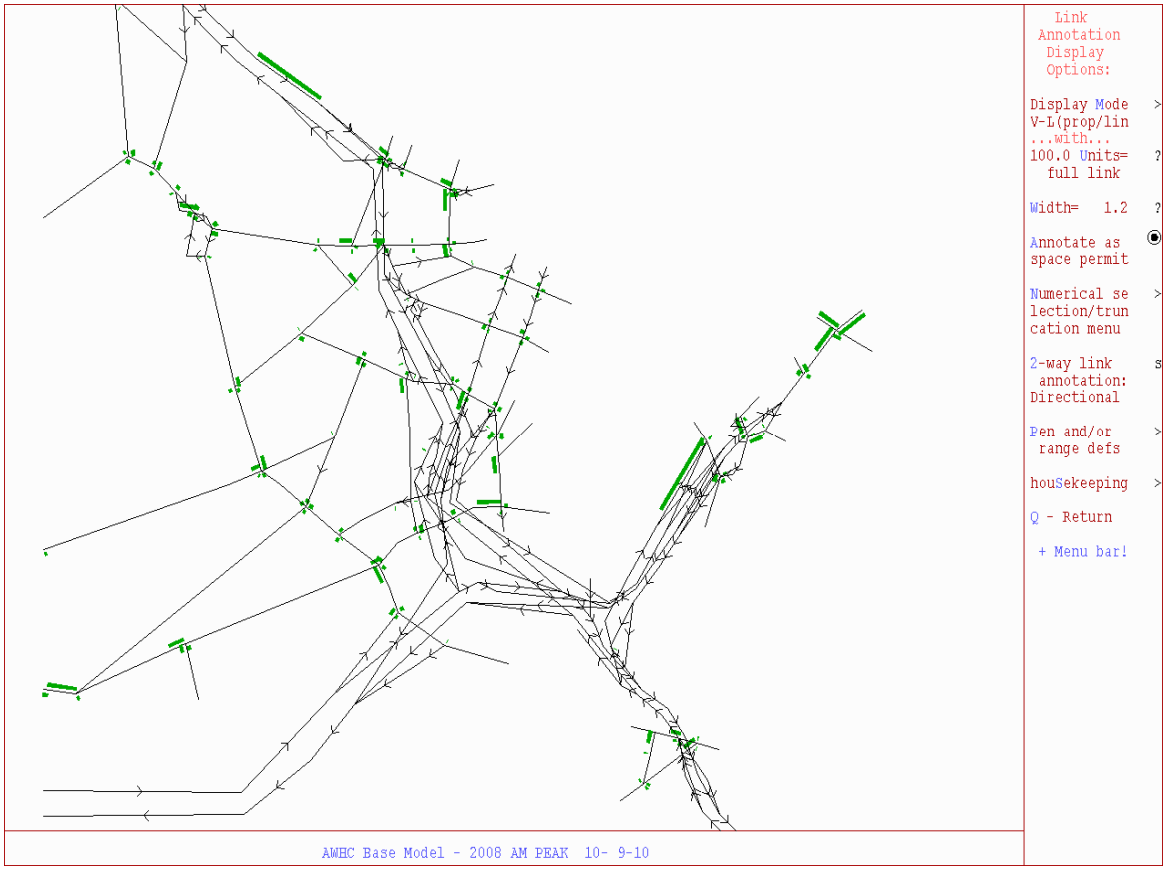


Figure 32: 2008 AM Peak Queues: Takapuna

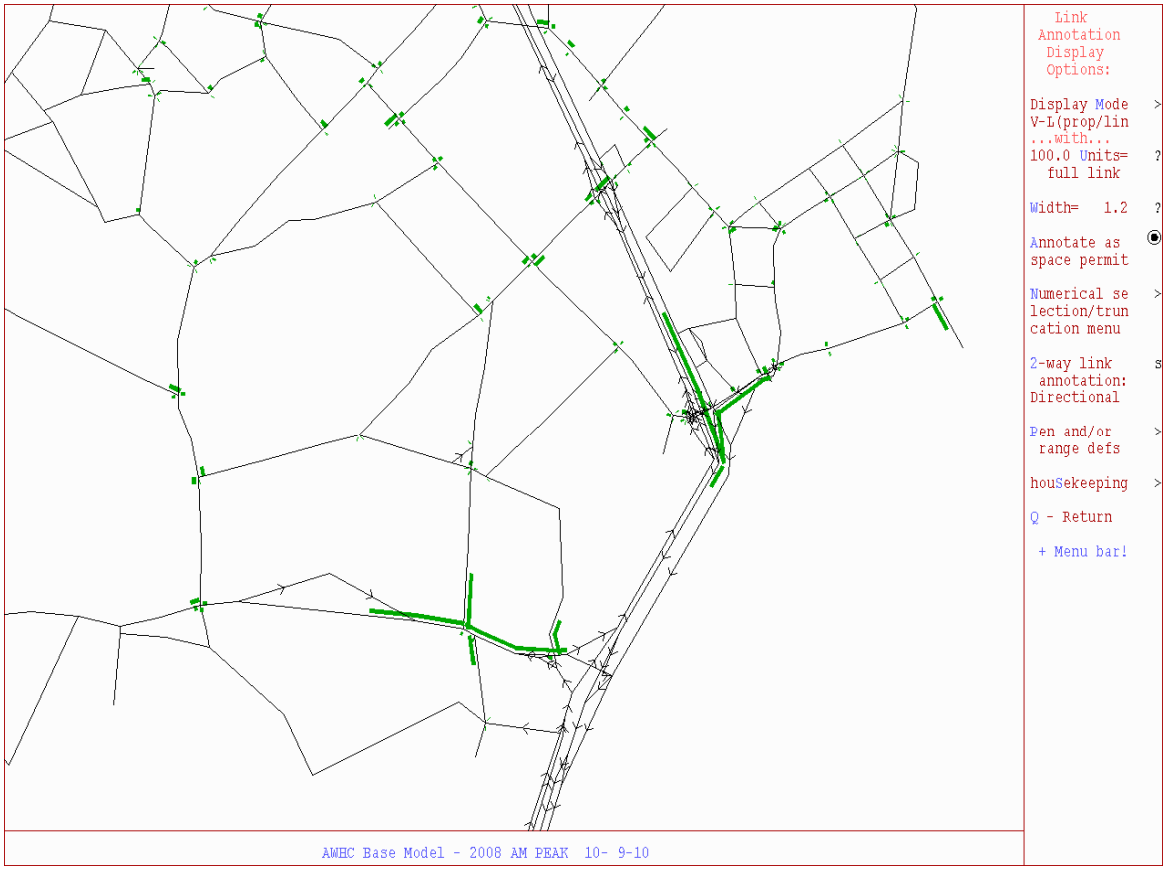


Figure 33: 2008 Inter Peak Queues: Whole Model

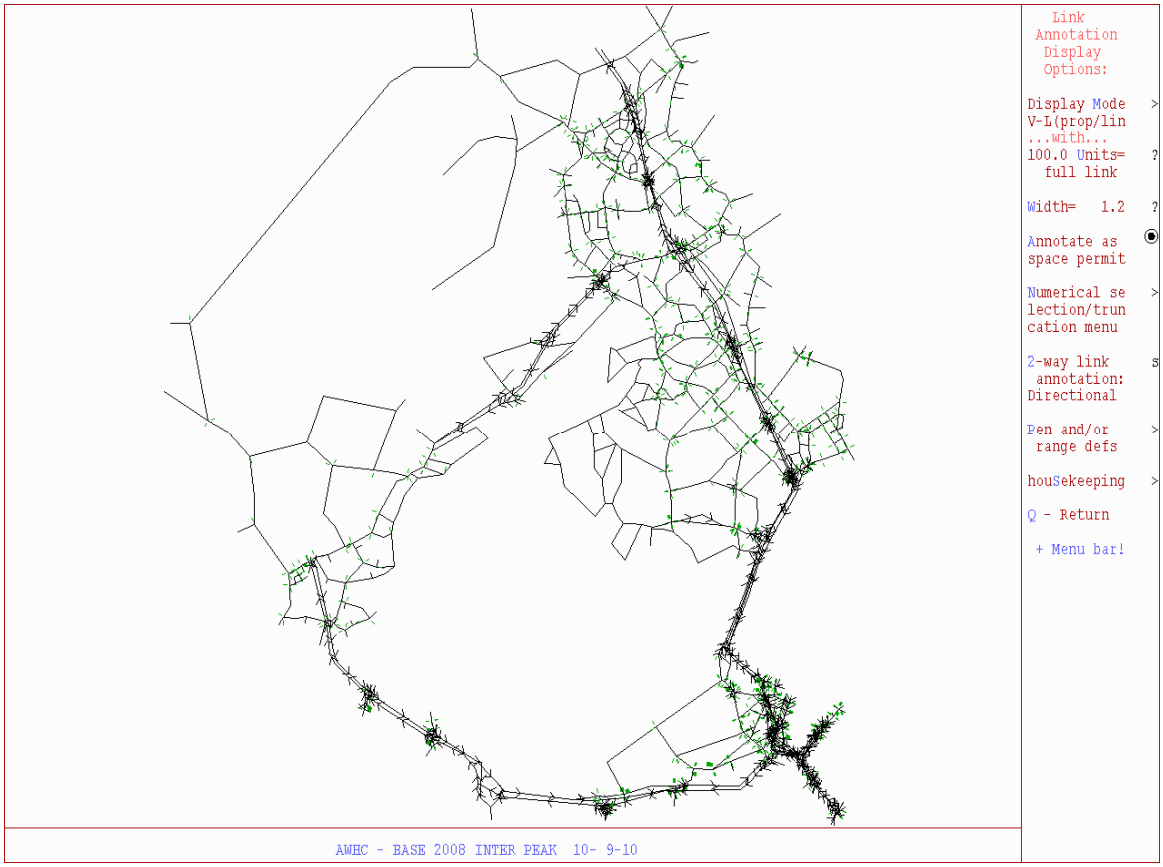


Figure 34: 2008 Inter Peak Queues: Auckland CBD

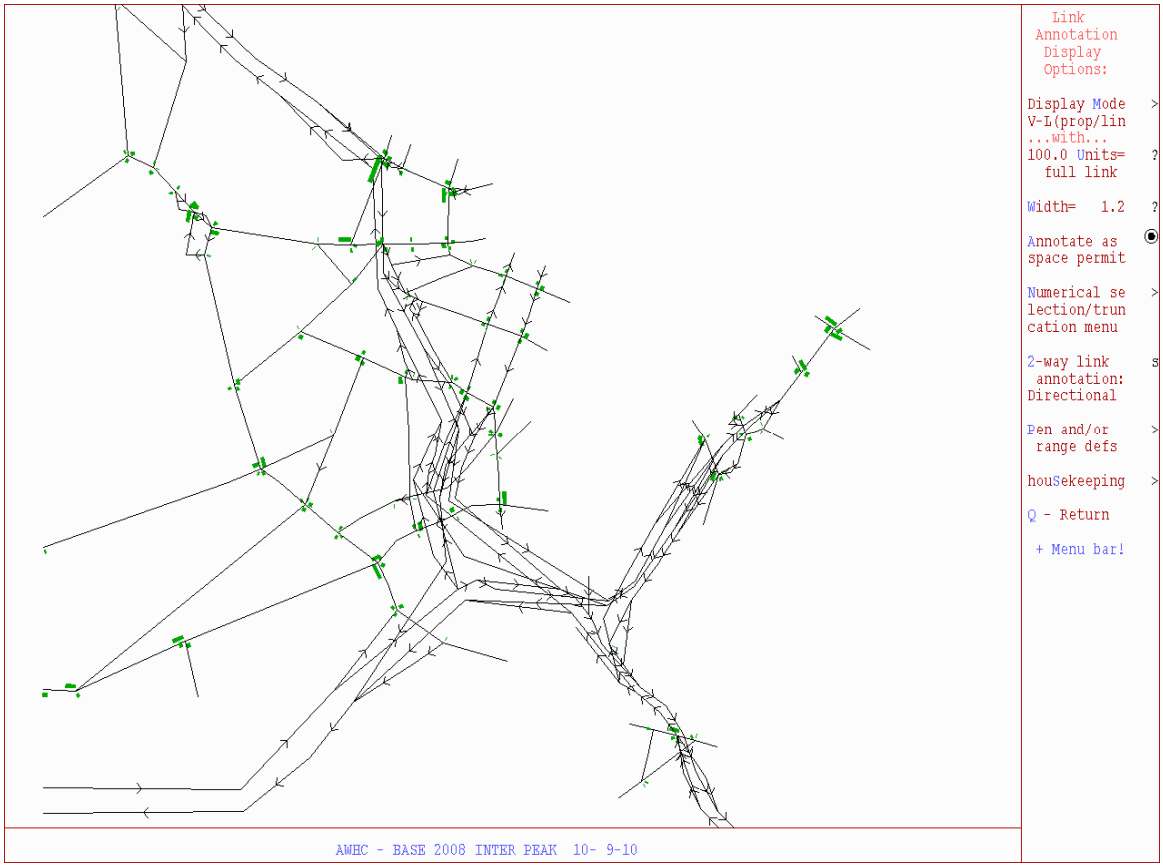


Figure 35: 2008 Inter Peak Queues: Takapuna

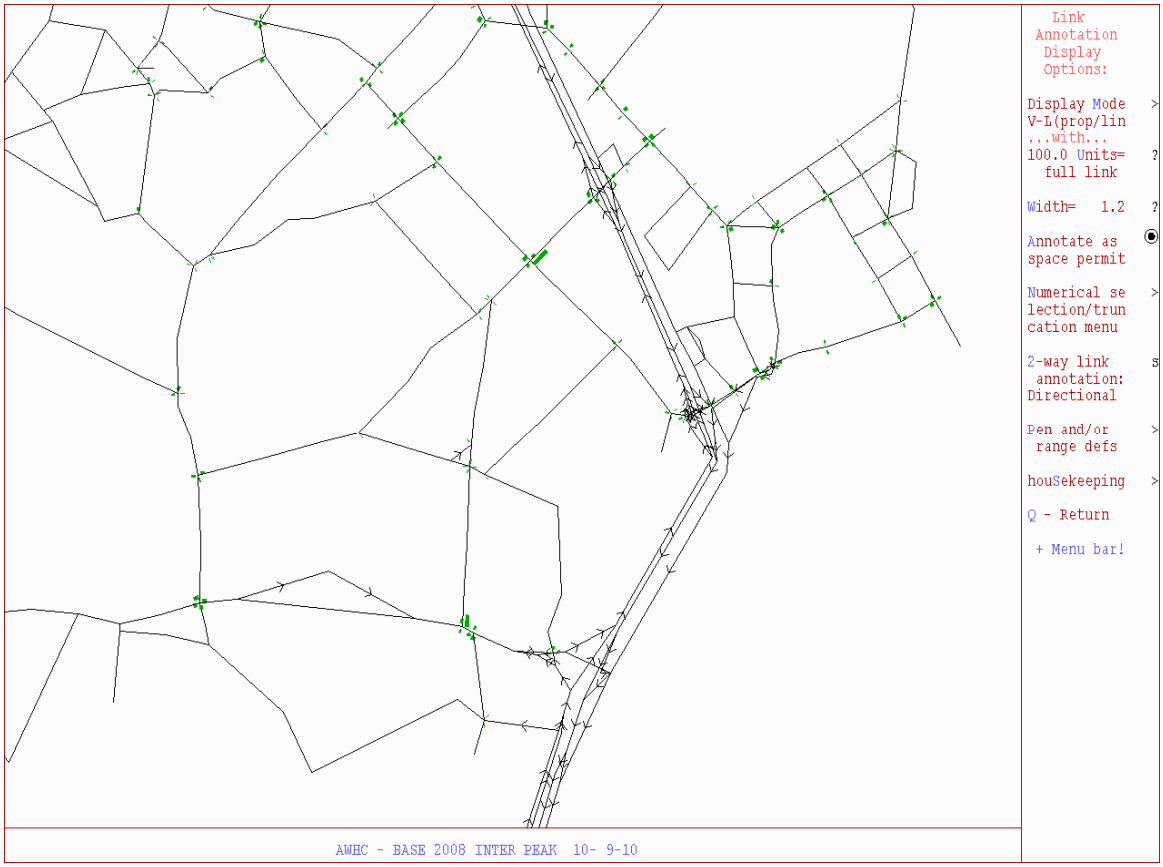


Figure 36: 2008 PM Peak Queues: Whole Model

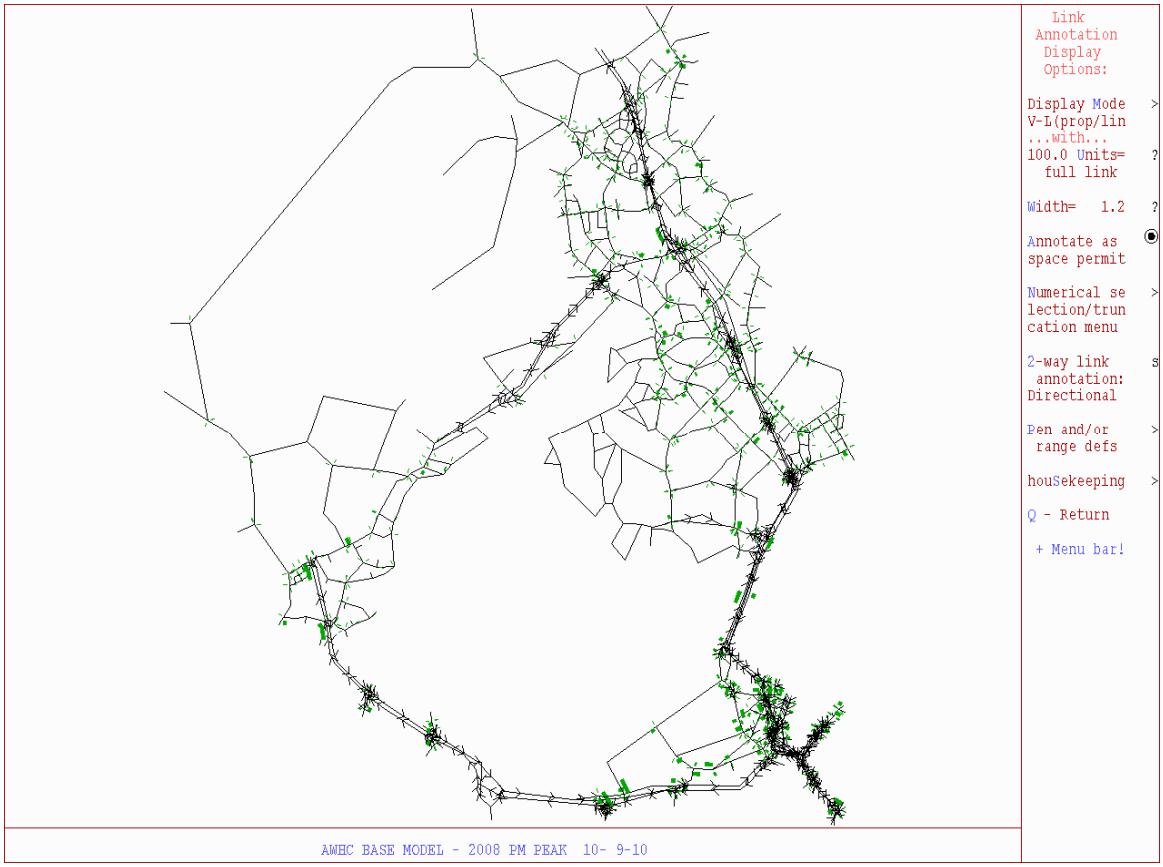


Figure 37: 2008 PM Peak Queues: Auckland CBD

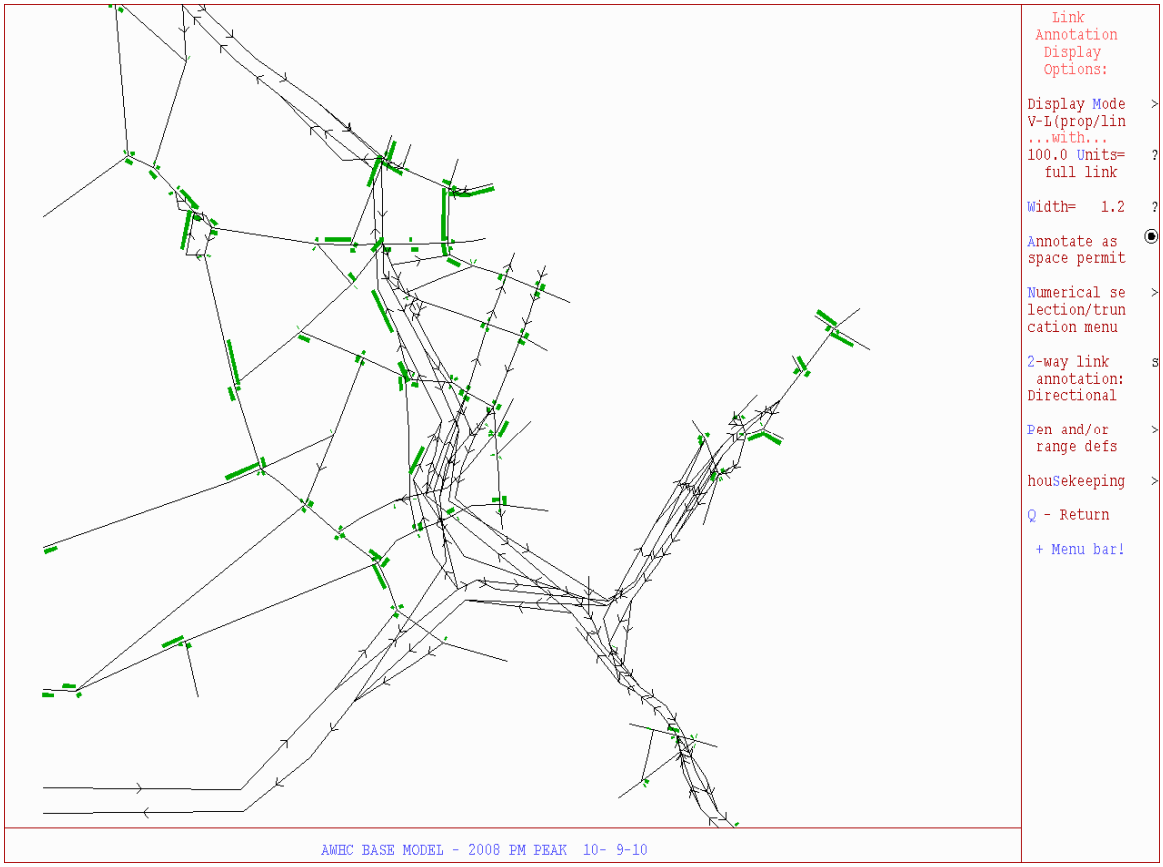
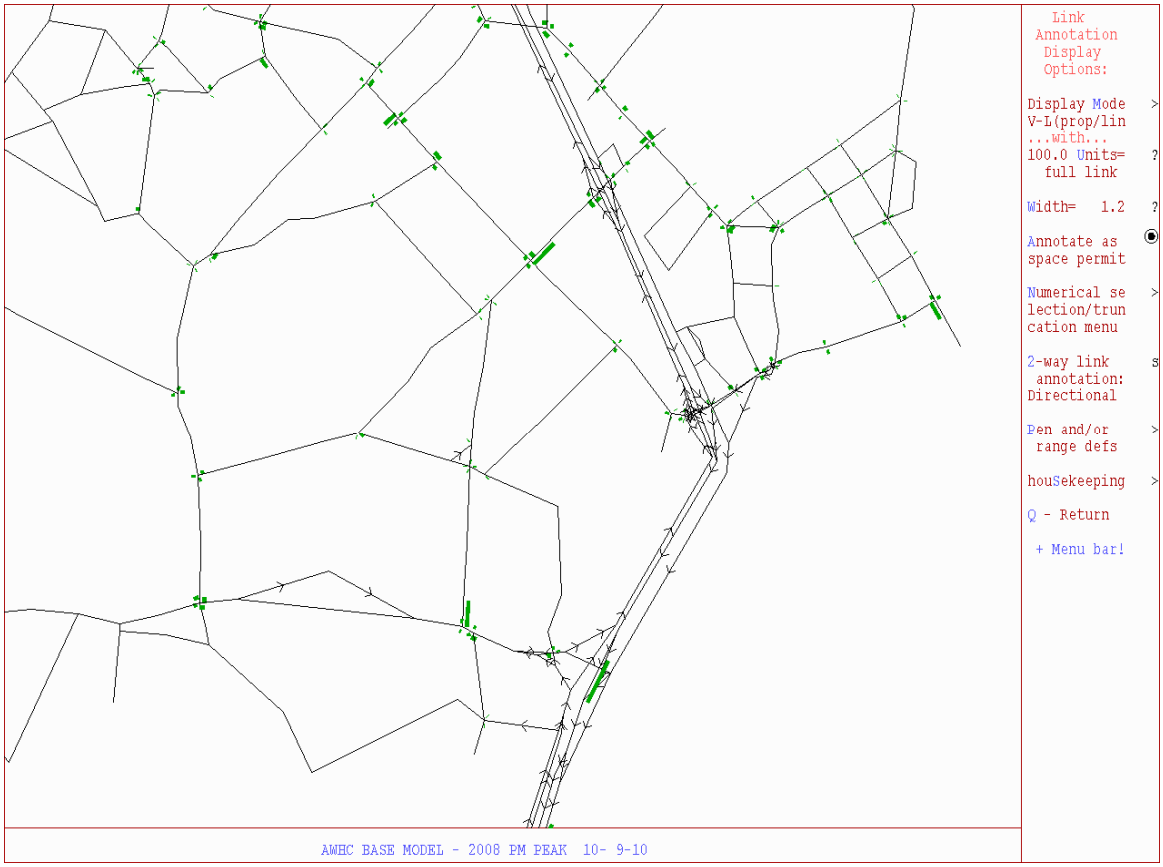


Figure 38: 2008 PM Peak Queues: Takapuna



Queues are shown in the following locations:

- Significant queues are shown as occurring along Onewa Road, Esmonde Road and on the motorway, southbound, approaching Esmonde Road, in the AM peak. Queues are also shown on the motorway, southbound approaching the Victoria Park Viaduct
- No significant queues are shown in the inter peak
- Relatively modest queues are shown as occurring at a number of locations in the PM peak, including on the Victoria Park Viaduct, northbound, on either side of the Harbour Bridge, and at the Constellation northbound on ramp merge.

6 PREDICTED OPERATION OF 2026 MODELS

6.1 Queue Plots for 2026 Do Minimum Scenario

The following figures show the queue plots for the AM Peak, the interpeak and the PM Peak for 2026. For each time period, plots are provided firstly for the whole modelled area, then for the Auckland CBD and Takapuna areas (ie the areas either side of the future Harbour Crossing.

Figure 39: 2026 Do Minimum Scenario: AM Peak Queues: Whole Model

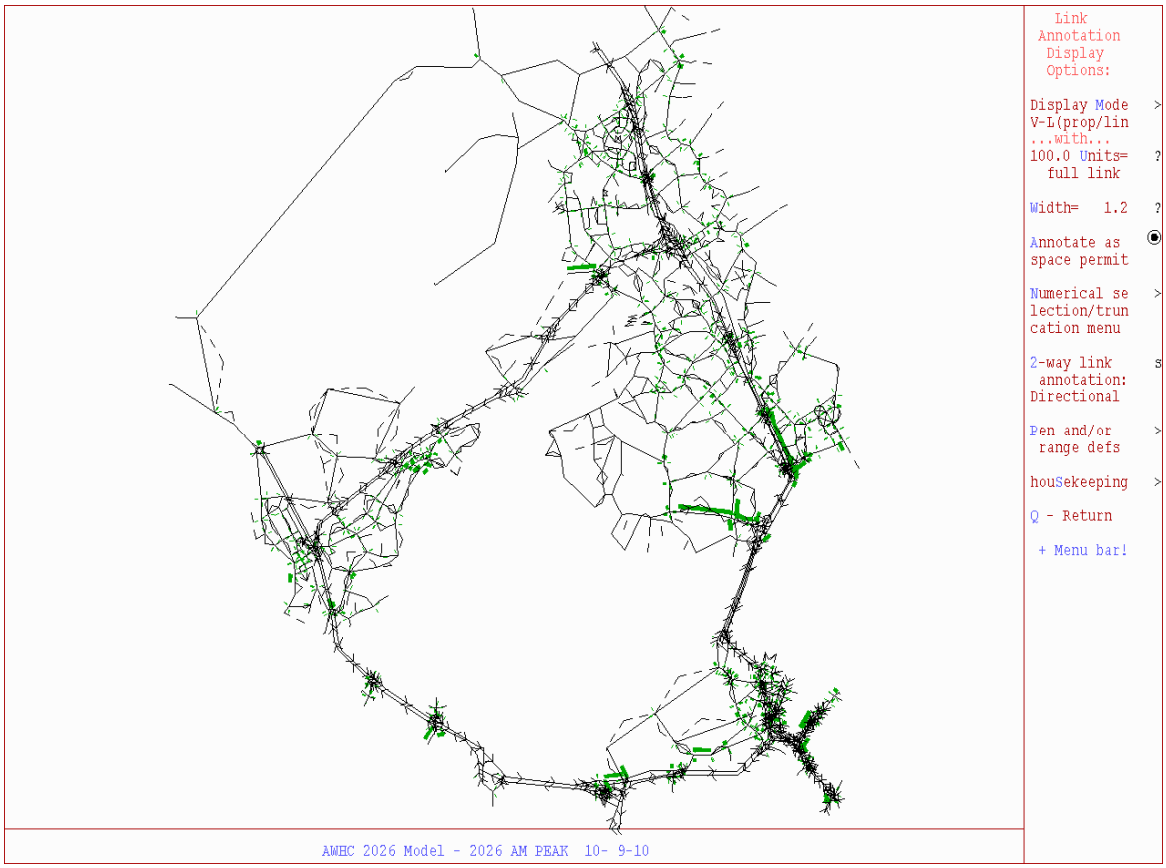


Figure 40: 2026 Do Minimum Scenario: AM Peak Queues: Auckland CBD

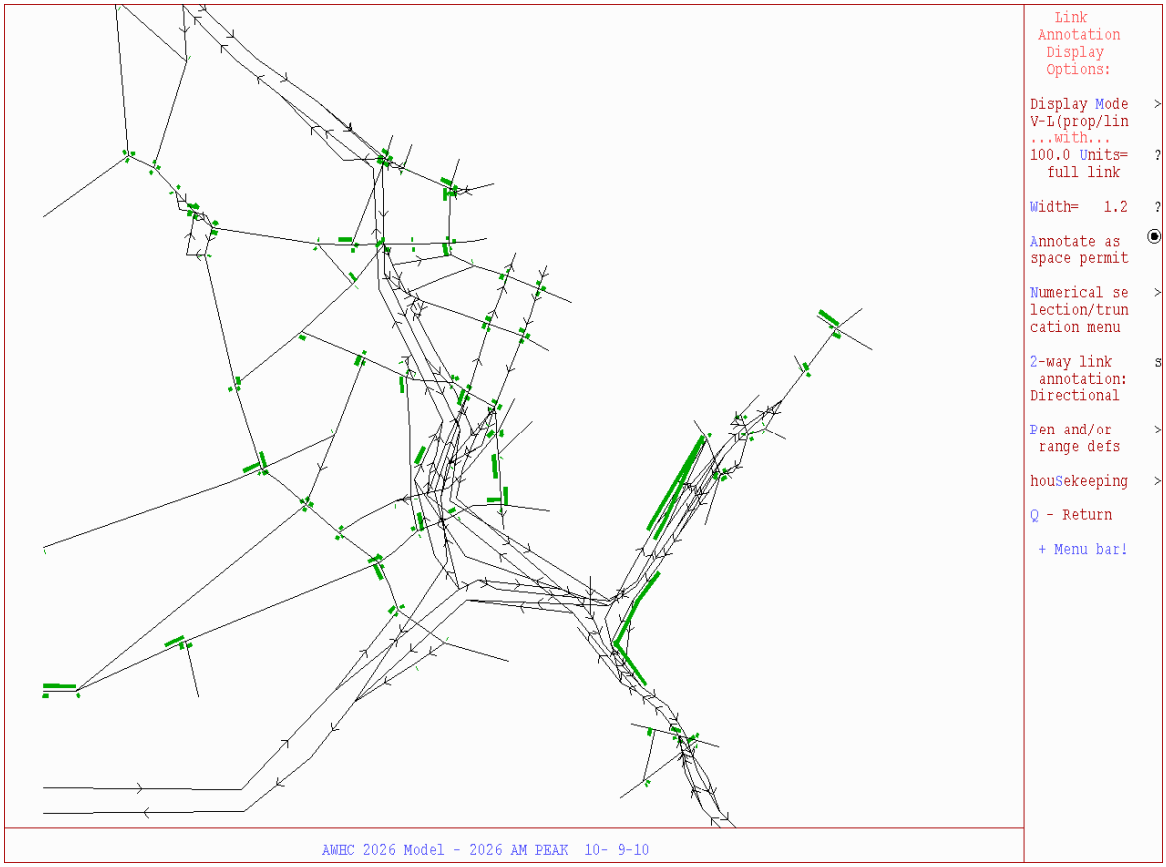


Figure 41: 2026 Do Minimum Scenario: AM Peak Queues: Takapuna

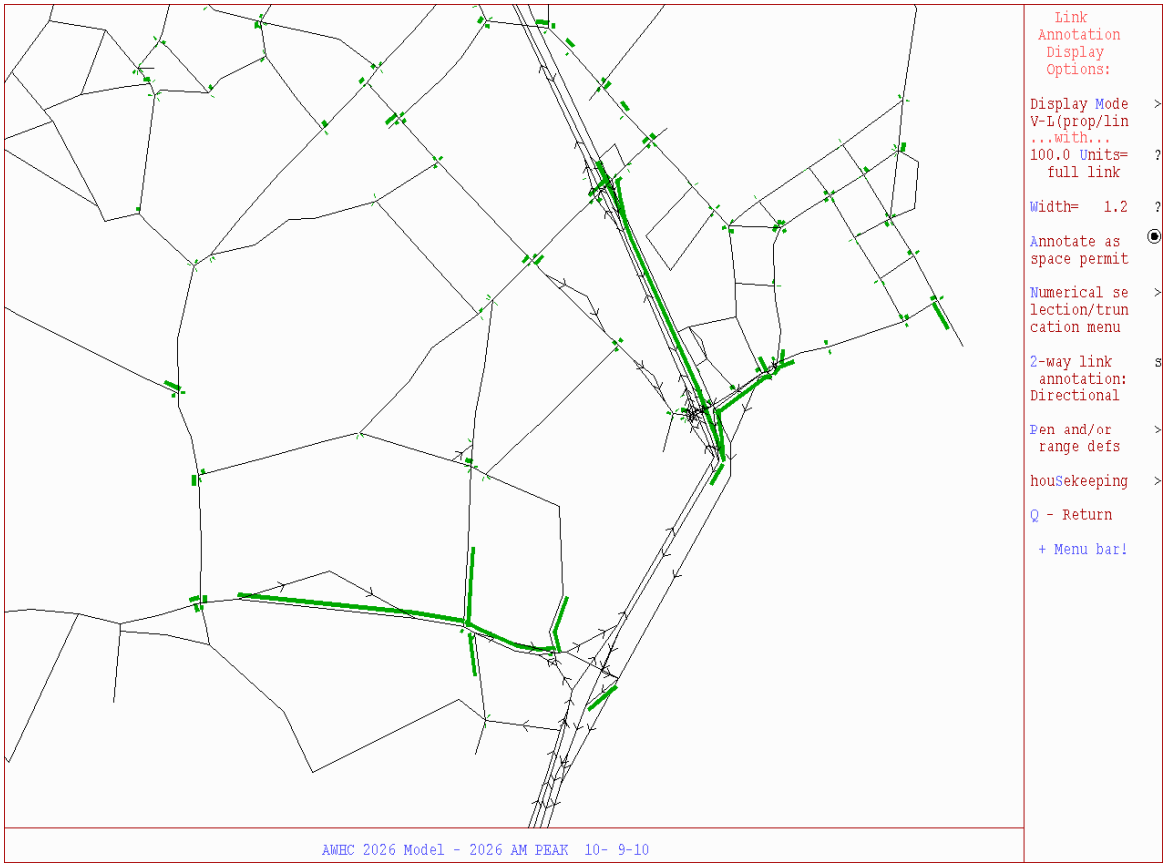


Figure 42: 2026 Do Minimum Scenario: Inter Peak Queues: Whole Model

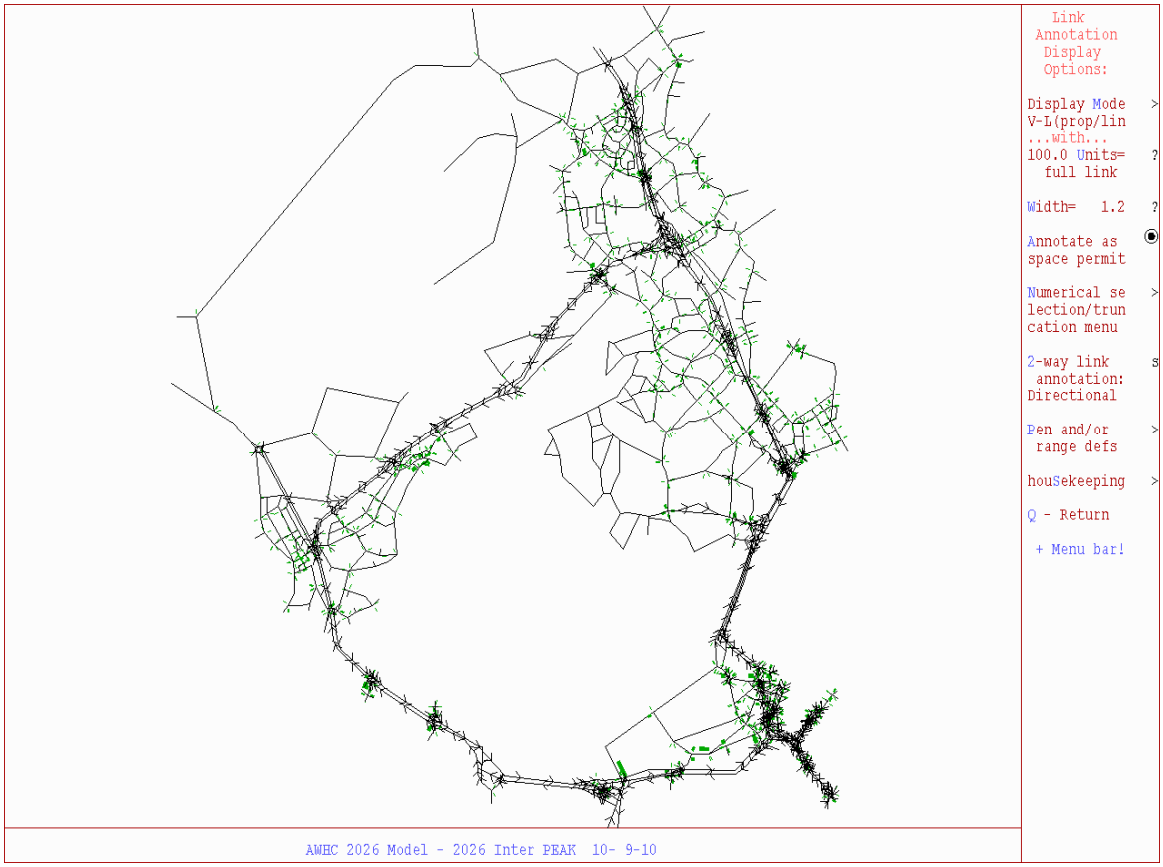


Figure 43: 2026 Do Minimum Scenario: Inter Peak Queues: Auckland CBD

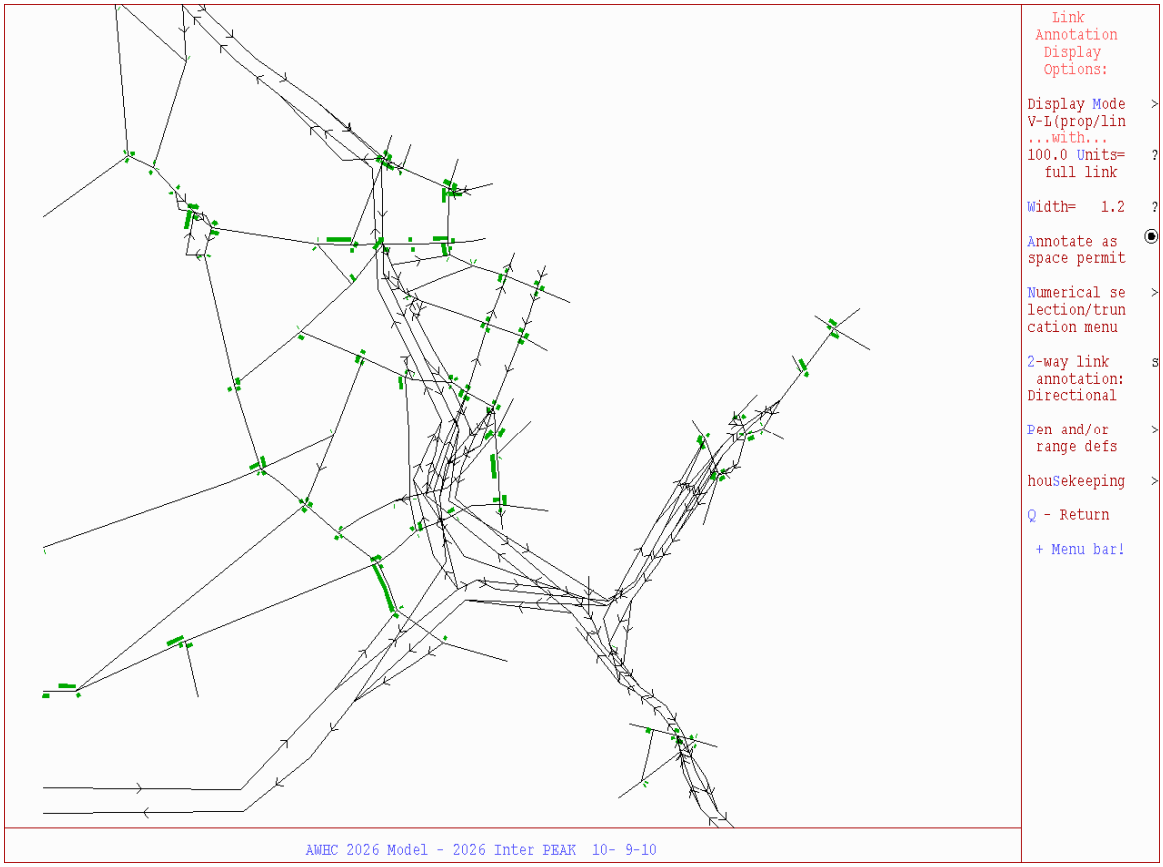


Figure 44: 2026 Do Minimum Scenario: Inter Peak Queues: Takapuna

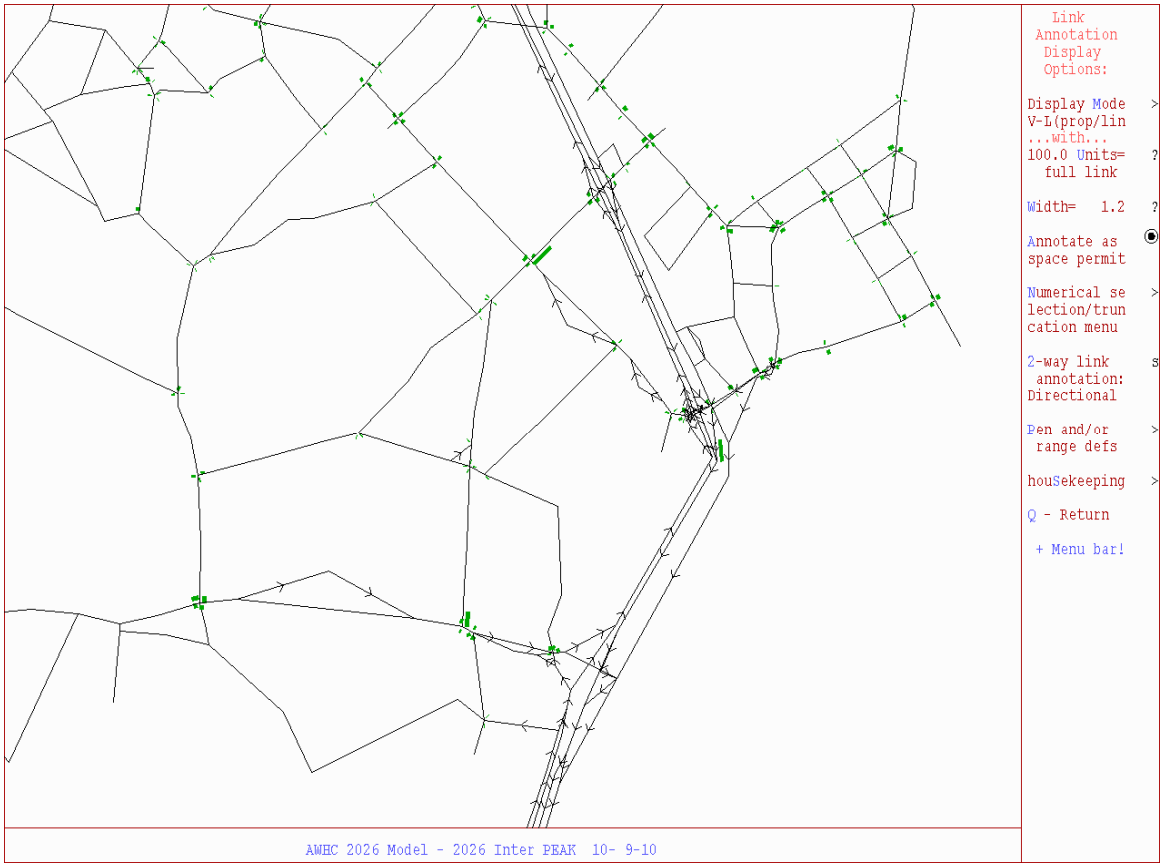


Figure 45: 2026 Do Minimum Scenario: PM Peak Queues: Whole Model

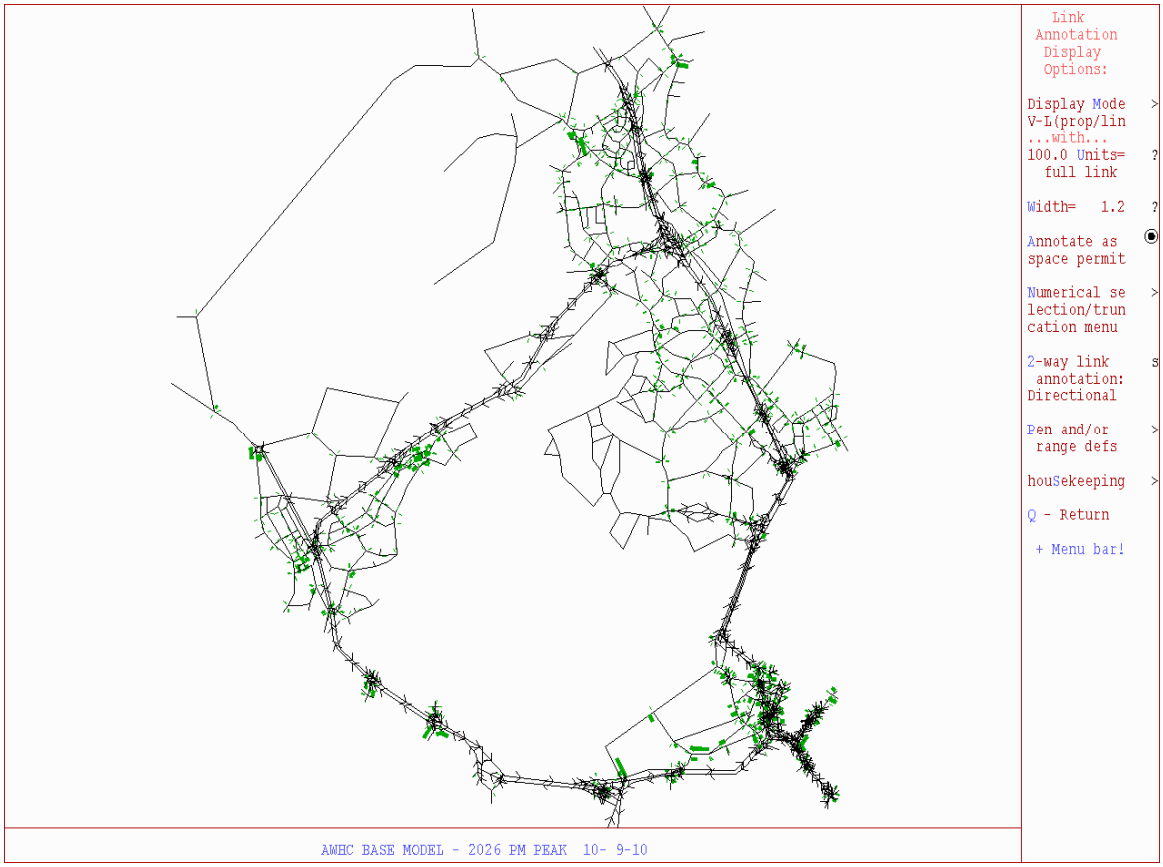


Figure 46: 2026 Do Minimum Scenario: PM Peak Queues: Auckland CBD

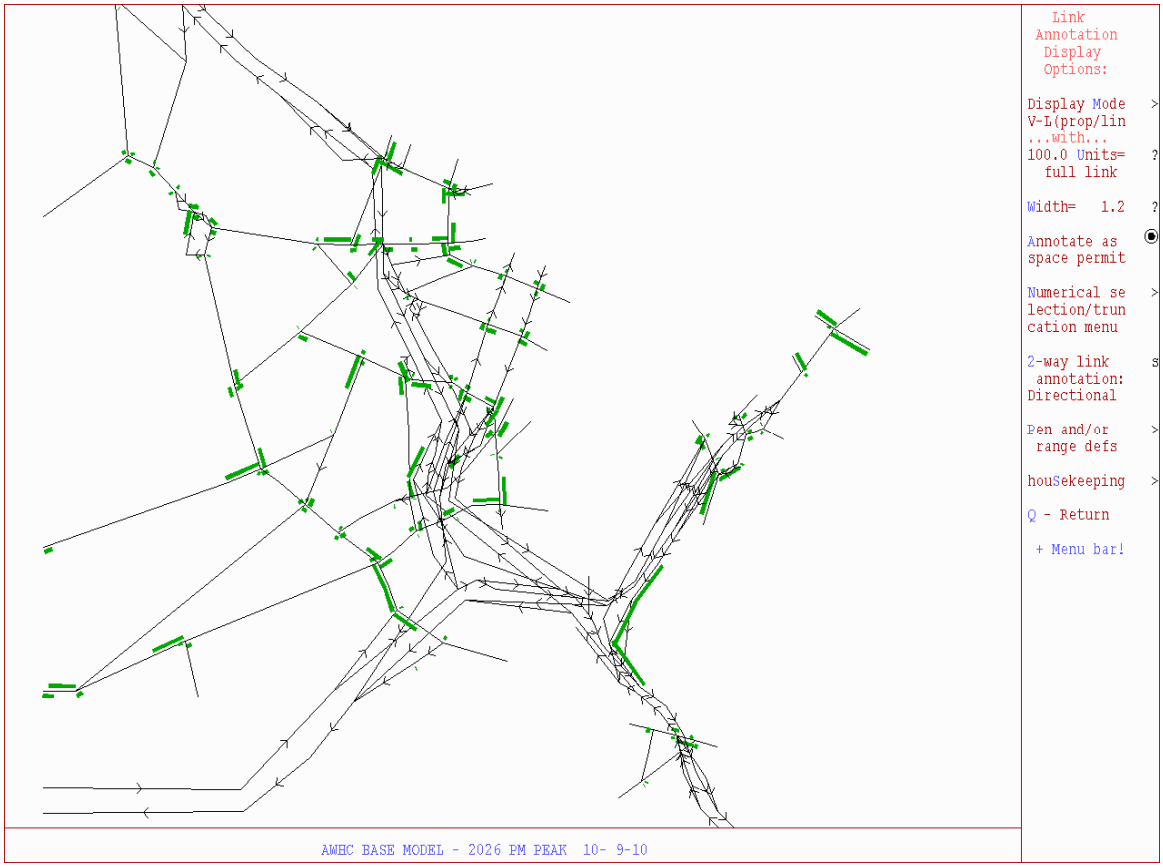
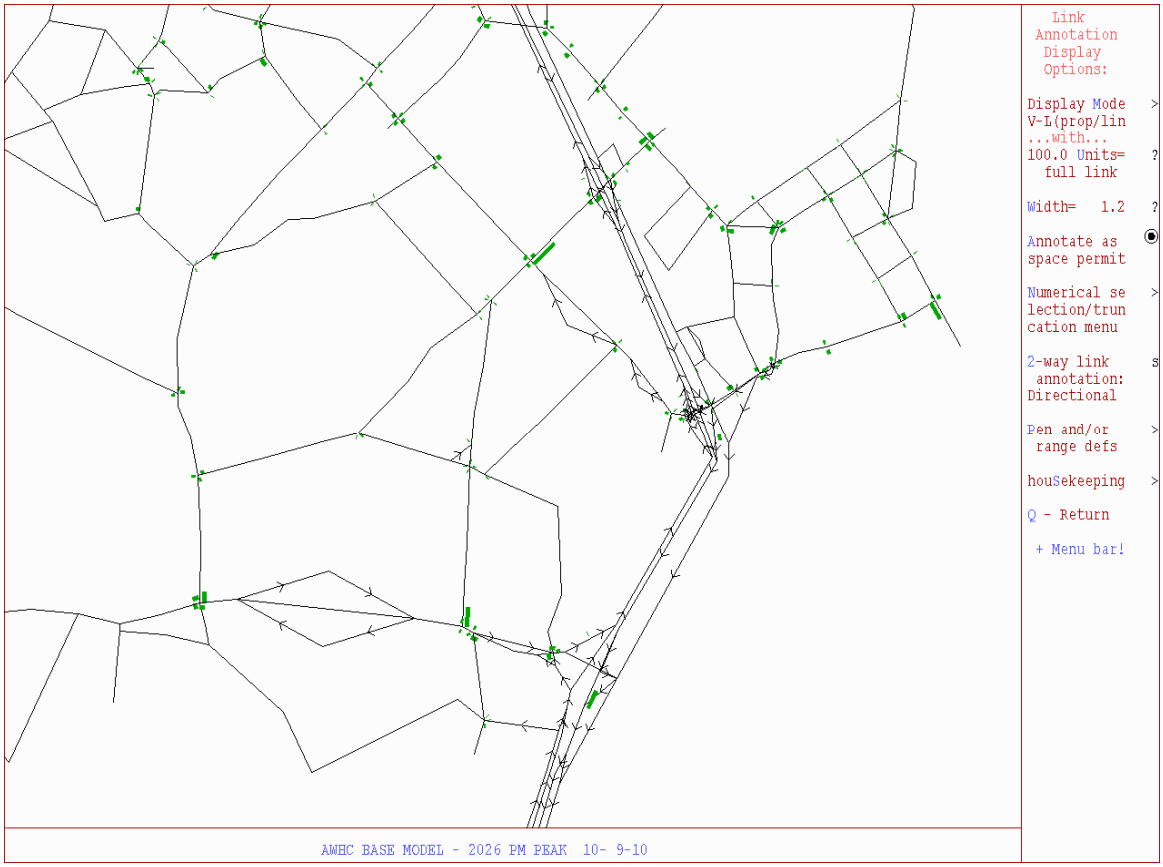


Figure 47: 2026 Do Minimum Scenario: PM Peak Queues: Takapuna



Queues are shown in the following locations in the 2026 Do Minimum Scenario:

- Significant queues are shown as occurring along Onewa Road, Esmonde Road and on the motorway, southbound, approaching Esmonde Road, in the AM peak. No queues are shown around Victoria Park, due to the completion of the Victoria Park Tunnel, however queues are predicted within Grafton Gully

- No significant queues are shown in the inter peak

- Relatively modest queues are shown as occurring at a number of locations in the PM peak, due to the assumed completion of the Victoria Park Tunnel and SH1/18 interchange projects. However, reasonably significant queuing is predicted southbound up Grafton Gully, partly due to the assumed completion of Grafton Gully Stage 3, and on the Wellington Street and SH16 on ramps. Also, the congestion plots at Appendix C indicate a number of locations where the link is predicted to be operating very close to capacity, including both northbound and southbound on the AHB.

The results of the queue plots are reflected in the differences between the demand and arrival flows in the Tables at Appendix A. Greater differences (implying greater queues) are predicted in both directions across the Auckland Harbour Bridge in the AM peak (reflecting capacity constraints on the approaches

rather than on the Bridge itself), particularly in the southbound direction. However, the tables indicate a reduction in the differences between the demand and the arrival flows northbound in the PM peak. This is a result of the completion of the Victoria Park Tunnel project, which will release the queues between the Central Motorway Junction and the southern foot of the Bridge.

6.2 Queue Plots 2026 Scenario with AWHC

Figure 48: 2026 with Additional Crossing: AM Peak Queues: Whole Model

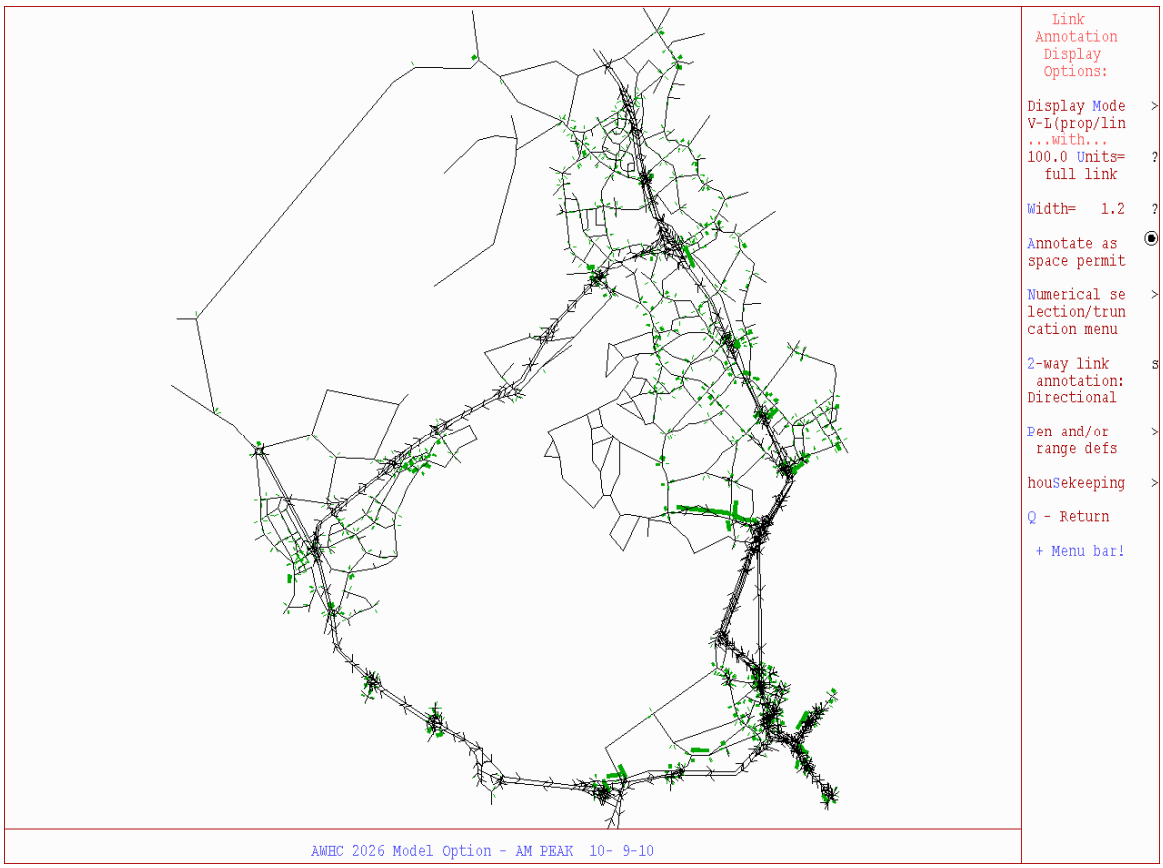


Figure 49: 2026 with Additional Crossing: AM Peak Queues: Auckland CBD

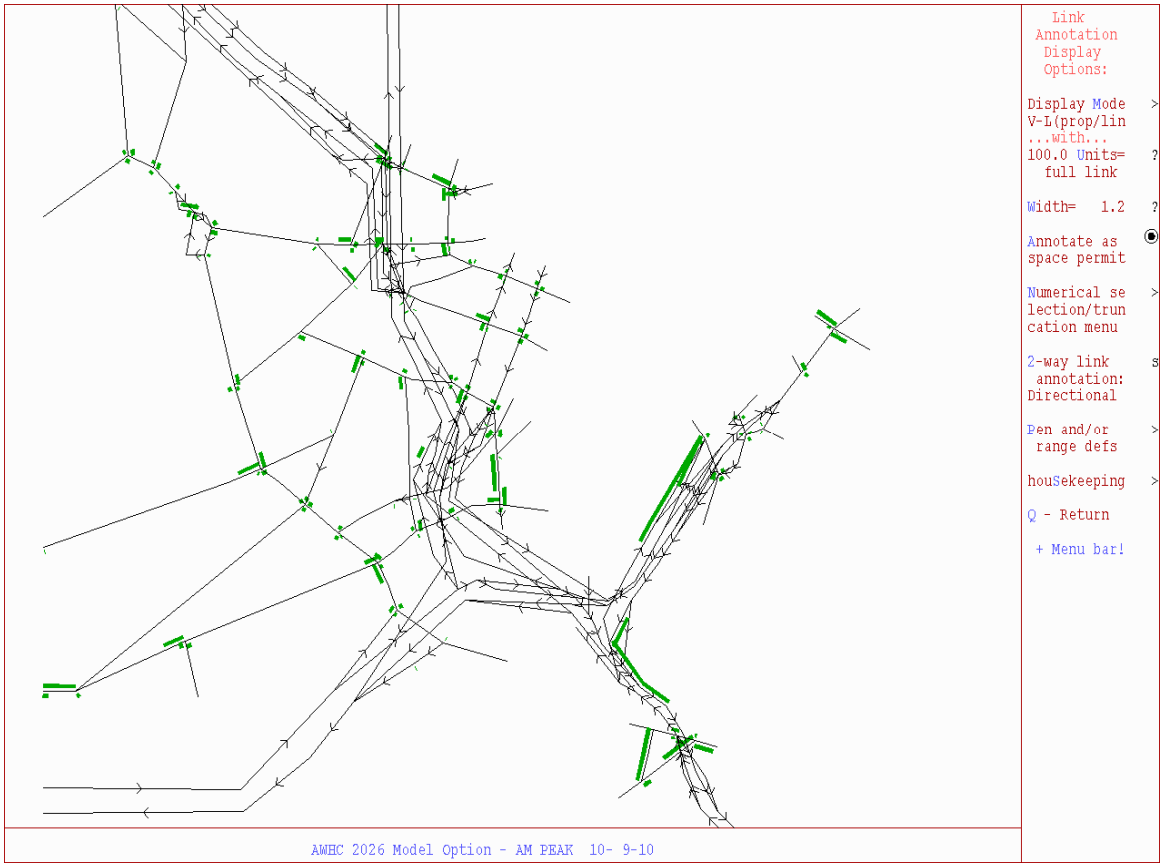


Figure 50: 2026 with Additional Crossing: AM Peak Queues: Takapuna

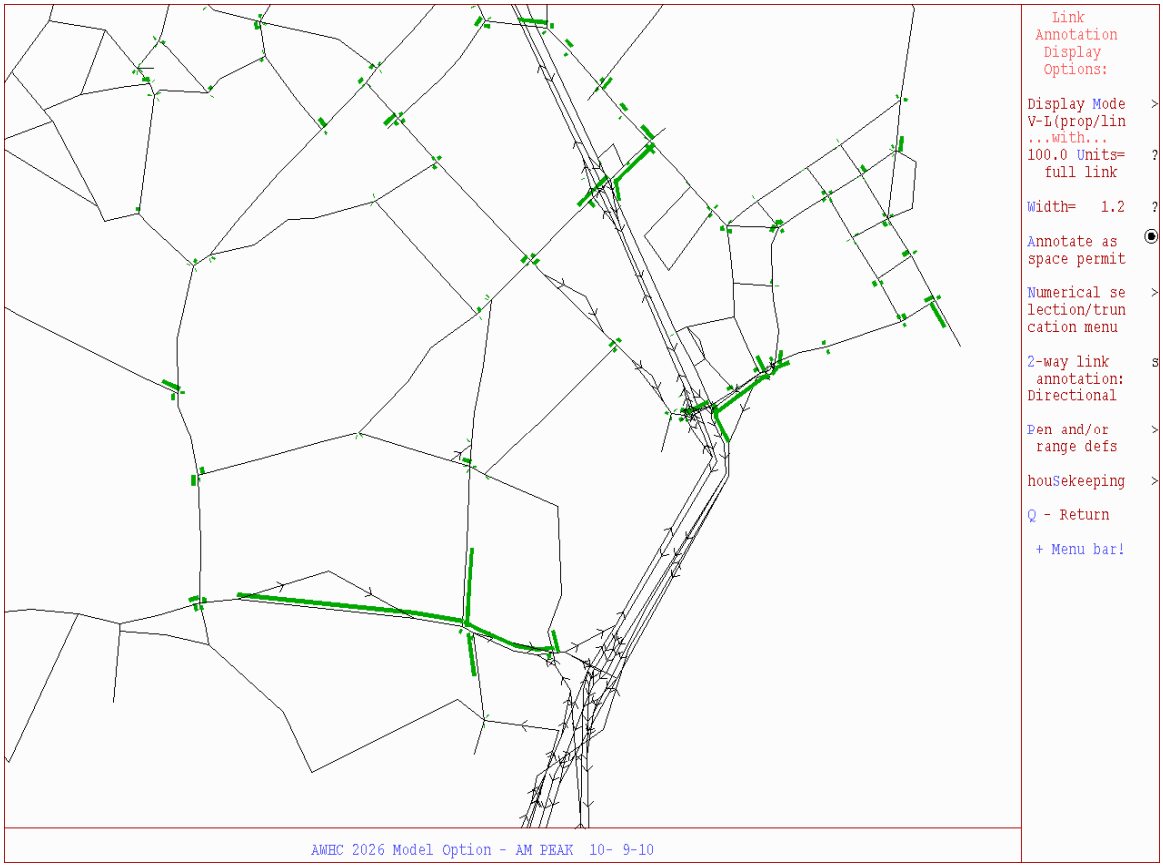


Figure 51: 2026 with Additional Crossing: Inter Peak Queues: Whole Model

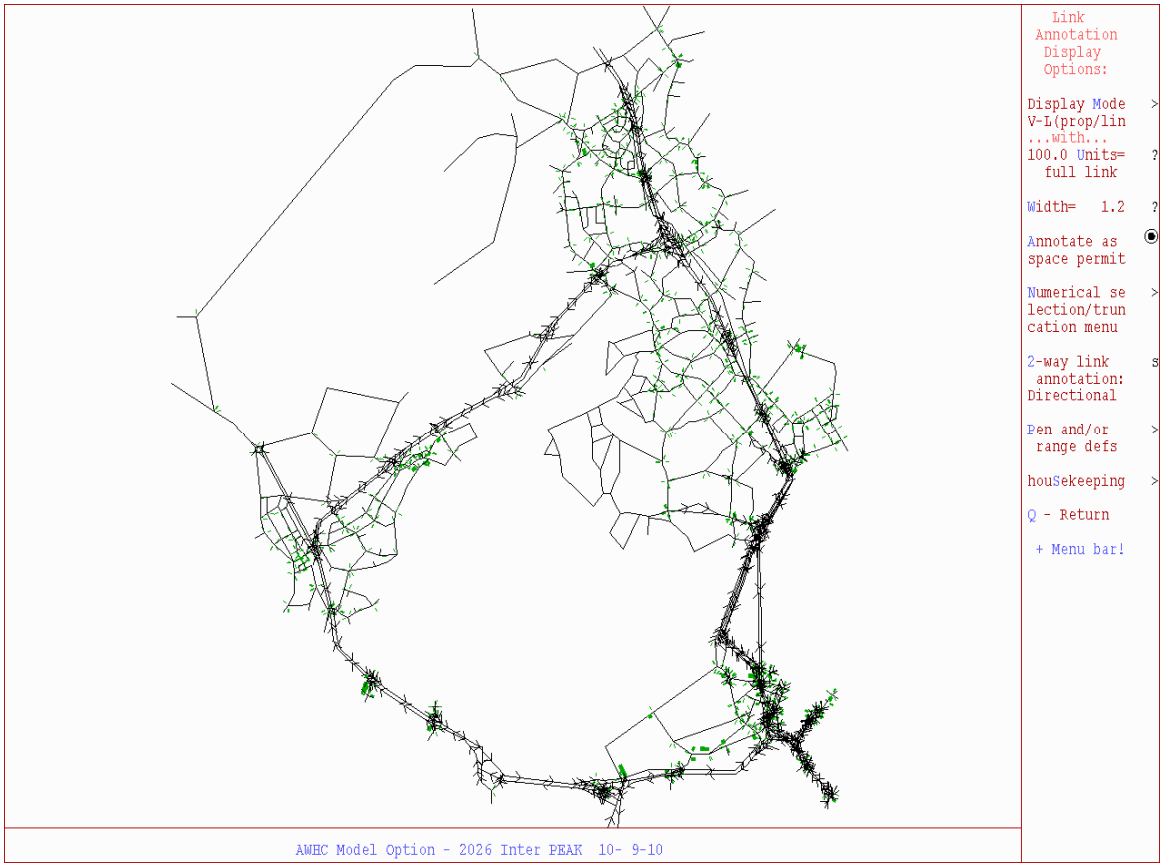


Figure 52: 2026 with Additional Crossing: Inter Peak Queues: Auckland CBD

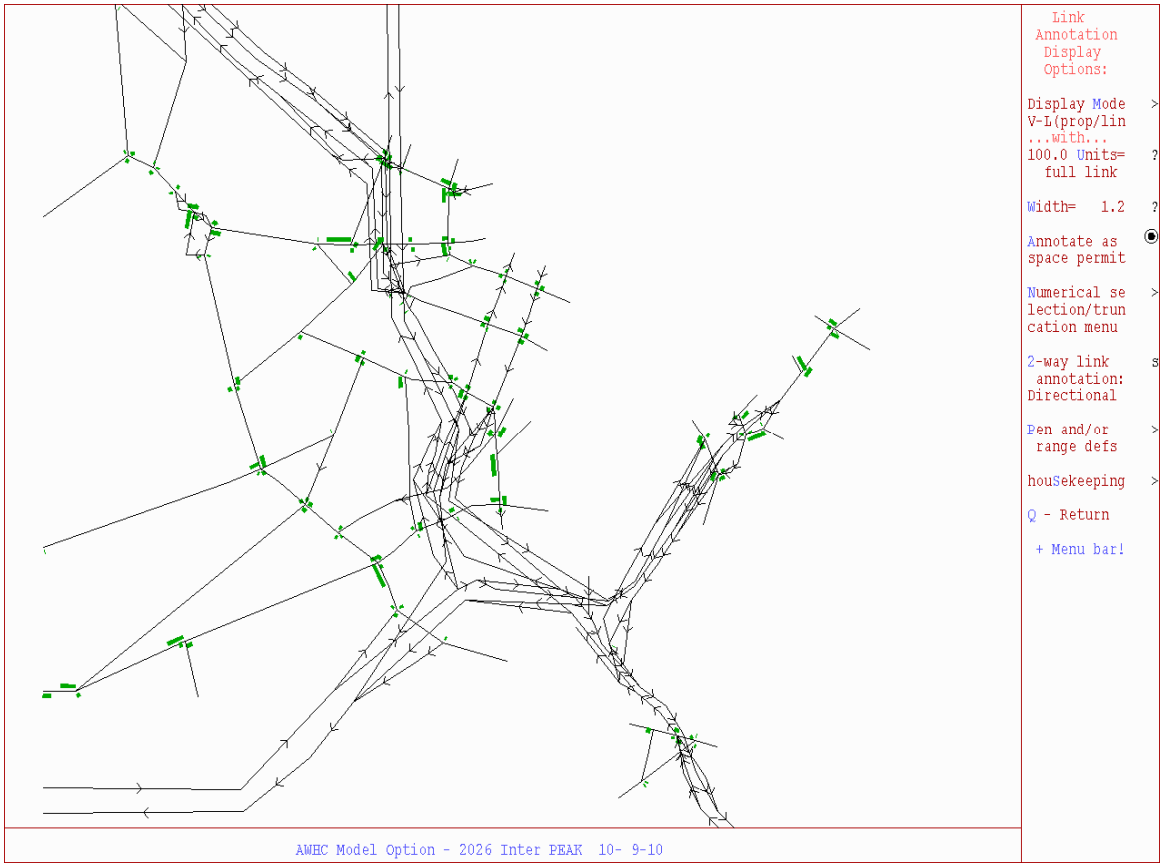


Figure 53: 2026 with Additional Crossing: Inter Peak Queues: Takapuna

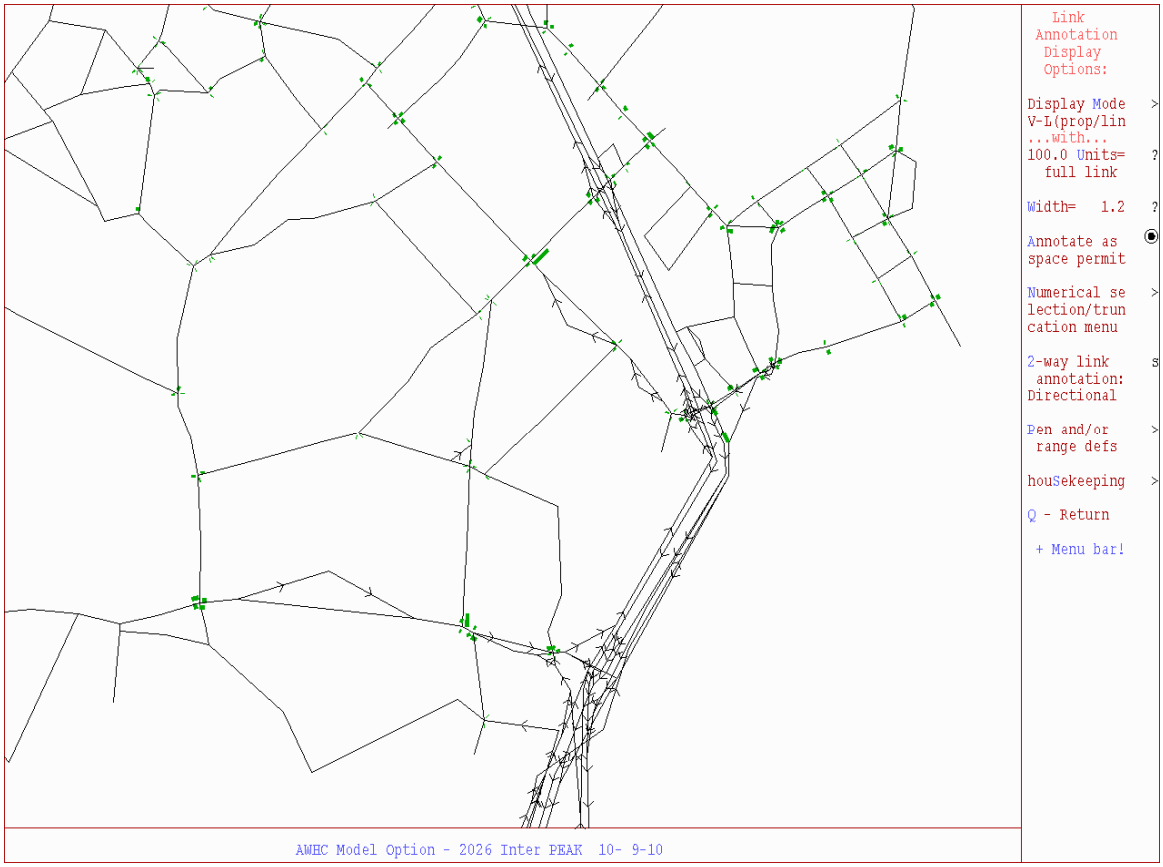


Figure 54: 2026 with Additional Crossing: PM Peak Queues: Whole Model

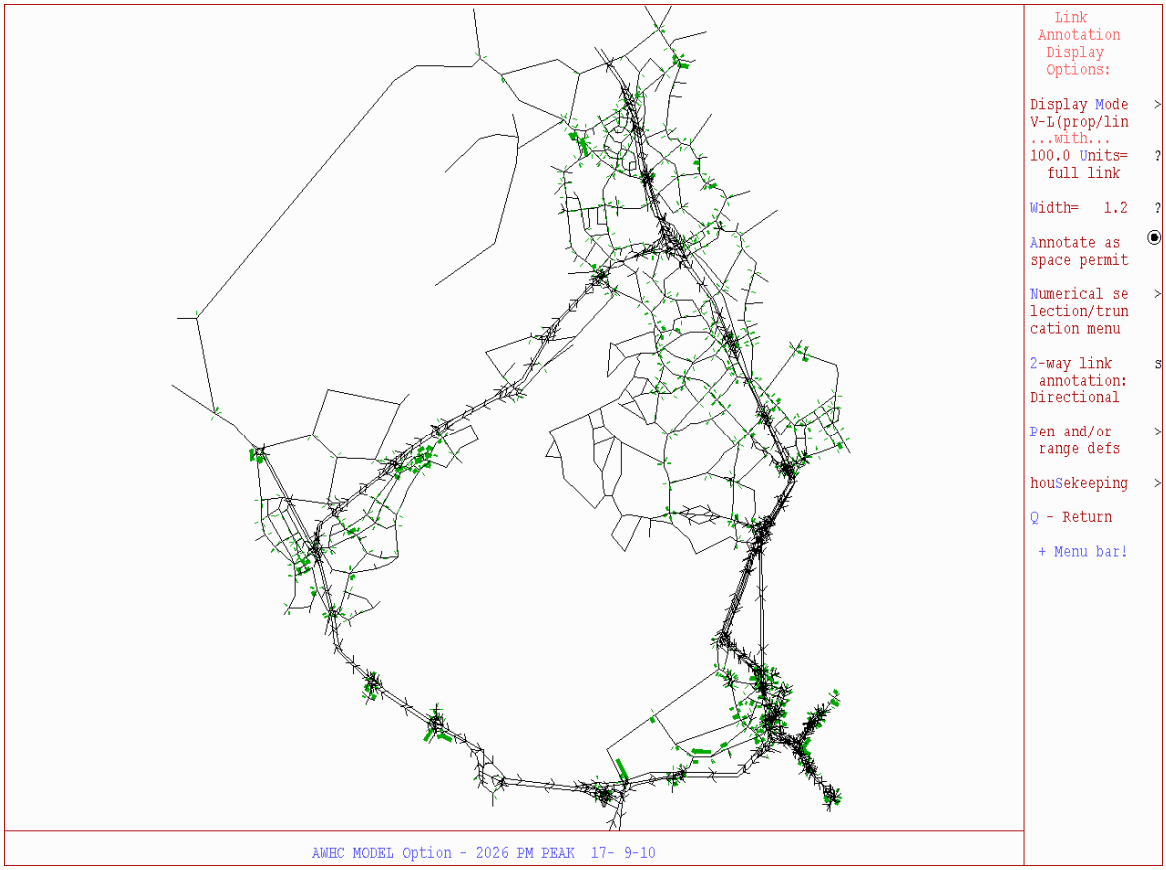


Figure 55: 2026 with Additional Crossing: PM Peak Queues: Auckland CBD

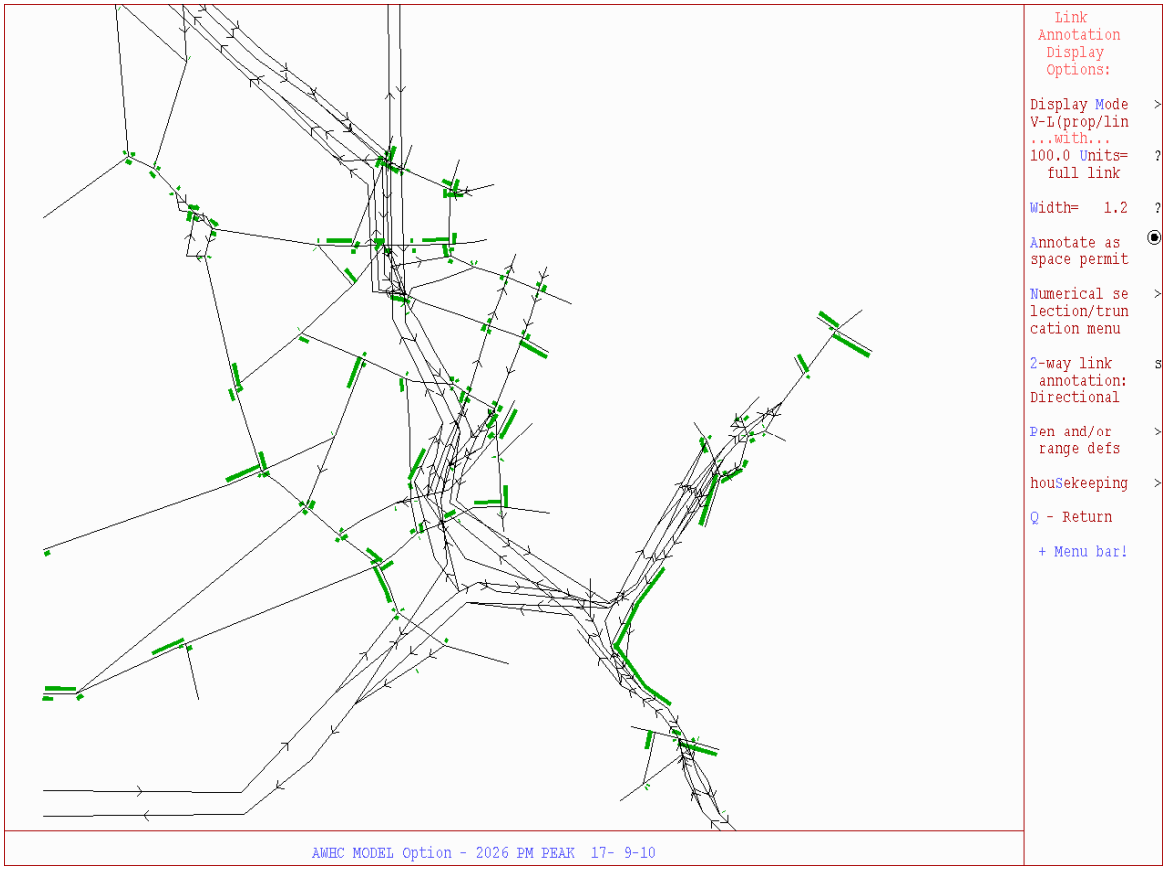
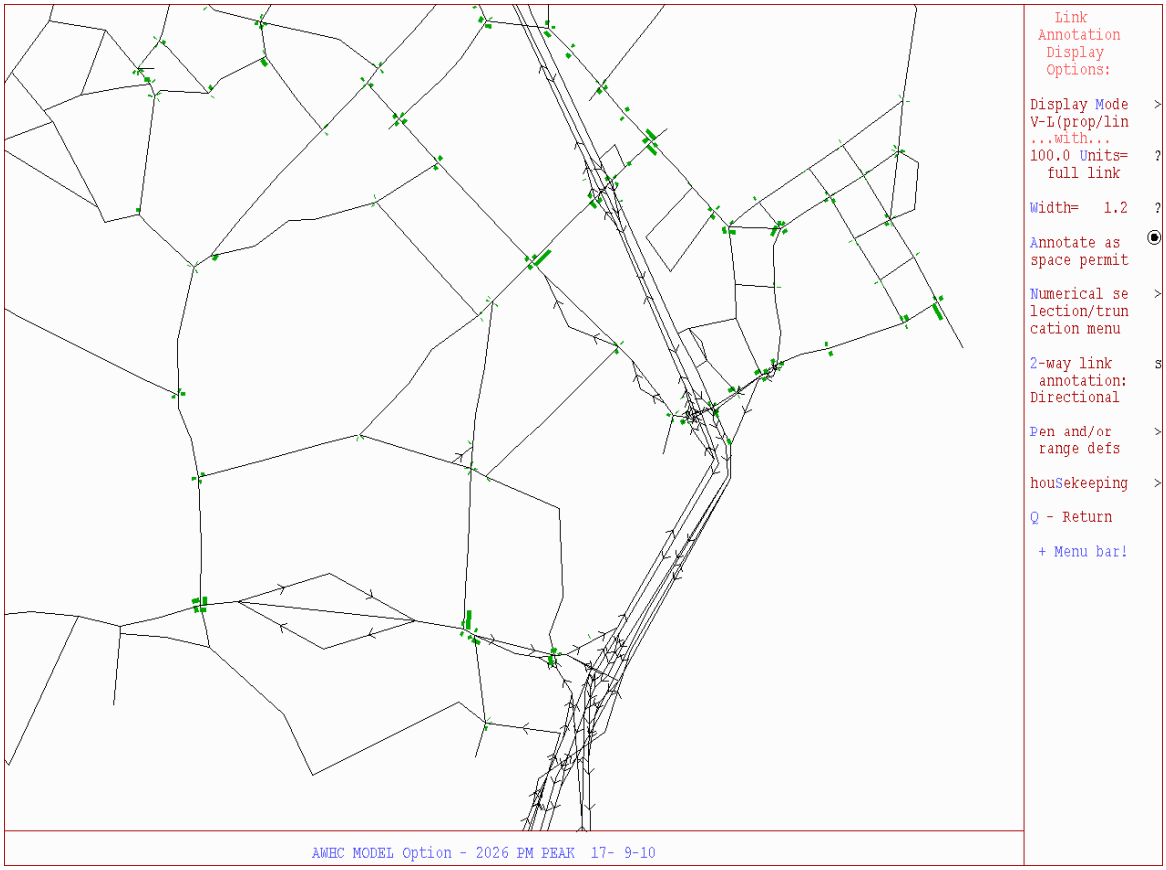


Figure 56: 2026 with Additional Crossing: PM Peak Queues: Takapuna



The operation of the network with the Additional Crossing in 2026 is set out below.

6.2.1 2026 Morning Peak

In the morning peak, significant queues are shown as occurring along Onewa Road, as is predicted to be the case in the Do Minimum scenario. The situation along the motorway is predicted to be significantly different, with the bottleneck at the Esmonde Road on ramp merge being resolved. However, congestion is predicted at the following points in the morning peak:

- The merge of SH18 with SH1 (at the Constellation Drive interchange) is predicted to be a bottleneck, with a free flow interchange at this point, but with only two southbound lanes (from the SH18 interchange to Tristram Avenue), this is predicted to be a bottleneck

- The Tristram Avenue on ramp will join the motorway as a lane gain situation (from two to three southbound lanes), as is currently the case. Queues on the on ramp are predicted due to ramp signals

- The Northcote Road on ramp also will join the motorway as a lane gain situation (from three to four southbound lanes). This is different from the current situation. Queues on the on ramp are predicted due to ramp signals.

As a result, with two additional lanes on the motorway from Esmonde Road, the Esmonde on ramp itself will not be a bottleneck, but it has been agreed that ramp signals should be assumed at this point, to limit the downstream effects. Queues are therefore shown on the Esmonde Road on ramp, affecting both traffic from Esmonde Road and from Akoranga Drive, where the right turn is to be introduced. The demand for the new right turn is predicted to be fairly modest, due to the limited green times assumed for this movement.

The interchange of the SH1 ramps with Esmonde Road and Akoranga Drive is predicted to be at capacity in the morning peak in 2026.

The original modelling of the AWHC option indicated that queues would occur where the approach from the Esmonde and Onewa interchanges merges from two lanes to one lane, prior to the merge onto the new crossing (as a lane gain). This issue is resolved by the assumption that traffic will be held up on the Esmonde Road on ramp, with the arrival flow able to reach the single lane now predicted to be 1,930 vehicles/hour in the morning peak in 2026, meaning that this lane will be operating satisfactorily but close to capacity.

The maximum directional flow on the AWHC in the 2026 AM peak is predicted to be 5,330 vehicles/hour, southbound, with 4,020 northbound. With three lanes assumed in each direction, the new crossing is expected to operate satisfactorily. Of the 5,330 vehicles travelling southbound, 3,660 vehicles/hour are predicted to be heading to the two lane southbound section through CMJ. This flow is within the capacity of the two lane section.

On the AHB, the flow on the southbound clip on is predicted to be 1,320 vehicles/hour in the morning peak. The single traffic lane will be used by buses and general traffic heading for the Shelly Beach off ramp. With this level of flow, the lane should operate satisfactorily, provided that no queues extend back from Shelly Beach Road to the motorway.

6.2.2 2026 Inter Peak

No significant queues are shown in the inter peak. However, the ramp signal on the Esmonde Road southbound on ramp is predicted to be right at capacity and the interchange of the SH1 ramps with Esmonde Road and Akoranga Drive is predicted to be approaching capacity.

The maximum directional flow on the AWHC in the 2026 inter peak is predicted to be 4,430 vehicles/hour, northbound, with 4,430 vehicles/hour southbound. With three lanes assumed in each direction the new crossing is expected to operate satisfactorily. However, it is noted that this flow is just greater than the capacity of a new crossing with two lanes per direction.

6.2.3 2026 Evening Peak

Relatively modest queues are shown as occurring at a number of locations in the PM peak within Auckland City. However, reasonably significant queuing is predicted southbound up Grafton Gully, as is predicted to be the case in the Do minimum scenario (due partly to the assumed completion of Grafton Gully Stage 3).

The proposed Cook Street on ramp will form the start of the future motorway connection from the Auckland CBD to the AHB. However, we have assumed a two lane ramp signal on this on ramp, and this will give rise to queues at this point in the 2026 evening peak.

The maximum directional flow on the AWHC in the 2026 evening peak is predicted to be 5,270 vehicles/hour, northbound, with 4,730 vehicles/hour southbound. With three lanes assumed in each direction the new crossing is expected to operate satisfactorily.

On the AHB, the flow on the southbound clip on is predicted to be 950 vehicles/hour in the evening peak. The single traffic lane will be used by buses and general traffic heading for the Shelly Beach off ramp.

The northbound clip on will have two traffic lanes, and will be used by buses and general traffic either joining the motorway from the Curran Street on ramp or heading to the Stafford Road off ramp. Traffic from the Curran Street is assumed to merge with the bus lane before merging across to the adjacent lane. The total flow using the single general traffic lane (ie traffic from Curran Street or traffic to Stafford Road) in the evening peak is 1,750 vehicles/hour.

Northbound at Onewa Road, (immediately north of the off ramp to Onewa Road) two lanes are proposed to link from the AHB to join the AWHC toward Esmonde Road. The flow on this two lane link is predicted to be around 4,080 vehicles/hour, which will be right at capacity.

The interchange of the SH1 ramps with Esmonde Road and Akoranga Drive is predicted to be at capacity in the evening peak in 2026.

7 PREDICTED OPERATION OF 2041 MODELS

7.1 Queue Plots 2041 Do Minimum Scenario

Figure 57: 2041 Do Minimum Scenario: AM Peak Queues: Whole Model

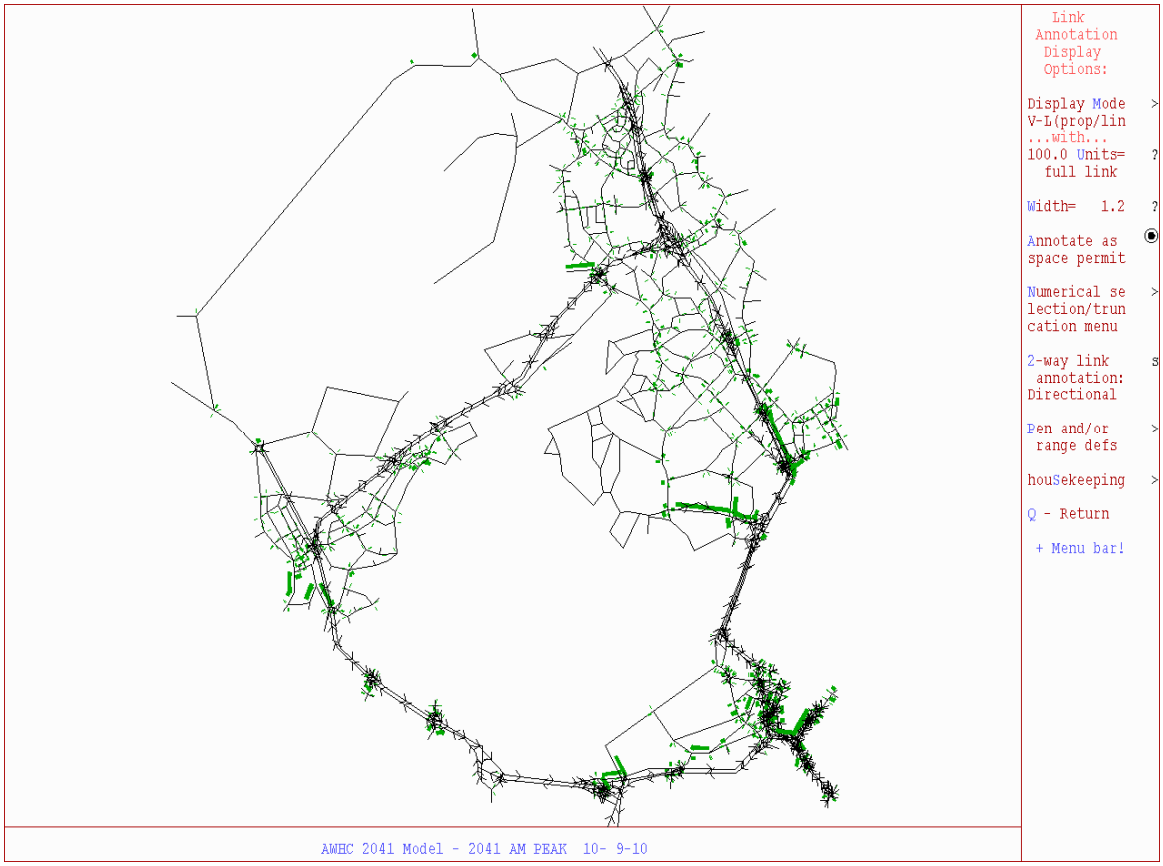


Figure 58: 2041 Do Minimum Scenario: AM Peak Queues: Auckland CBD

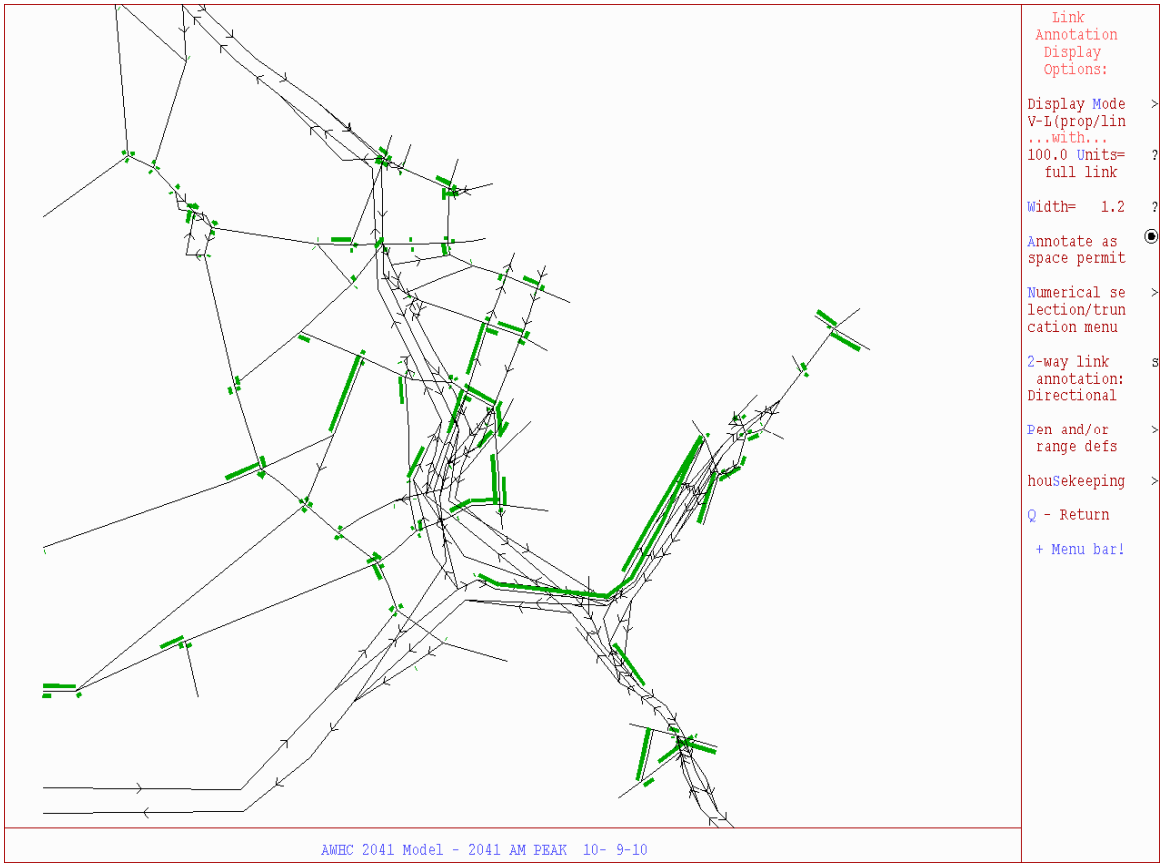


Figure 59: 2041 Do Minimum Scenario: AM Peak Queues: Takapuna

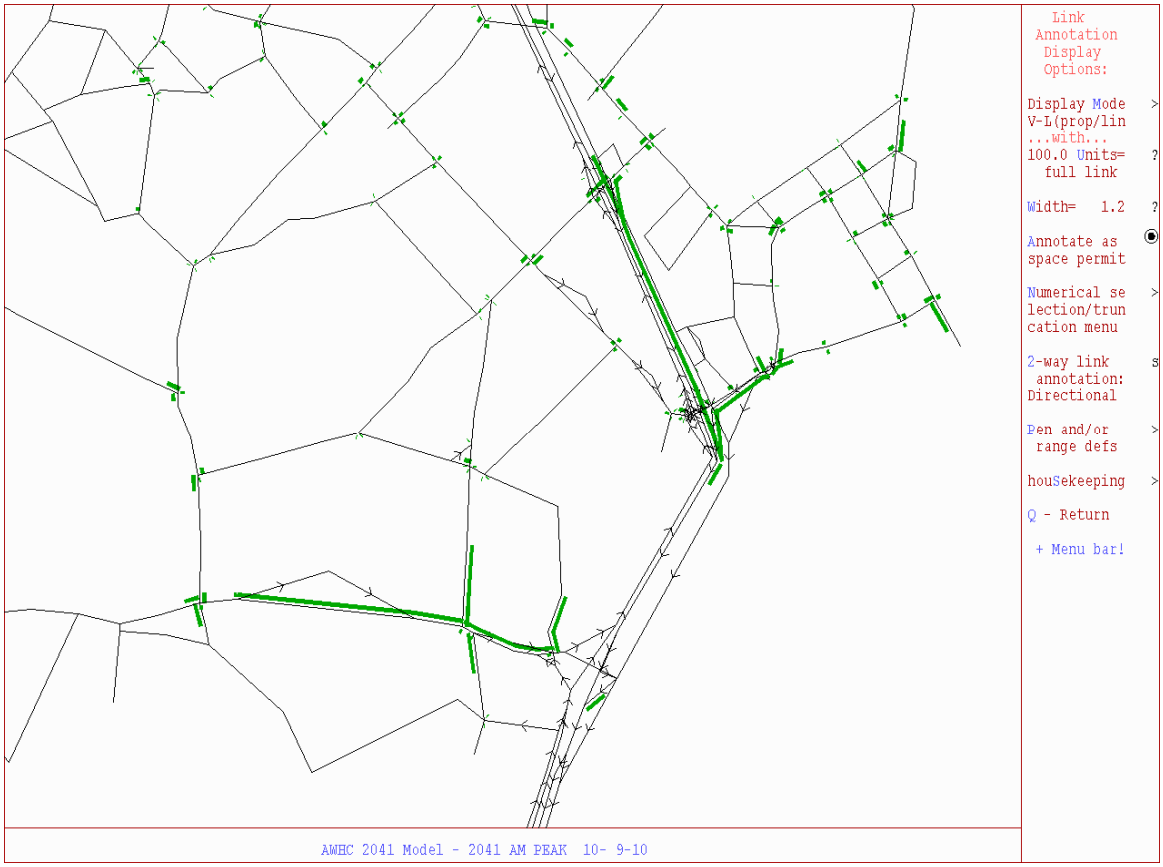


Figure 60: 2041 Do Minimum Scenario: Inter Peak Queues: Whole Model

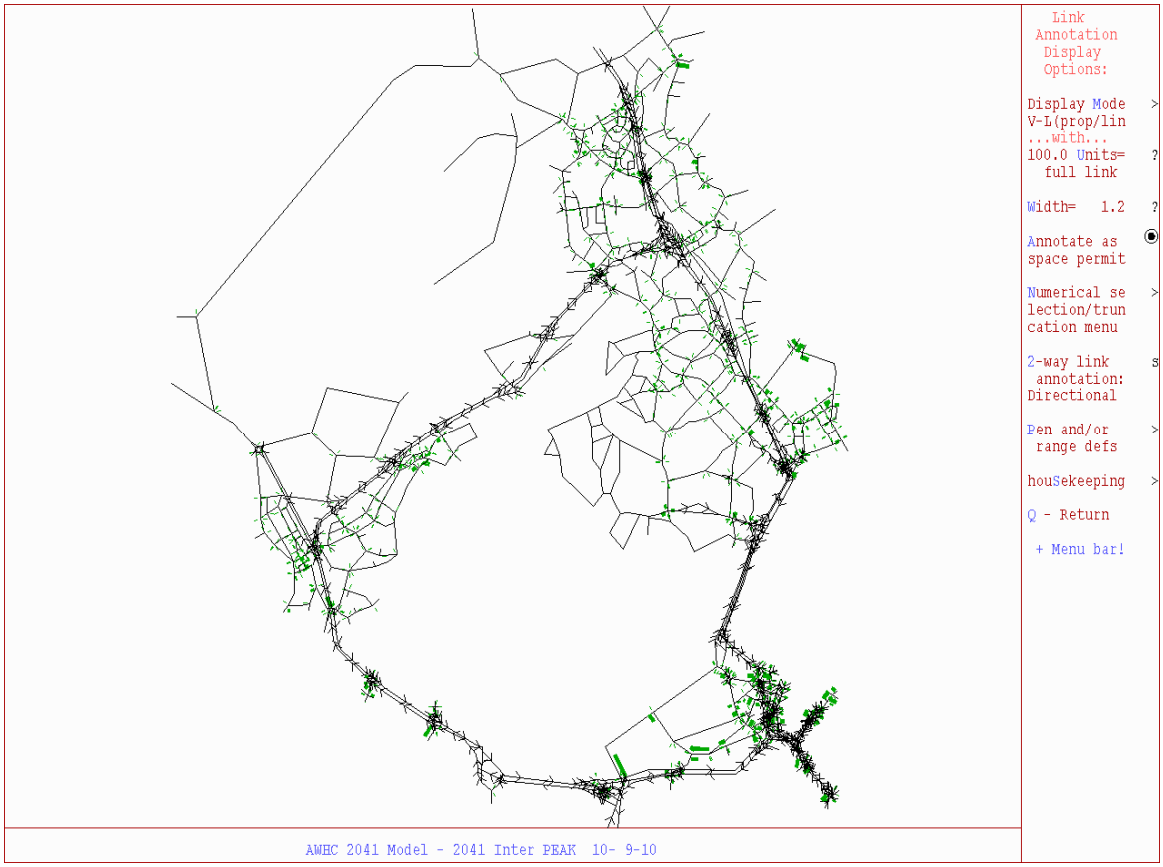


Figure 61: 2041 Do Minimum Scenario: Inter Peak Queues: Auckland CBD

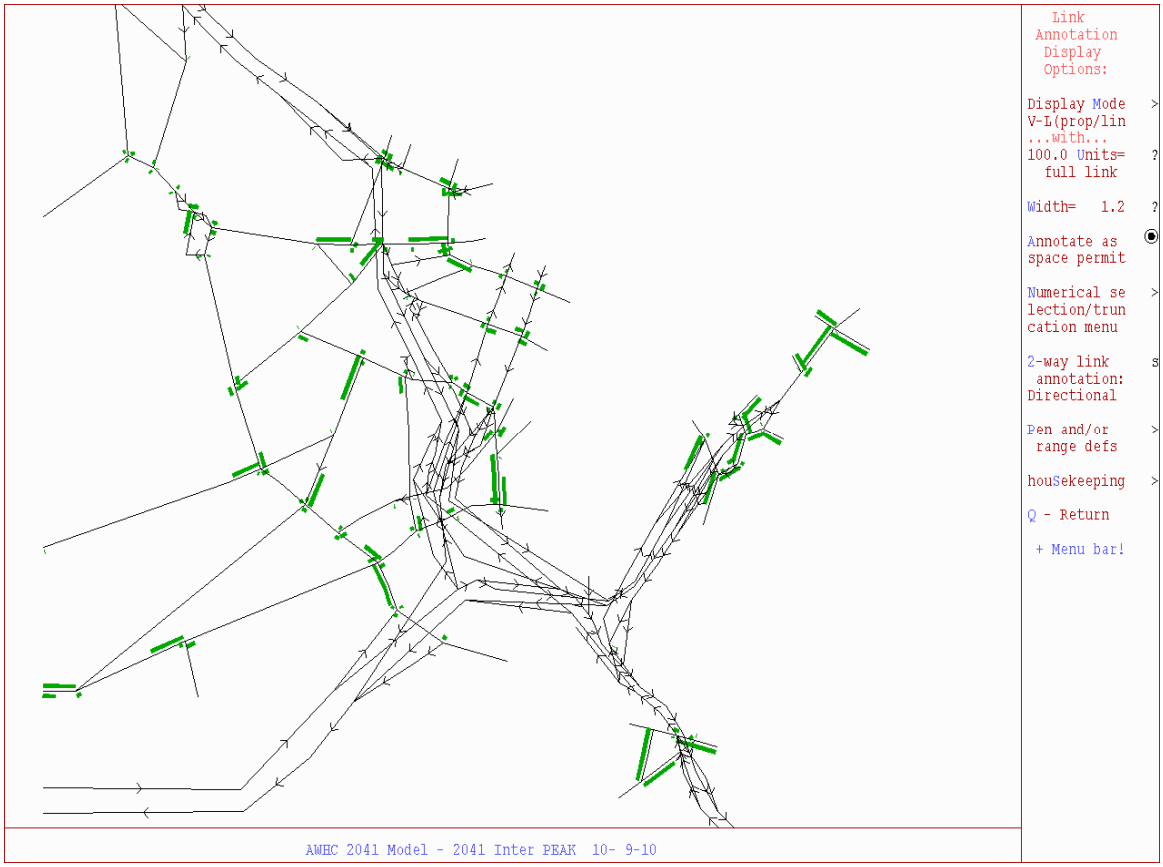


Figure 62: 2041 Do Minimum Scenario: Inter Peak Queues: Takapuna

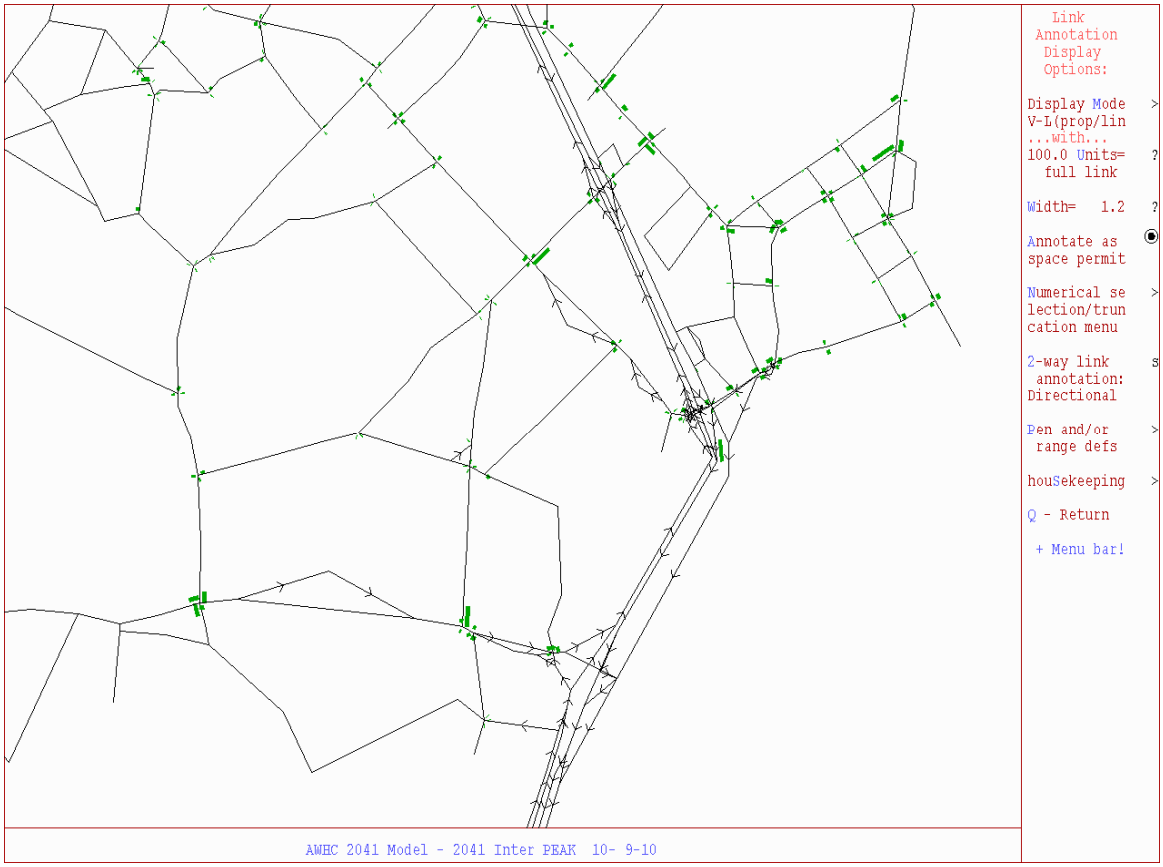


Figure 63: 2041 Do Minimum Scenario: PM Peak Queues: Whole Model

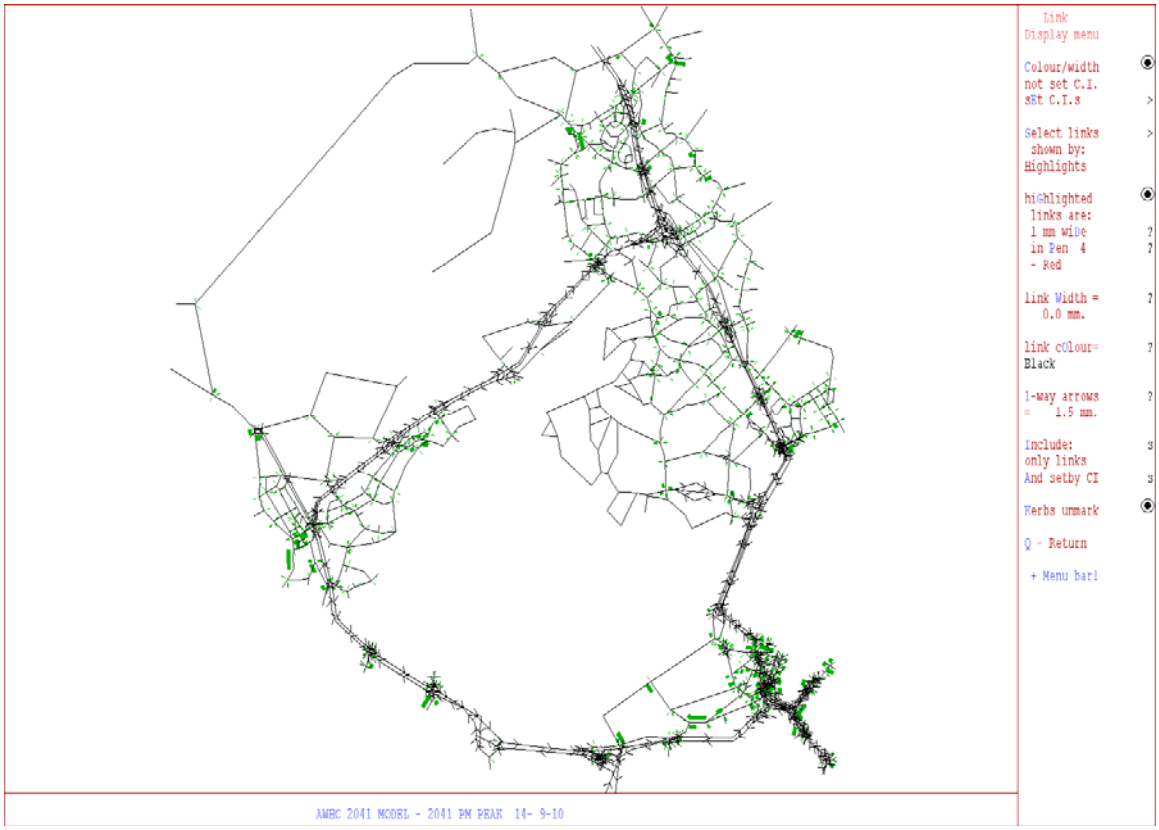


Figure 64: 2041 Do Minimum Scenario: PM Peak Queues: Auckland CBD

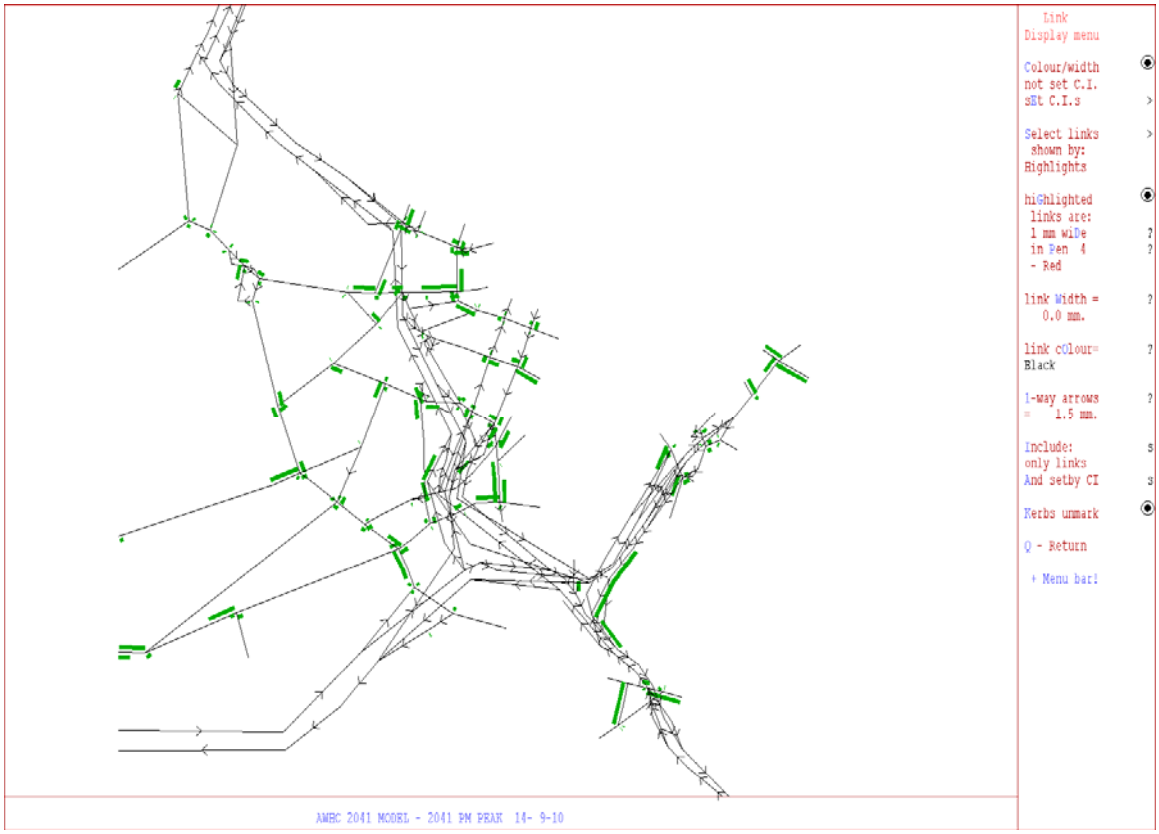
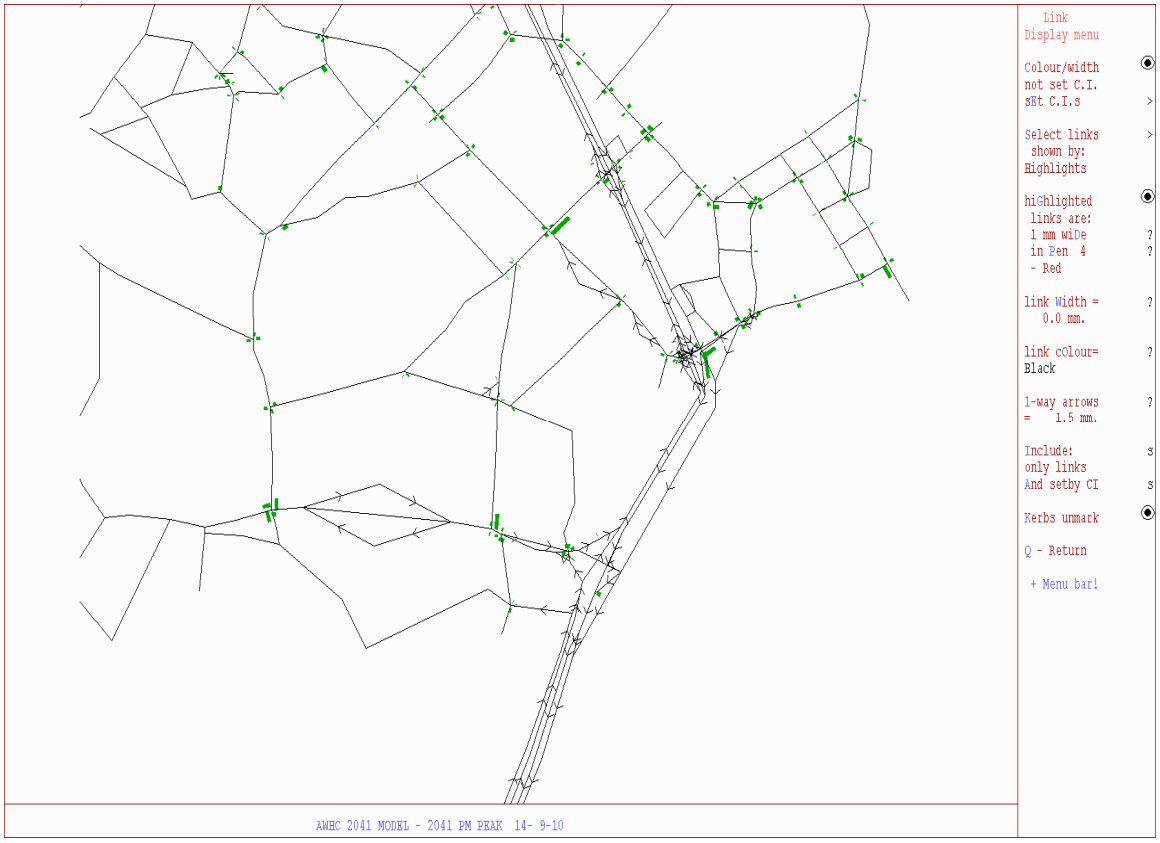


Figure 65: 2041 Do Minimum Scenario: PM Peak Queues: Takapuna



The queues in 2041 are generally similar to those predicted for 2026, although increases in queues are predicted around the Auckland CBD in the AM peak, especially on the off ramps from Grafton Gully to Wellesley Street, where no improvements are included in the model.

This situation (with similar queues generally predicted in 2041) is to be expected, given that the overall growth is predicted to be quite modest after 2026 and the networks are assumed to be almost identical.

As noted earlier, the results of the queue plots are reflected in the differences between the demand and arrival flows in the Tables at Appendix A. Slightly greater differences (implying greater queues) are predicted in 2041, compared with 2026, across the Auckland Harbour Bridge, southbound in the AM peak and northbound in the PM peak. This reflects capacity constraints on the approaches rather than on the Bridge itself, mainly from Onewa Road and Esmonde Road southbound in the AM peak and from Wellington Street and SH16 northbound in the PM peak. Also, by 2041, some modest differences are emerging in the inter peak period. Modest queues are predicted at a number of locations, with the main bottlenecks being on the Esmonde Road southbound on ramp and southbound along Albany Expressway, approaching the Greville Road interchange.

7.2 2041 Scenario with AWHC Queue Plots

Figure 66: 2041 with Additional Crossing: AM Peak Queues: Whole Model

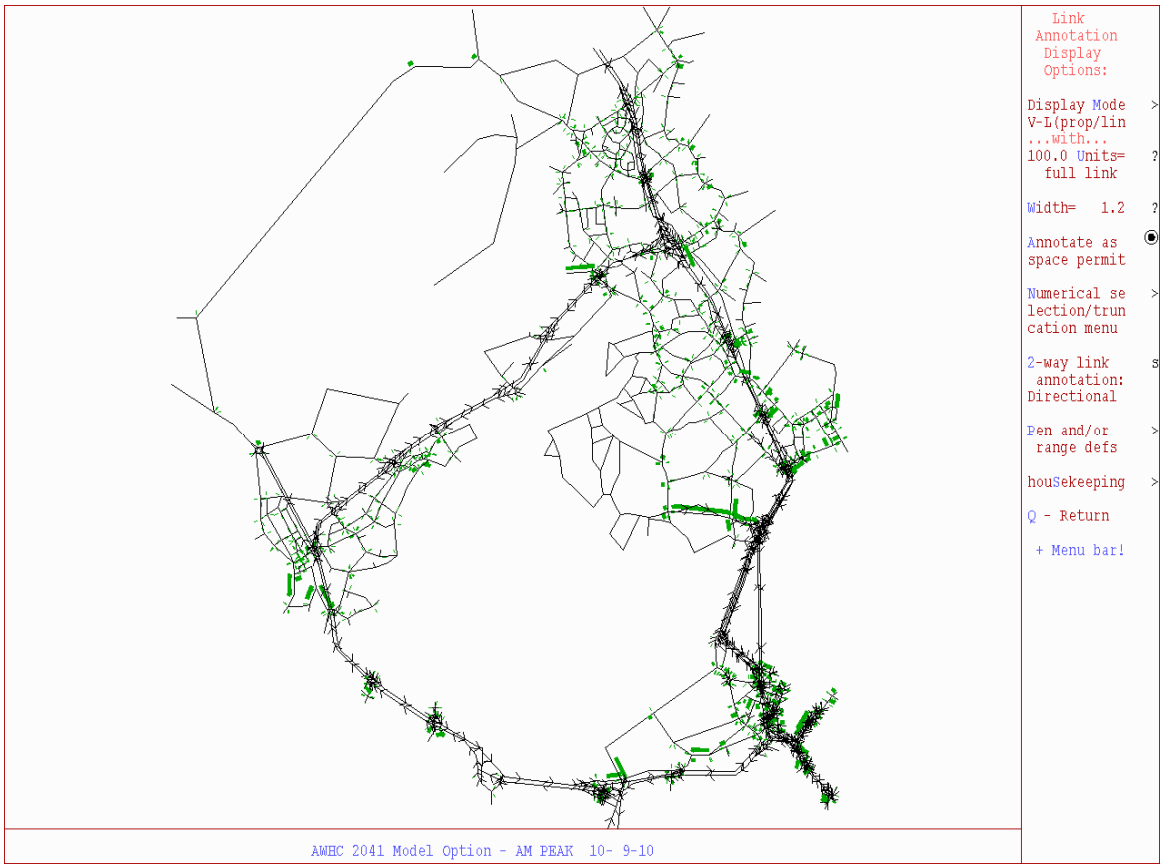


Figure 67: 2041 with Additional Crossing: AM Peak Queues: Auckland CBD

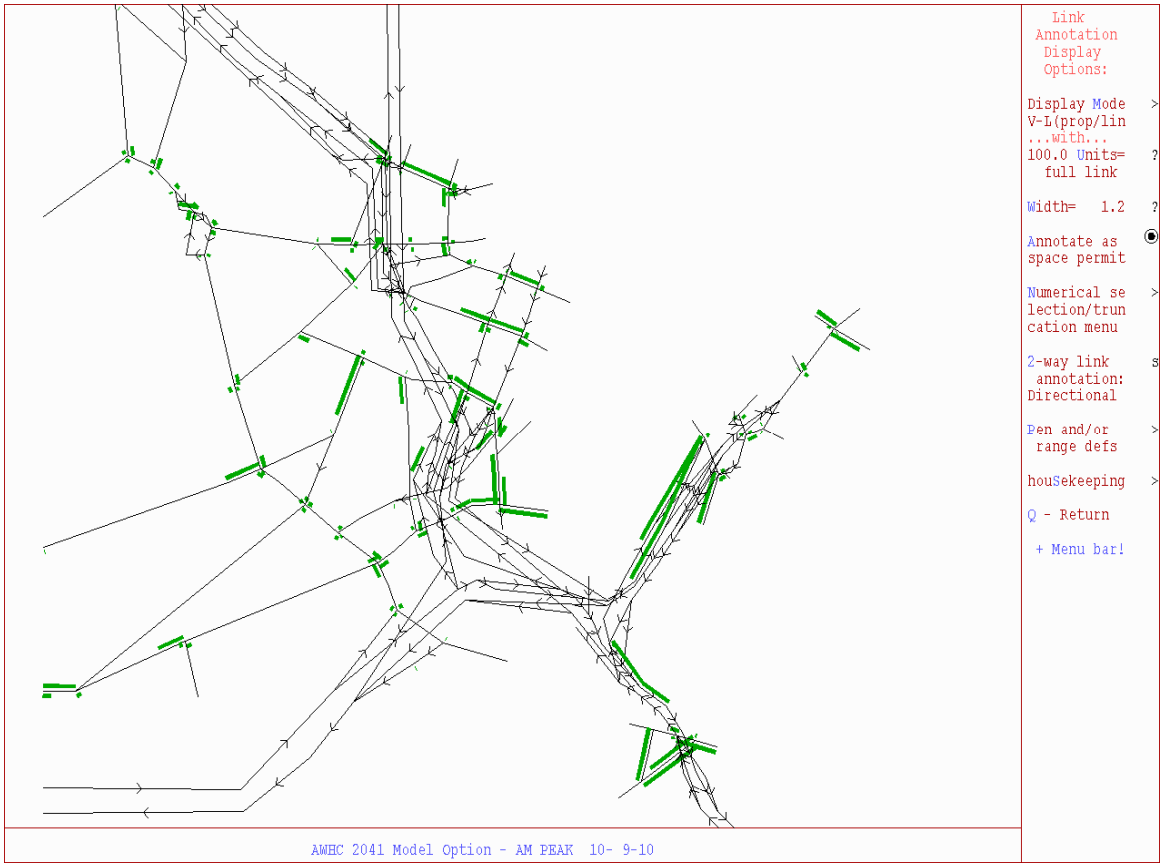


Figure 68: 2041 with Additional Crossing: AM Peak Queues: Takapuna

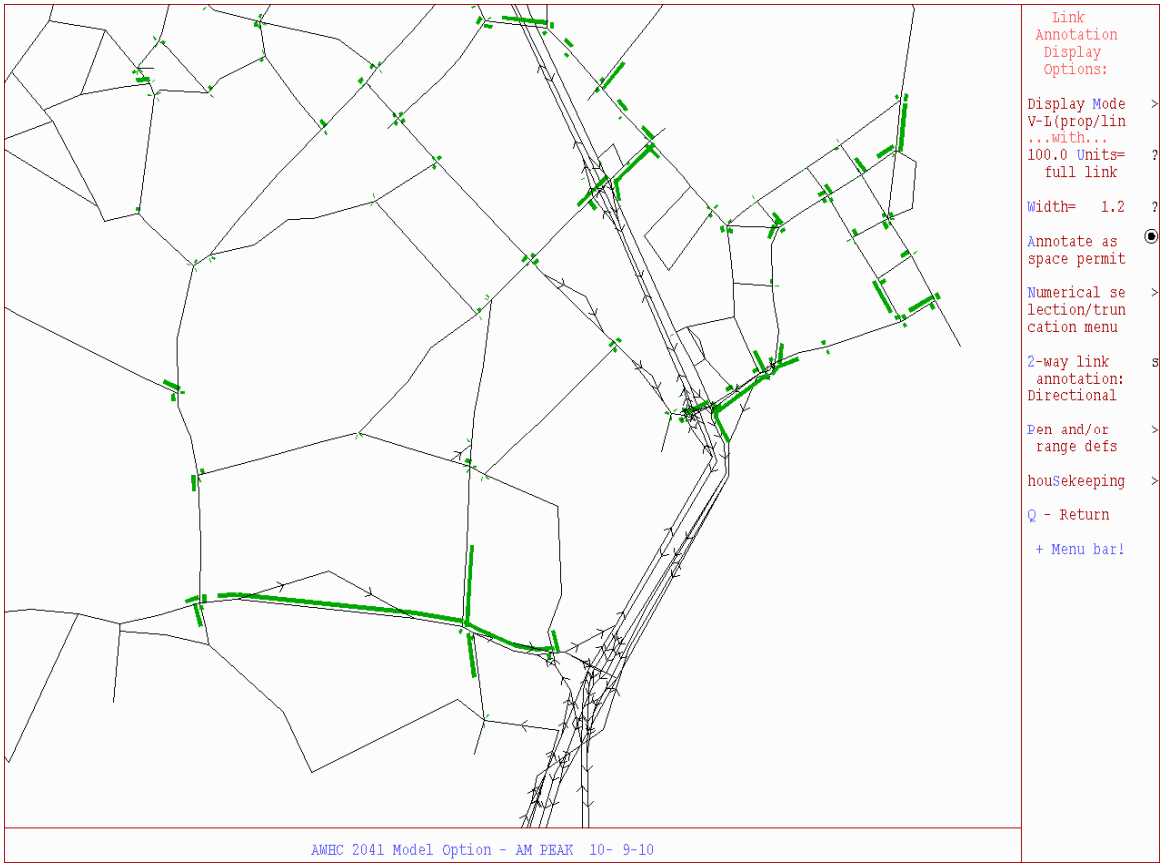


Figure 69: 2041 with Additional Crossing: Inter Peak Queues: Whole Model

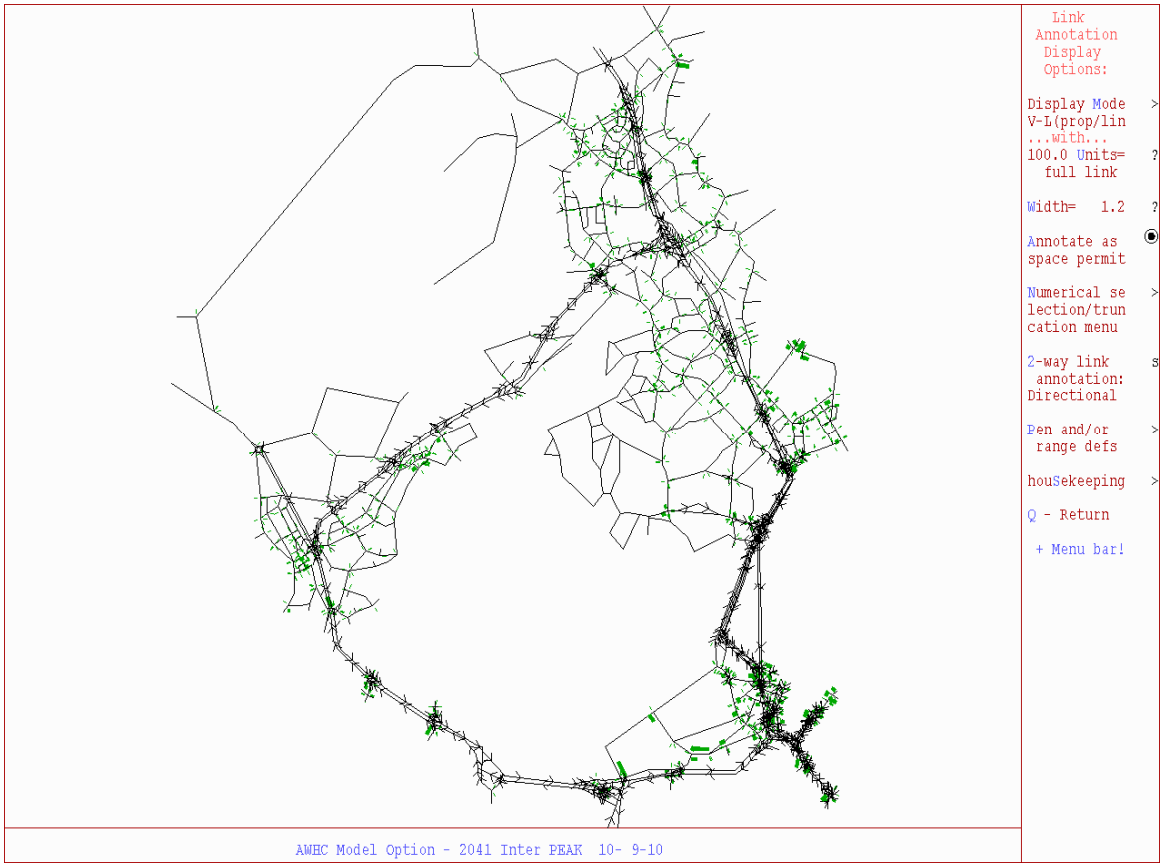


Figure 70: 2041 with Additional Crossing: Inter Peak Queues: Auckland CBD

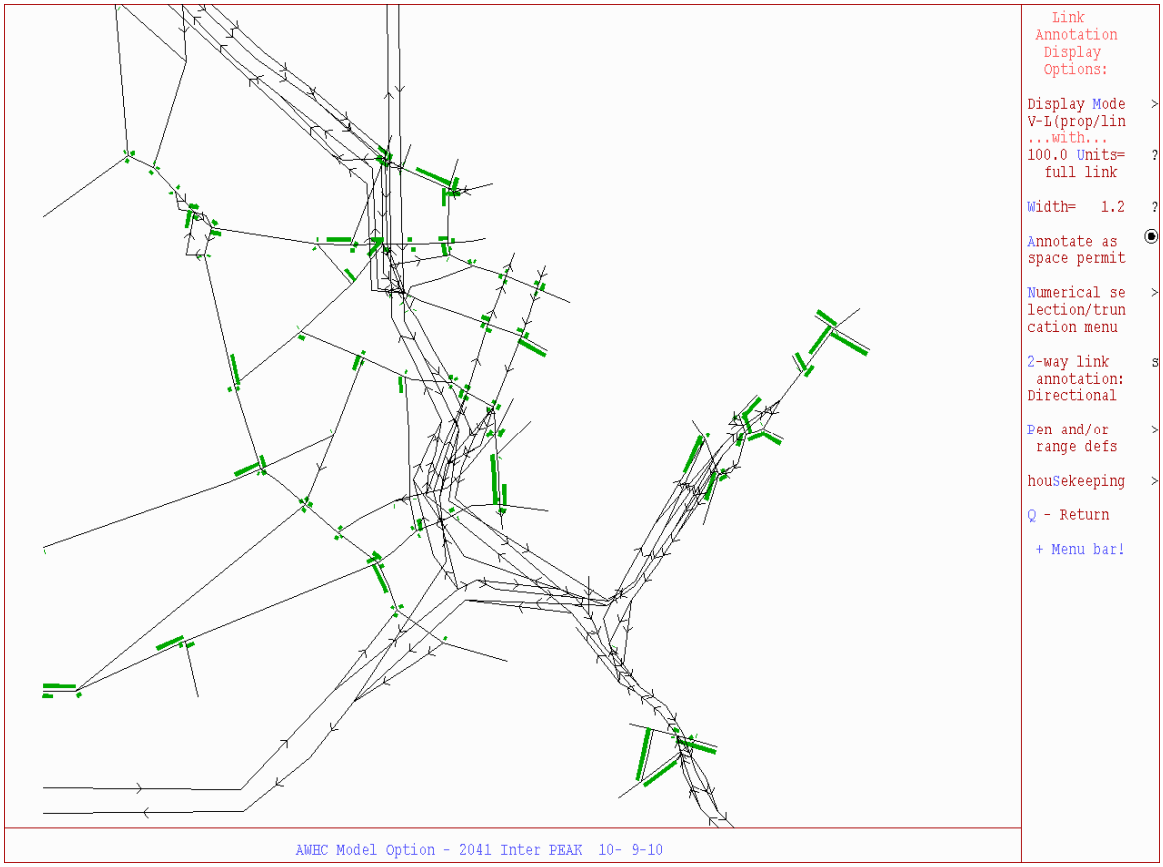


Figure 71: 2041 with Additional Crossing: Inter Peak Queues: Takapuna

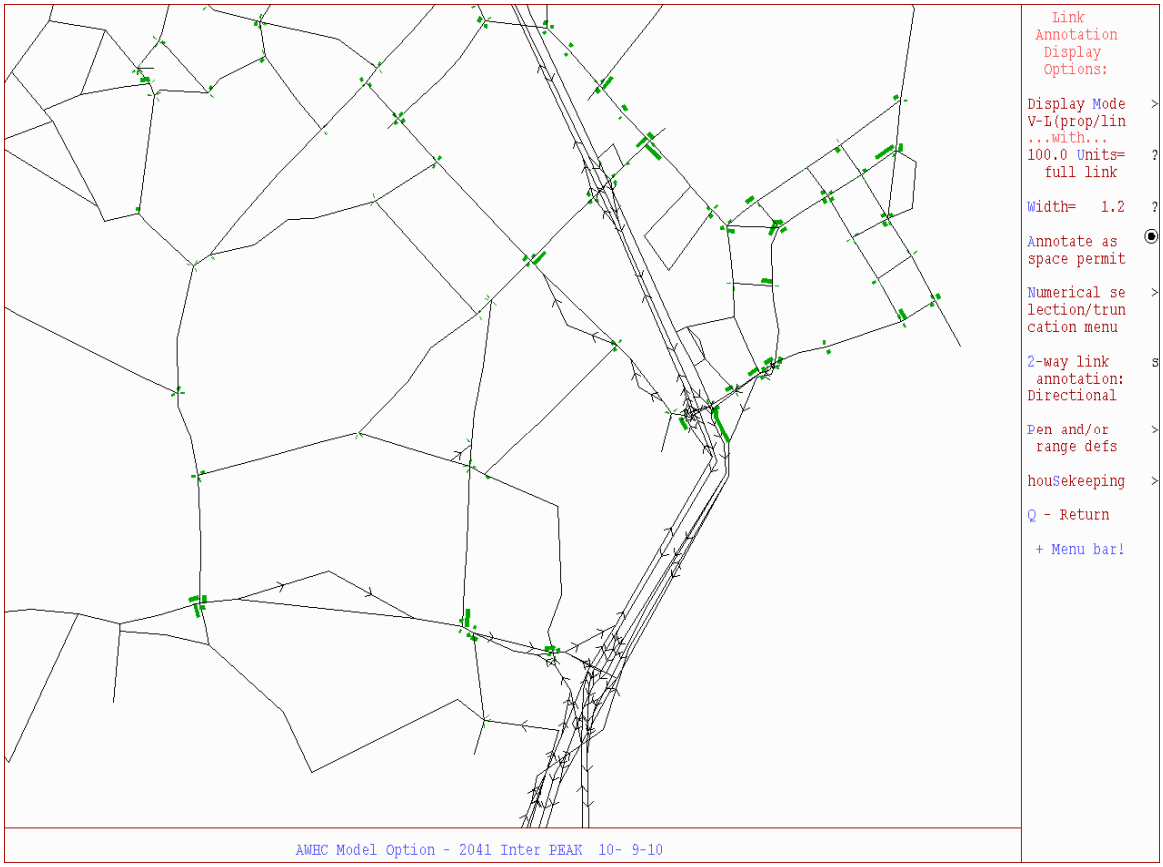


Figure 72: 2041 with Additional Crossing: PM Peak Queues: Whole Model

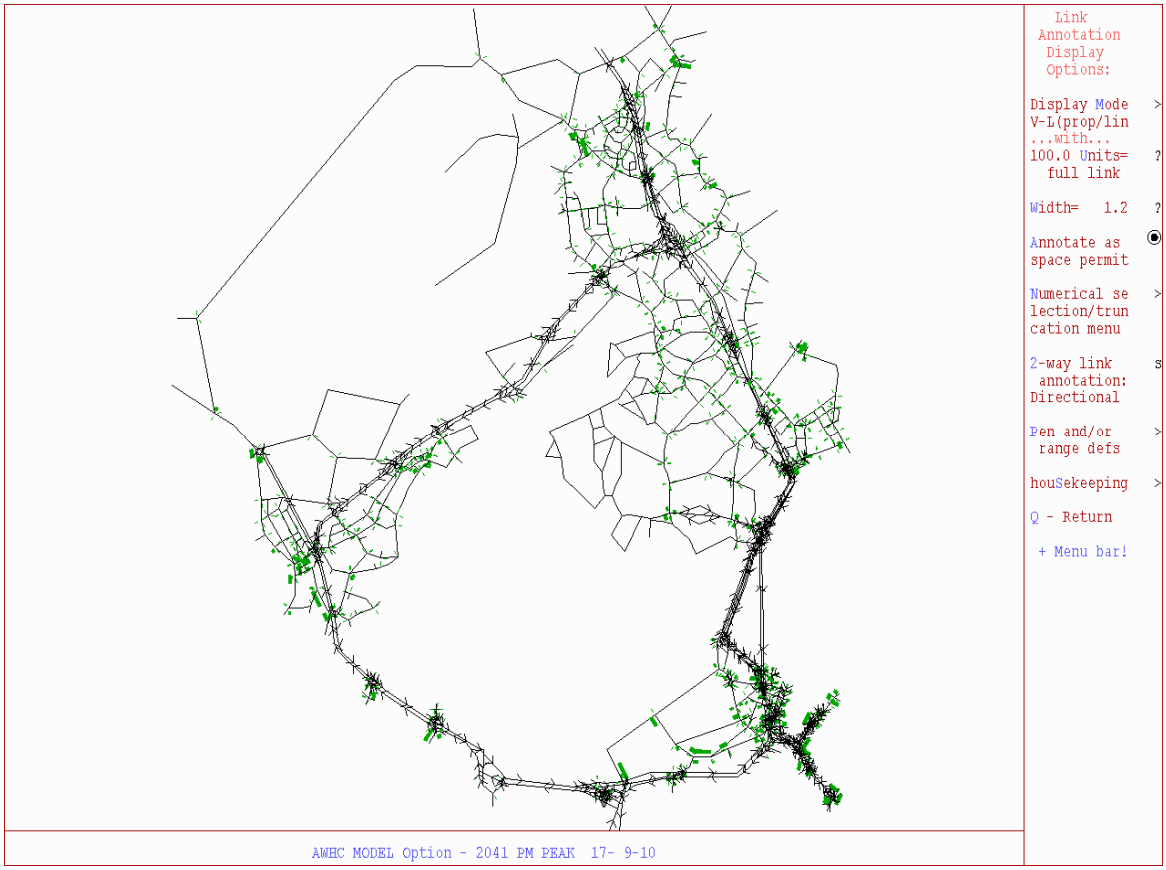


Figure 73: 2041 with Additional Crossing: PM Peak Queues: Auckland CBD

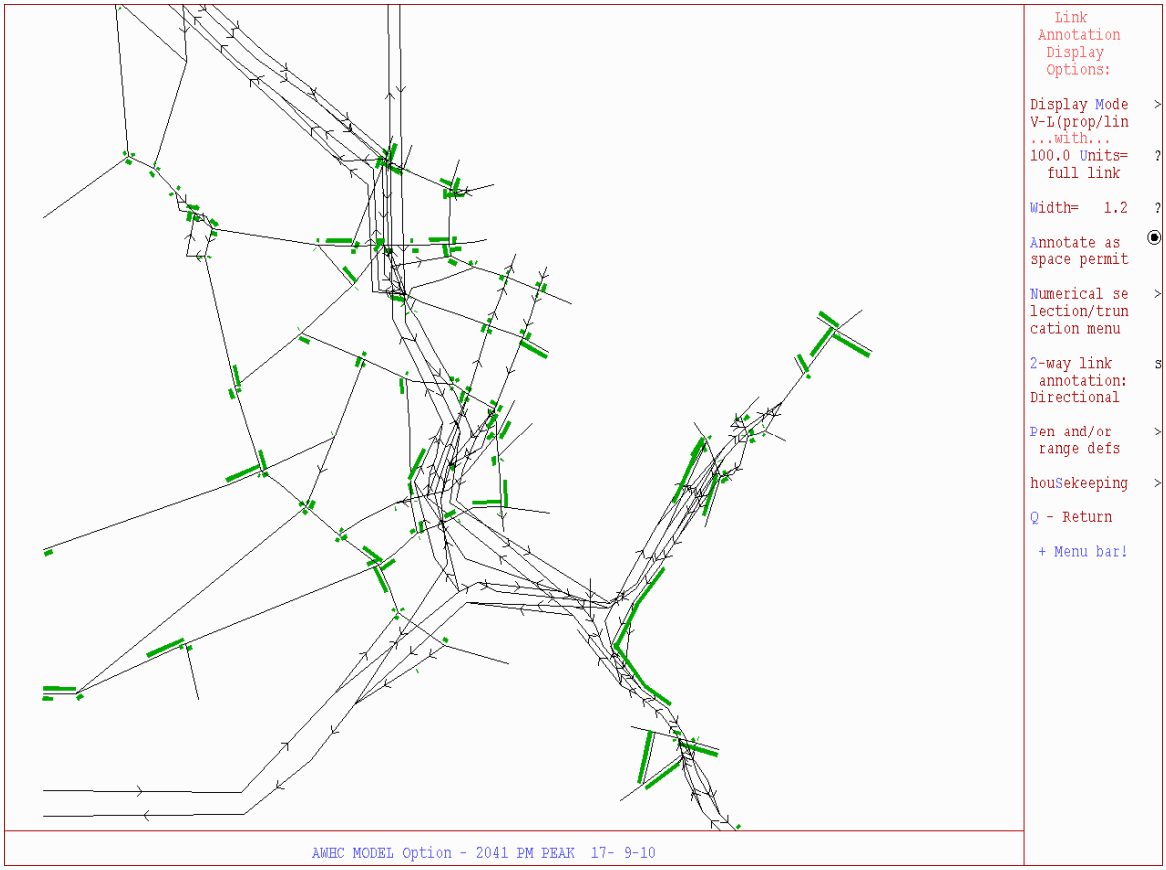
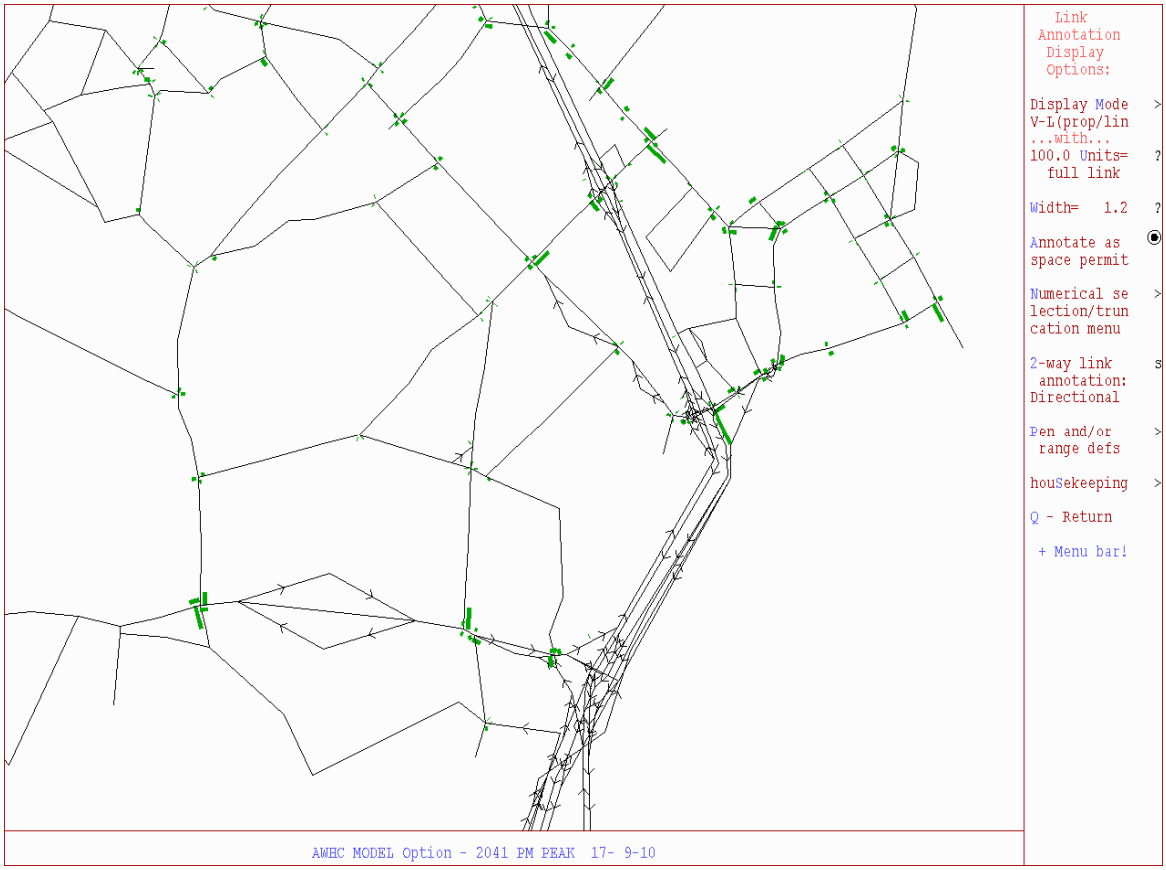


Figure 74: 2041 with Additional Crossing: PM Peak Queues: Takapuna



The queues in 2041 are generally similar to those predicted for 2026 with the additional crossing in place.

7.2.1 2041 Morning Peak

In the morning peak in 2041, significant queues are shown as occurring along Onewa Road, and southbound on the motorway at SH18, at the entries to the motorway from Tristram Avenue, Northcote Road and Esmonde Road, as in 2026.

The interchange of the SH1 ramps with Esmonde Road and Akoranga Drive is predicted to be operating at or slightly over capacity in the morning peak in 2041.

The arrival flow able to reach the single lane from Esmonde Road and Onewa Road to the AWHC in 2041 is predicted to be 1,950 vehicles/hour in the morning peak. This flow is very similar to that predicted for 2026, as the rate of flow will be constrained by the upstream bottlenecks.

The maximum directional flow on the AWHC in the 2041 AM peak is predicted to be 5,400 vehicles/hour, southbound. With three lanes assumed in each direction the new crossing is expected to operate

satisfactorily. Of these 5,400 vehicles, 3,580 vehicles/hour are predicted to be heading to the two lane southbound section through CMJ. This flow is within the capacity of the two lane section.

On the AHB, the flow on the southbound clip on is predicted to be 1,475 vehicles/hour in the morning peak (including around 225 buses/hour). Again, the lane should operate satisfactorily, provided that no queues extend back from Shelly Beach Road to the motorway.

7.2.2 2041 Inter Peak

No significant queues are shown in the inter peak in 2041. However, the ramp signal on the Esmonde Road southbound on ramp is predicted to be operating over capacity and the interchange of the SH1 ramps with Esmonde Road and Akoranga Drive is predicted to be at capacity.

The maximum directional flow on the AWHC in the 2041 inter peak is predicted to be 4,750 vehicles/hour.

7.2.3 2041 Evening Peak

The maximum directional flow on the AWHC in the 2041 evening peak is predicted to be 5,270 vehicles/hour, northbound. This is similar to the 2026 flow.

On the AHB, the flow on the southbound clip on is predicted to be 925 vehicles/hour in the evening peak. The single traffic lane will be used by buses and general traffic heading for the Shelly Beach off ramp.

The northbound clip on will have two traffic lanes, and will be used by buses and general traffic either joining the motorway from the Curran Street on ramp or heading to the Stafford Road off ramp. Traffic from the Curran Street is assumed to merge with the bus lane before merging across to the adjacent lane. The total flow using the single general traffic lane (ie traffic from Curran Street or traffic to Stafford Road) in the evening peak is 1,850 vehicles/hour.

Northbound at Onewa Road, (immediately north of the off ramp to Onewa Road) two lanes are proposed to link from the AHB to join the AWHC toward Esmonde Road. The flow on this two lane link is predicted to be around 4,150 vehicles/hour, which will be right at and probably slightly over capacity.

The interchange of the SH1 ramps with Esmonde Road and Akoranga Drive is predicted to be right at and probably slightly over capacity in the evening peak in 2041.

8 COMPARISON OF STATE HIGHWAY RAMP TRAFFIC FLOWS

The following tables set out the flows that can get through each location. That is, they are not the demand flows but are what SATURN terms the "actual" flows. Where the network is at capacity, the demand may go up between different modelled years but the rate of flow that can get through a particular bottleneck may not.

Table 17: 'Actual' Flows in relation to motorway ramps between Esmonde Road and the CBD: AM Peak

	2008	2026		2041	
Southbound	**Do Min**	**Do Min**	**Option**	**Do Min**	**Option**
SH1 (north of Esmonde Road)	5,080	4,847	6,886	4,851	6,853
Esmonde on ramp	1,385	1,170	2,002	1,170	2,002
Onewa Road off ramp	3		37	1	42
Onewa Road on ramp	1,864	1,939	1,970	1,930	1,971
Existing AHB	**7,731**	**7,909**	**5,800**	**8,049**	**5,846**
AWHC			**5,329**		**5,387**
Shelly Beach Road off ramp	1,200	734	1,212	590	1,335
Fanshawe Street off ramp	2,178	1,583	2,696	1,968	2,685
Cook Street off ramp	657	1,312	1,629	1,163	1,468
Northbound					
Wellington Street on ramp	455	607		523	
Cook Street on ramp			806		1,175
Fanshawe Street on ramp	710	589	1,027	690	887
Curran Street on ramp	880	783	967	741	1,038
Existing AHB	**4,875**	**5,135**	**2,846**	**5,182**	**3,179**
AWHC			**4,018**		**4,220**
Stafford Road off ramp	97	96	116	92	126
Onewa Road off ramp	625	581	837	592	926
Onewa Road on ramp	2		2	2	2
Esmonde Road off ramp	1,374	1,681	2,539	1,858	2,915
SH1 (north of Esmonde Road)	2,800	2,782	3,318	2,647	3,337

Table 18: 'Actual' Flows in relation to motorway ramps between Esmonde Road and the CBD: Inter Peak

	2008	2026		2041	
Southbound	**Do Min**	**Do Min**	**Option**	**Do Min**	**Option**
SH1 (north of Esmonde Road)	3,000	3,600	4,140	4,004	4,929
Esmonde on ramp	1,317	1,619	1,994	1,563	2,002
Onewa Road off ramp	362	331	475	325	493
Onewa Road on ramp	1,225	1,445	1,497	1,559	1,706
Existing AHB	**5,250**	**6,454**	**2,823**	**7,001**	**3,508**
AWHC			**4,428**		**4,742**
Shelly Beach Road off ramp	559	471	774	460	863
Fanshawe Street off ramp	1,161	885	1,202	1,270	1,896
Cook Street off ramp	609	830	762	714	644
Northbound					
Wellington Street on ramp	571	616		577	
Cook Street on ramp			1,099		1,491
Fanshawe Street on ramp	1,077	1,169	1,176	1,237	974
Curran Street on ramp	570	529	690	520	844
Existing AHB	**5,203**	**6,685**	**2,998**	**6,831**	**3,358**
AWHC			**4,428**		**4,704**
Stafford Road off ramp	164	179	218	211	255
Onewa Road off ramp	933	1,023	1,181	1,071	1,327
Onewa Road on ramp	333	427	357	523	395
Esmonde Road off ramp	1,471	1,913	2,087	2,140	2,530
SH1 (north of Esmonde Road)	2,957	3,996	4,245	3,931	4,289

Table 19: 'Actual' Flows in relation to motorway ramps between Esmonde Road and the CBD: PM Peak

	2008	2026		2041	
Southbound	**Do Min**	**Do Min**	**Option**	**Do Min**	**Option**
SH1 (north of Esmonde Road)	3,535	3,418	4,496	3,512	4,850
Esmonde on ramp	1,370	1,451	2,017	1,477	2,004
Onewa Road off ramp	399	481	473	597	532
Onewa Road on ramp	1,639	1,284	1,472	1,317	1,636
Existing AHB	**5,958**	**5,684**	**2,868**	**5,767**	**3,188**
AWHC			**4,727**		**4,915**
Shelly Beach Road off ramp	868	431	916	413	891
Fanshawe Street off ramp	1,013	562	1,248	698	1,558
Cook Street off ramp	584	498	620	422	624
Northbound					
Wellington Street on ramp	720	900		900	
Cook Street on ramp			1,644		1,614
Fanshawe Street on ramp	3,061	3,347	3,064	2,753	3,314
Curran Street on ramp	1,029	1,029	1,029	1,029	1,029
Existing AHB	**8,346**	**9,526**	**5,816**	**8,975**	**6,157**
AWHC			**5,268**		**5,273**
Stafford Road off ramp	359	559	688	563	761
Onewa Road off ramp	1,282	1,421	1,693	1,325	1,697
Onewa Road on ramp	146	216	164	206	168
Esmonde Road off ramp	2,328	2,812	3,283	2,556	3,354
SH1 (north of Esmonde Road)	4,224	4,966	5,375	4,770	5,489

A key point to note from these tables is that there are increases in the flows that are able to cross the harbour. These figures are shown in bold. The total flows crossing the Harbour (either via the AHB or the AWHC) are summarised in the following tables.

Table 20: 'Actual' Flows on Harbour Crossings: 2026

	AHB S/b	AWHC s/b	Total s/b	AHB n/b	AWHC n/b	Total n/b
Do Min AM	7,910		7,910	5,140		5,140
AWHC AM	5,800	5,330	11,130	2,850	4,020	6,870
Do Min Inter Peak	6,450		6,450	6,690		6,690
AWHC Inter Peak	2,820	4,430	7,250	3,000	4,430	7,430
Do Min PM	5,680		5,680	9,530		9,530
AWHC PM	2,870	4,730	7,600	5,820	5,270	11,090

Table 21: 'Actual' Flows on Harbour Crossings: 2041

	AHB S/b	AWHC s/b	Total s/b	AHB n/b	AWHC n/b	Total n/b
Do Min AM	8,050		8,050	5,180		5,180
AWHC AM	5,850	5,390		3,180	4,220	7,400
Do Min Inter Peak	7,000		7,000	6,830		6,830
AWHC Inter Peak	3,510	4,740		3,360	4,700	8,060
Do Min PM	5,770		5,770	8,980		8,980
AWHC PM	3,190	4,920		6,160	5,270	11,430

APPENDIX A Overall Demands Summary

OVERALL DEMANDS

The modelled demands have been derived from the ART model runs undertaken for this project, details of which have been set out in a File Note from SKM dated 6 September 2010. The SATURN demands have used the Regional Growth Strategy land use and with other inputs as included within what the SKM File Note termed Alternative 1.

It is important that the changes to the demands that were applied to the base SATURN models are retained within the future forecasts. Therefore, the ART matrices have been used to determine the differences between the base and forecast demands. These differences have then been applied using the multiplicative approach (ie the ratios of changes to the base model are applied to the future matrices). This is consistent with the approach taken for the SH18 Strategic Improvements Study.

Issues were encountered in terms of the demands predicted by ART for the Wynyard Quarter area and the demands were modified to reflect those predicted by the Wynyard Quarter Transport Assessment. Details of these changes were set out in the Flow File Note dated 6 September 2010.

The total traffic demands in the SATURN model are set out in Table 9

Table 22:Total Traffic Demands in Saturn Model

Scenario	AM	Inter Peak	PM Peak
2008 Base	95,520	85,330	106,280
2026 Do Minimum	119,820	114,100	131,270
2026 Option	120,250	113,580	131,550
2041 Do Minimum	127,070	124,830	139,850
2041 Option	128,440	124,640	140,200

The table indicates that the overall demands are predicted to increase with the Do Minimum Scenario by 24-26% in the peak hours, between 2008 and 2026, and by 34% in the inter peak. 2041 demands are expected to be 32-33% above 2008 flows in the peak hours, and 46% higher in the inter peak.

The table also indicates that the trip totals are similar with the AWHC. Modest increases in the total trips are predicted in the weekday morning and evening peaks, as a result of the improved conditions, but modest decreases are predicted in the inter peak period. The Do Minimum scenario is generally predicted to operate satisfactory in the inter peak period.

We have rerun the 2026 Do Minimum AM peak matrices using the additive method (where the absolute trip numbers in 2008 are added to the ART model differences). This leads to 121,380 trips/hour, which is within 1.5% of the figure given in Table 1, indicating that the total flows are consistent using either approach.

CROSS HARBOUR DEMANDS

The arrival flows and demand flows across Waitemata Harbour are set out in the following tables. These are based on the average hours for the three modelled periods and the models have been run without a preload, so as not to influence the predicted demands. It should be emphasised that these tables (without the preload) have only been provided to establish the level of changes in demands and to establish predicted daily flows. The numbers given in the operational assessment in earlier sections of this report relate to the models with a preload.

The tables give information firstly for the base years, for the two existing bridges across the Waitemata Harbour, then the two forecast years. Daily flows have been derived from the demand flows by assuming two AM hours, two PM hours and 10.5 inter peak hours per day. These are the default values that we have derived for a number of studies in this area.

Table 23: 2008 Flows on Upper Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Base	Eastbound	1,630	1,610	770	770	1,310	1,220	14,010
	Westbound	1,080	1,070	780	780	1,420	1,390	13,160
	Total	**2,710**	**2,680**	**1,550**	**1,550**	**2,730**	**2,610**	**27,170**

Table 24: 2008 Flows on Auckland Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Base	Northbound	5,010	4,800	5,170	5,170	9,280	8,020	82,890
	Southbound	8,980	7,640	5,210	5,210	6,290	5,950	85,260
	Total	**13,990**	**12,450**	**10,380**	**10,380**	**15,570**	**13,970**	**168,150**

Table 25: 2026 Flows on Upper Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	Actual	Demand	Actual	Demand	Actual	
Do Min	Eastbound	3,080	3,030	2,470	2,450	3,100	2,990	38,340
	Westbound	3,320	3,280	2,540	2,530	3,320	3,260	39,930
	Total	**6,400**	**6,310**	**5,010**	**4,980**	**6,420**	**6,250**	**78,260**
Option	Eastbound	3,380	3,340	2,570	2,530	3,120	3,020	39,950
	Westbound	2,990	2,960	2,540	2,530	3,400	3,330	39,390
	Total	**6,370**	**6,290**	**5,100**	**5,060**	**6,520**	**6,340**	**79,340**

Table 26: 2026 Flows on Auckland Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		
		Demand	**Actual**	**Demand**	**Actual**	**Demand**	**Actual**	**AADT**
Do Min	Northbound	5,270	5,050	6,600	6,580	9,850	9,370	99,530
	Southbound	9,860	7,750	6,380	6,300	5,810	5,630	98,300
	Total	**15,120**	**12,800**	**12,980**	**12,880**	**15,660**	**15,010**	**197,830**
Option	Northbound	2,780	2,720	2,930	2,920	5,900	5,470	48,100
	Southbound	6,390	5,430	2,770	2,760	2,810	2,740	47,490
	Total	**9,170**	**8,140**	**5,700**	**5,680**	**8,700**	**8,210**	**95,590**

Table 27:2026 Flows on Additional Harbour Crossing (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	**Actual**	**Demand**	**Actual**	**Demand**	**Actual**	
Option	Eastbound	4,100	4,020	4,410	4,400	5,470	5,270	65,420
	Westbound	6,260	5,300	4,420	4,400	4,860	4,750	68,680
	Total	**10,360**	**9,320**	**8,830**	**8,800**	**10,340**	**10,010**	**134,100**

Table 28: 2041 Flows on Upper Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	**Actual**	**Demand**	**Actual**	**Demand**	**Actual**	
Do Min	Eastbound	3,080	3,020	2,600	2,570	2,920	2,780	3,9280
	Westbound	3,390	3,350	2,670	2,660	3,180	3,110	4,1220
	Total	**6,470**	**6,370**	**5,270**	**5,230**	**6,100**	**5,880**	**80,500**
Option	Eastbound	3,280	3,230	2,710	2,680	3,000	2,850	40,990
	Westbound	3,040	3,000	2,630	2,610	3,320	3,220	40,350
	Total	**6,320**	**6,220**	**5,340**	**5,290**	**6,310**	**6,070**	**81,340**

Table 29: 2041 Flows on Auckland Harbour Bridge (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		
		Demand	**Actual**	**Demand**	**Actual**	**Demand**	**Actual**	**AADT**
Do Min	Northbound	5,290	5,110	6,870	6,790	9,260	8,670	101,210
	Southbound	9,990	7,820	6,890	6,700	5,850	5,640	103,990
	Total	**15,280**	**12,930**	**13,760**	**13,490**	**15,110**	**14,310**	**205,200**
Option	Northbound	3,180	3,090	3,350	3,260	6,320	5,800	5,4210
	Southbound	6,500	5,430	3,460	3,360	3,240	3,070	55,860
	Total	**9,690**	**8,520**	**6,820**	**6,620**	**9,550**	**8,870**	**110,070**

Table 30: 2041 Flows on Additional Harbour Crossing (vehicles/hour and vehicles/day)

		AM		Interpeak		PM		AADT
		Demand	**Actual**	**Demand**	**Actual**	**Demand**	**Actual**	
Option	Eastbound	4,410	4,280	4,840	4,760	5,670	5,320	71,010
	Westbound	6,440	5,350	4,770	4,620	5,130	4,850	73,230
	Total	**10,850**	**9,630**	**9,620**	**9,380**	**10,800**	**10,170**	**144,240**

Tables 16 to 18 below sets out the total predicted flows across the screenline (vehicles/day).

Table 31: 2008 Daily Flows across Harbour (vehicles/day)

	Northbound	**Southbound**	**Total**
Upper Harbour Bridge	14,010	13,160	27,160
Auckland Harbour Bridge	82,890	85,260	168,150
Total	96,890	98,420	195,310

Table 32: 2026 Daily Flows across Harbour (vehicles/day)

	Northbound	Southbound	Total
Do Minimum			
Upper Harbour Bridge	38,340	39,930	78,260
Auckland Harbour Bridge	99,530	98,300	197,830
Total	137,870	138,230	276,100
With AWHC			
Upper Harbour Bridge	39,950	39,390	79,340
Auckland Harbour Bridge	48,100	47,490	95,590
Additional Harbour Crossing	65,420	68,680	134,100
Total	153,460	155,570	309,030

Table 33: 2041 Daily Flows across Harbour (vehicles/day)

	Northbound	Southbound	Total
Do Minimum			
Upper Harbour Bridge	39,280	41,220	80,500
Auckland Harbour Bridge	101,210	103,990	205,200
Total	140,490	145,210	285,700

With AWHC			
Upper Harbour Bridge	40,990	40,350	81,340
Auckland Harbour Bridge	54,210	55,860	110,070
Additional Harbour Crossing	71,010	73,230	144,240
Total	166,220	169,430	335,650

The tables indicate that the total daily flows across the Harbour are predicted to increase by 41% between 2008 and 2026, with the Do Minimum scenario, with the majority of this growth on the Upper Harbour Bridge. Demands across the Auckland Harbour Bridge are only predicted to increase by 18% over this period. Table 19 also indicates an increase of over 30,000 vehicles/day crossing the Harbour in 2026 with the AWHC. Negligible differences in daily flows are predicted on the Upper Harbour Bridge, relative to the Do Minimum scenario, while the daily flow on the AHB will be halved. The split of traffic between the AHB and the Additional Crossing indicates greater traffic (almost 60%) on the Additional Crossing.

Modest growth is predicted between 2026 and 2041, with the Do Minimum scenario, with the 2041 flows predicted to be around 46% above the 2008 flows. Table 20 also indicates an increase of around 50,000 vehicles/day crossing the Harbour in 2041 with the AWHC. Again negligible differences in daily flows are predicted on the Upper Harbour Bridge, relative to the Do Minimum scenario, while the daily flow on the AHB will be approximately halved. The split of traffic between the AHB and the Additional Crossing indicates greater traffic (almost 60%) on the Additional Crossing.

APPENDIX B **Volume/Capacity Plots**

Volume Over Capacity (V/C) Ratio Plots: 2008 Scenario

The following plots set out the links that are predicted by the model as operating at greater than 95% capacity.

Figure 75: 2008 Base Model: AM Peak V/C Ratios: Whole Model

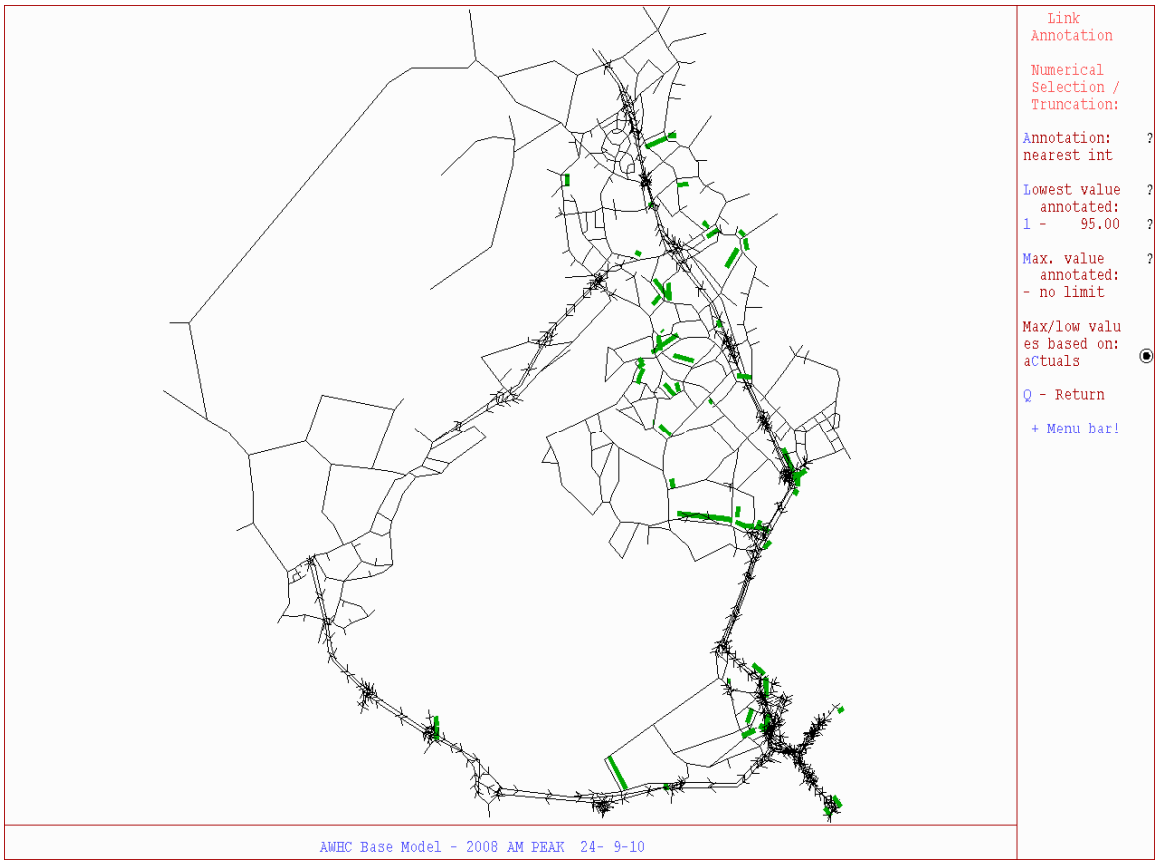


Figure 76: 2008 Base Model: AM Peak V/C Ratios: Auckland CBD

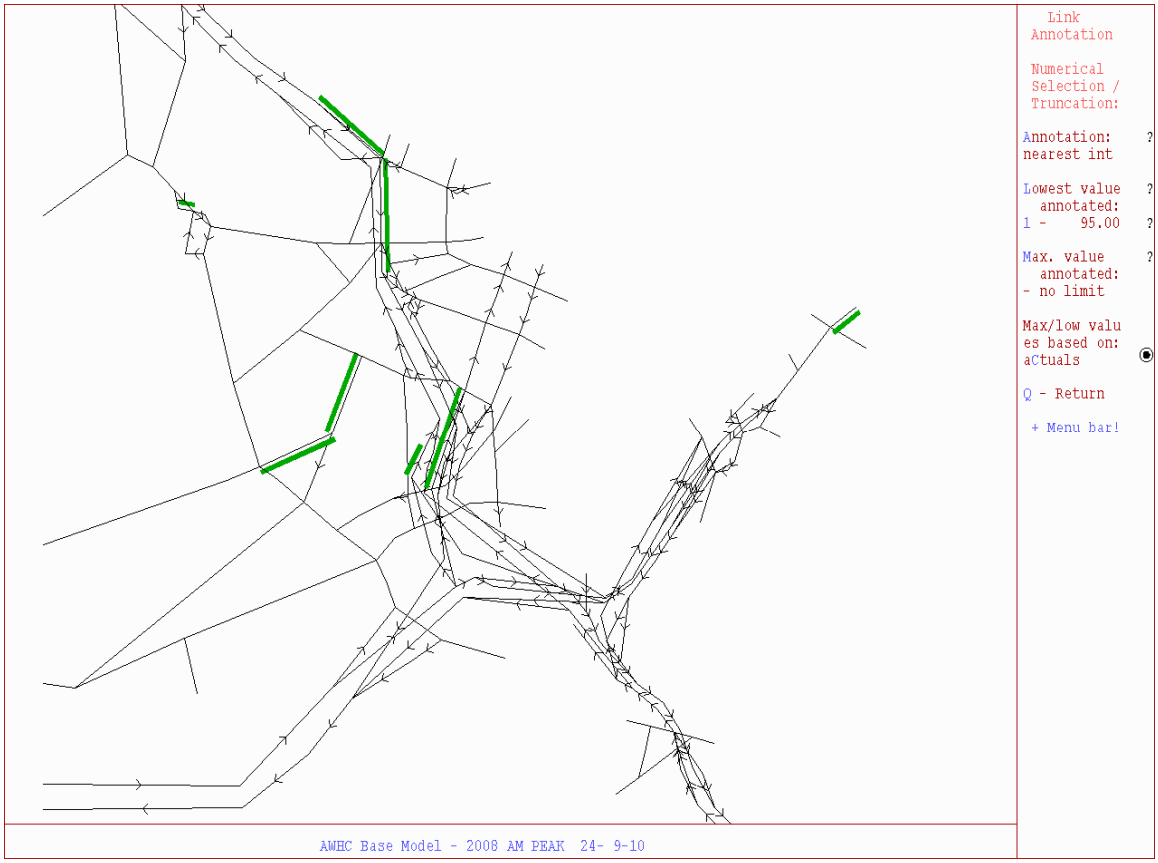


Figure 77: 2008 Base Model: AM Peak V/C Ratios: Takapuna

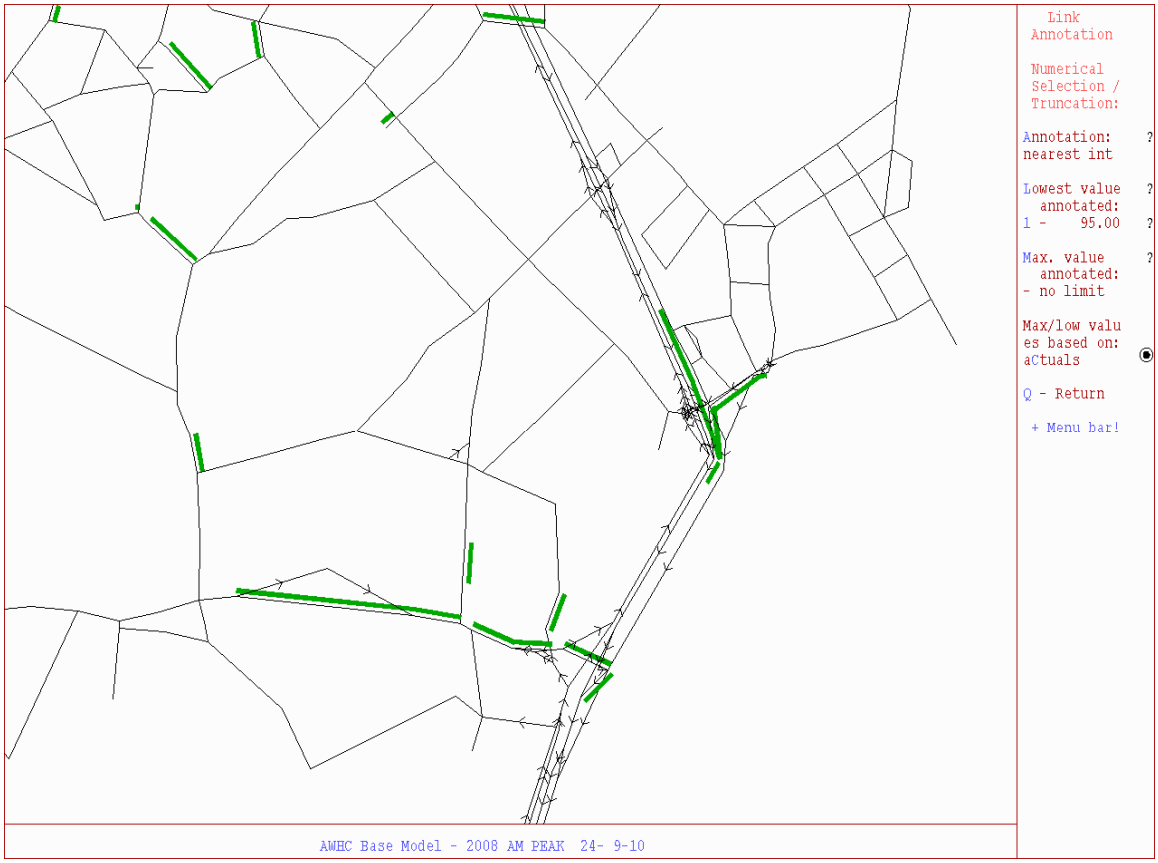


Figure 78: 2008 Base Model: Inter Peak V/C Ratios: Whole Model

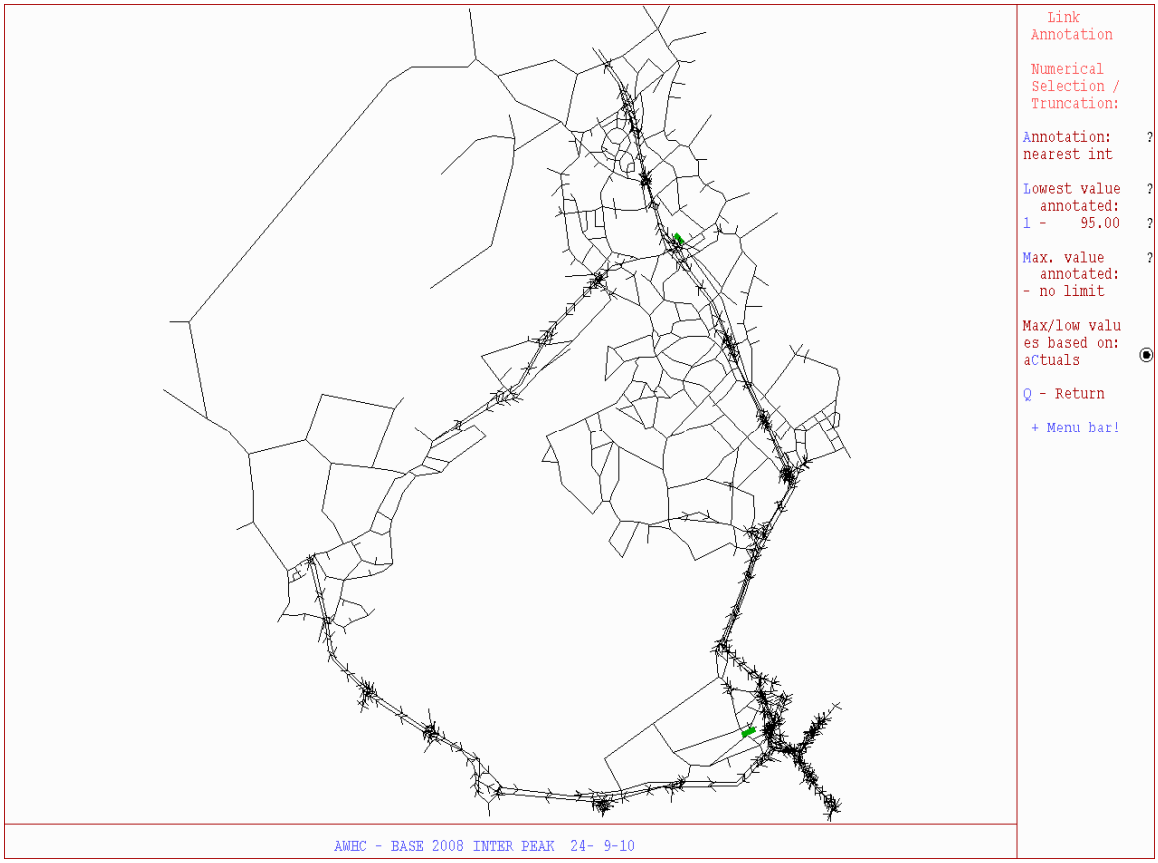


Figure 79: 2008 Base Model: Inter Peak V/C Ratios: Auckland CBD

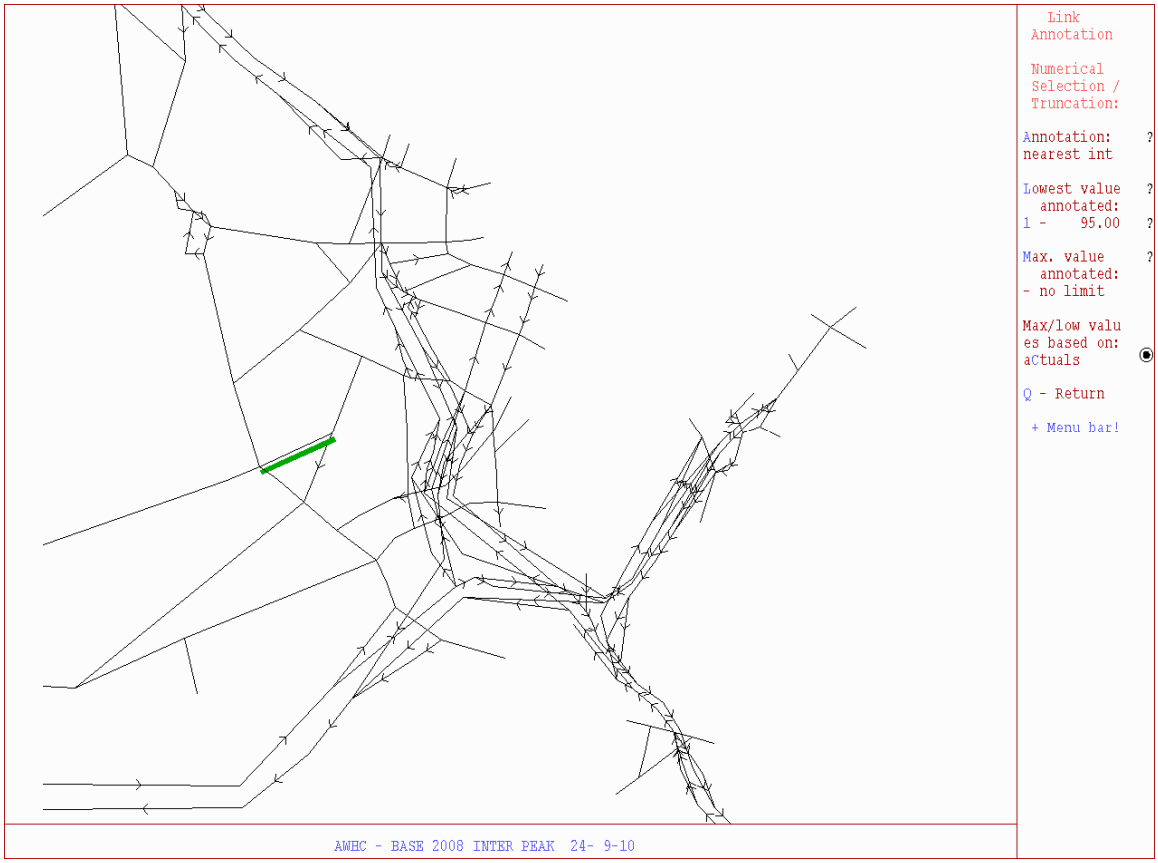


Figure 80: 2008 Base Model: Inter Peak V/C Ratios: Takapuna

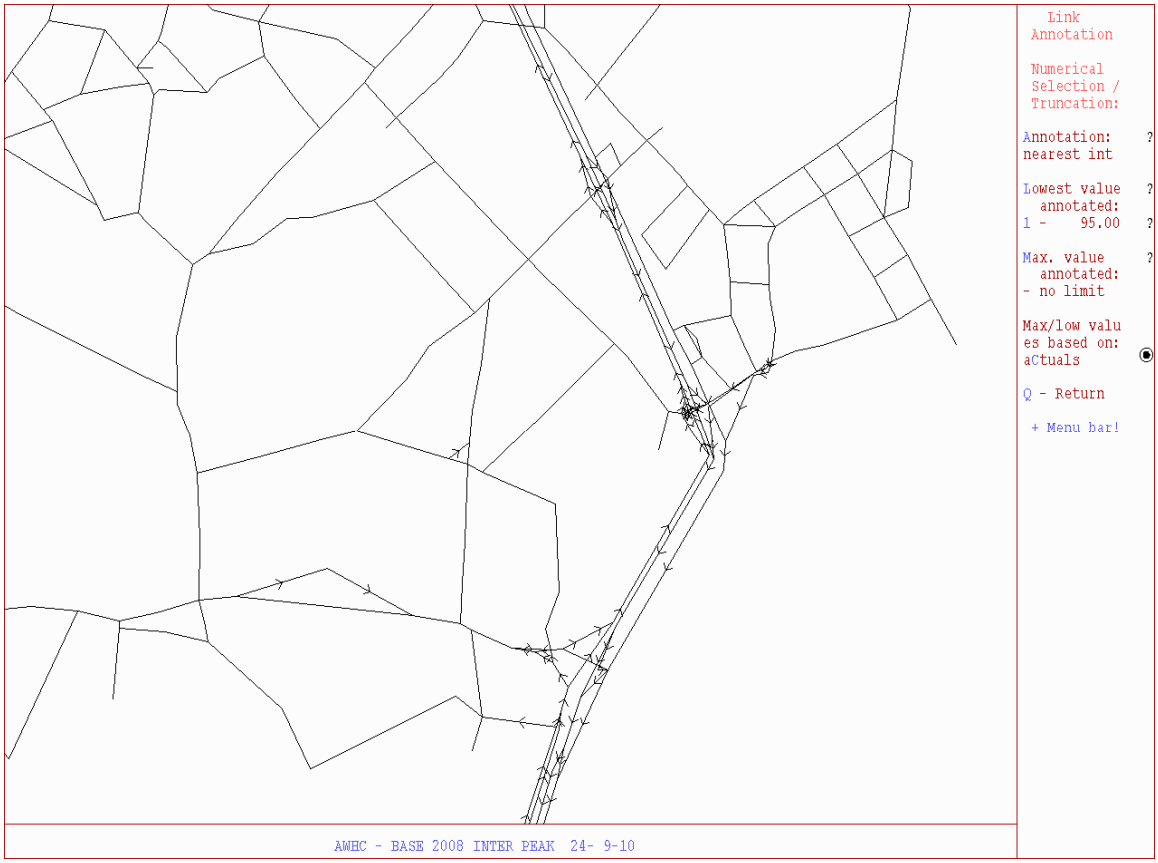


Figure 81: 2008 Base Model: PM Peak V/C Ratios: Whole Model

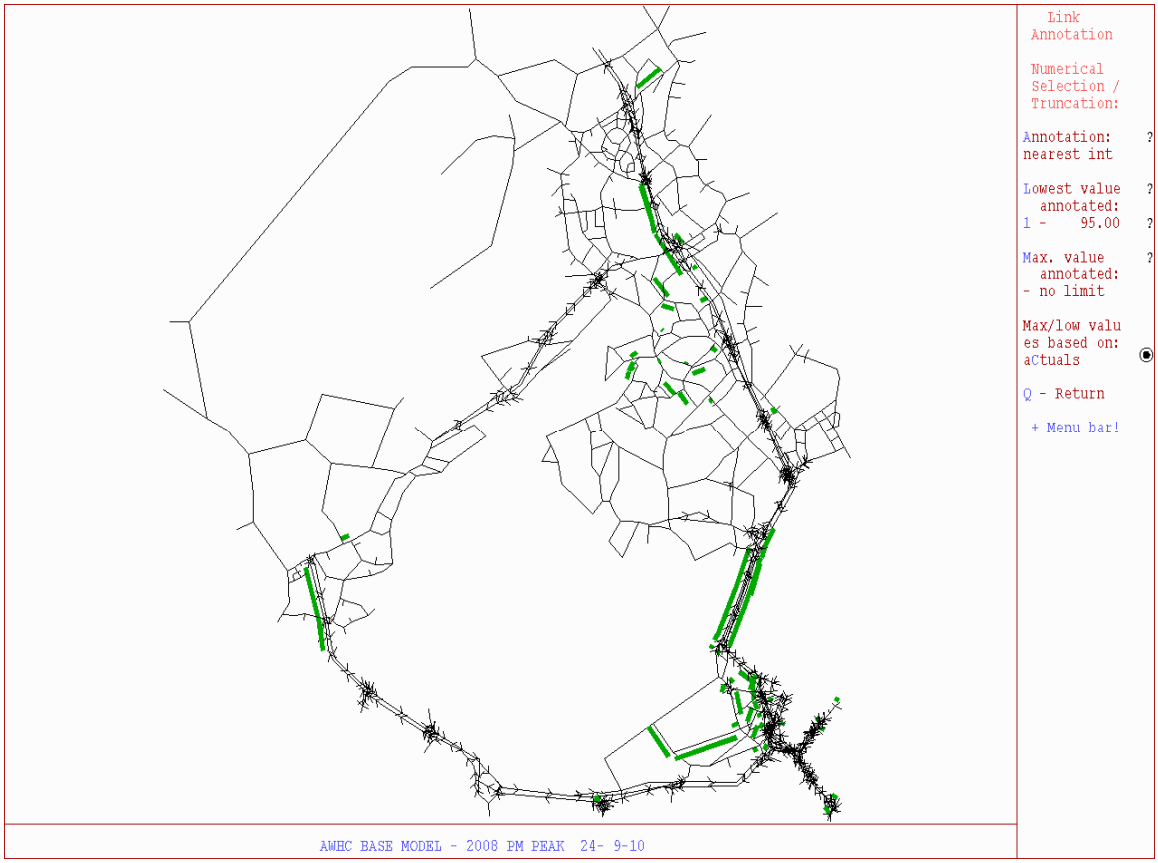


Figure 82: 2008 Base Model: PM Peak V/C Ratios: Auckland CBD

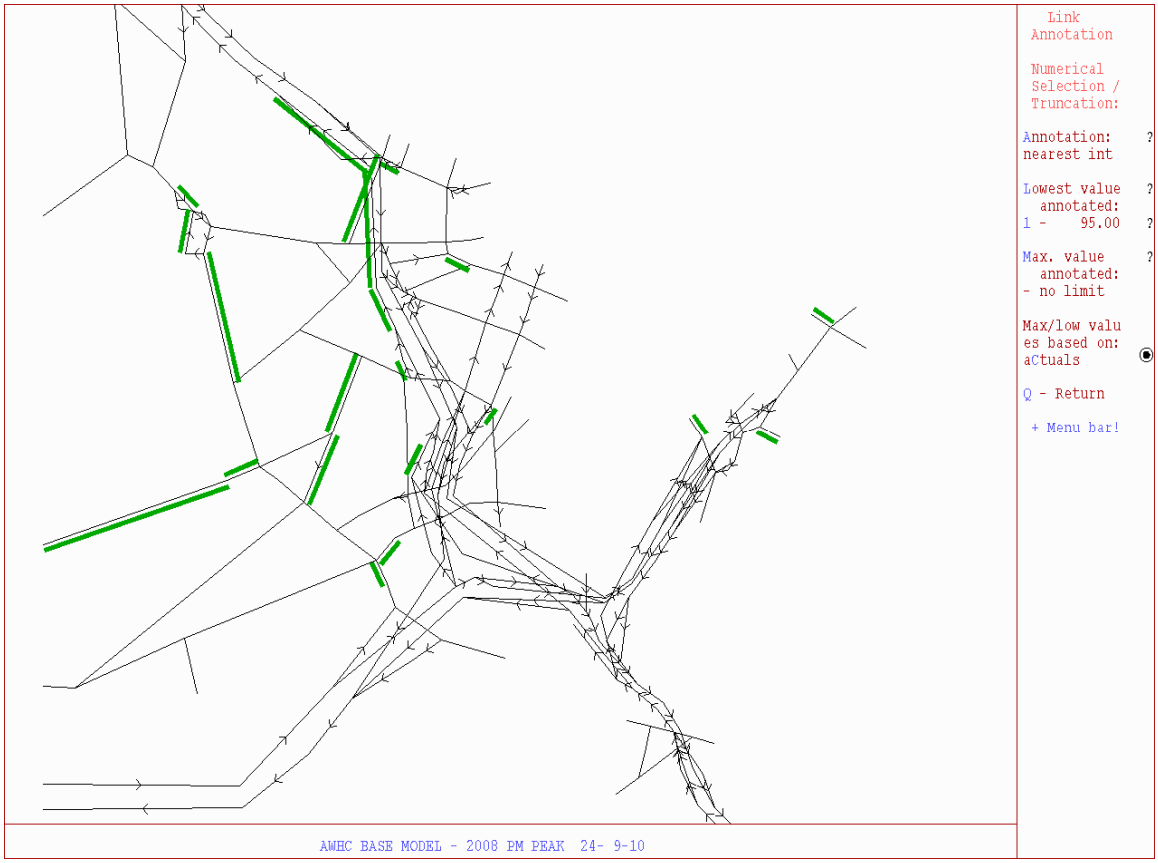
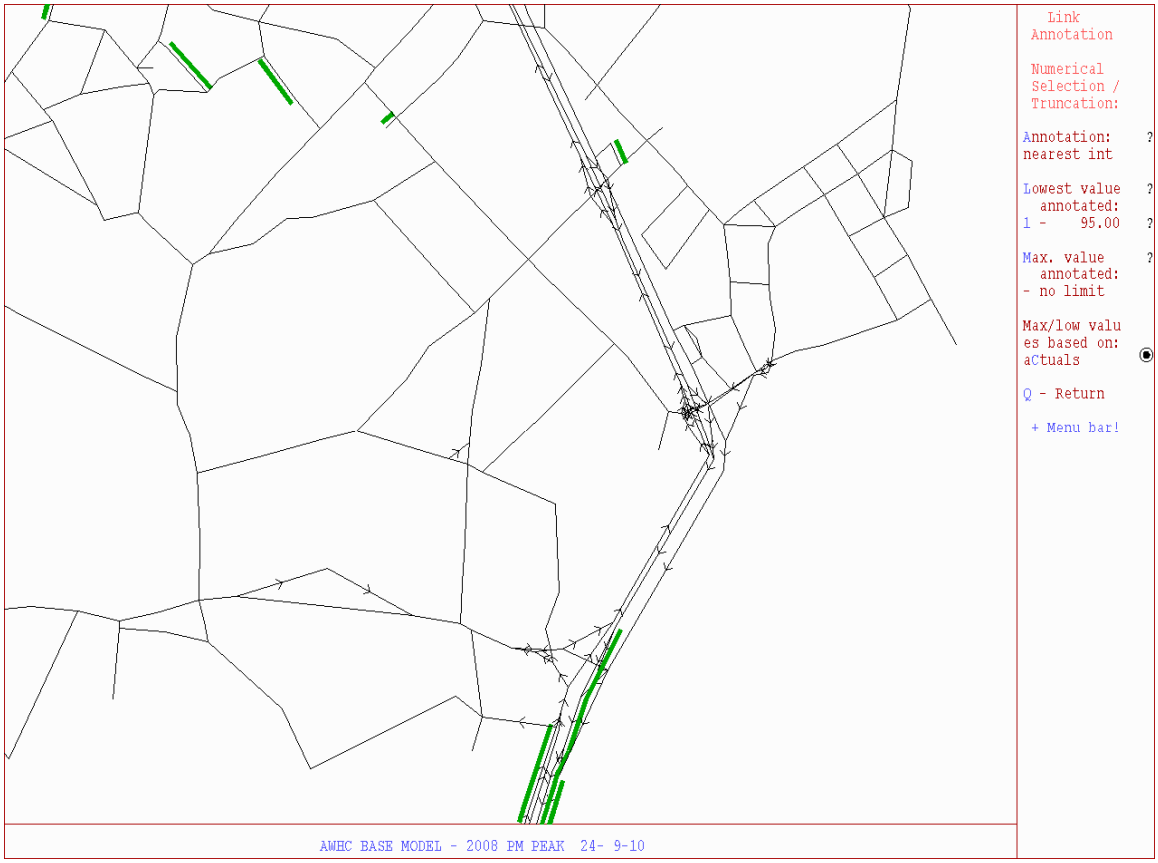


Figure 83: 2008 Base Model: PM Peak V/C Ratios: Takapuna



8.1 Volume Over Capacity Plots 2026 Do Minimum Scenario

Figure 84: 2026 Do Minimum Scenario: AM Peak V/C Ratios: Whole Model

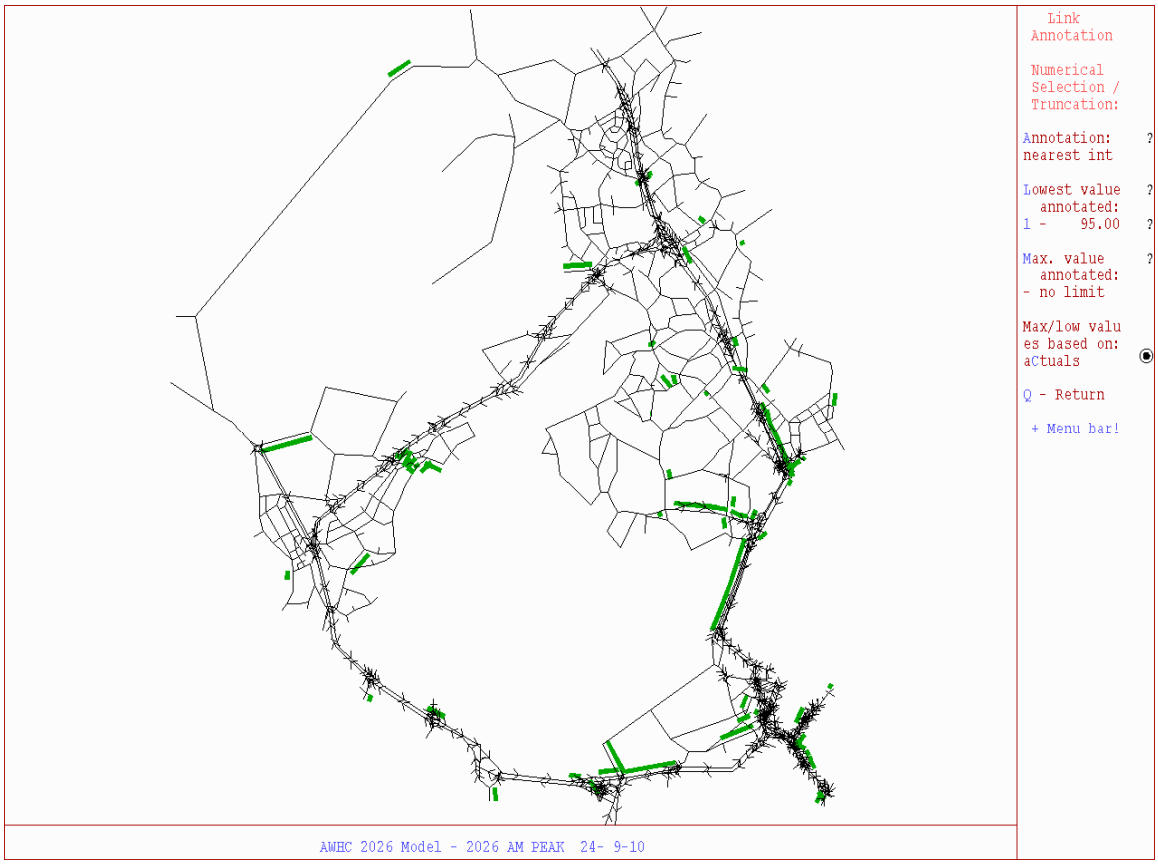


Figure 85: 2026 Do Minimum Scenario: AM Peak V/C Ratios: Auckland CBD

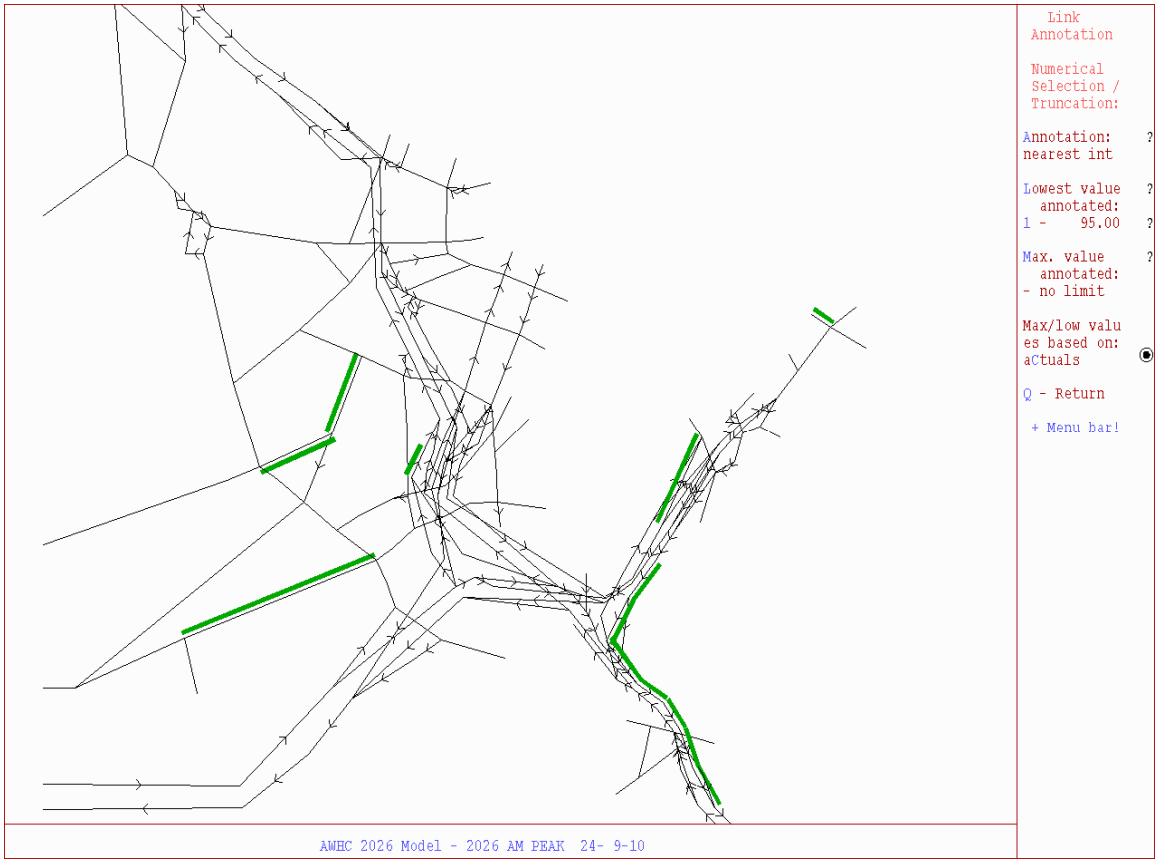


Figure 86: 2026 Do Minimum Scenario: AM Peak V/C Ratios: Takapuna

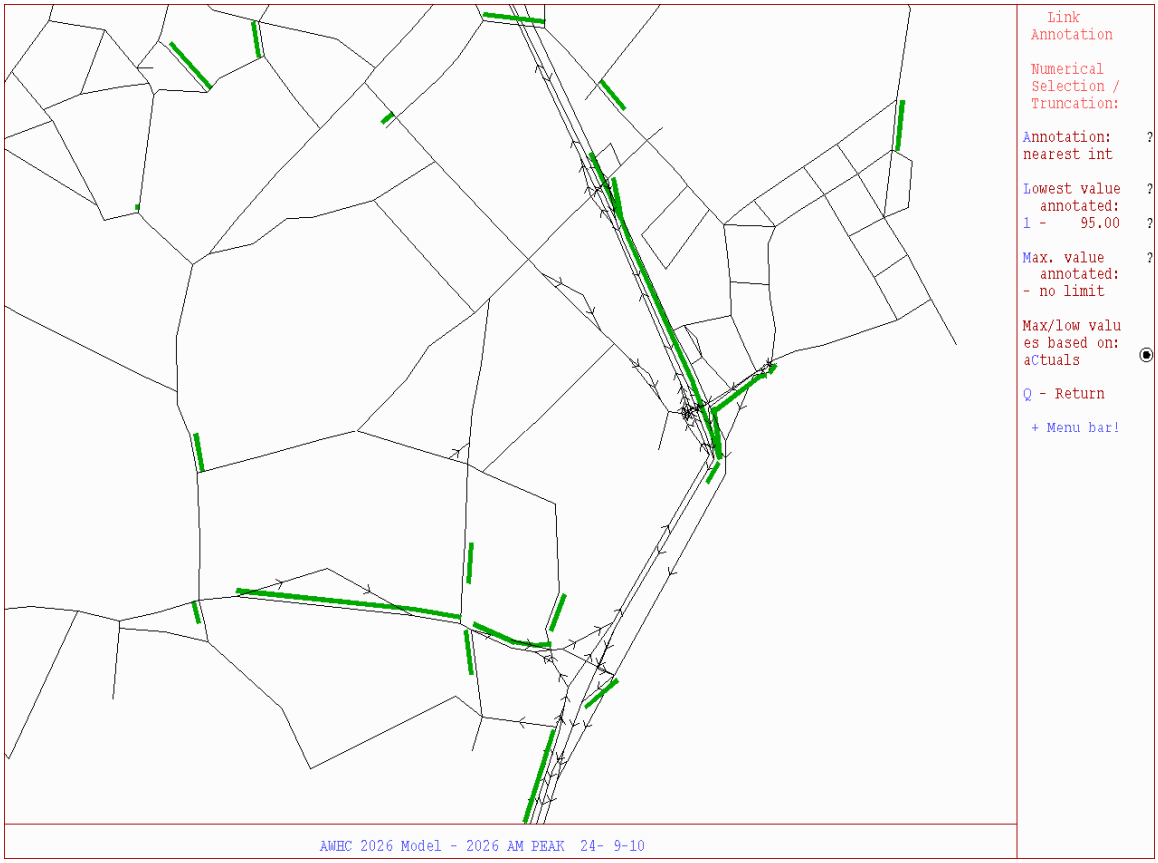


Figure 87: 2026 Do Minimum Scenario: Inter Peak V/C Ratios: Whole Model

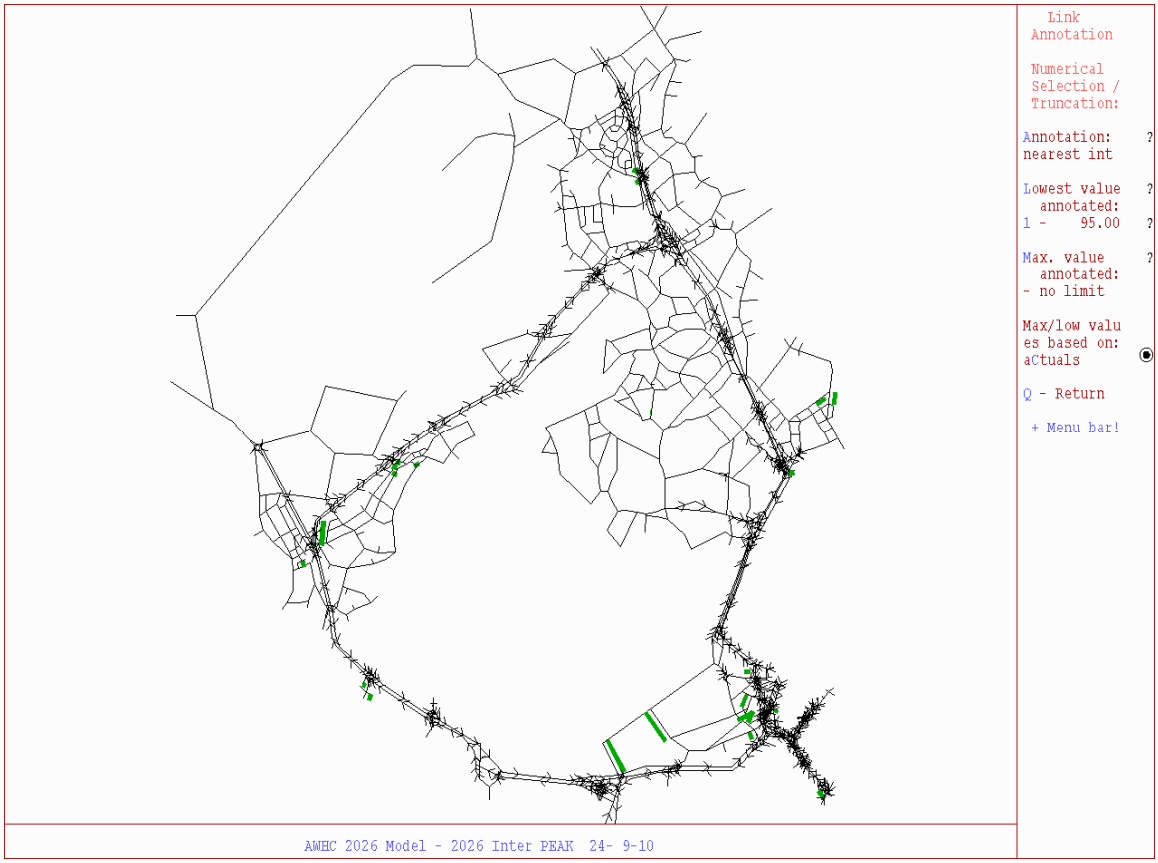


Figure 88: 2026 Do Minimum Scenario: Inter Peak V/C Ratios: Auckland CBD

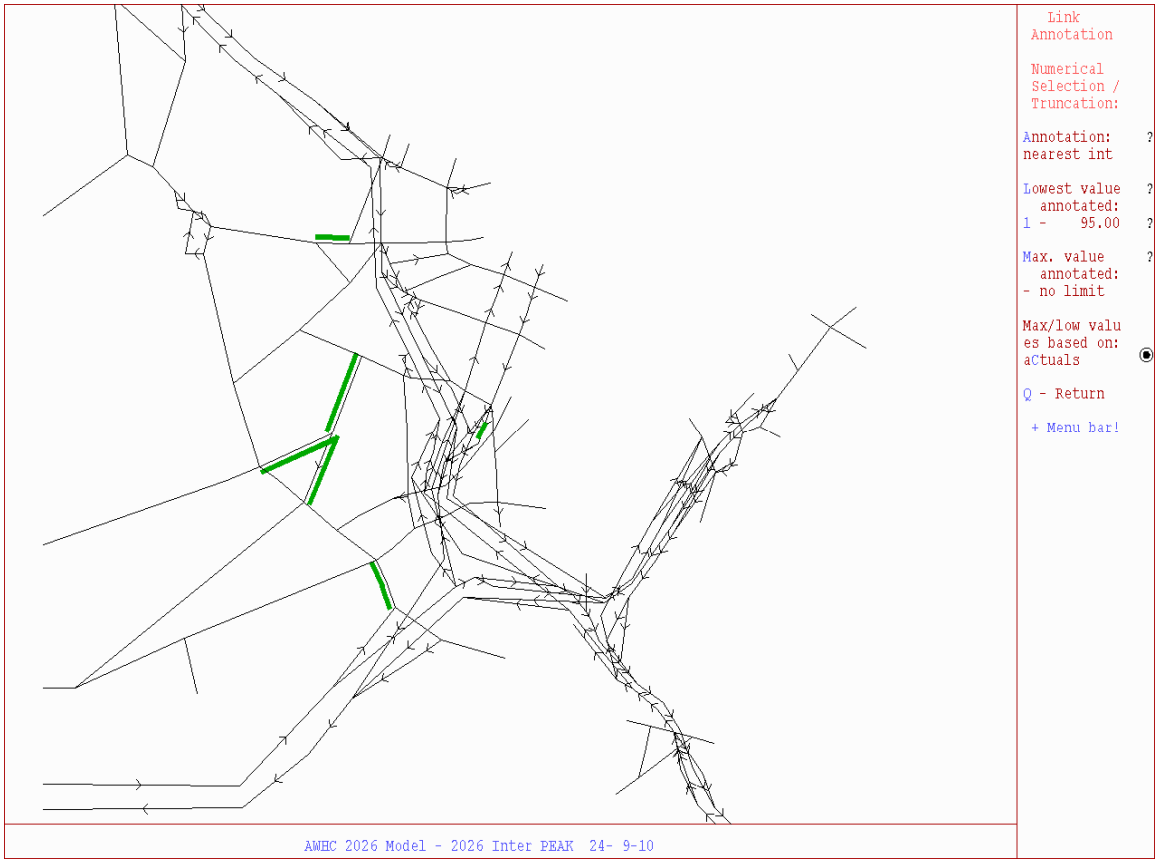


Figure 89: 2026 Do Minimum Scenario: Inter Peak V/C Ratios: Takapuna

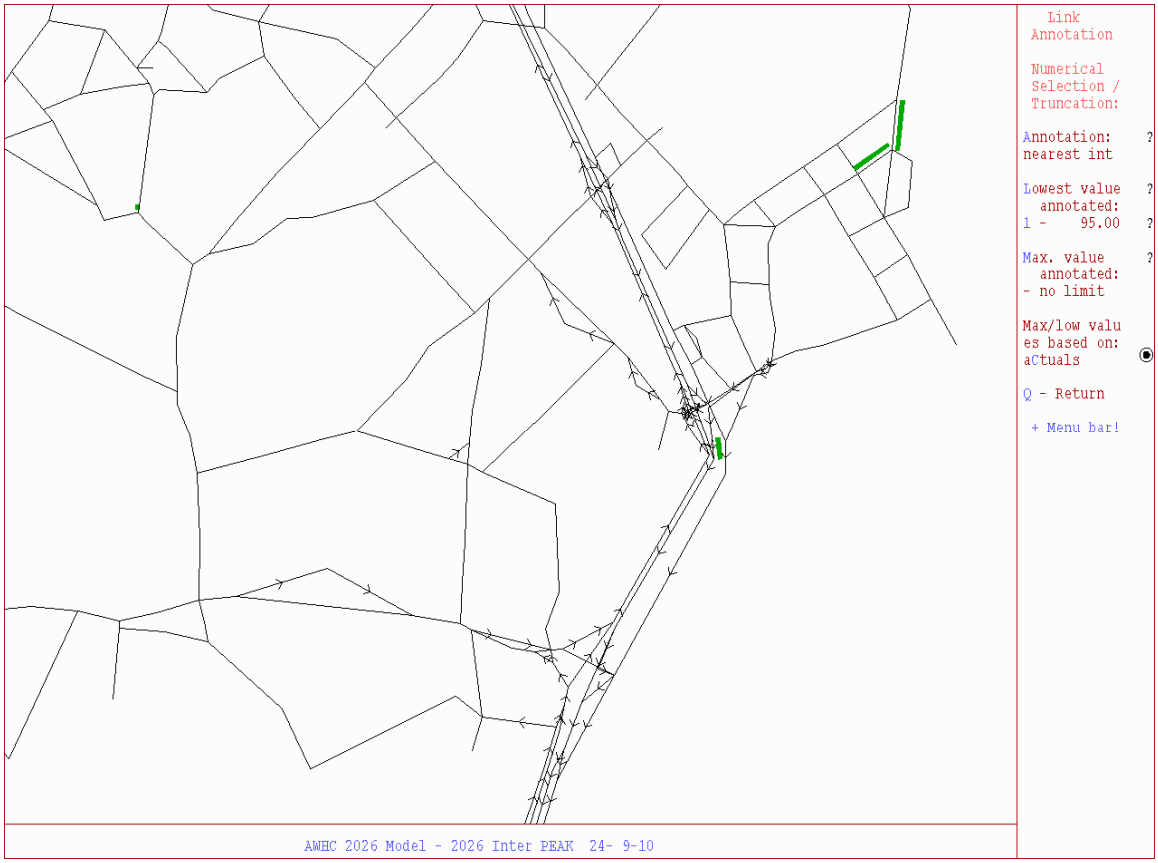


Figure 90: 2026 Do Minimum Scenario: PM Peak V/C Ratios: Whole Model

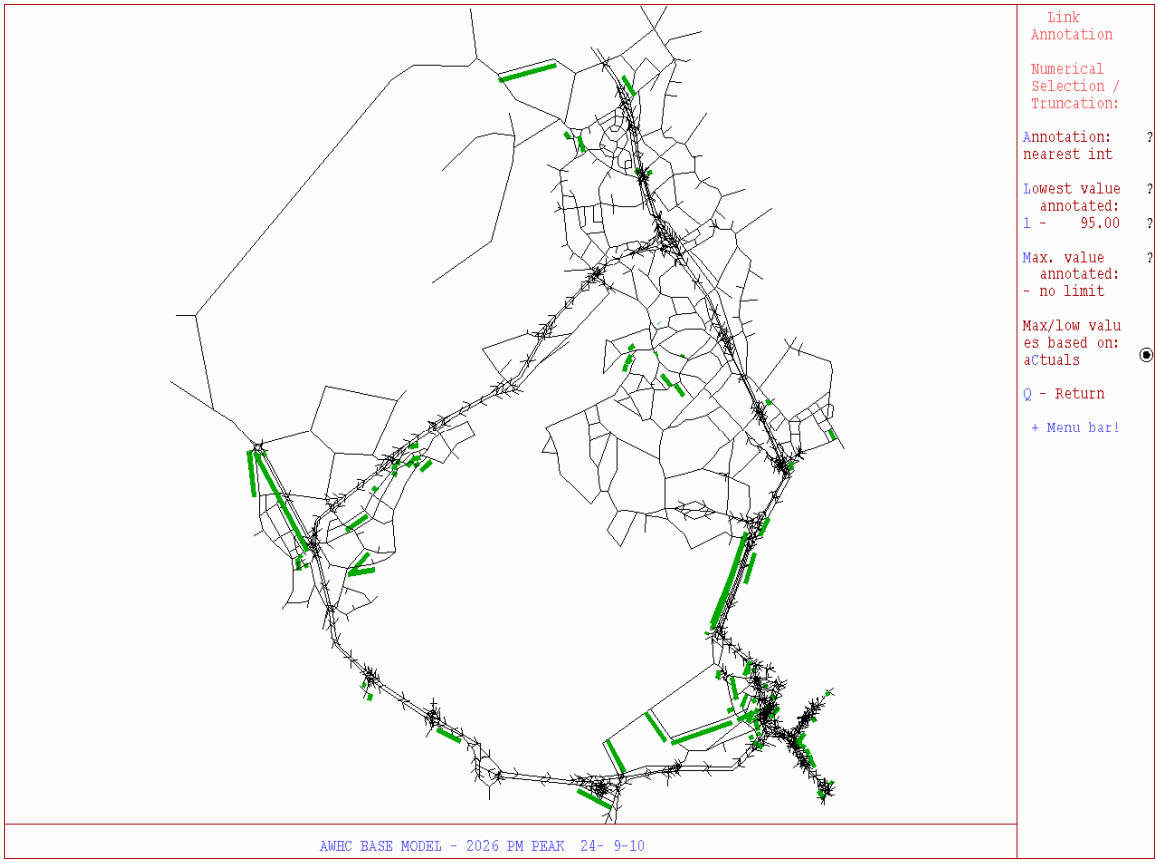


Figure 91: 2026 Do Minimum Scenario: PM Peak V/C Ratios: Auckland CBD

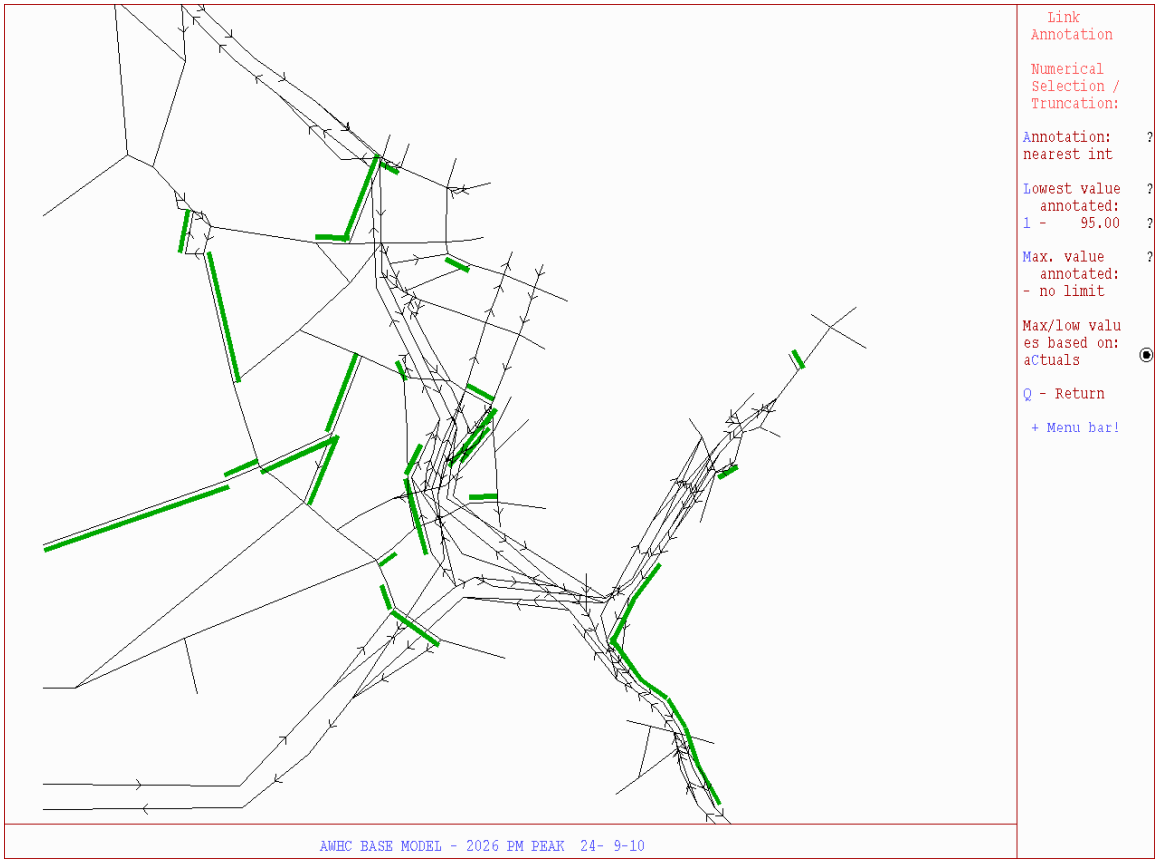
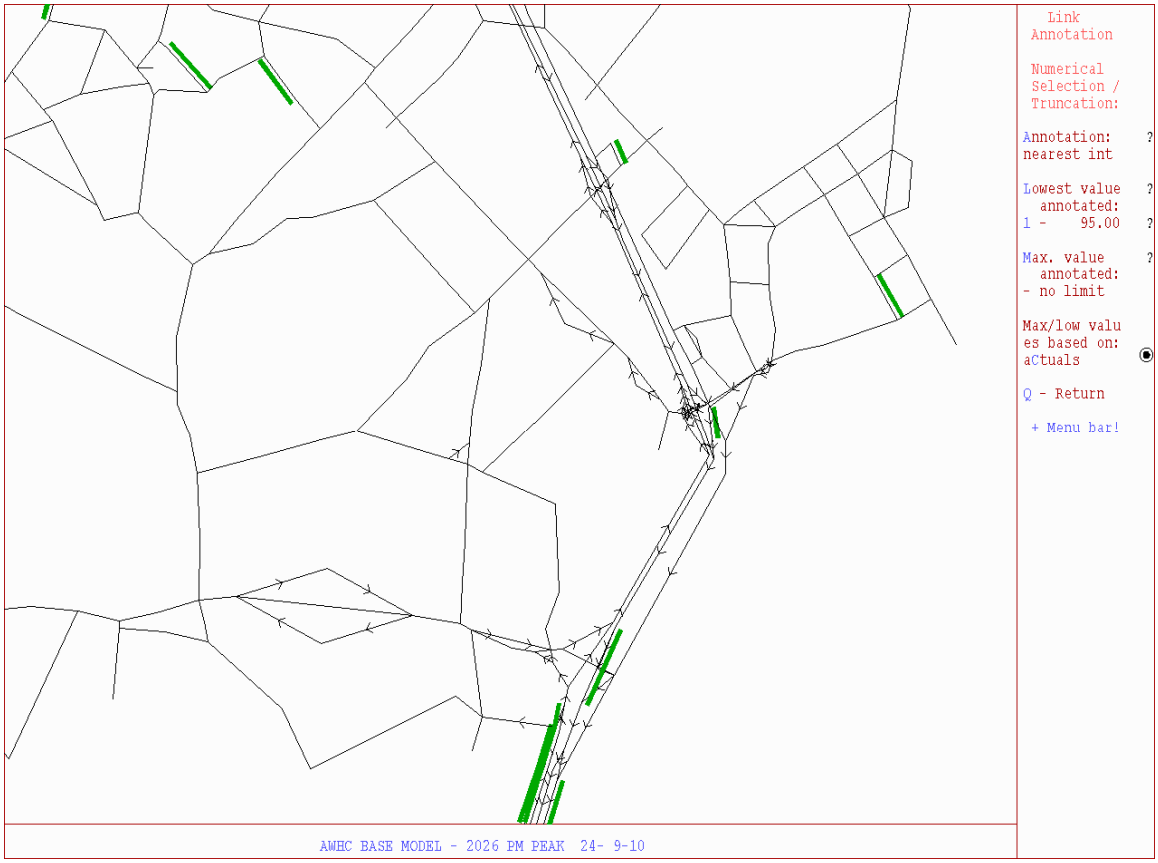


Figure 92: 2026 Do Minimum Scenario: PM Peak V/C Ratios: Takapuna



8.2 2026 Scenario with AWHC

Figure 93: 2026 with Additional Crossing: AM Peak V/C Ratios: Whole Model

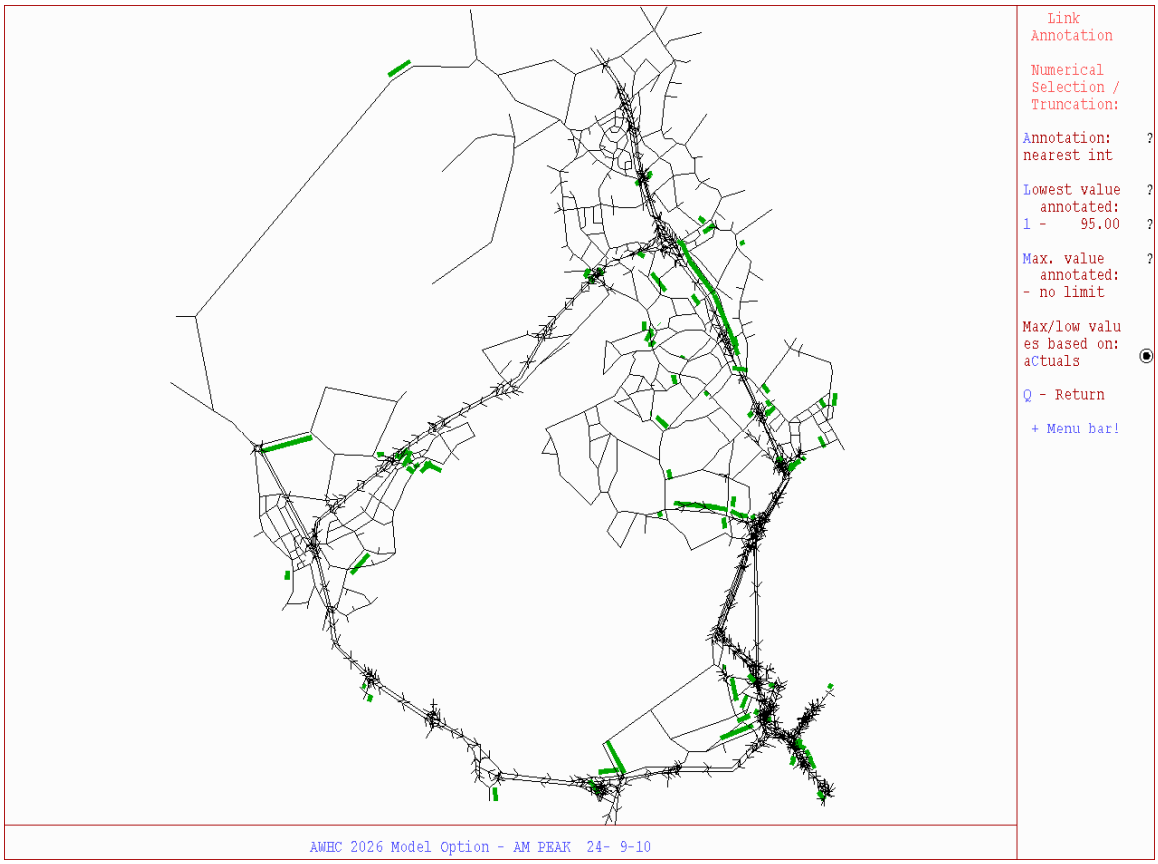


Figure 94: 2026 with Additional Crossing: AM Peak V/C Ratios: Auckland CBD

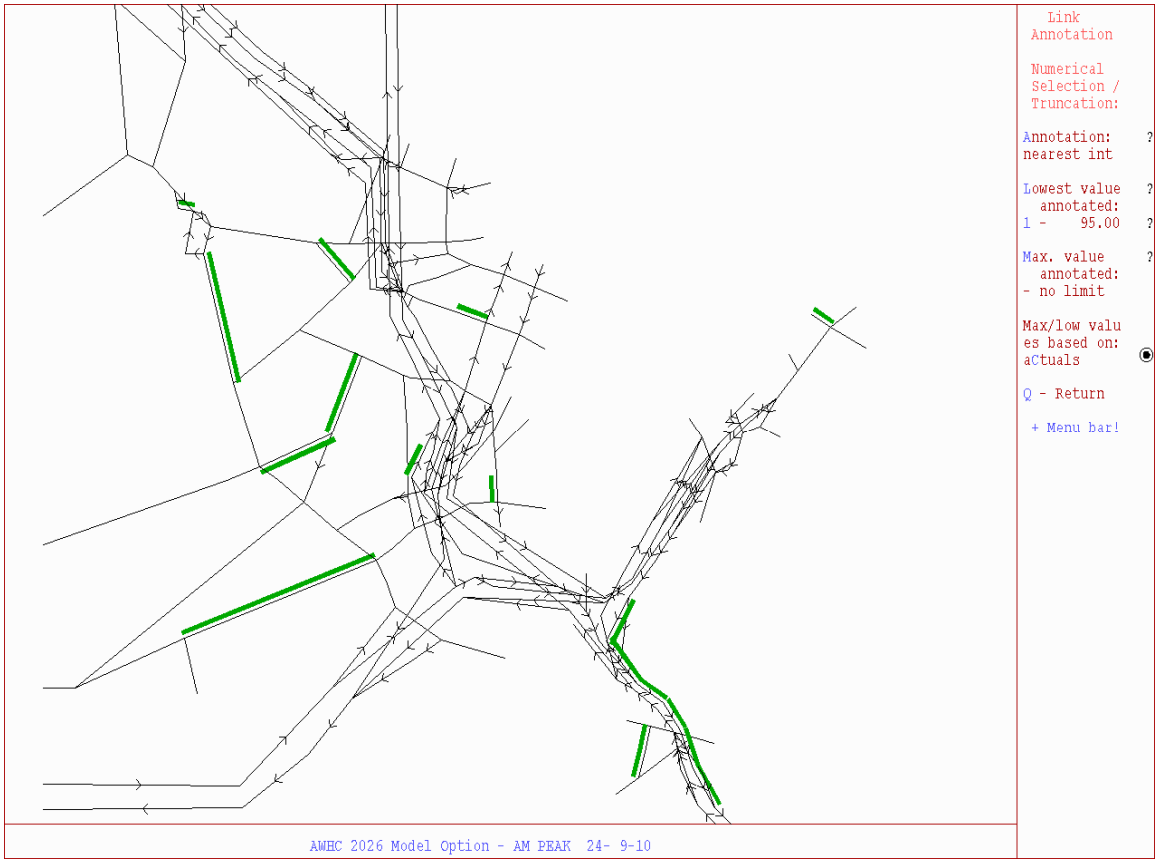


Figure 95: 2026 with Additional Crossing: AM Peak V/C Ratios: Takapuna

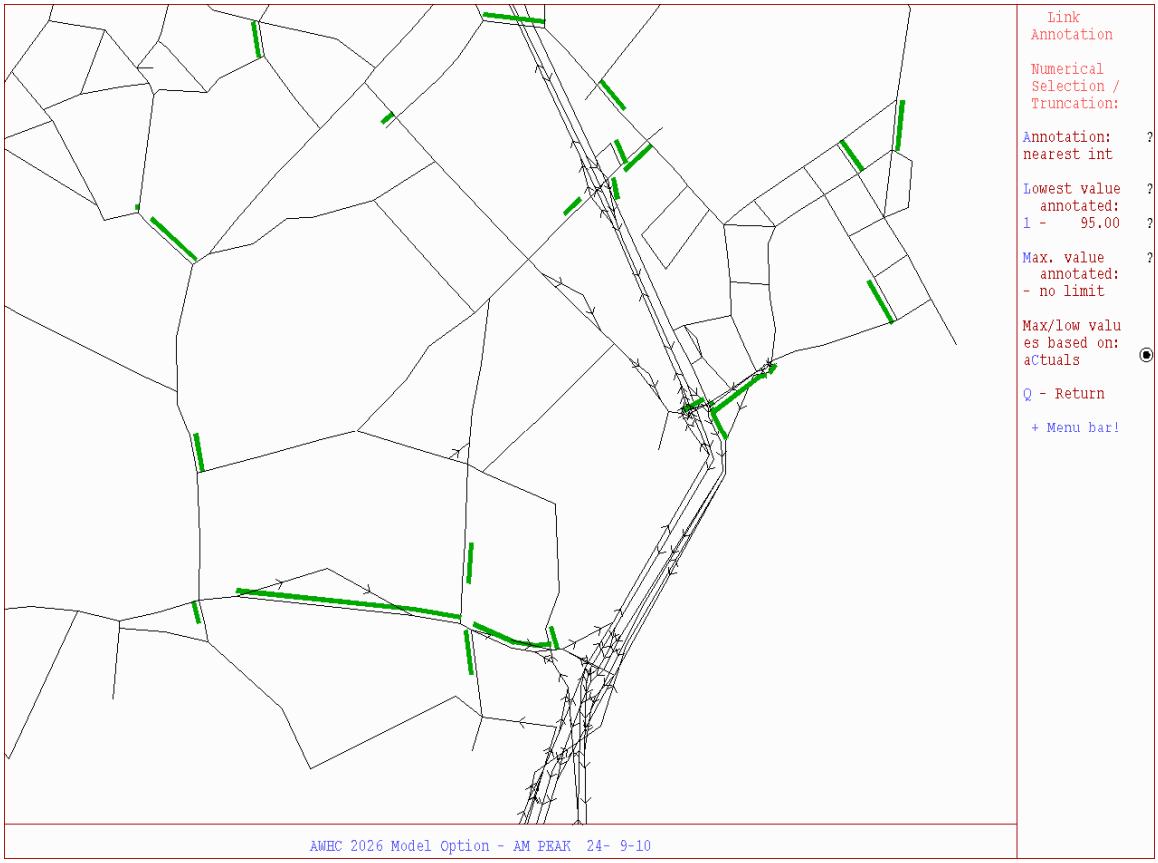


Figure 96: 2026 with Additional Crossing: Inter Peak V/C Ratios: Whole Model

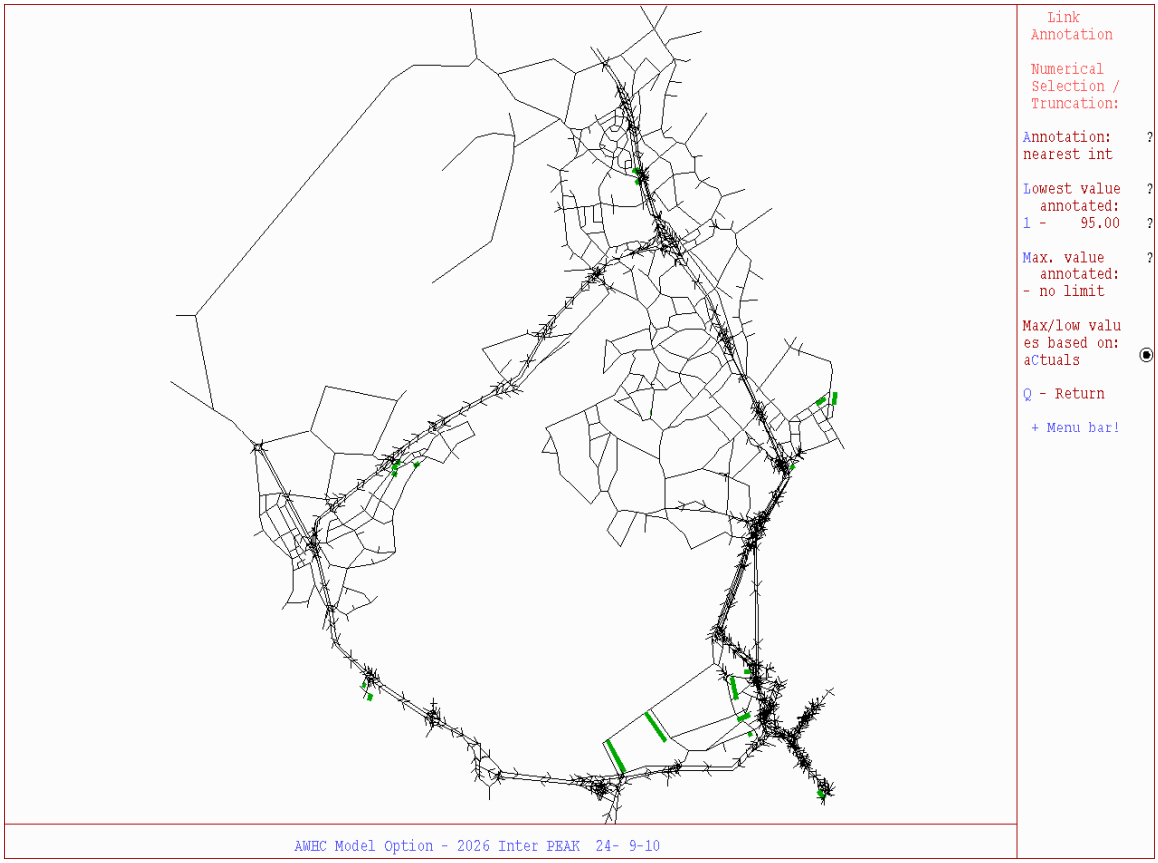


Figure 97: 2026 with Additional Crossing: Inter Peak V/C Ratios: Auckland CBD

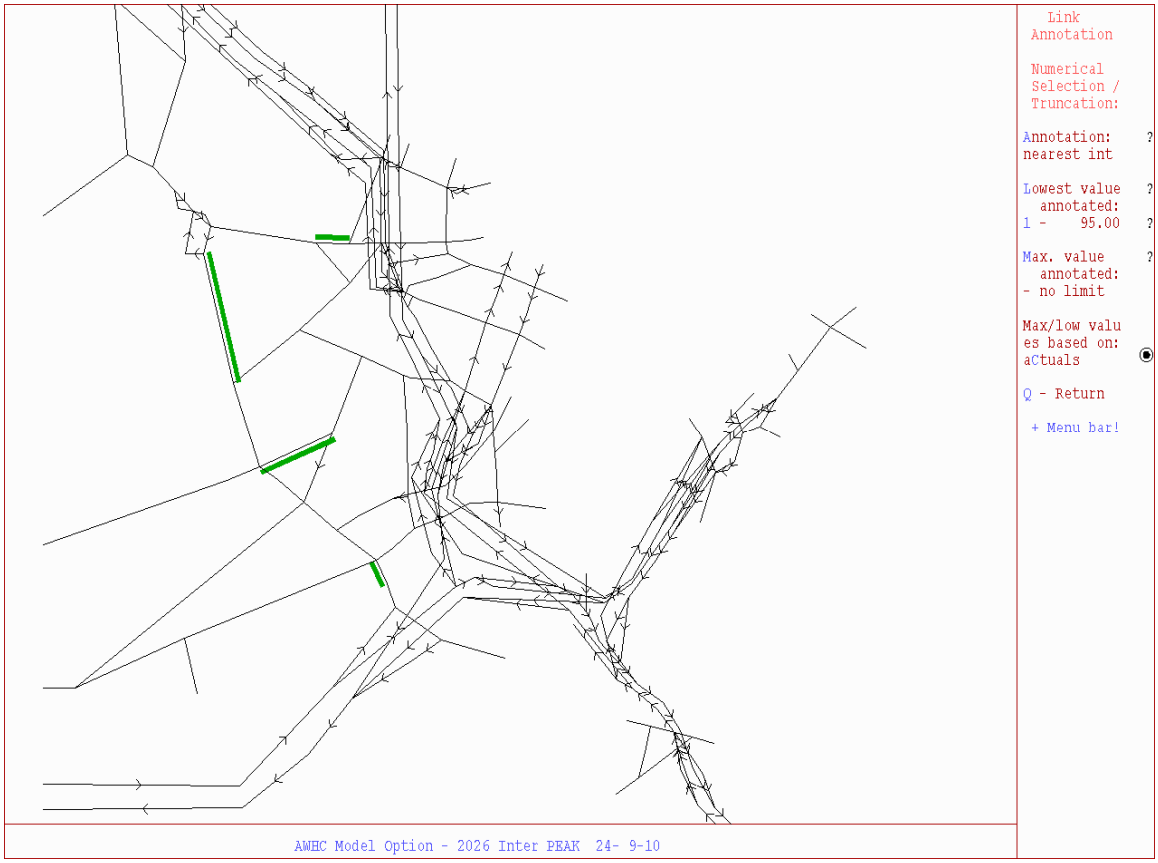


Figure 98: 2026 with Additional Crossing: Inter Peak V/C Ratios: Takapuna

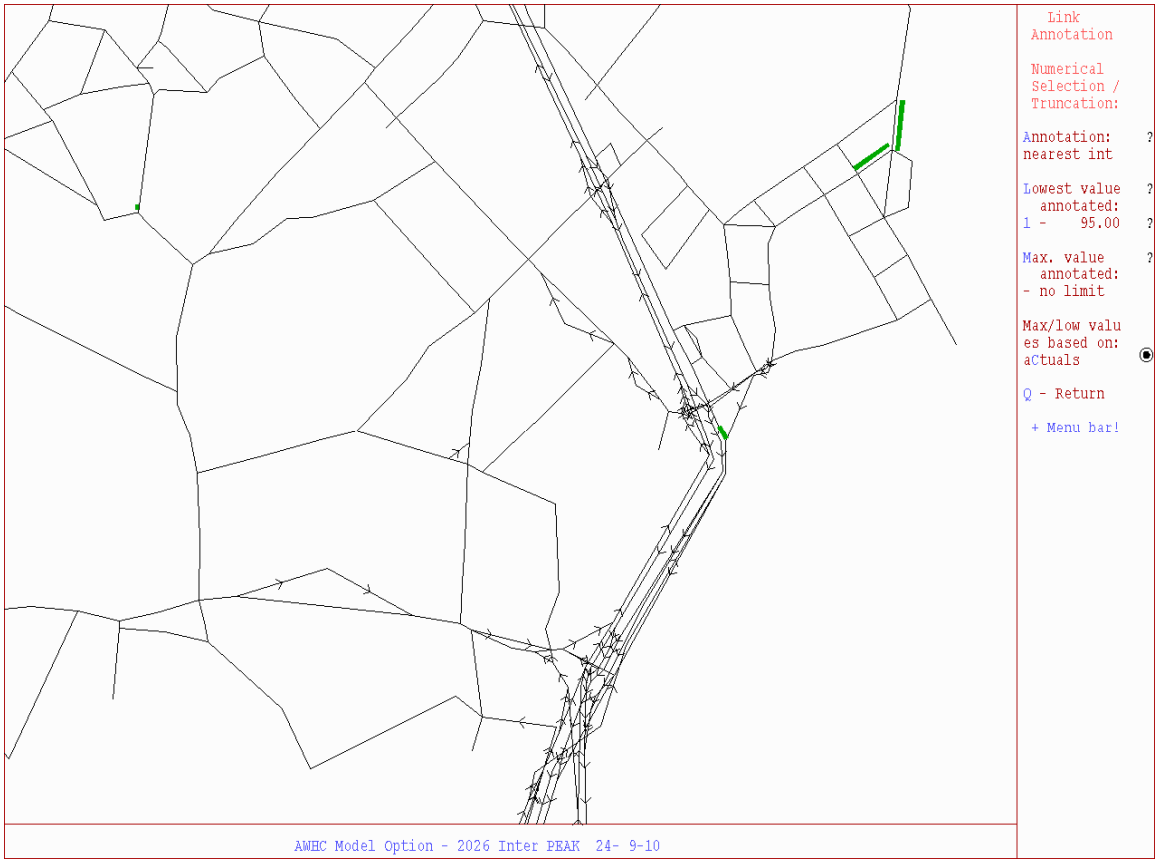


Figure 99: 2026 with Additional Crossing: PM Peak V/C Ratios: Whole Model

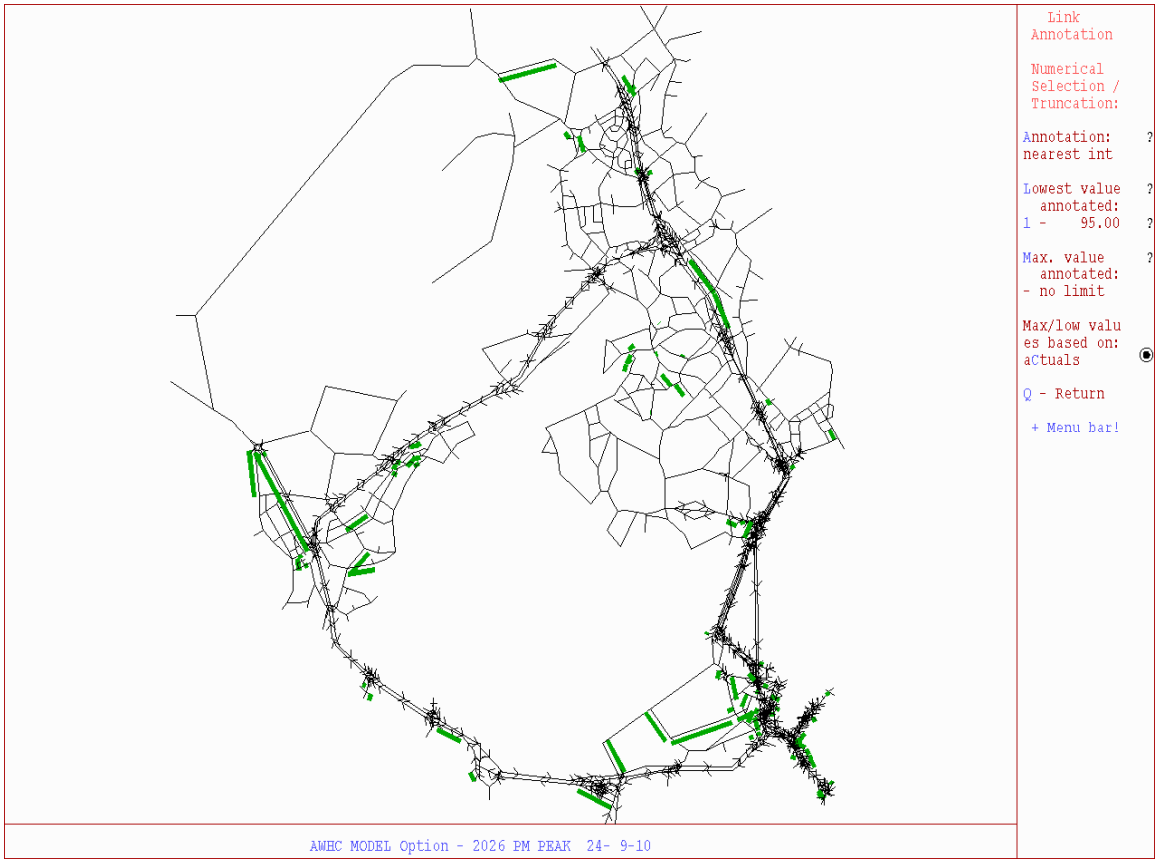


Figure 100: 2026 with Additional Crossing: PM Peak V/C Ratios: Auckland CBD

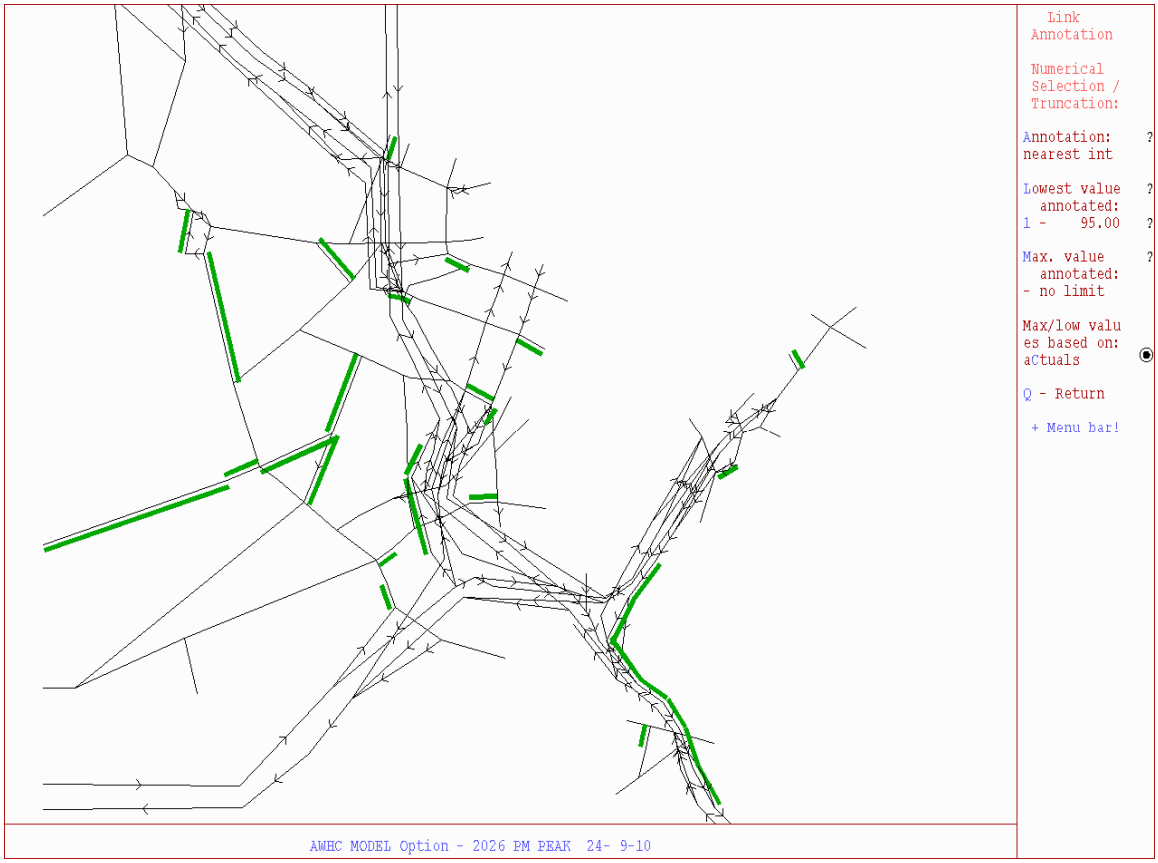
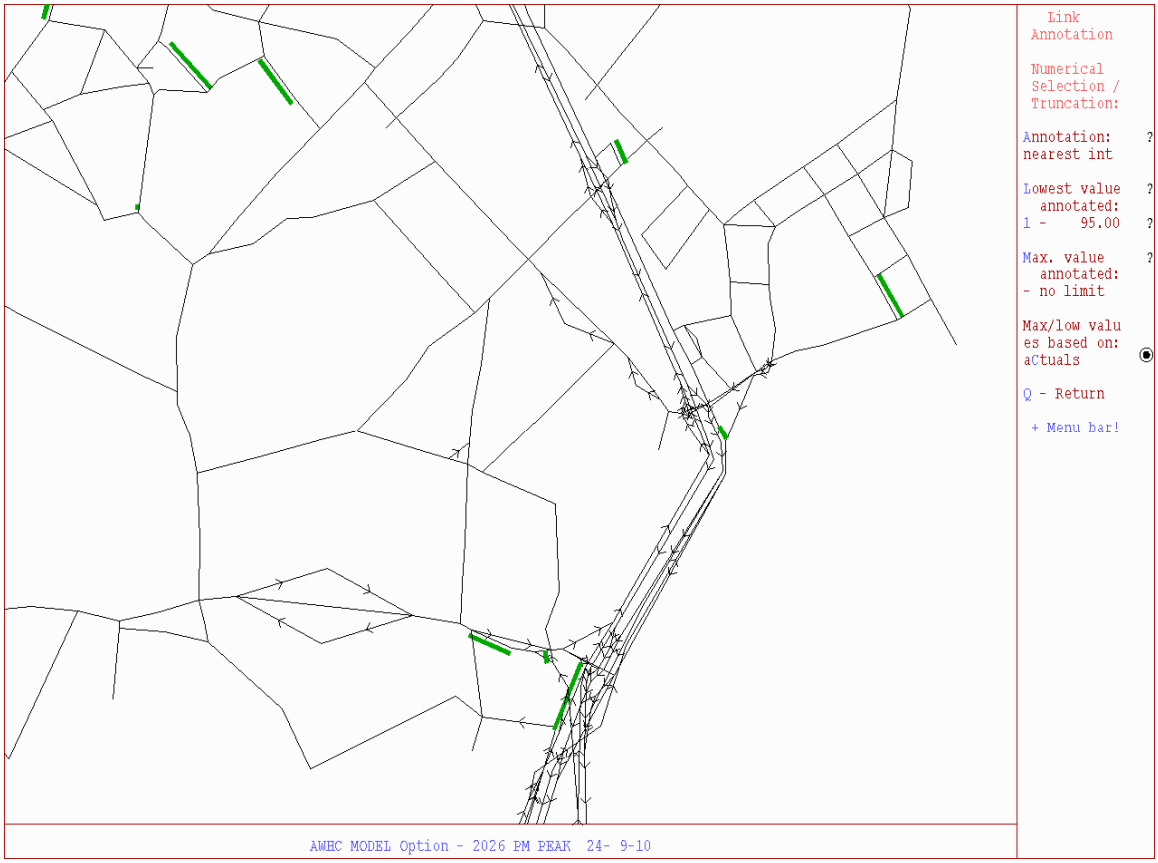


Figure 101: 2026 with Additional Crossing: PM Peak V/C Ratios: Takapuna



8.3 Volume Over Capacity Plots 2041 Do Minimum Scenario

Figure 102: 2041 Do Minimum Scenario: AM Peak V/C Ratios: Whole Model (V/C)

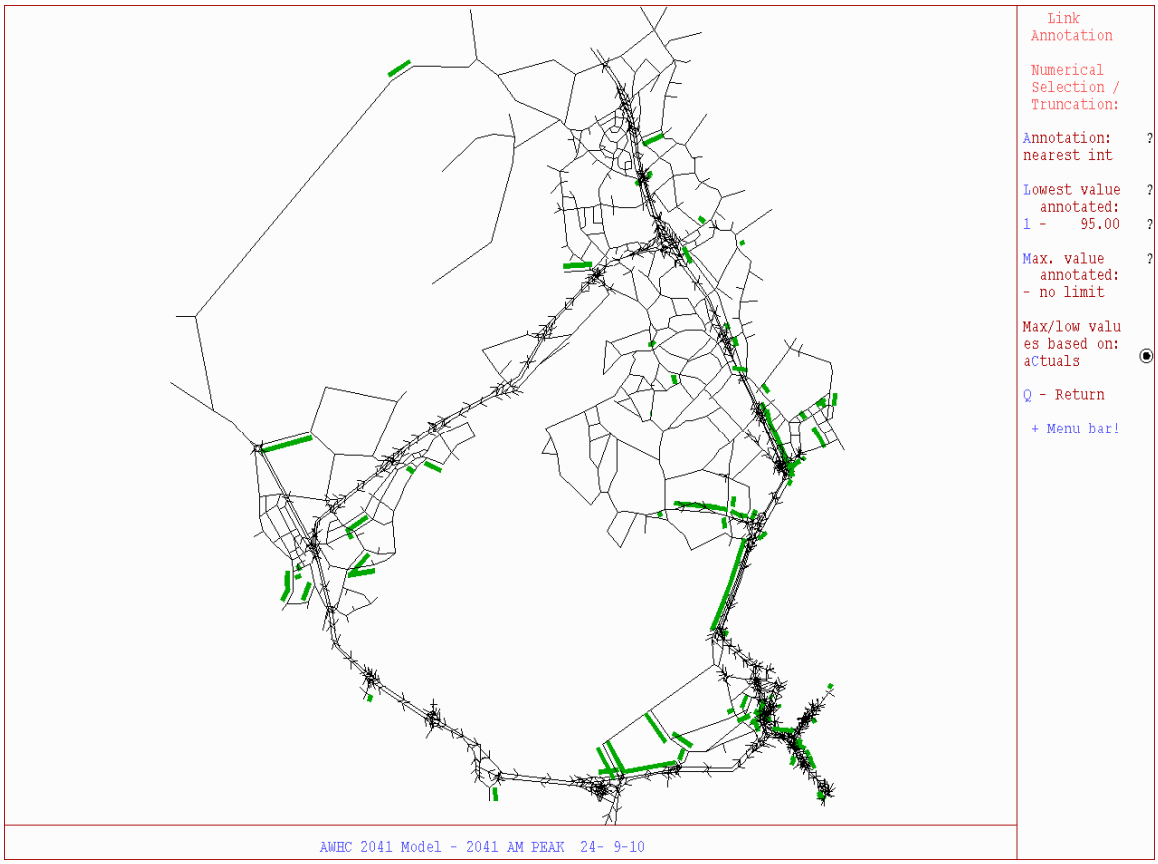


Figure 103: 2041 Do Minimum Scenario: AM Peak V/C Ratios: Auckland CBD

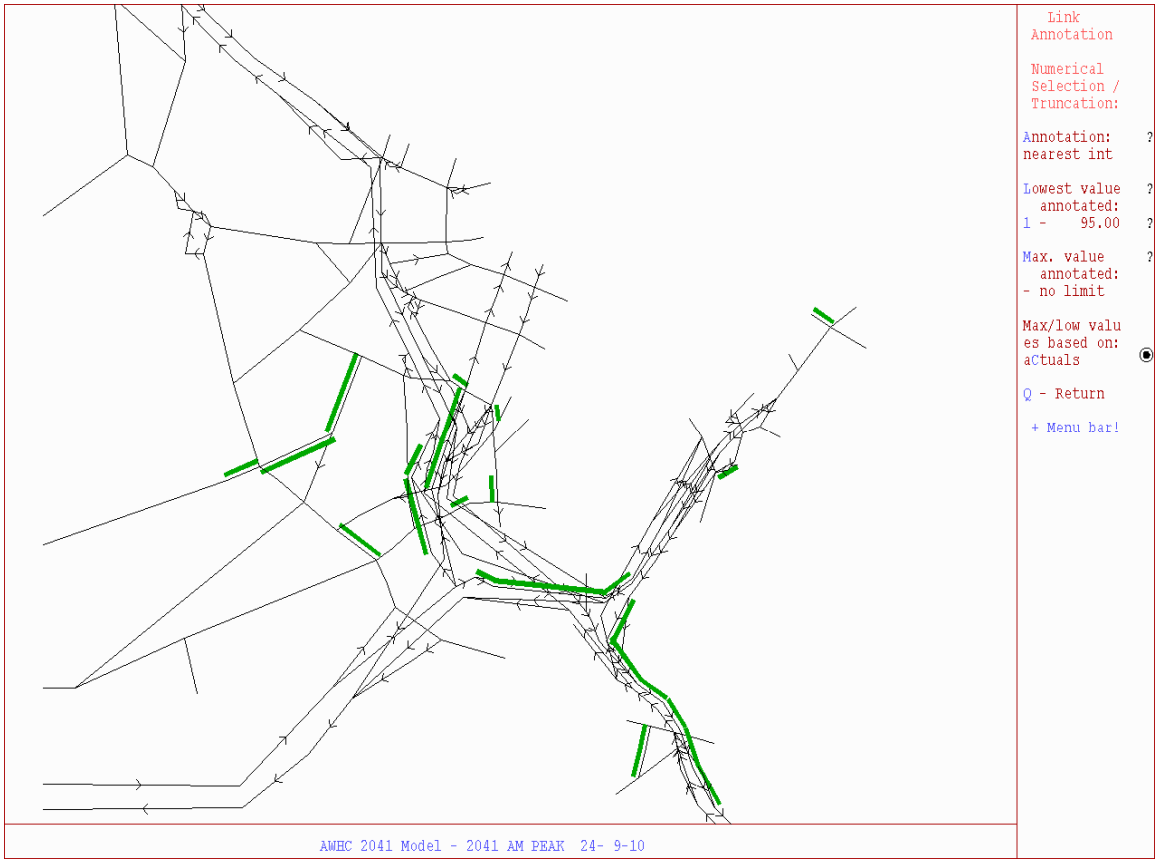


Figure 104: 2041 Do Minimum Scenario: AM Peak V/C Ratios: Takapuna

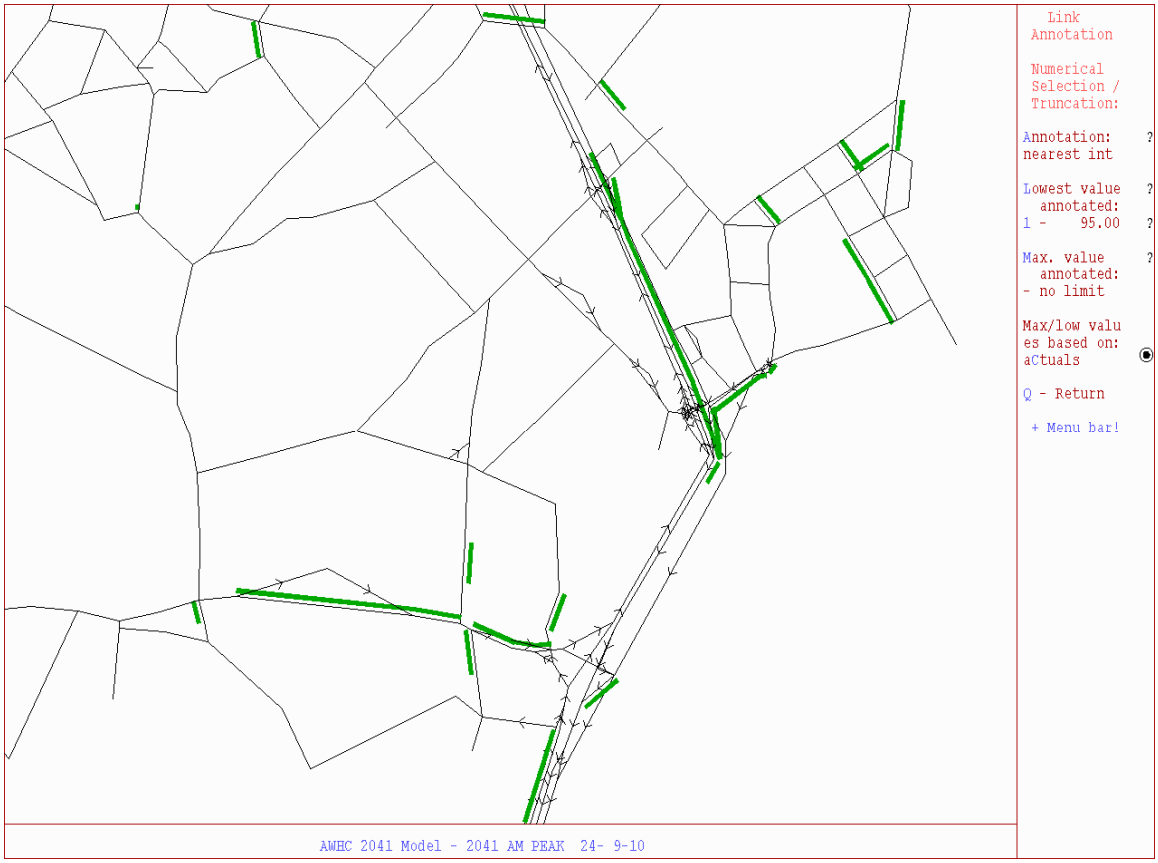


Figure 105: 2041 Do Minimum Scenario: Inter Peak V/C Ratios: Whole Model

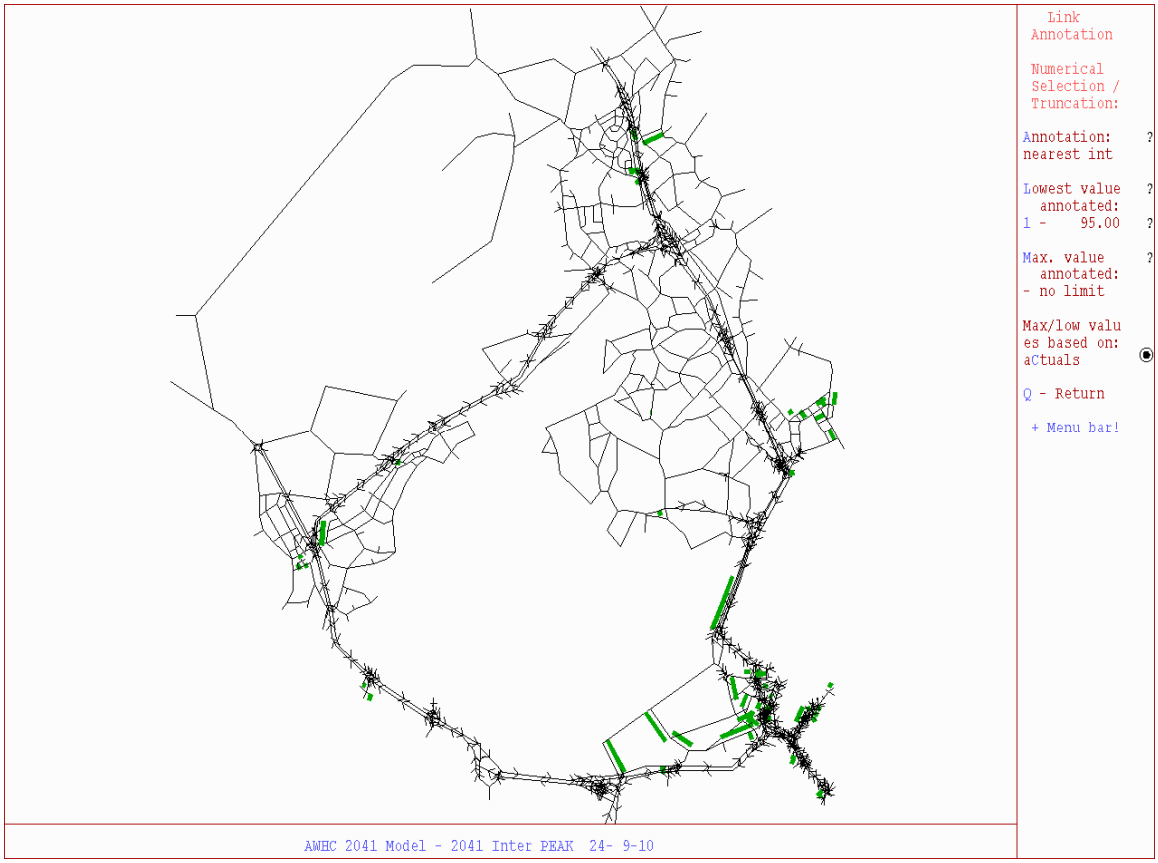


Figure 106: 2041 Do Minimum Scenario: Inter Peak V/C Ratios: Auckland CBD

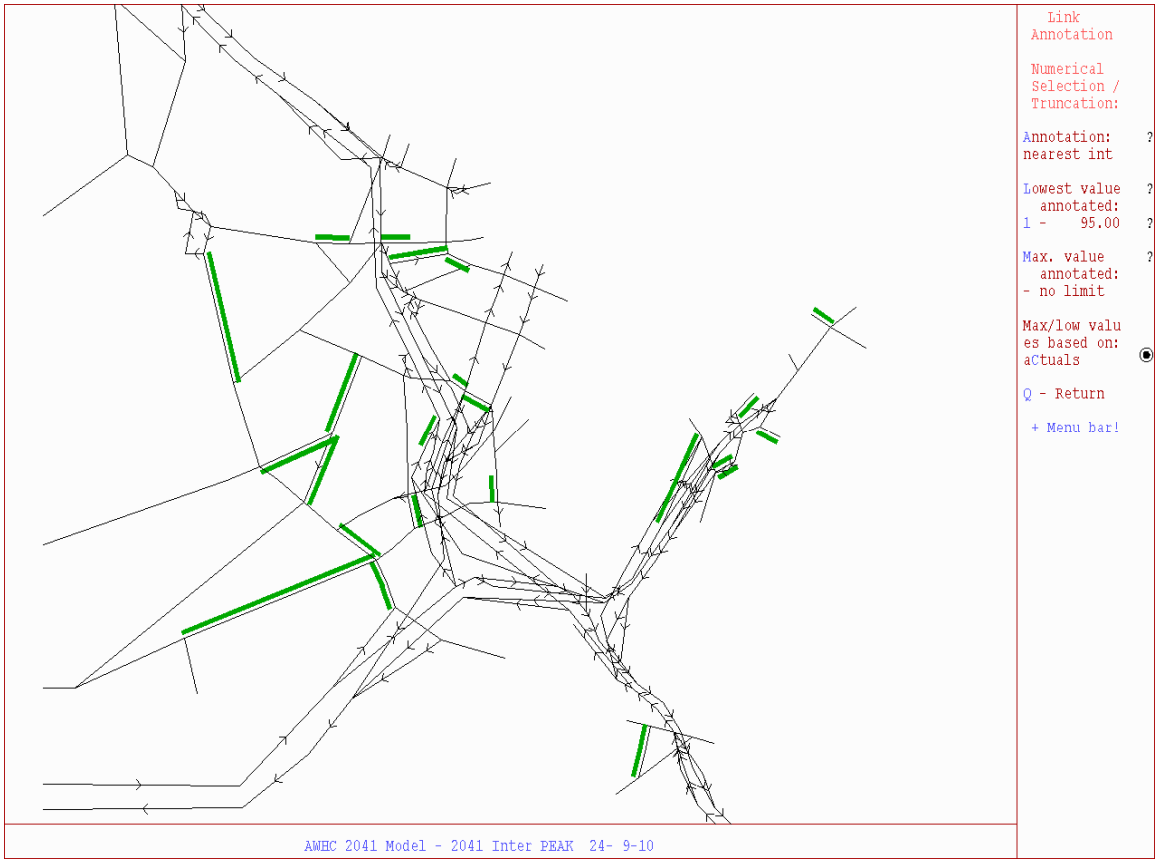


Figure 107: 2041 Do Minimum Scenario: Inter Peak V/C Ratios: Takapuna

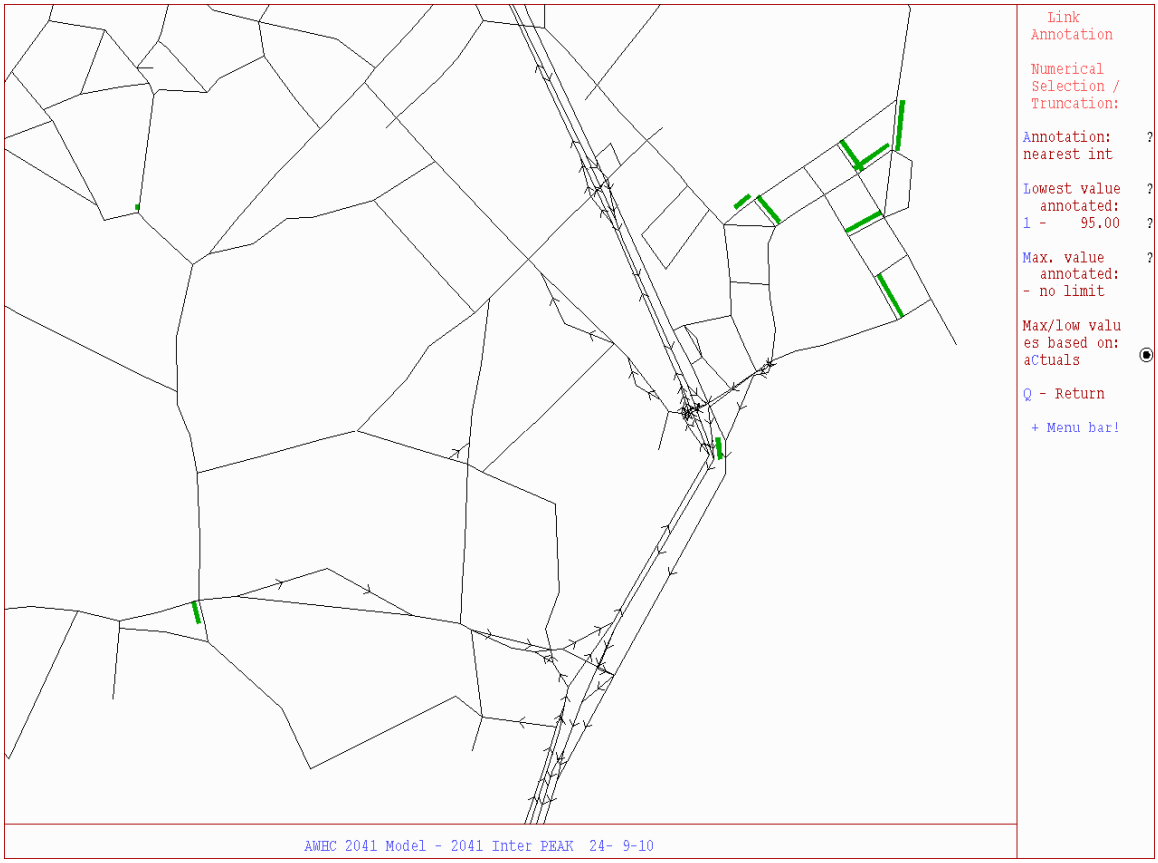


Figure 108: 2041 Do Minimum Scenario: PM Peak V/C Ratios: Whole Model

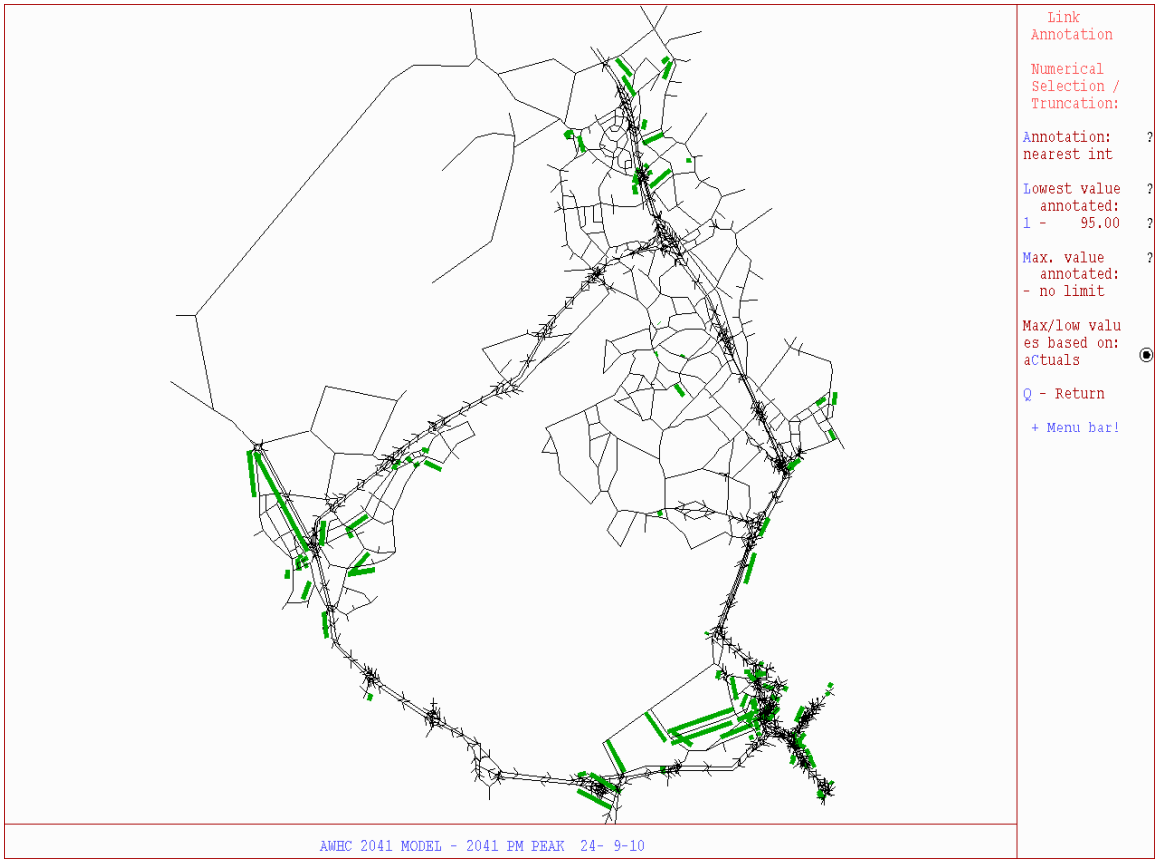


Figure 109: 2041 Do Minimum Scenario: PM Peak V/C Ratios: Auckland CBD

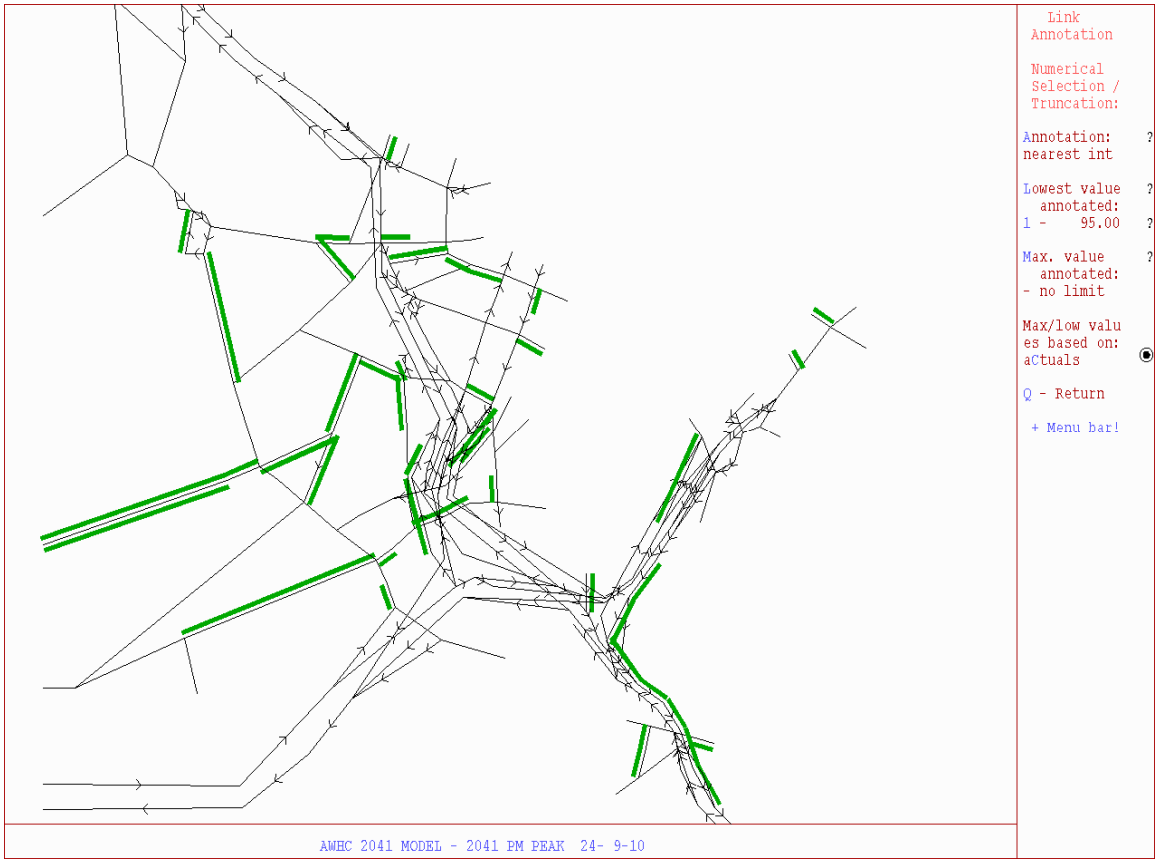
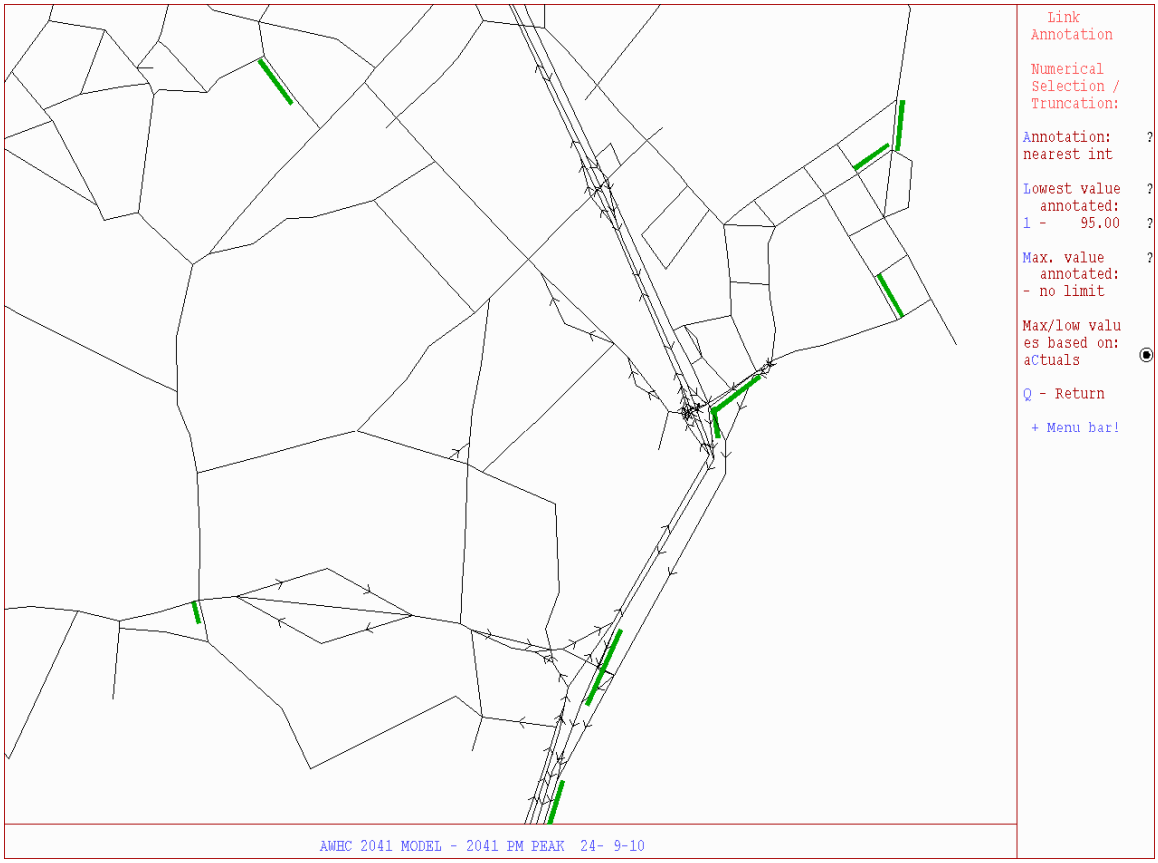


Figure 110: 2041 Do Minimum Scenario: PM Peak V/C Ratios: Takapuna



8.4 2041 Scenario with AWHC

Figure 111: 2041 with Additional Crossing: AM Peak V/C Ratios: Whole Model

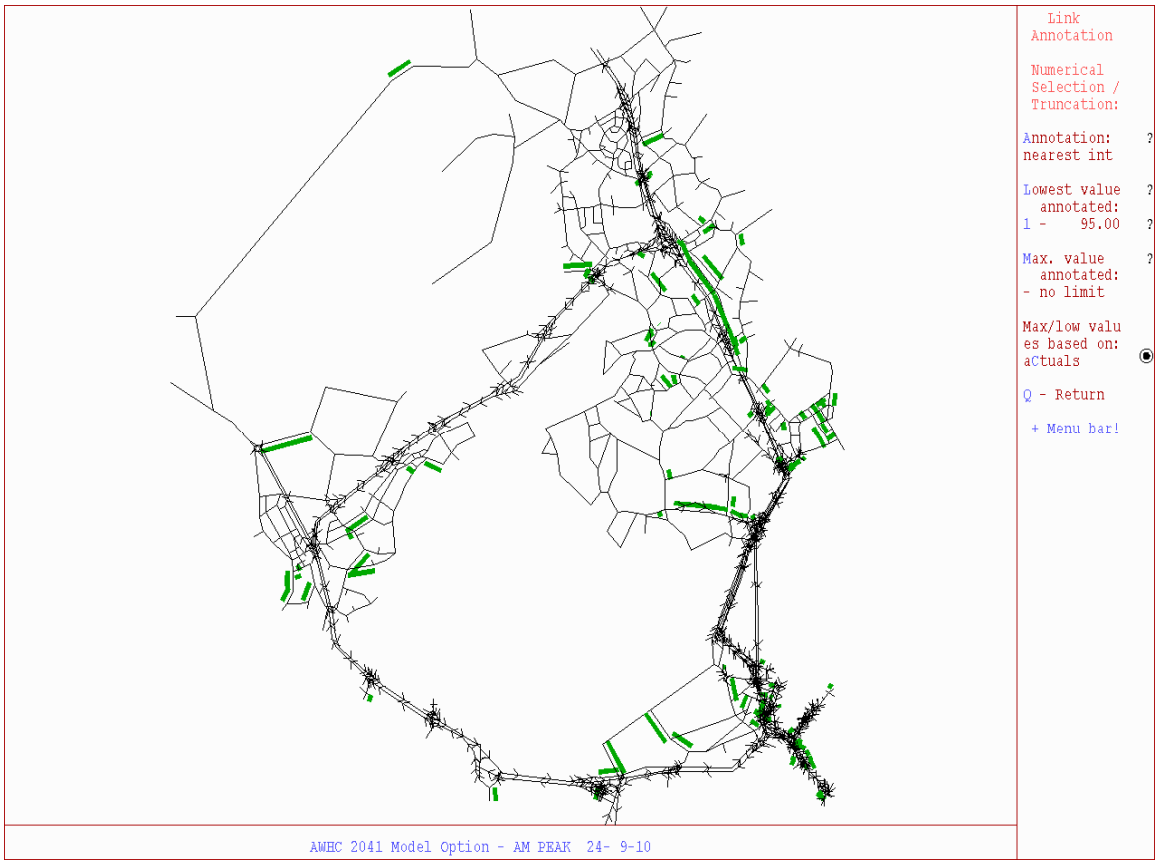


Figure 112: 2041 with Additional Crossing: AM Peak V/C Ratios: Auckland CBD

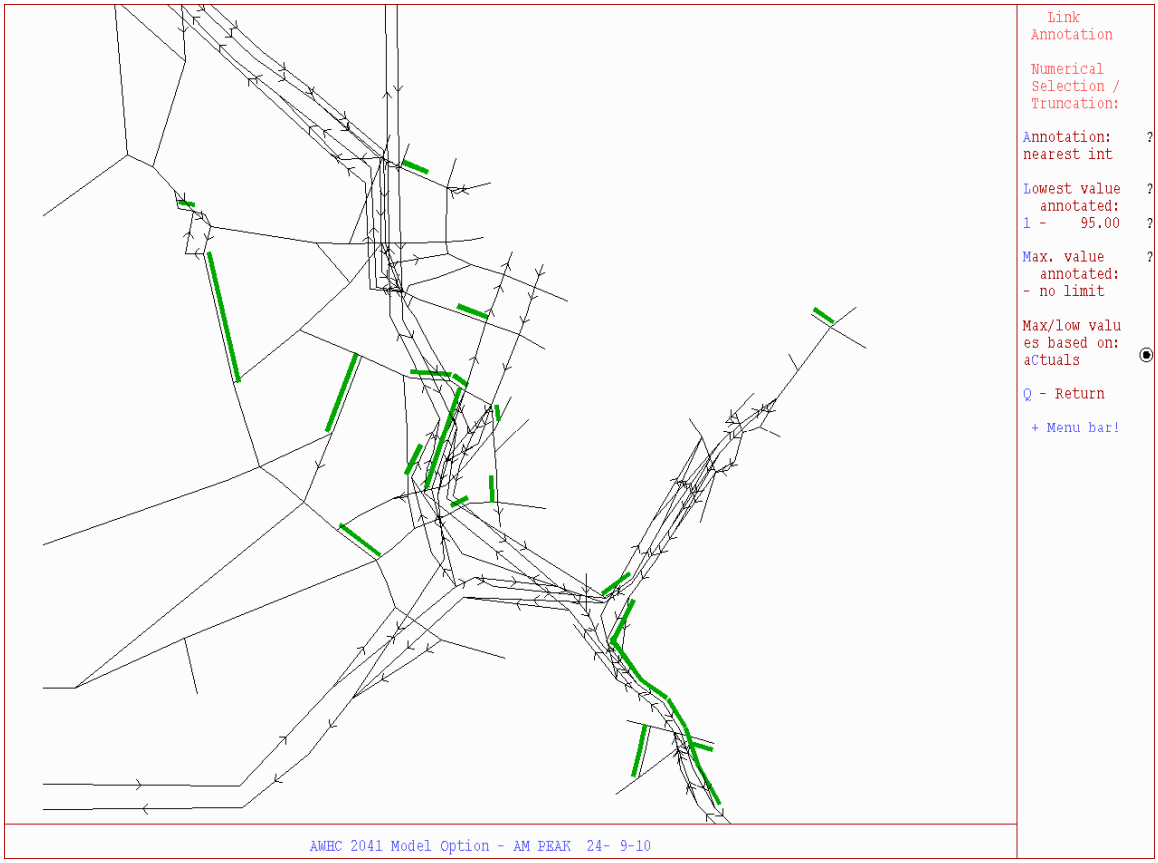


Figure 113: 2041 with Additional Crossing: AM Peak V/C Ratios: Takapuna

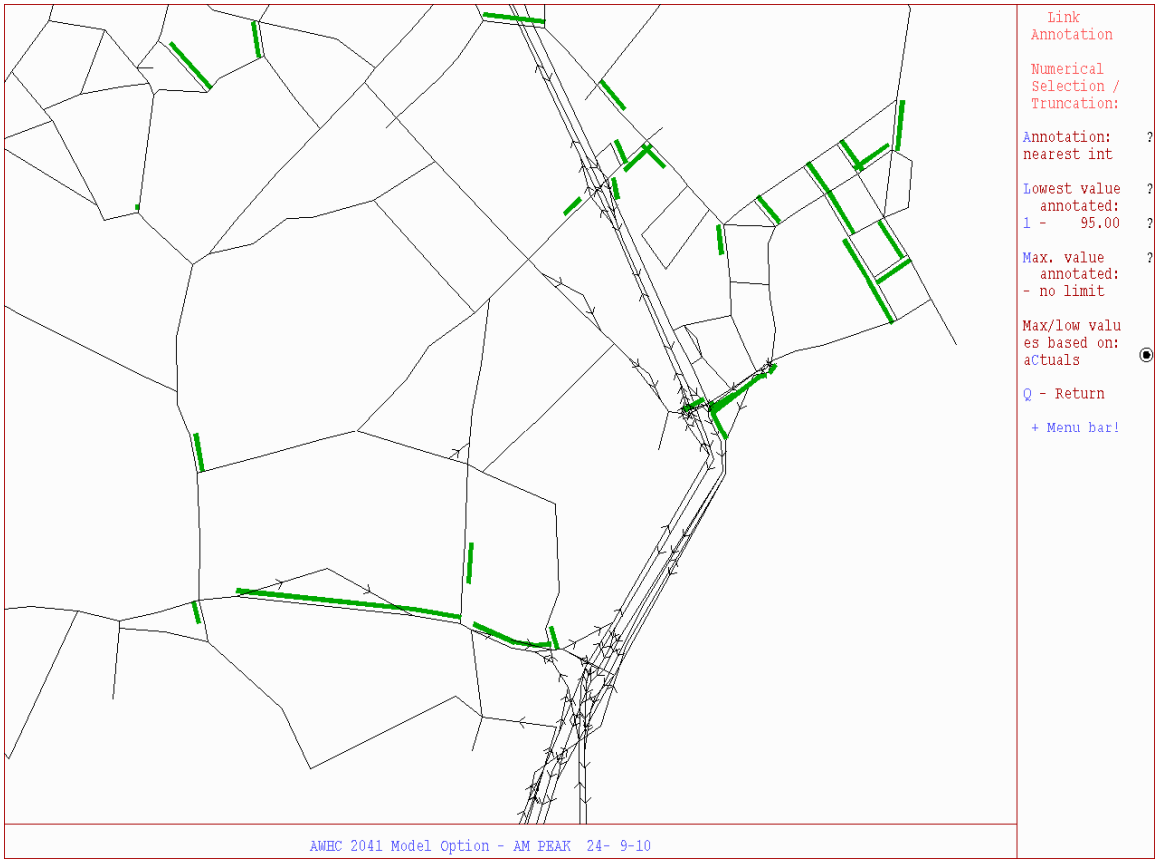


Figure 114: 2041 with Additional Crossing: Inter Peak V/C Ratios: Whole Model

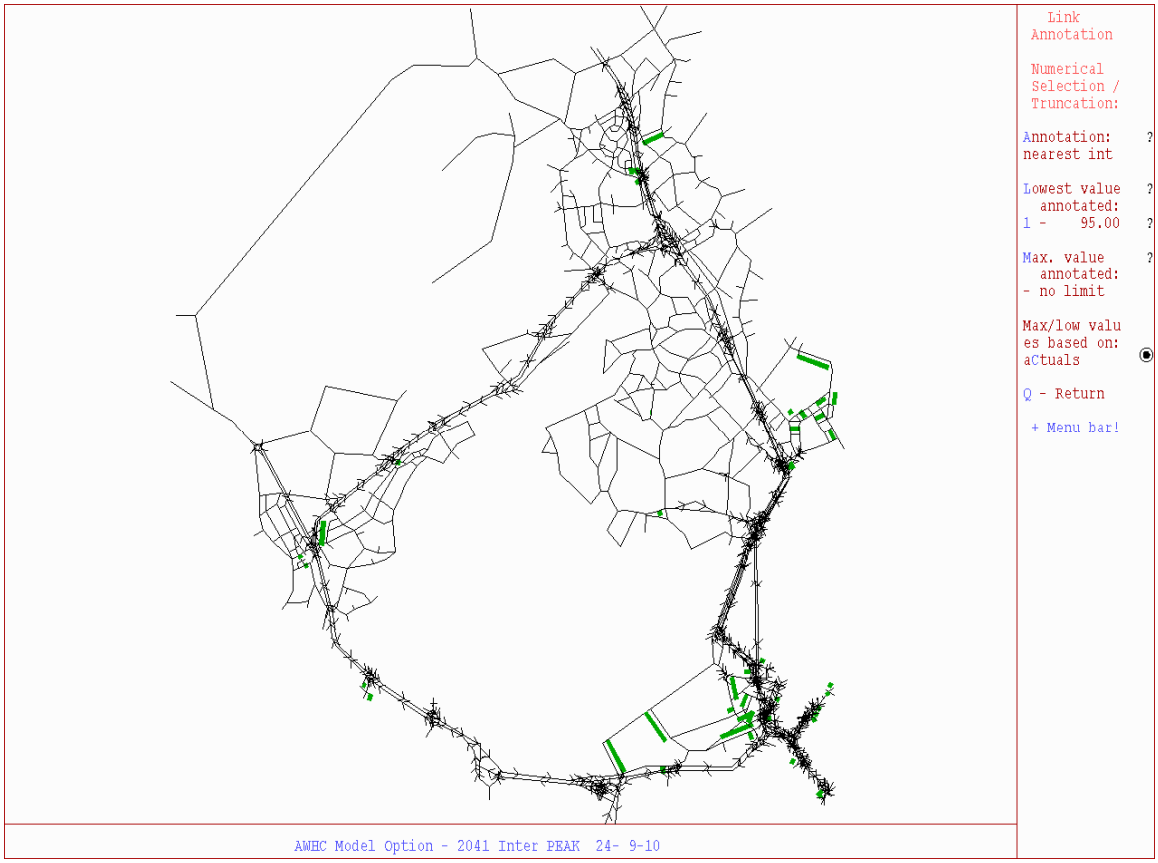


Figure 115: 2041 with Additional Crossing: Inter Peak V/C Ratios: Auckland CBD

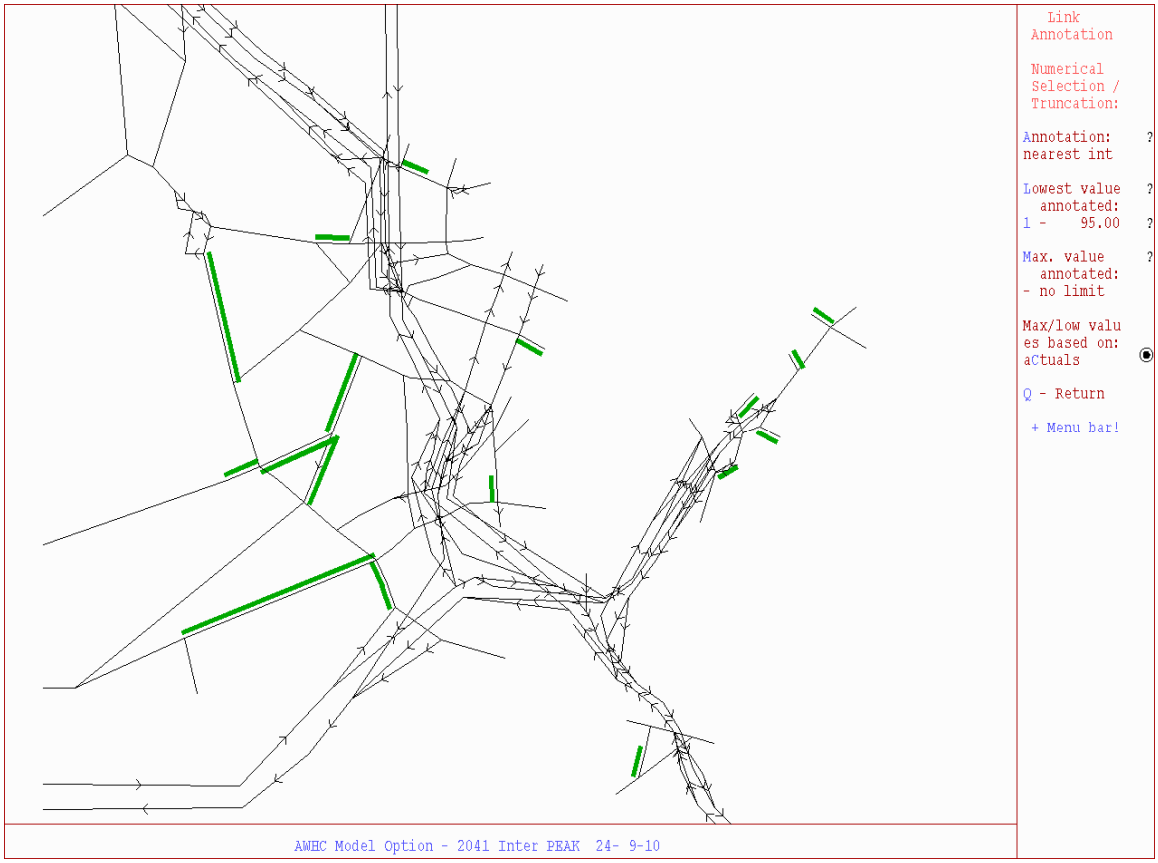


Figure 116: 2041 with Additional Crossing: Inter Peak V/C Ratios: Takapuna

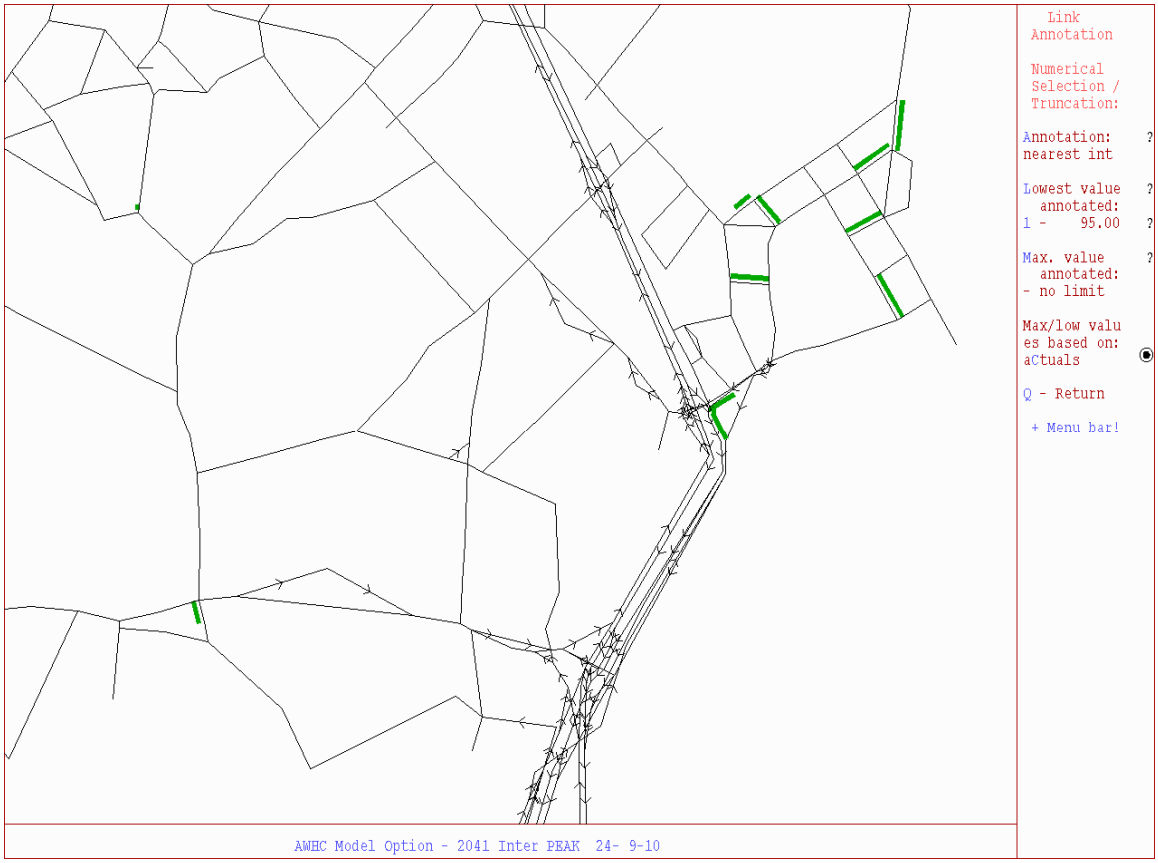


Figure 117: 2041 with Additional Crossing: PM Peak V/C Ratios: Whole Model

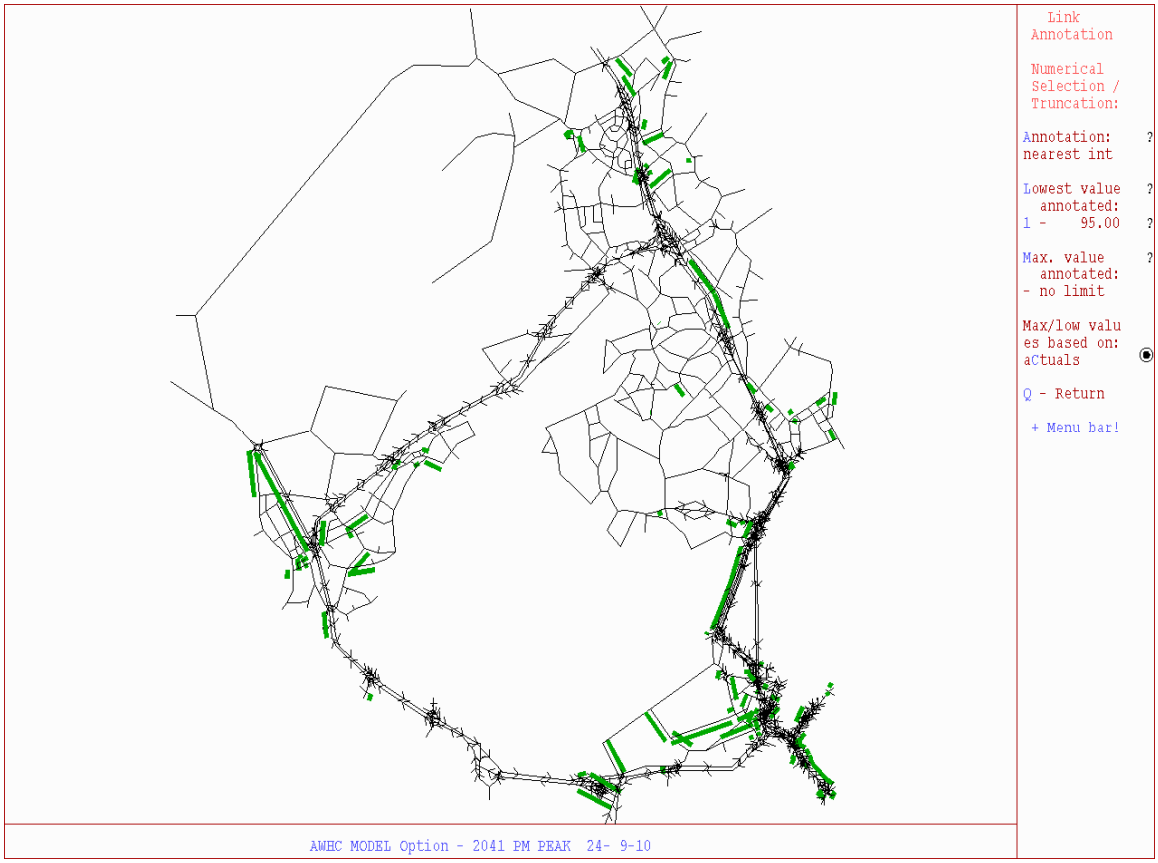


Figure 118: 2041 with Additional Crossing: PM Peak V/C Ratios: Auckland CBD

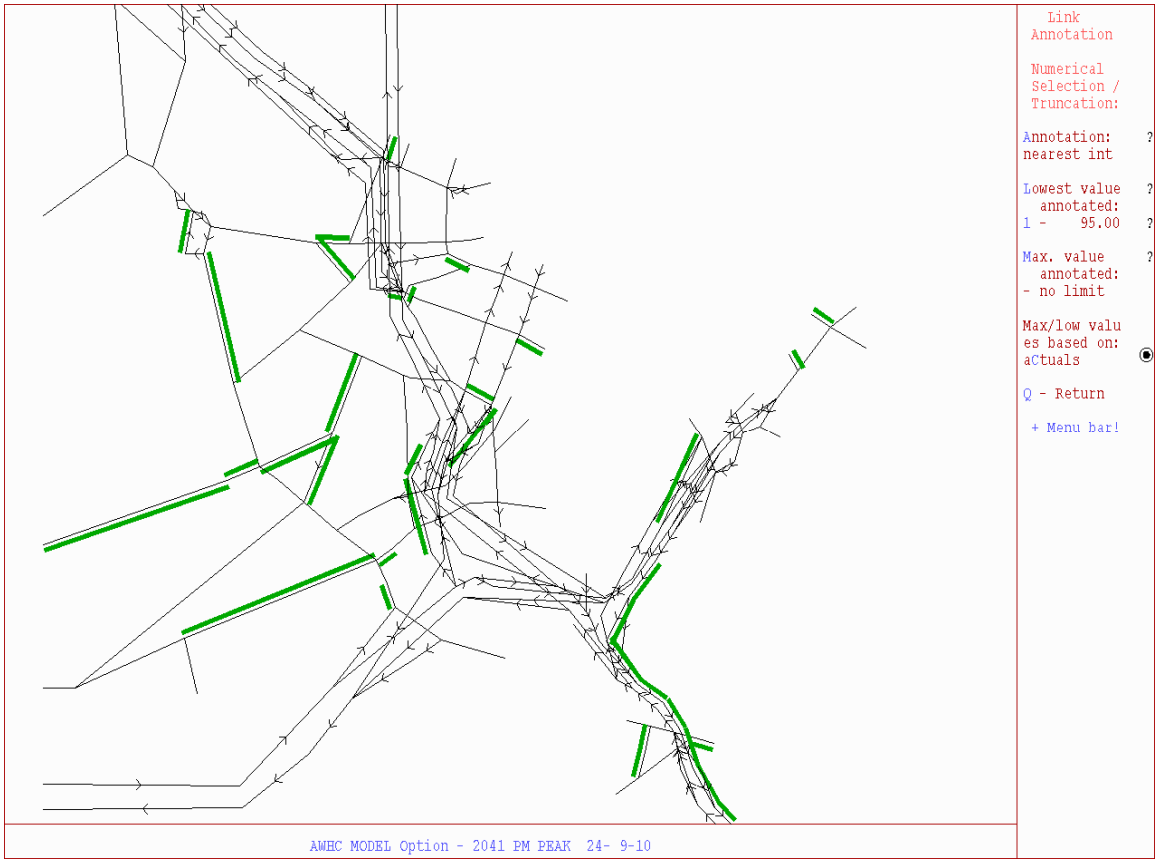
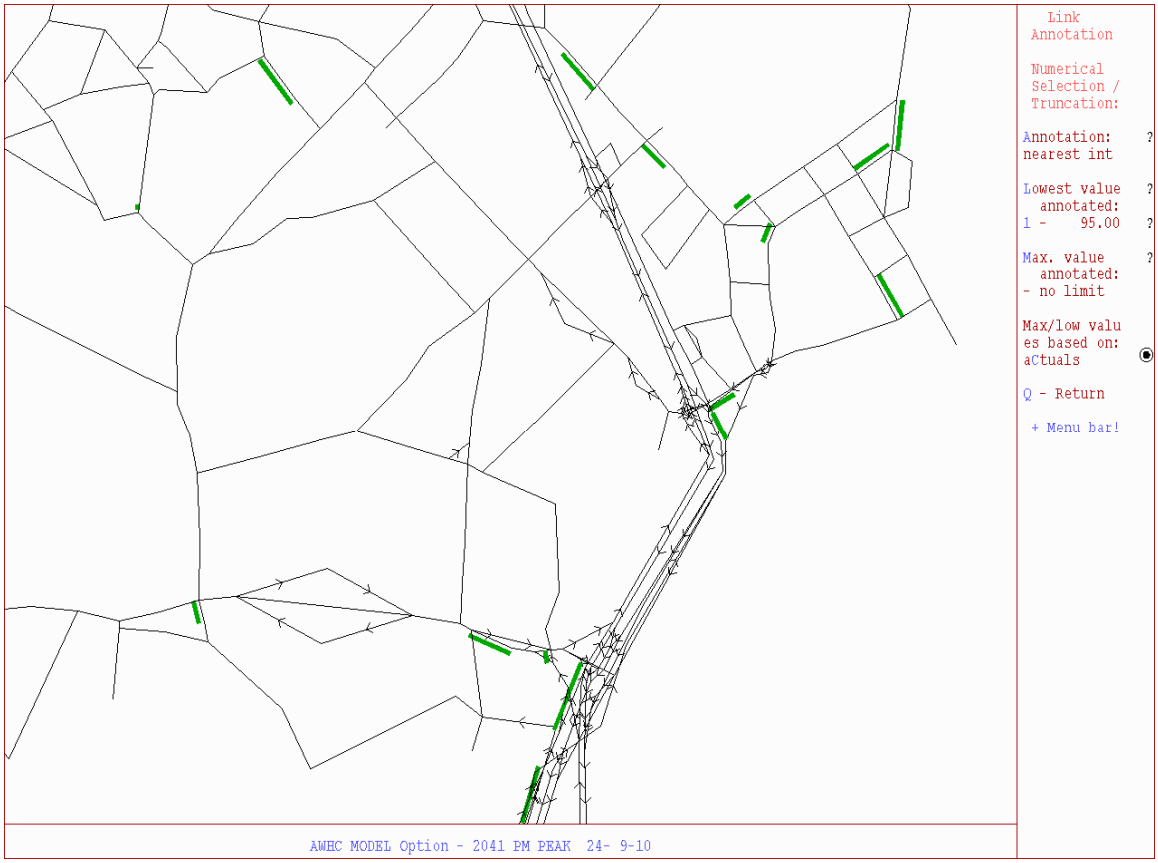


Figure 119: 2041 with Additional Crossing: PM Peak V/C Ratios: Takapuna



APPENDIX C **2026 Actual Flow Plots (Option)**

Figure 120: 2026 'Actual' Flows: AM Peak Esmonde Interchange

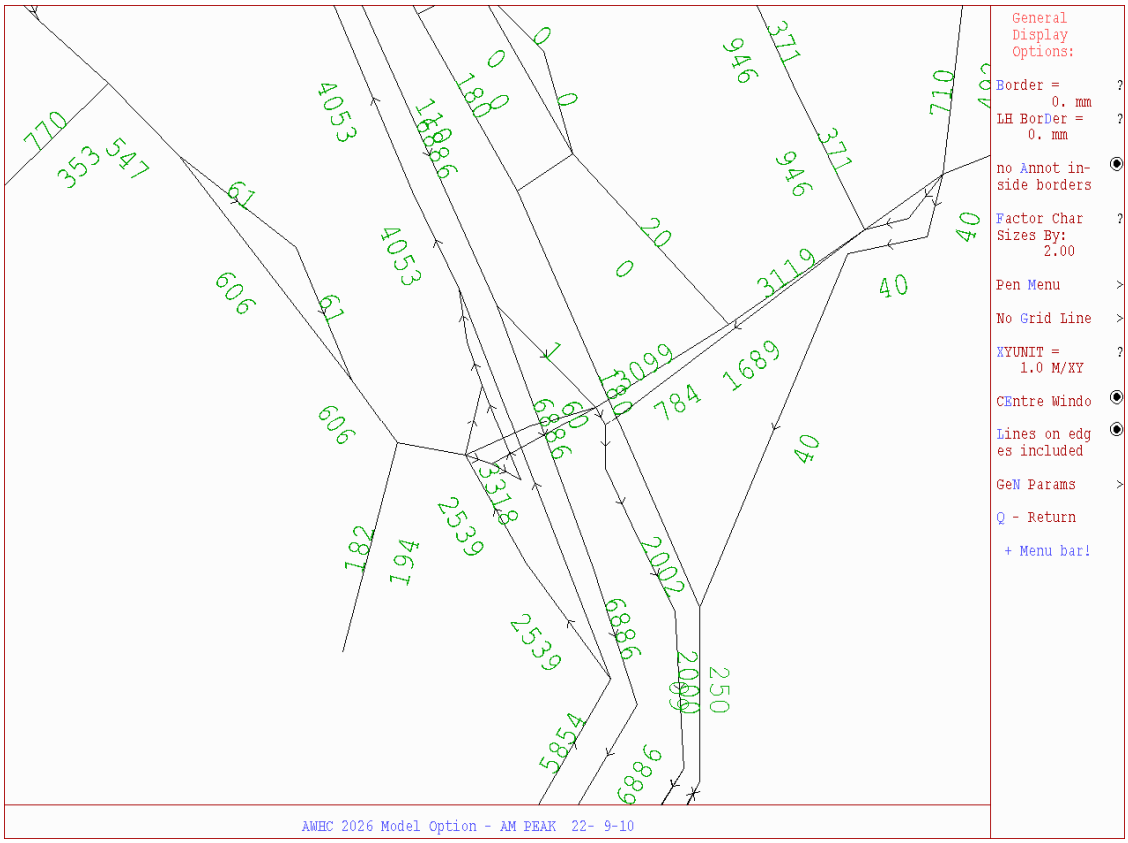


Figure 121: 2026 'Actual' Flows: Inter Peak Esmonde Road Interchange

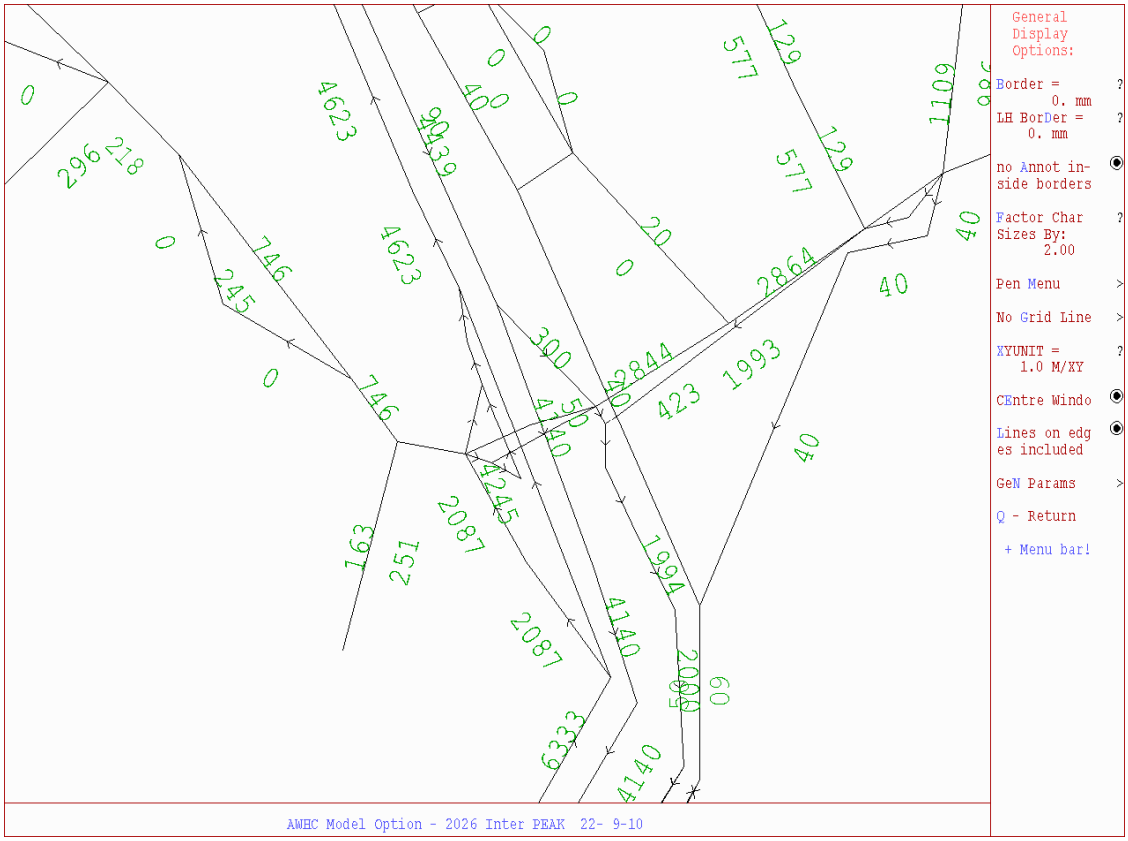


Figure 122: 2026 'Actual' Flows: PM Peak Esmonde Road Interchange

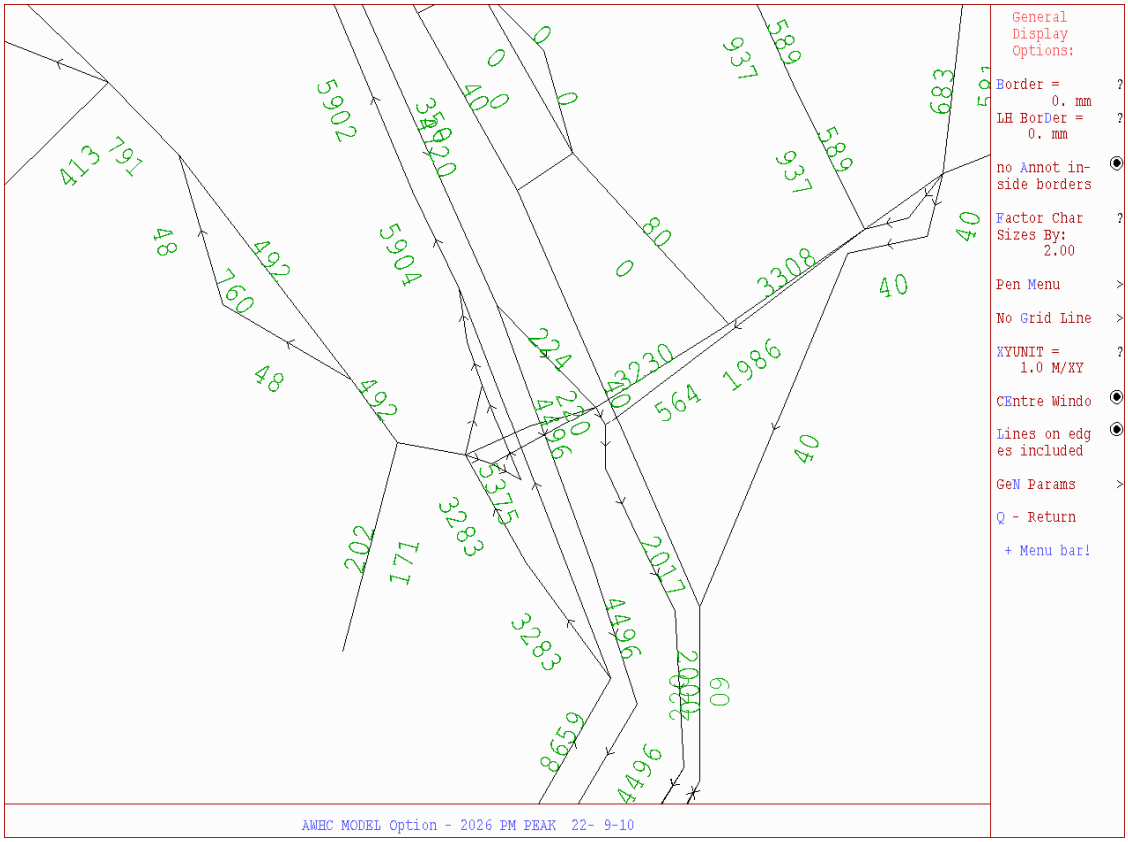


Figure 123: 2026 'Actual' Flows: AM Peak Onewa Road Interchange

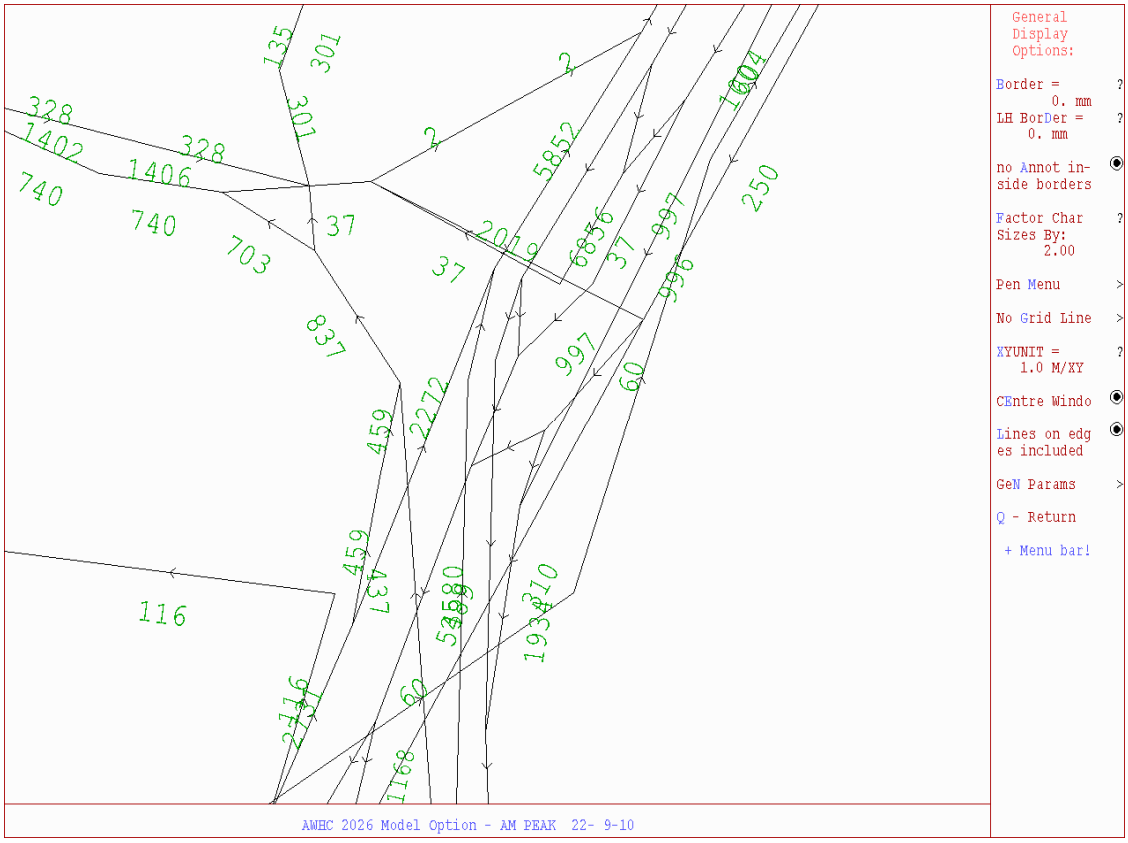


Figure 124: 2026 'Actual' Flows: Inter Peak Onewa Road Interchange

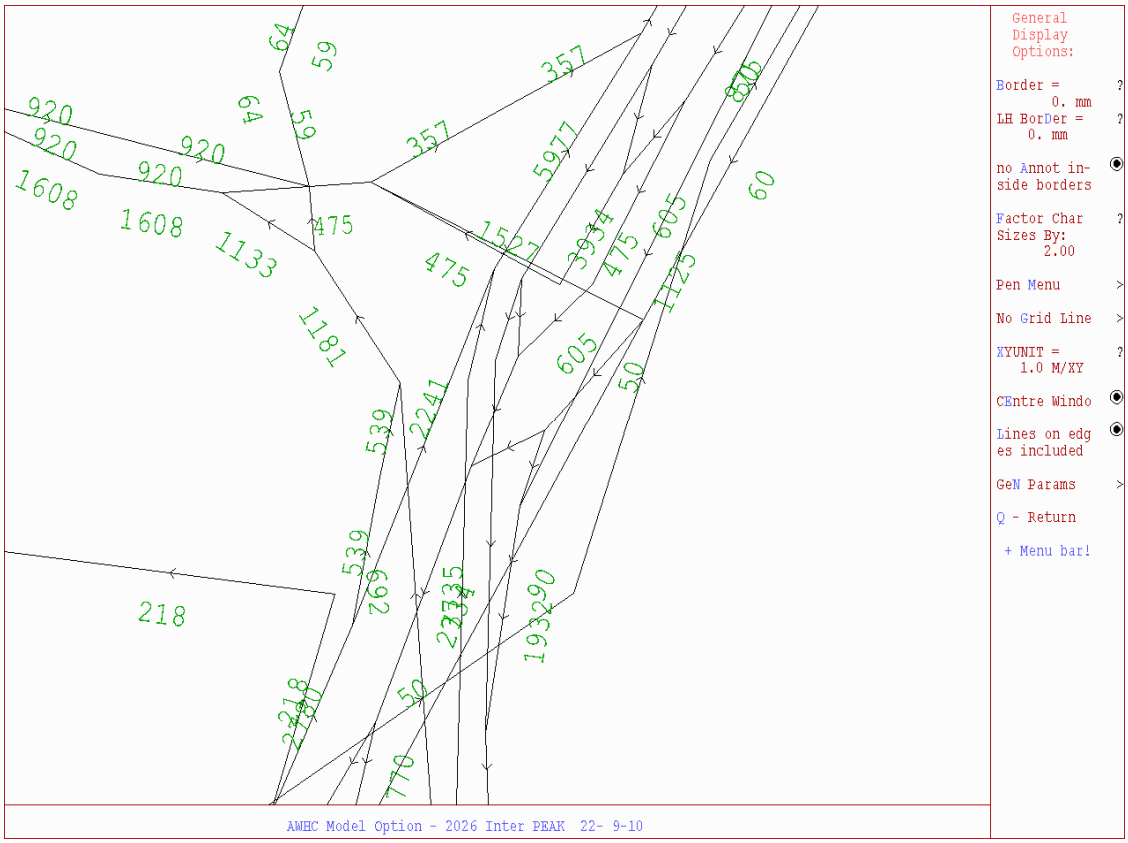


Figure 125: 2026 'Actual' Flows: PM Peak Onewa Road Interchange

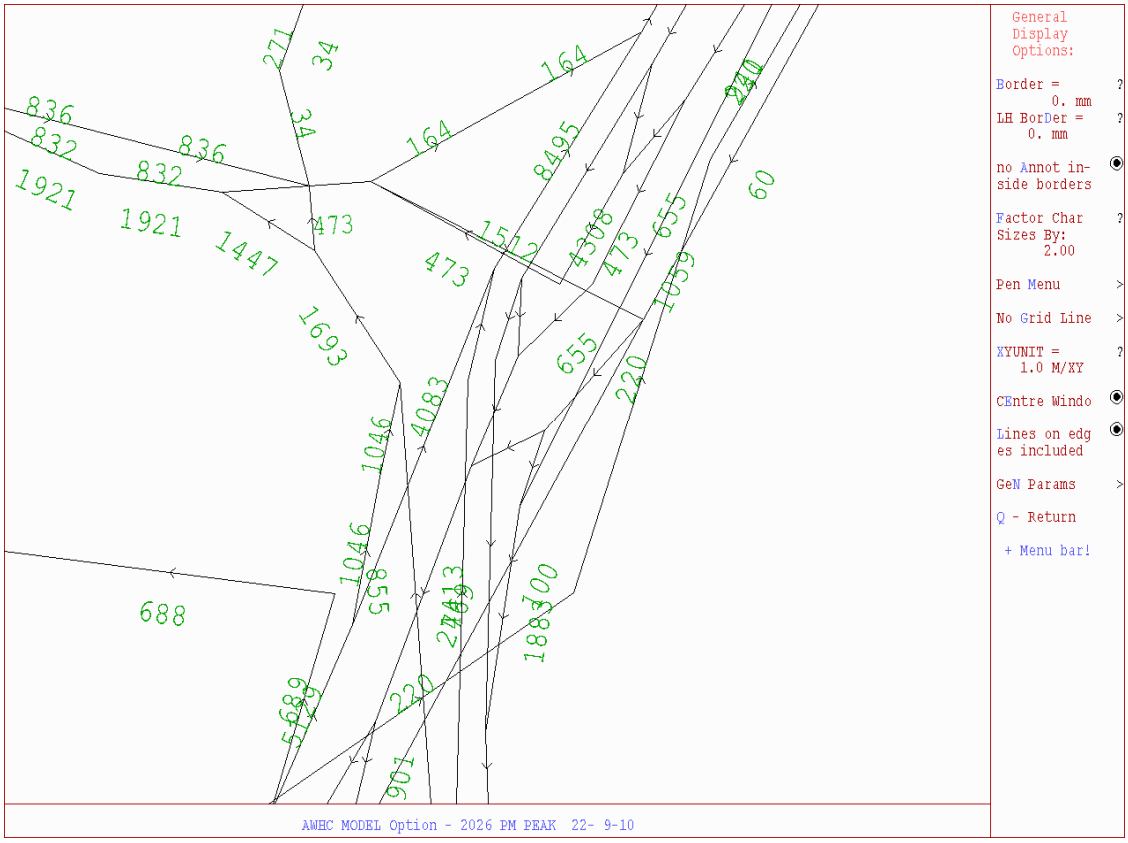


Figure 126: 2026 'Actual' Flows: AM Peak Shelly Beach Road Interchange

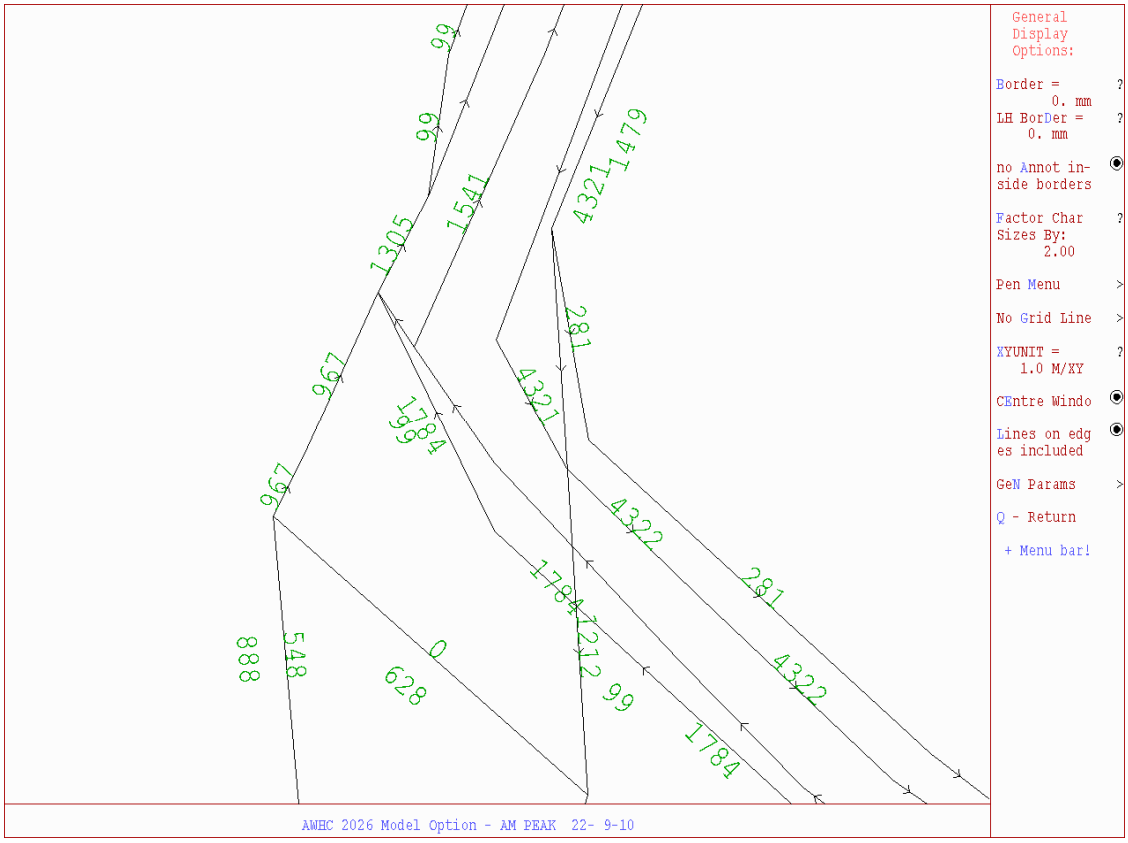


Figure 127: 2026 'Actual' Flows: Inter Peak Shelly Beach Road Interchange

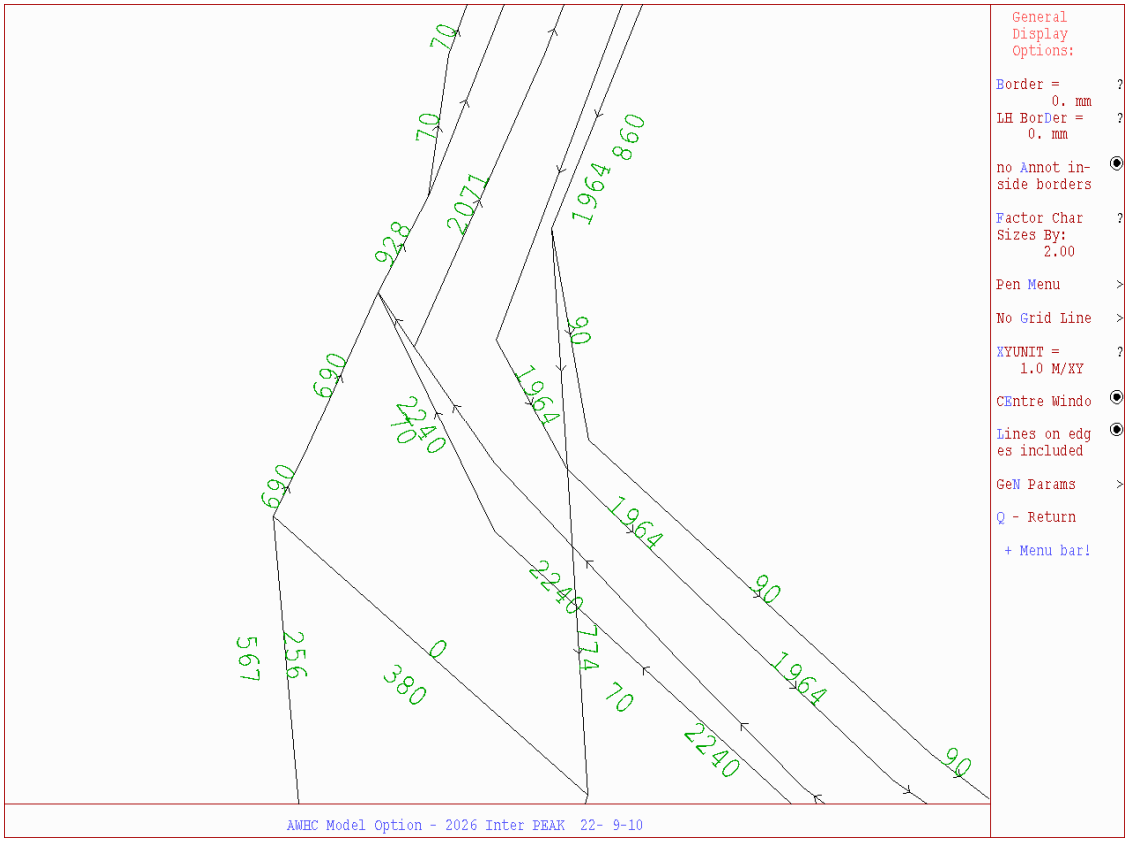


Figure 128: 2026 'Actual' Flows: PM Peak Shelly Beach Road Interchange

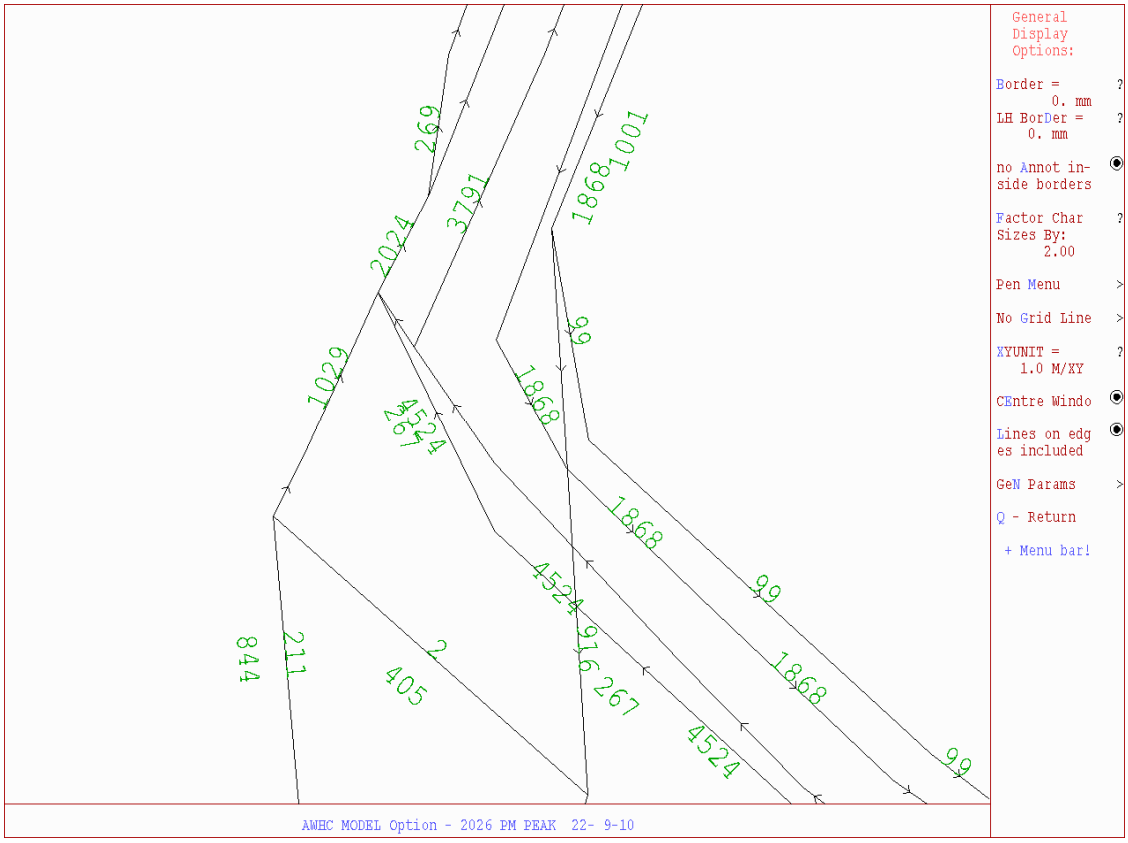


Figure 129: 2026 'Actual' Flows: AM Peak Fanshawe Street and Cook Street Interchanges

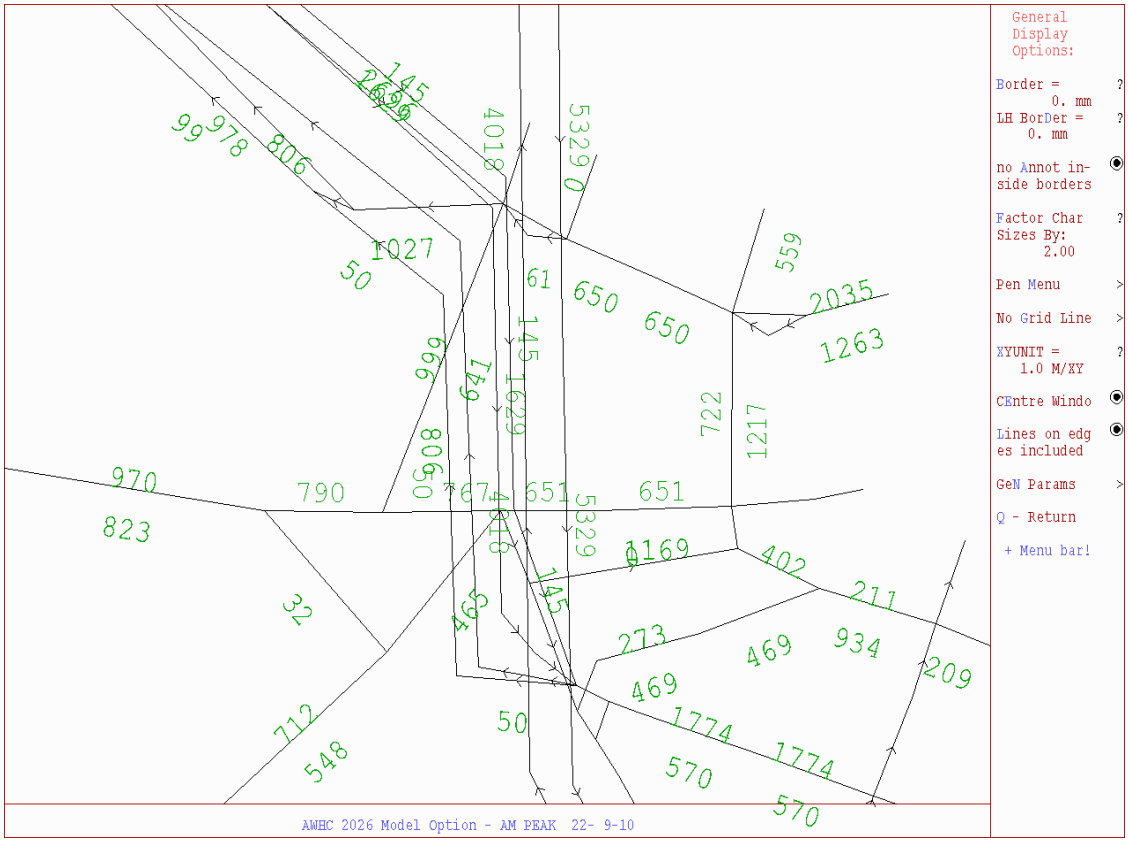


Figure 130: 2026 'Actual' Flows: Inter Peak Fanshawe Street and Cook Street Interchanges

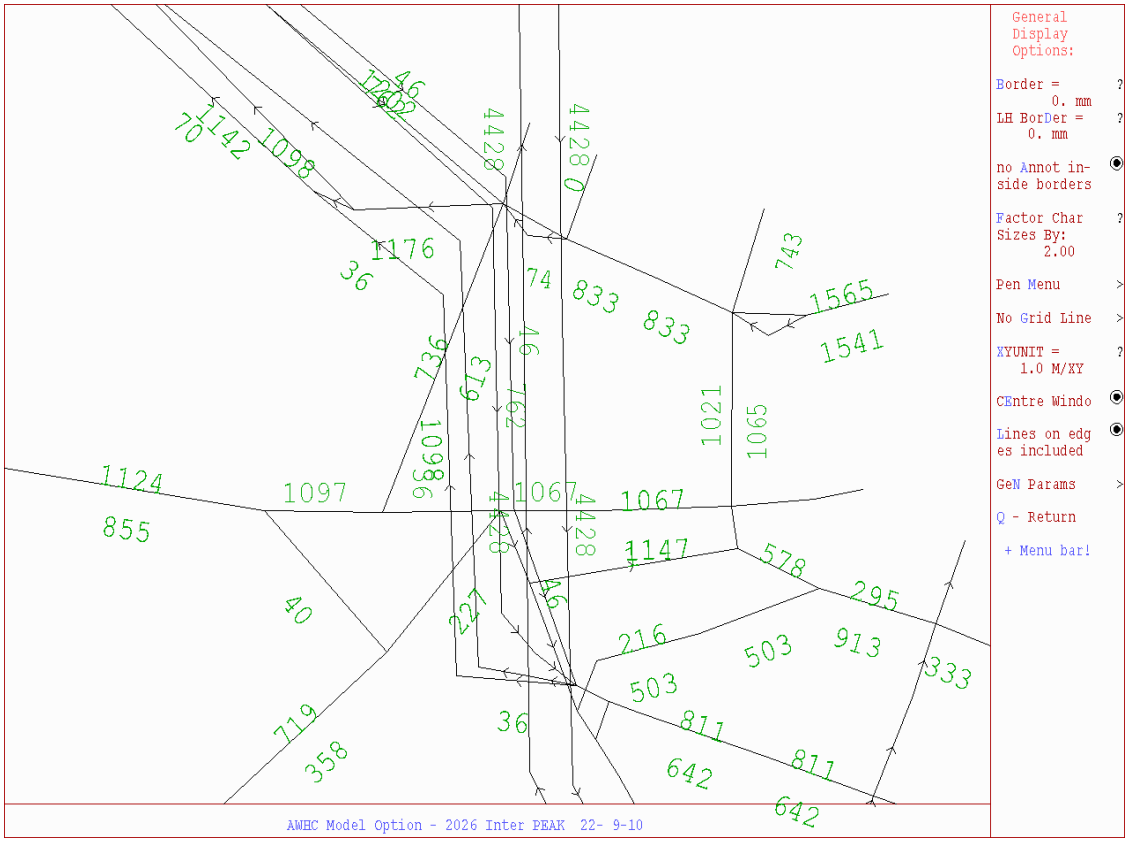


Figure 131: 2026 'Actual' Flows: PM Peak Fanshawe Street and Cook Street Interchanges

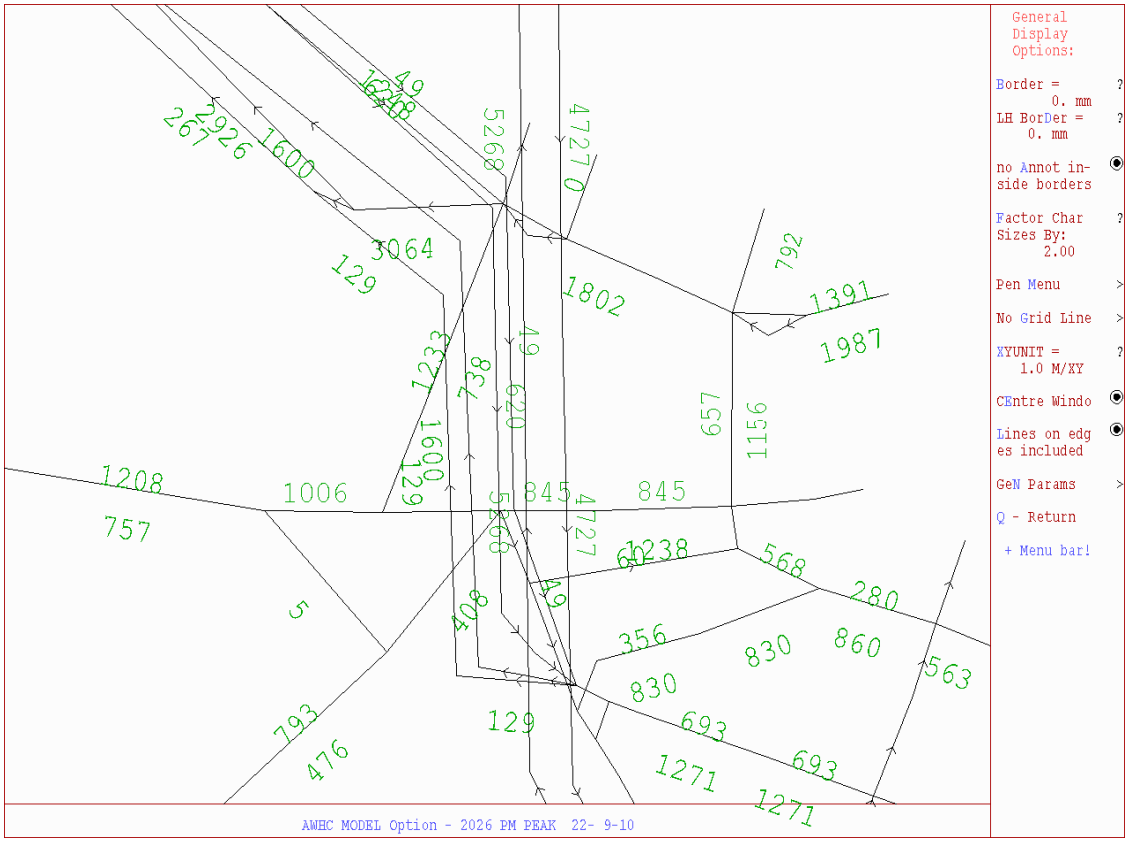


Figure 132: 2026 'Actual' Flows: AM Peak Nelson and Hobson Interchange

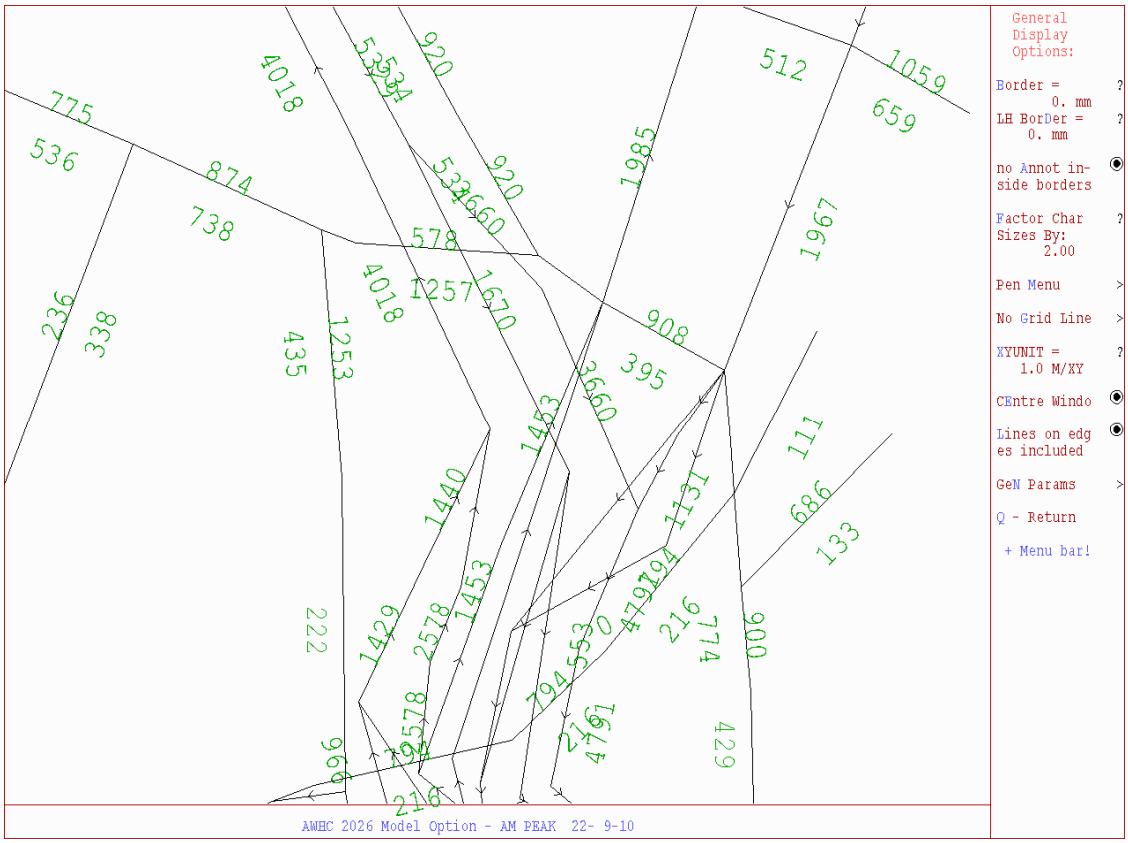


Figure 133: 2026 'Actual' Flows: Inter Peak Nelson and Hobson Interchange

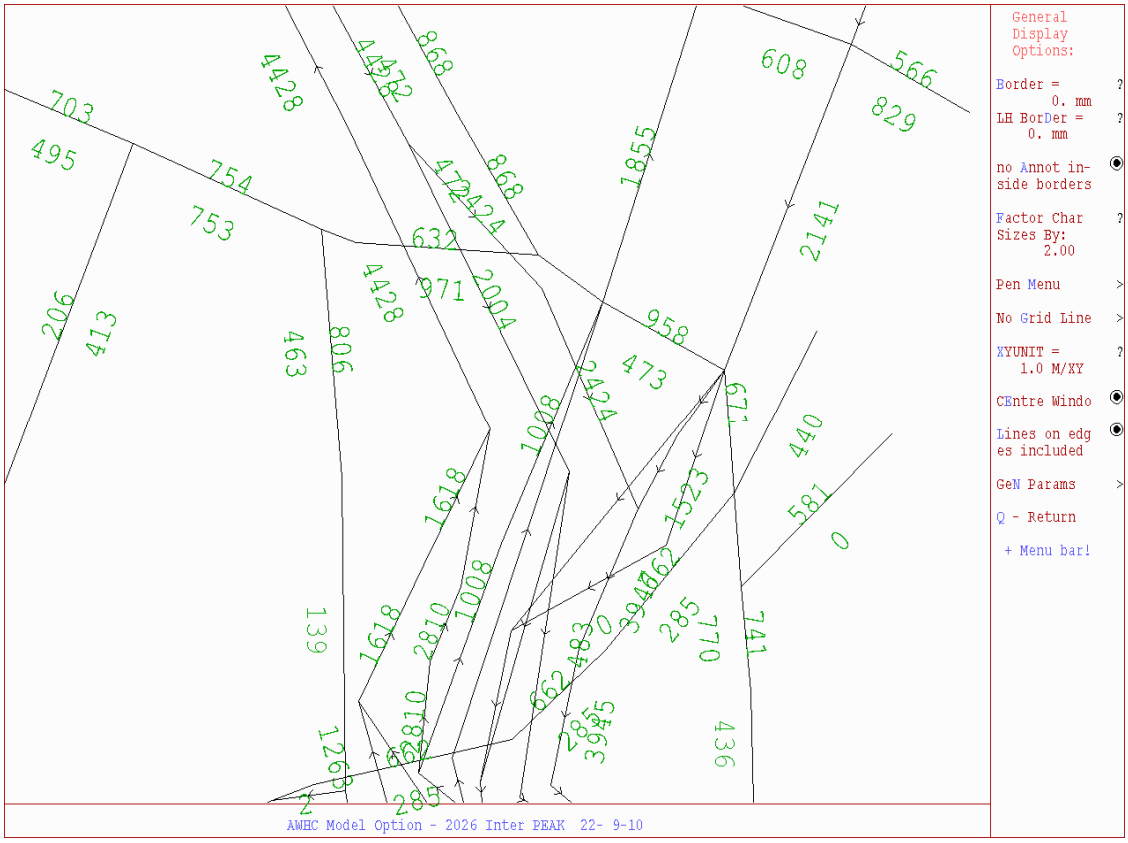


Figure 134: 2026 'Actual' Flows: PM Peak Nelson and Hobson Interchange

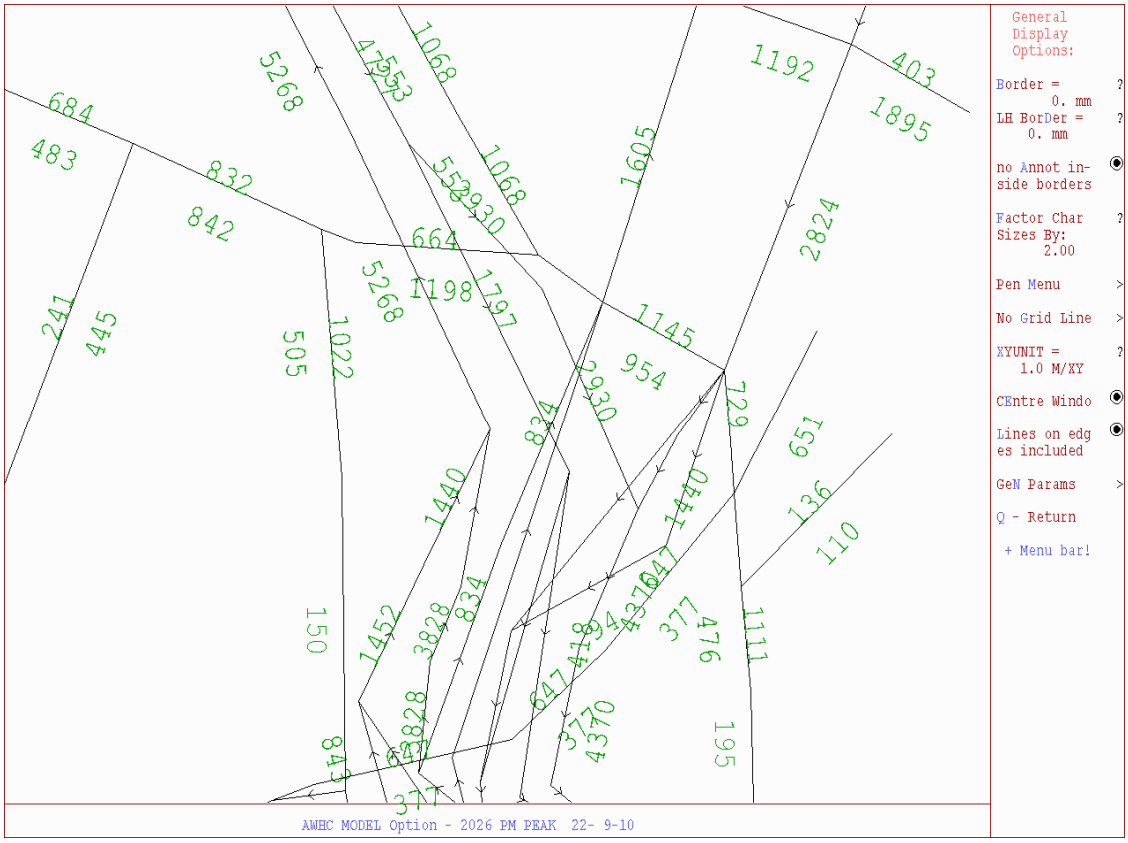


Figure 135: 2041 'Actual' Flows: AM Peak Esmonde Road Interchange

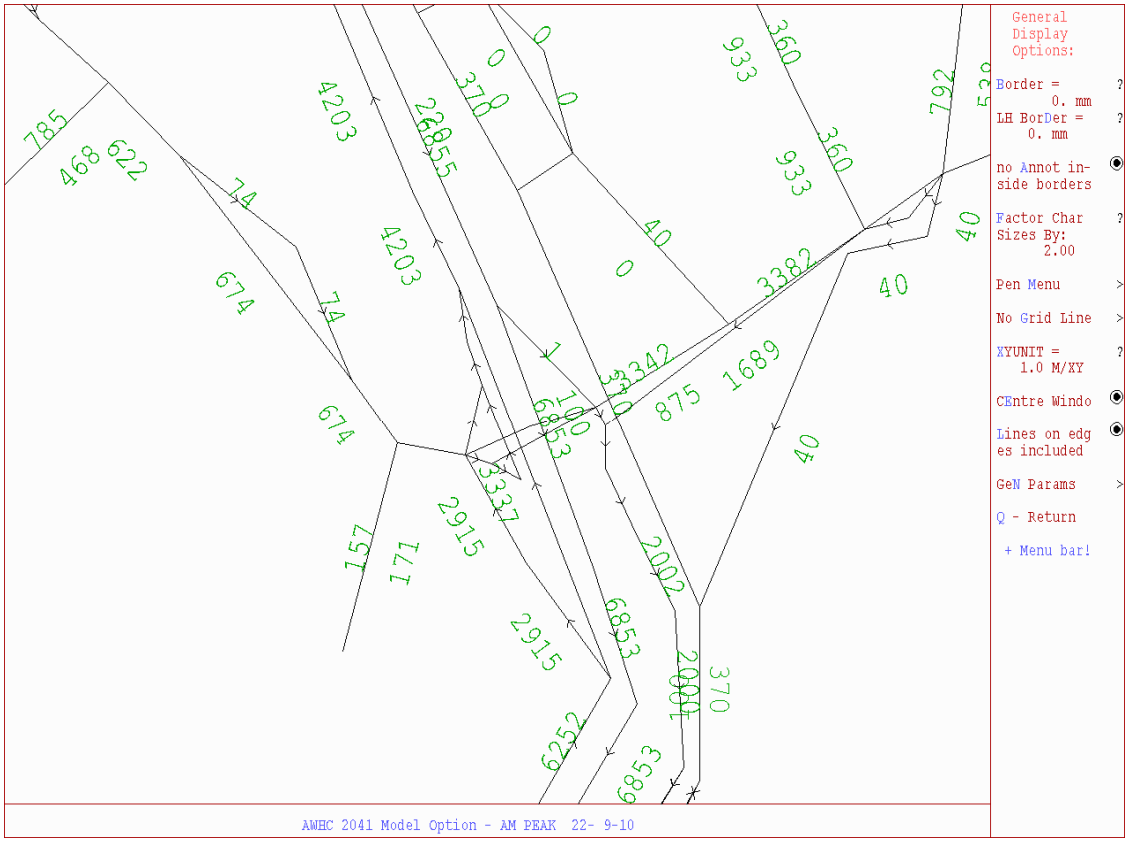


Figure 136: 2041 'Actual' Flows: Inter Peak Esmonde Road Interchange

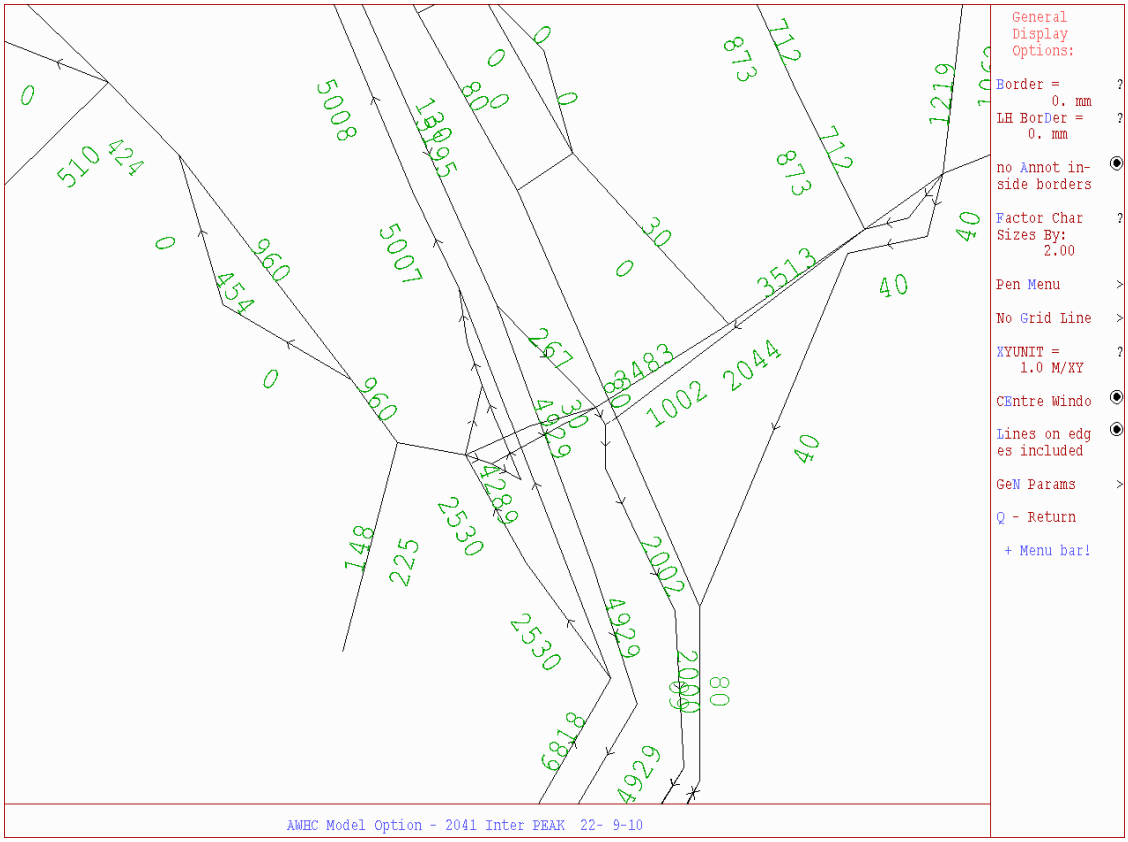


Figure 137: 2041 'Actual' Flows: PM Peak Esmonde Road Interchange

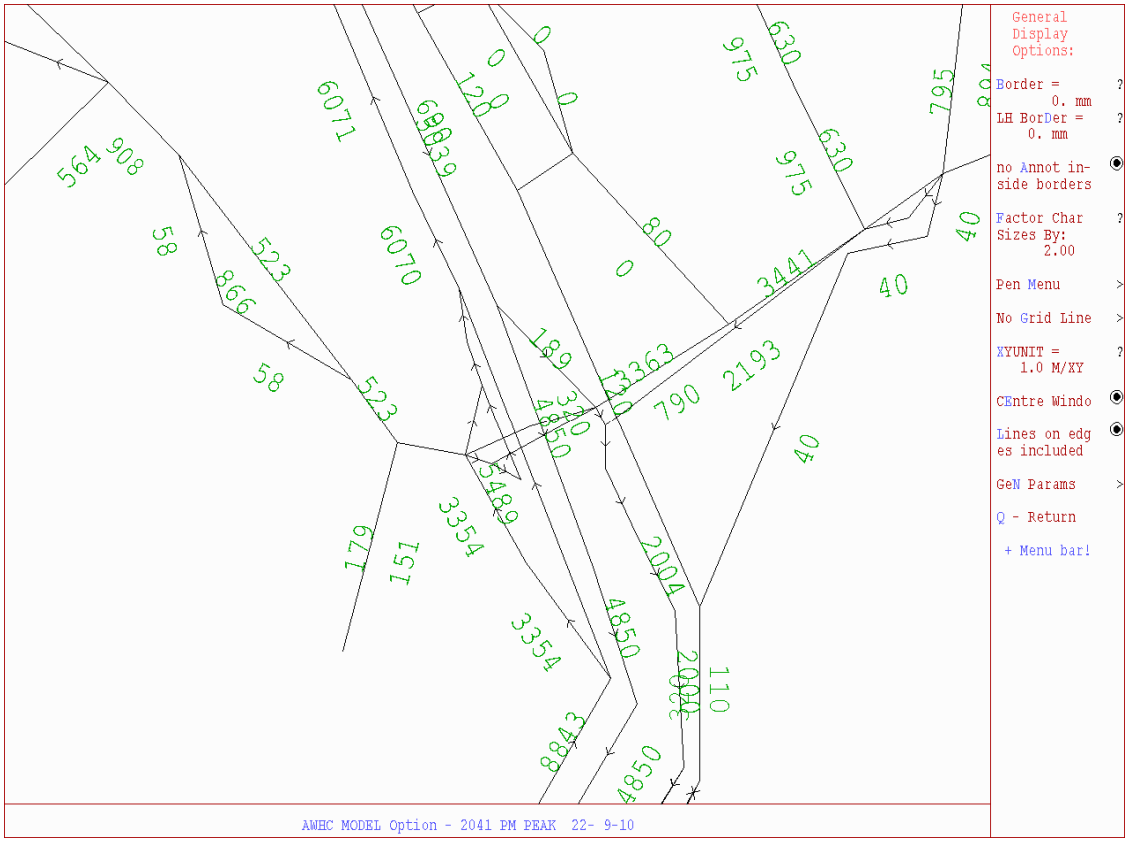


Figure 138: 2041 'Actual' Flows: AM Peak Onewa Road Interchange

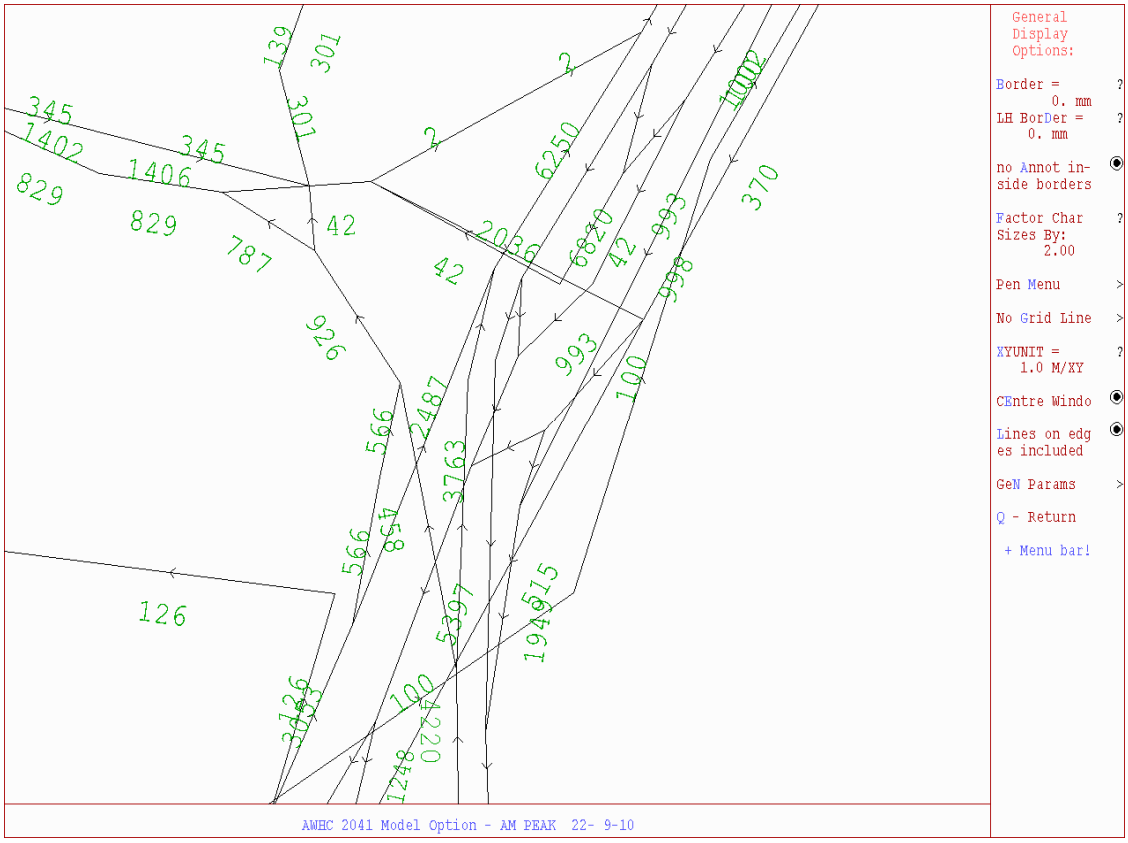


Figure 139: 2041 'Actual' Flows: Inter Peak Onewa Road Interchange

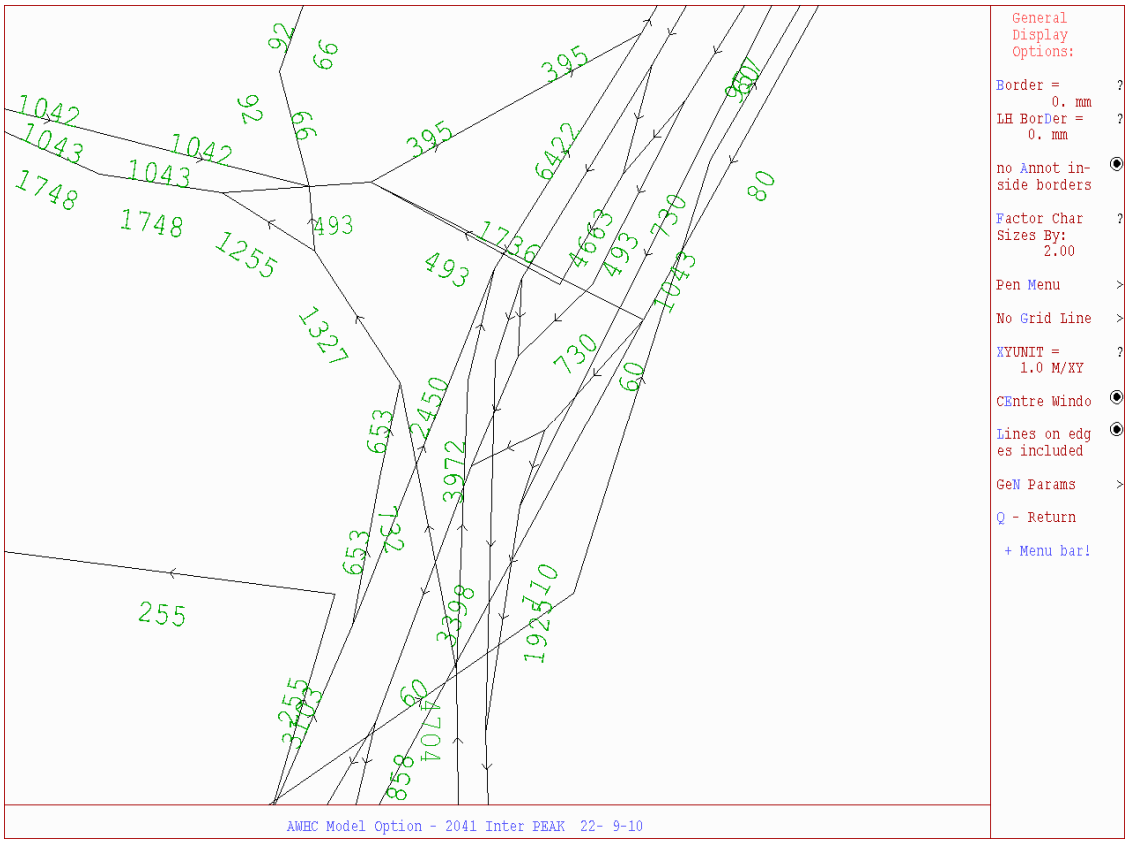
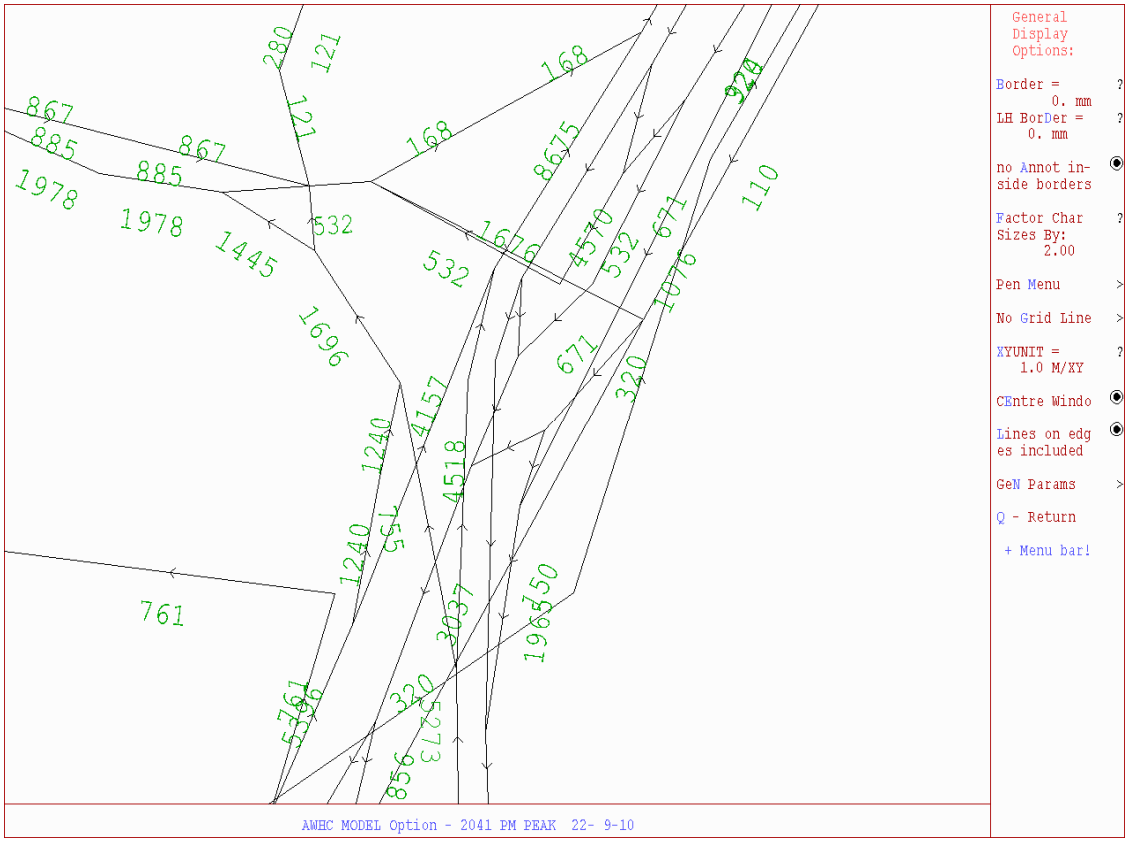


Figure 140: 2041 'Actual' Flows: PM Peak Onewa Road Interchange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8675
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920
110
1696
671
320
4157
1240
4518
1240
795
761
3037
1965
150
761
5396
320
2273
856
AWHC MODEL Option - 2041 PM PEAK 22- 9-10
General
Display
Options:
Border = ?
0. mm
LH BorDer = ?
0. mm
no Annot in-
side borders
Factor Char ?
Sizes By:
2.00
Pen Menu >
No Grid Line >
XYUNIT = ?
1.0 M/XY
CEntre Windo
Lines on edg
es included
GeN Params >
Q - Return
+ Menu bar!

Figure 141: 2041 'Actual' Flows: AM Peak Shelly Beach Road Interchange

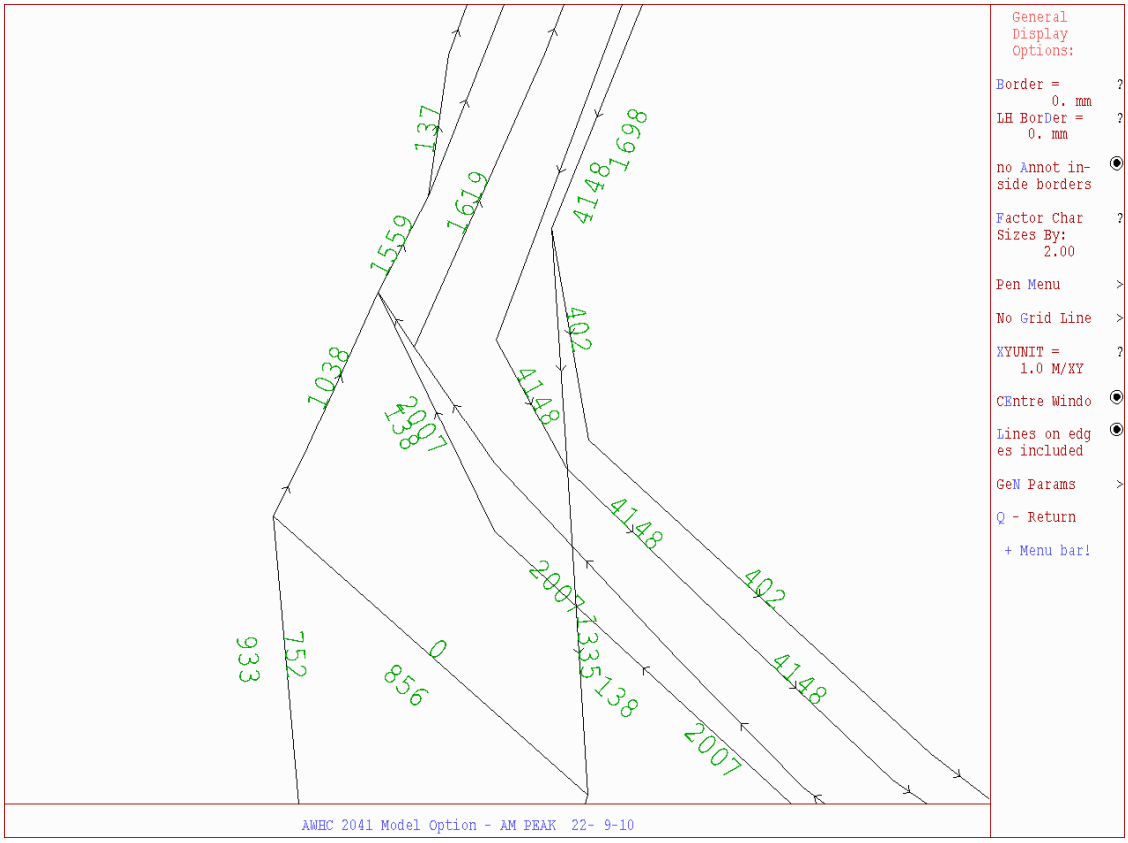


Figure 142: 2041 'Actual' Flows: Inter Peak Shelly Beach Road Interchange

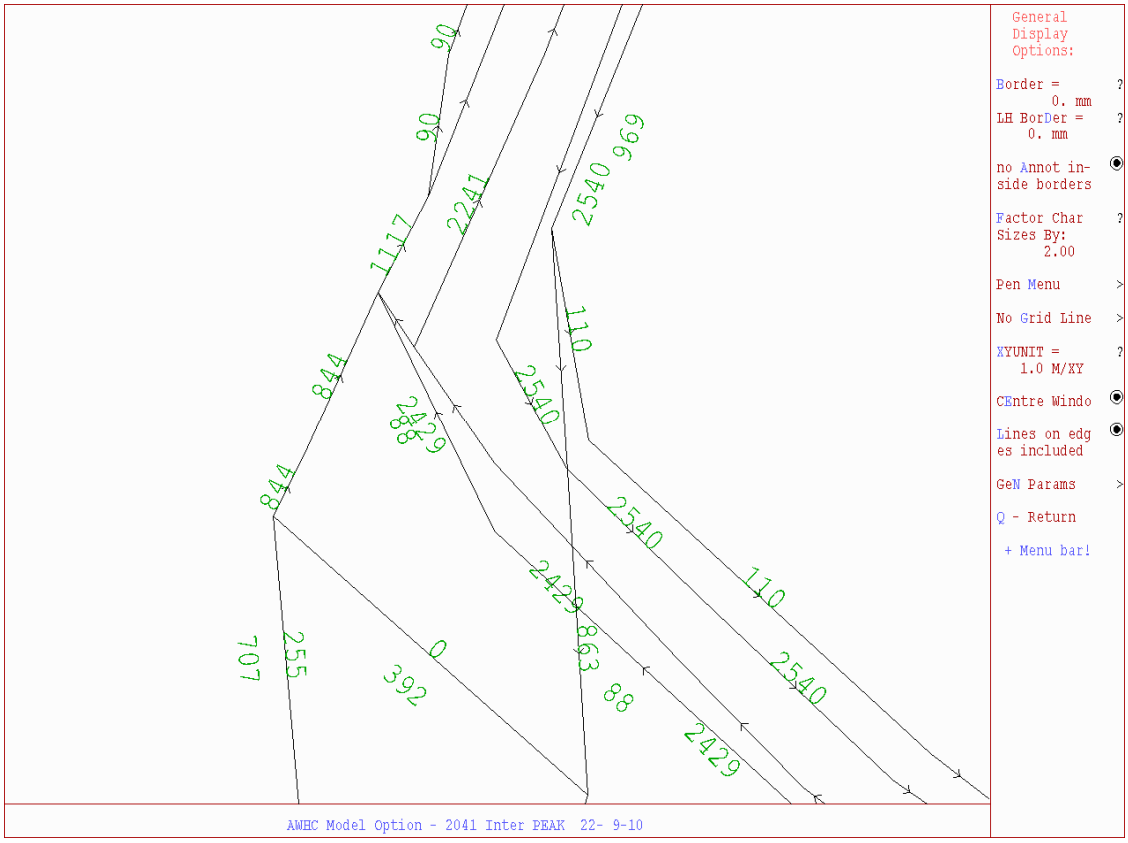


Figure 143: 2041 'Actual' Flows: PM Peak Shelly Beach Road Interchange

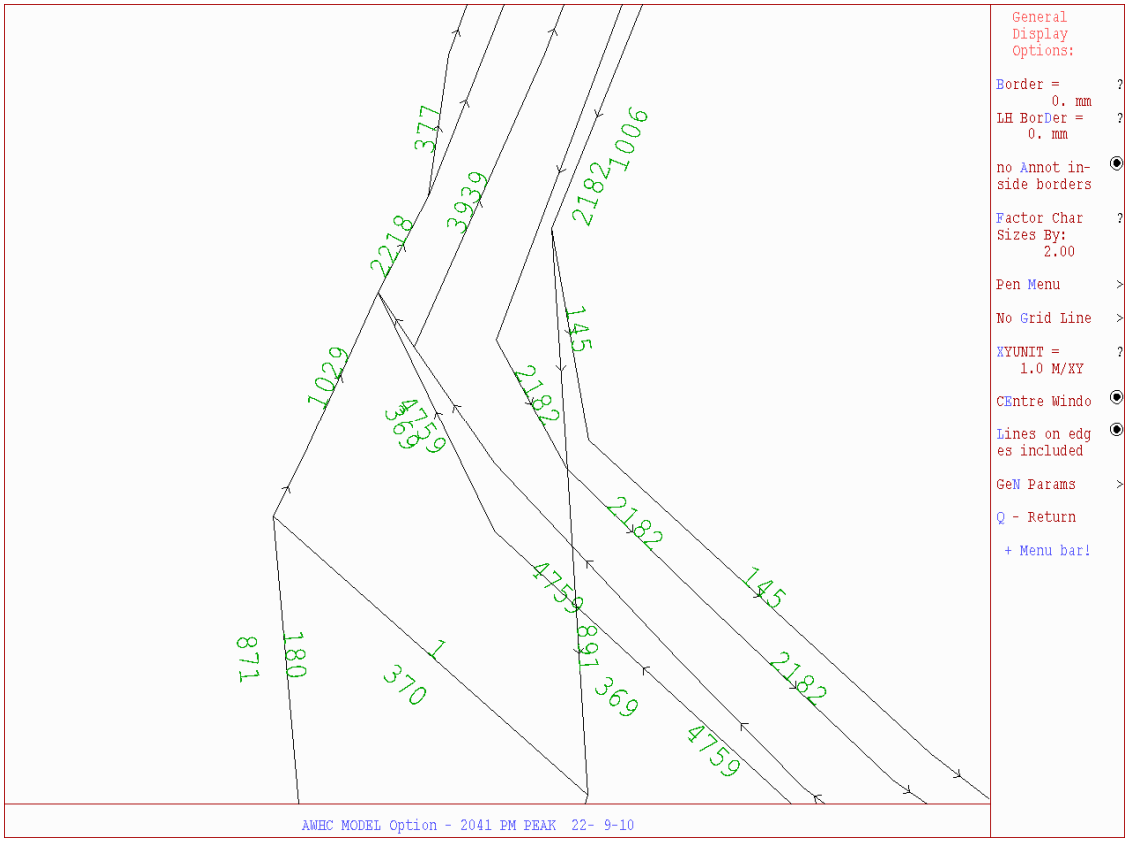


Figure 144: 2041 'Actual' Flows: AM Peak Fanshawe Street and Cook Street Interchanges

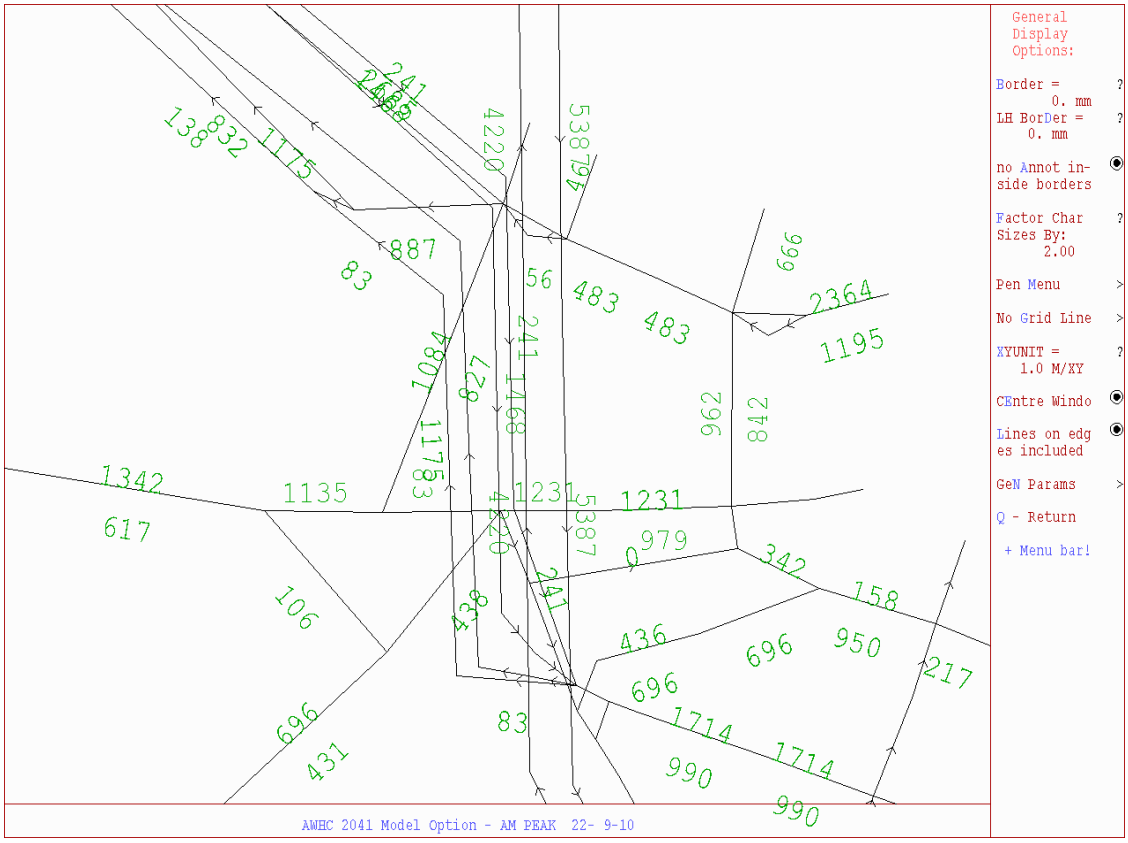


Figure 145: 2041 'Actual' Flows: Inter Peak Fanshawe Street and Cook Street Interchanges

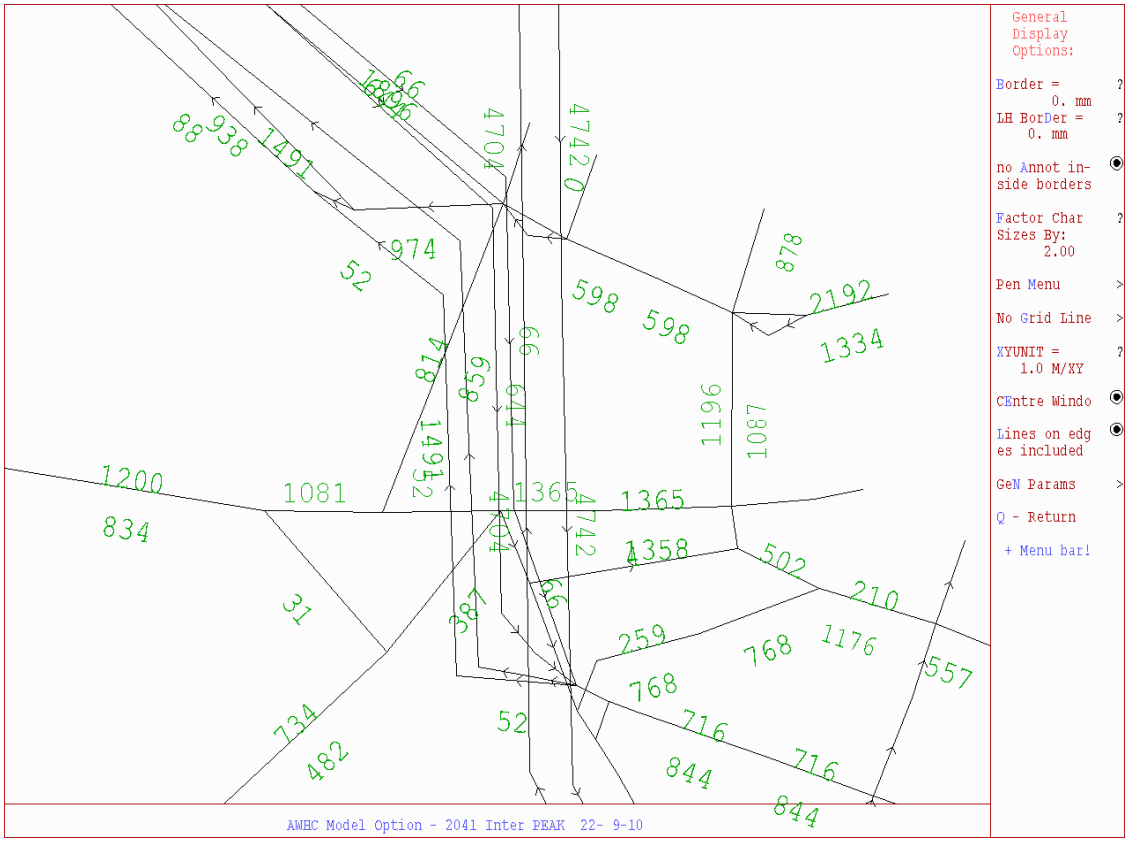


Figure 146: 2041 'Actual' Flows: PM Peak Fanshawe Street and Cook Street Interchanges

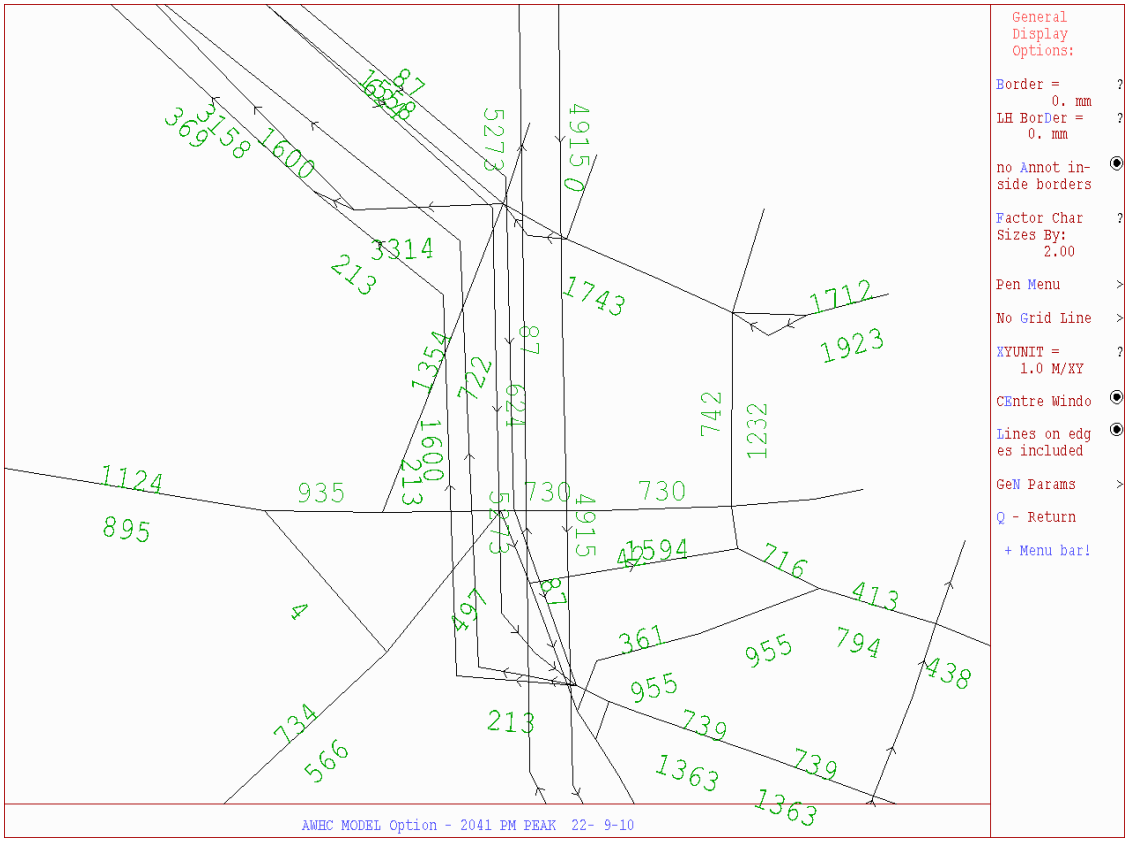


Figure 147: 2041 'Actual' Flows: AM Peak Nelson and Hobson Interchange

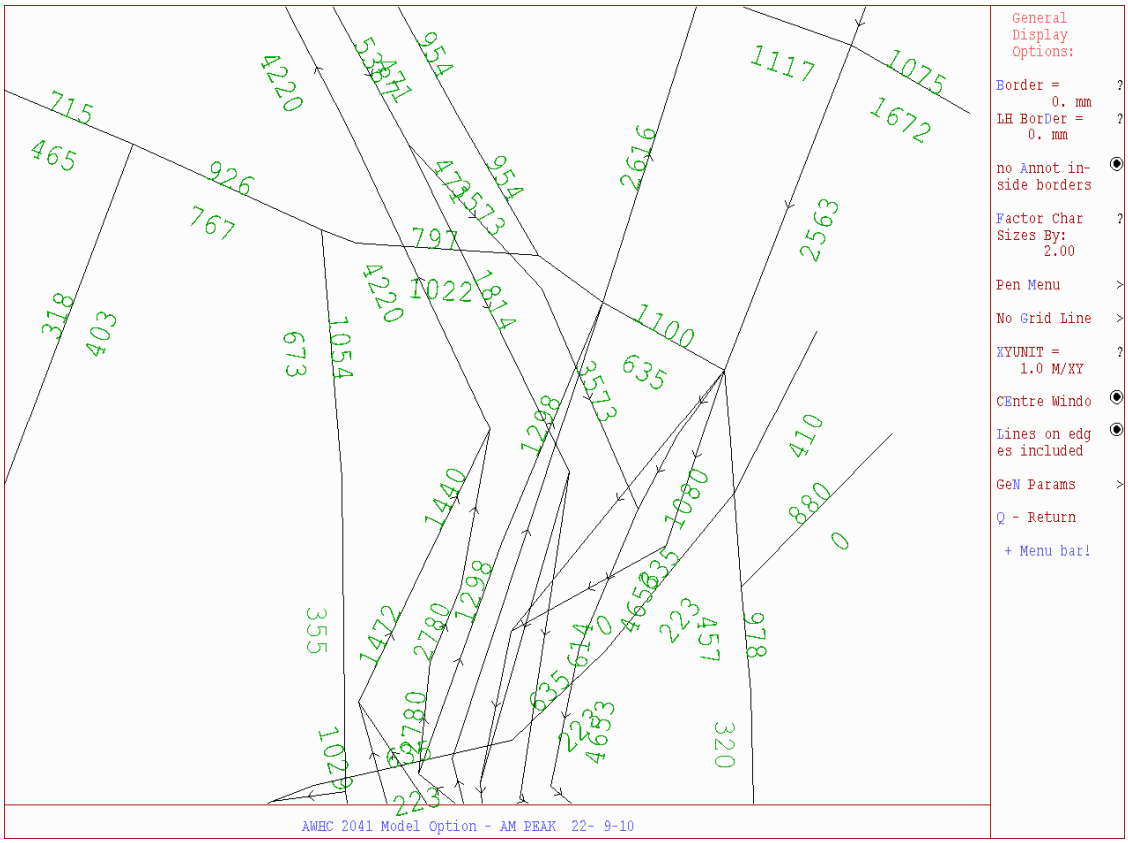


Figure 148: 2041 'Actual' Flows: Inter Peak Nelson and Hobson Interchange

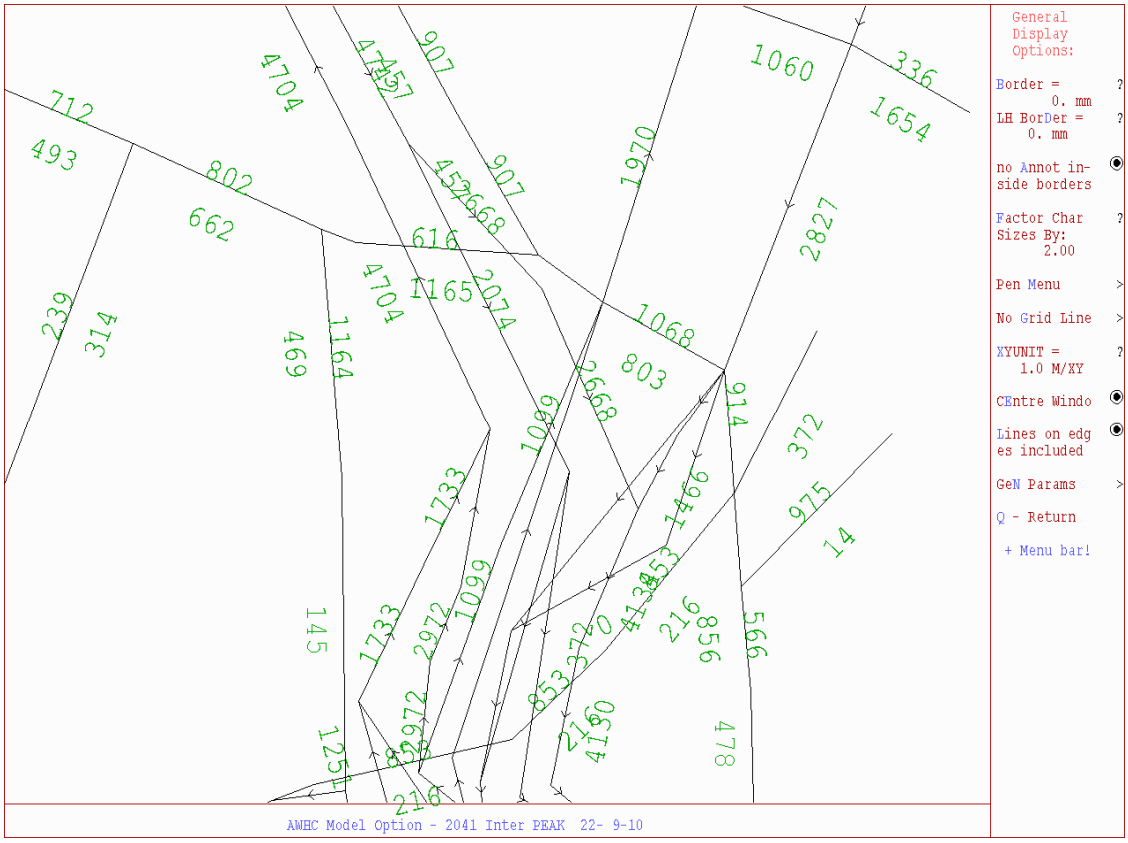
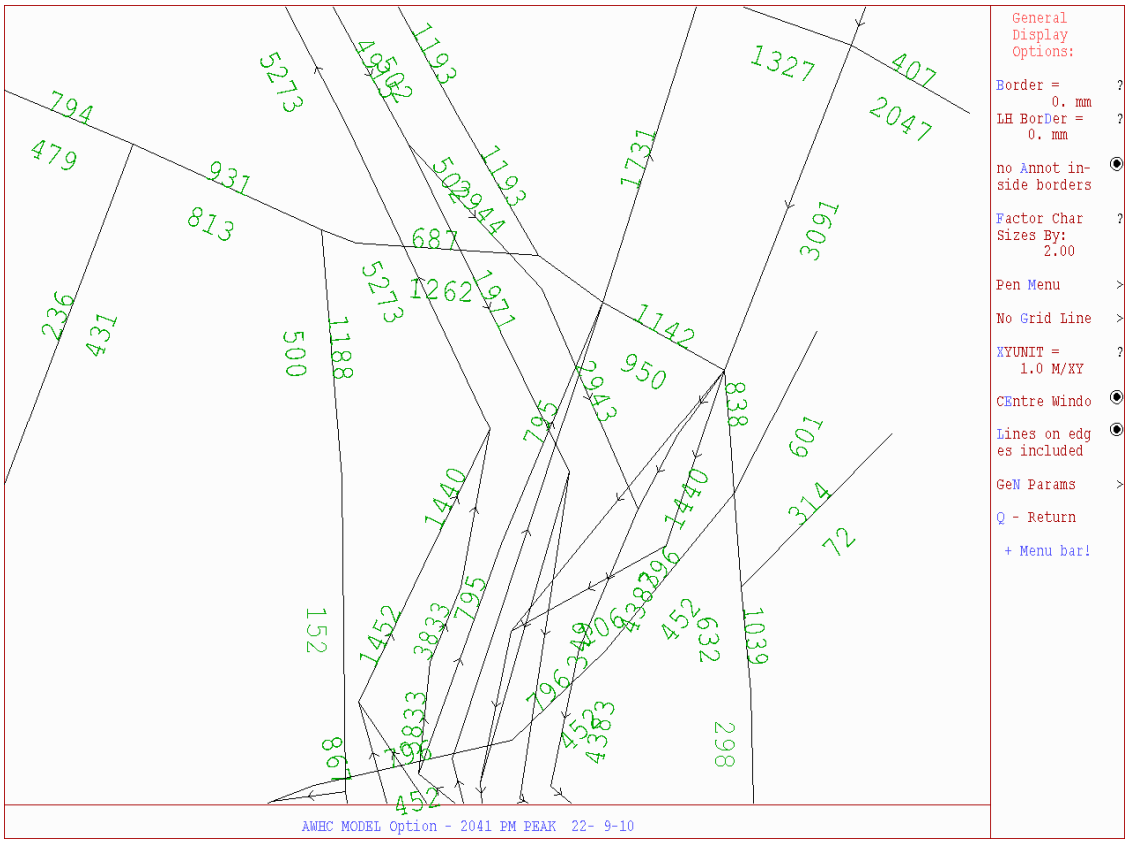


Figure 149: 2041 'Actual' Flows: PM Peak Nelson and Hobson Interchange



Appendix J Toll Modelling Scope

1 Introduction

This note follows discussions between NZTA project managers, Karen Boyt (NZTA, Project Manager Tolls), and the Traffic and Toll Modelling and Economic Advisory Services teams on the scope of tolling investigations for the Additional Waitemata Harbour Crossing (AWHC) study. It is for distribution to the above parties for agreement.

2 Purpose and Objectives of Tolling

The AWHC tolling investigations are considered "preliminary" as per NZTA's Toll Modelling Functional Specification and the primary purpose is to determine revenues over a range of tolls, including the toll level that maximises revenue.

NZTA's objective for tolling is to raise revenue while also seeking to balance the traffic impacts so that the network operates well. Additionally the toll system requirements are that this is as simple as possible, that is, with minimal infrastructure and transaction costs in order to gain better efficiency in revenue generation.

3 Approach to Toll Modelling

The approach to toll modelling is set out in the Transport and Toll Modelling Scoping Report. In essence it entails use of ART3 to determine the traffic demands and use of a multi-class assignment model (the toll model) to determine route choice.

The toll modelling will be carried out on one option in years 2026 and 2041 in the three 2-hour modelled periods (AM peak, Interpeak, PM peak).

ART3, which has a single-class assignment for the demand-supply iterations, will be run with tolls included, to produce the vehicle demands. These will then be passed from ART3 to the toll model for the multi-class assignment.

There are variants to the inputs to the ART3 modelling in terms of the future land use inputs and other economic and policy inputs. Decisions will need to made on which of these are used, which can occur after the initial (non-tolling) modelling of the do minimum and the options. At this stage we would expect to use the latest RGS land use inputs (rather than the variants we have developed) and the revised other inputs that are set out in the file note "WHC – ART3 Inputs.doc".

The toll model will be developed from the ART3 road assignment model by introducing multi-user classes and differential values of time (VoT) representing the willingness to pay (WTP) of each class.

This will make use of the ART3 light vehicle demands by purpose and medium/heavy commercial vehicle (HCV) demands creating appropriate market segments. The WTP segments and their VoT to be used are based on those developed for NZTA's toll modelling for the Transmission Gully project in Wellington.

In summary the process is:

- Define four segments: commuting (HBW), employers business (EB) and other (Other) purposes plus medium and heavy commercial vehicles (HCV) with VoT for each;
- Determine the proportion of HBW, EB and Other in each time period (AM, IP, PM);
- Distribute HBW and Other VoT by income into six income groups and then combine these 12 groups into similar VoT groups to give nine HBW/Other segments;
- Distribute the proportions of these segments across time periods and make a final adjustment to the VoTs to ensure that the weighted average VoT across the 9 segments for each time period accumulates to the average time period-specific values;
- EB is a single segment with its own VoT;
- HCV is split into three equal segments, 'low', 'medium' and 'high', with corresponding VoTs.

This gives 13 segments, whereas the EMME software can cater for 12. The two segments with the lowest VoT can be combined (these have similar VoT and both have relatively small proportions) using the weighted average VoT of each.

The resulting 12 segments and the VoT of each are given in the table.

Segment No.	Name	VoT ($/hr, 2006)
1	Other1+Other2	$6.70
2	HBW1+Other3	$8.20
3	HBW2+Other4	$9.20
4	HBW3+Other5	$10.70
5	HBW4	$12.10
6	Other6	$13.60
7	HBW5	$14.30
8	HBW6	$17.60
9	EB	$30.00
10	HCV Low	$17.00
11	HCV Medium	$25.00
12	HCV High	$33.00

4 Tolling Strategies

In setting out the possible tolling strategies, this note does not debate the potential constraints of current legislation, such as the provision an alternative free route and what that might be (for example, whether SH18 and SH16 provide this).

A number of tolling strategies are possible including the tolling of:

- the new crossing only,
- the existing bridge only,
- both the new crossing and the existing bridge, and
- the new crossing with partial tolling of the existing bridge.

The first three of the above strategies will be modelled, following which a decision can be made on whether the fourth is considered, and then whether this is by way of further toll modelling or as desktop analysis using the results of the strategies modelled. This decision may depend on the time available and on the sensitivity of the results to the two strategies.

The tolls will be uniform across the day, that is, variation by time of day will not be investigated.

When both crossings are tolled, the third strategy above, the toll levels will be the same for both, that is, differential tolls will not be considered.

5 Toll Levels

For the three strategies a range of toll levels will be modelled to determine the revenue and traffic flows in each case. This will enable revenue and traffic flow vs toll graphs to be produced.

The suggested toll levels are: $2, $4, $6, $8, and $10. These will be increased at the rate of increase in the CPI.

HCVs will be tolled at three times the level of light vehicles. A test on the effect of varying this can be undertaken on a selected toll strategy and toll level following the main toll modelling.

Hence the above scope gives the following dimensions:

- 3 toll strategies each with 5 toll levels,
- HCVs tolled at three times the level of light vehicles,
- modelled on a single option in two future years.

Traffic flow and revenue would be produced in each case for the three modelled periods (AM, IP, PM) and then annualised. The annual flows and revenues can be represented in tabular form for each modelled year and each strategy as the following:

Toll ($)	**Existing Bridge**				**New Crossing**			
	Light Vehicles		HCVs		Light Vehicles		HCVs	
	Flow	Revenue	Flow	Revenue	Flow	Revenue	Flow	Revenue
0								
2								
4								
6								
8								
10								

6 Model Outputs from Toll Modelling

The outputs from the toll modelling, for each modelled year and toll strategy, are the annual flows and revenues as set out in the above table. These will be provided to the economics team who will create the revenue and flow streams for the evaluation period, including ramp-up.

7 Programme

The timing of the outputs of the toll modelling and the subsequent timing of the modelling itself are dependent on the finalisation of the option during the option-testing phase of the project. The timing is presently being discussed by the modelling and economics teams and should be confirmed by 20th August.

David Young

Appendix K Toll Modelling Results

1 Introduction

This note contains results from the modelling of the three toll strategies.

The strategies are:

- Tolling the new crossing (WHC) only,
- Tolling the existing bridge (AHB) only, and
- Tolling both the new crossing and the existing bridge.

Each has been modelled in years 2026 and 2041 with toll levels of $0, $2, $4, $6, and $8 (all-day in each direction).

In each case (toll strategy and toll level) ART3 has been run to produce the demands, and these have then been segmented and assigned in the multi-class assignment model.

The results in this note are structured as follows:

- Section 2: Provides some initial key points
- Section 3: Flows and Revenues for each toll strategy in turn, followed by a summary and the implied toll elasticities for Strategy 3;
- Section 4: Cross Harbour Flows by vehicle and PT for each strategy, modelled period, and direction in turn, followed by person flows;
- Section 5: AM peak Screenline flows for each strategy in turn;
- Section 6: AM Peak Vehicle Demands by Sector for a $4 toll for each strategy in turn;
- Section 7: 2026 AM Peak travel times between Albany and the CBD and Greenlane;
- Section 8: Test of Demand Response to Tolls using Toll Strategy 3 with a $4 toll in year 2026.

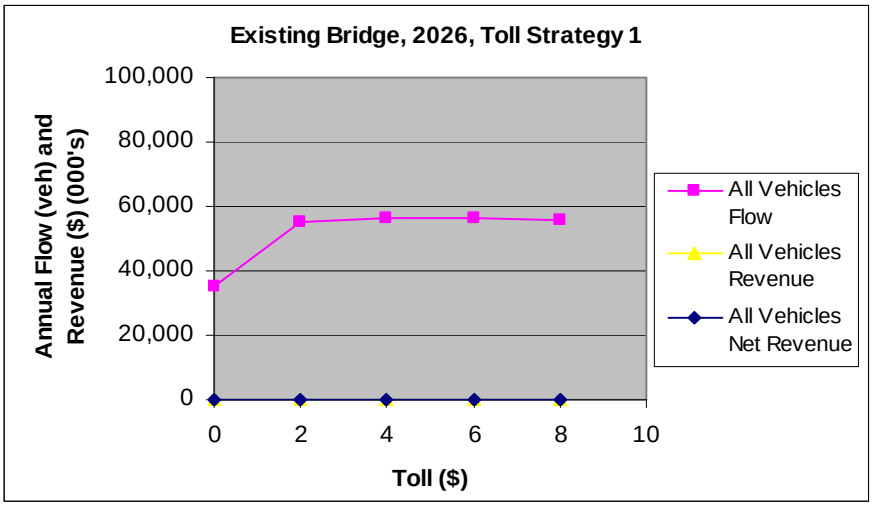
2 Key Points

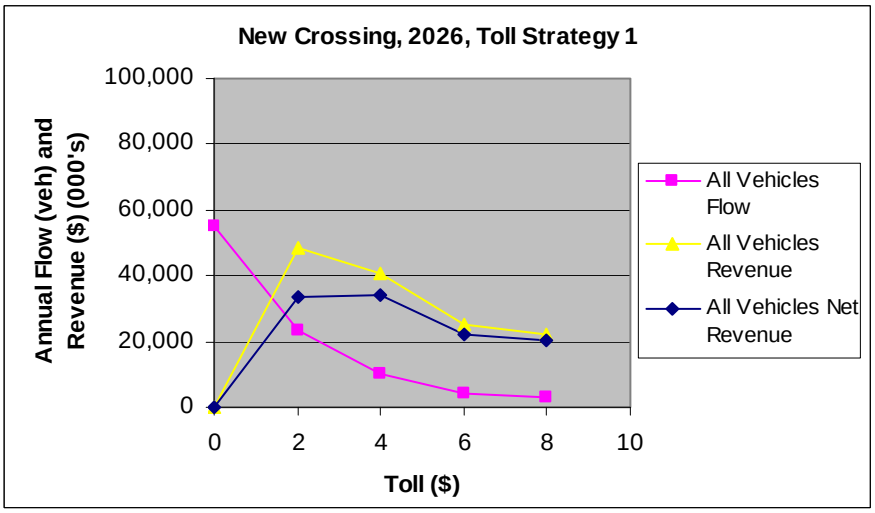
Some initial key points from the results that follow:

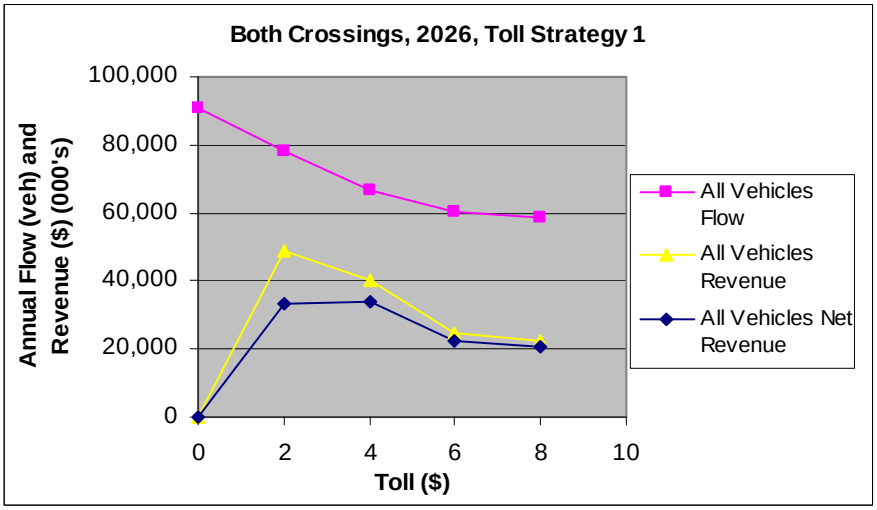
- The flows on WHC and AHB are sensitive to tolls when each is tolled alone, but less so when both are tolled;
- The sensitivity is reflected in the redistribution of trips, mode switching (both of which occur via ART3) and rerouteing (which occurs via the toll model);
- Mode shift to PT occurs when AHB is tolled alone or in conjunction with the new crossing (both crossings);
- The capacities of AHB and WHC are reached when one or other of the crossings is tolled, constraining the re-routeing diversion;
- Interactions with the Upper Harbour corridor (UHB) are small;
- Travel times on the tolled routes improve with tolls, but the average on all routes (weighted by trips) between two points does not necessarily improve;
- The demand responses to tolls occur in locations expected; more trips internal to the sectors either side of the harbour, North Shore/Rodney and CBD/Isthmus/South, and less demand between these sectors.

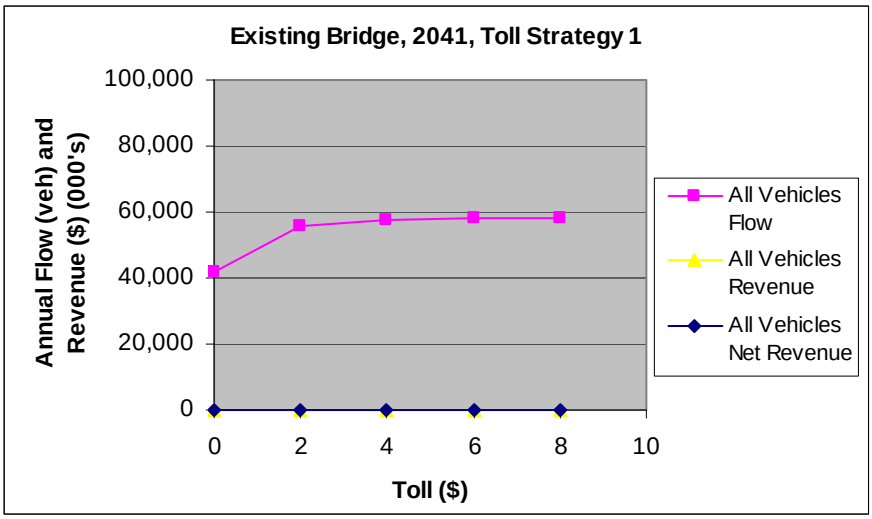
3 Flows and Revenues

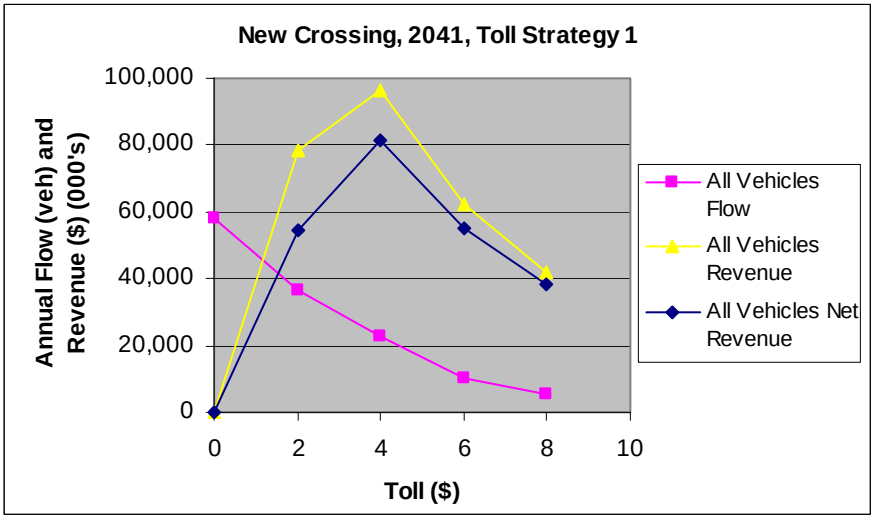
3.1 Toll Strategy 1: Tolling New Crossing Only

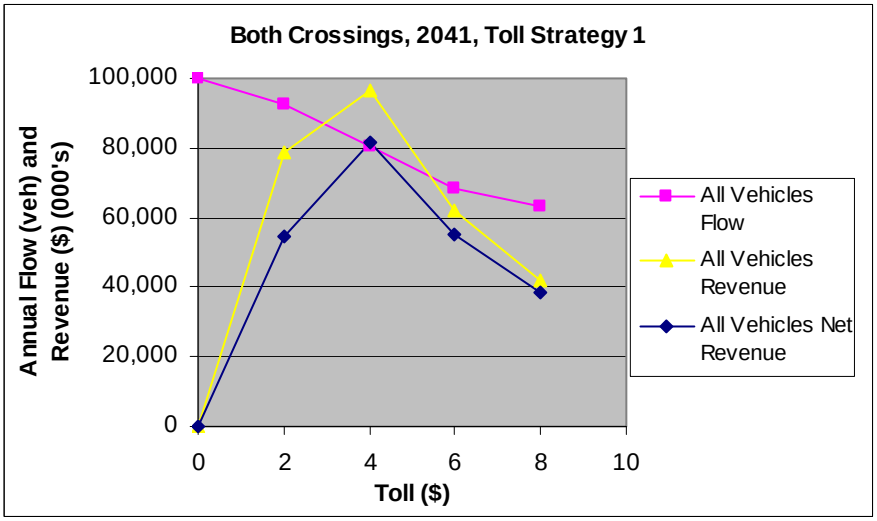




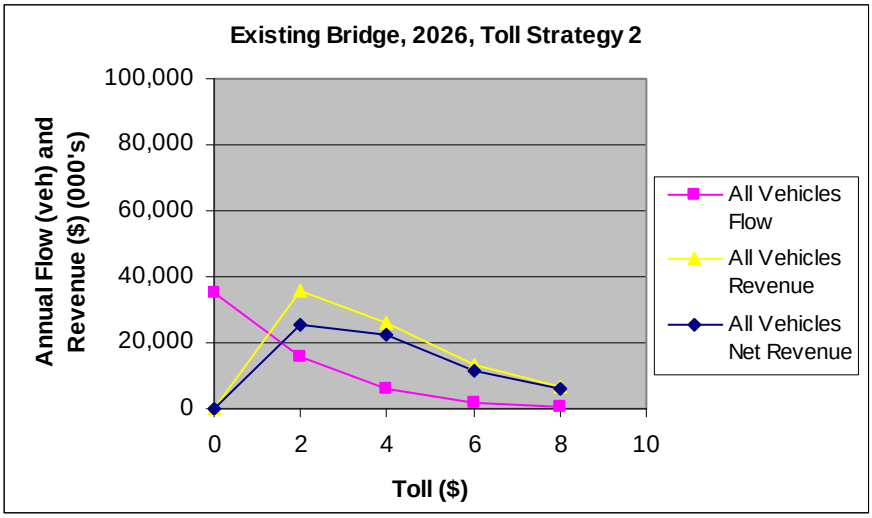


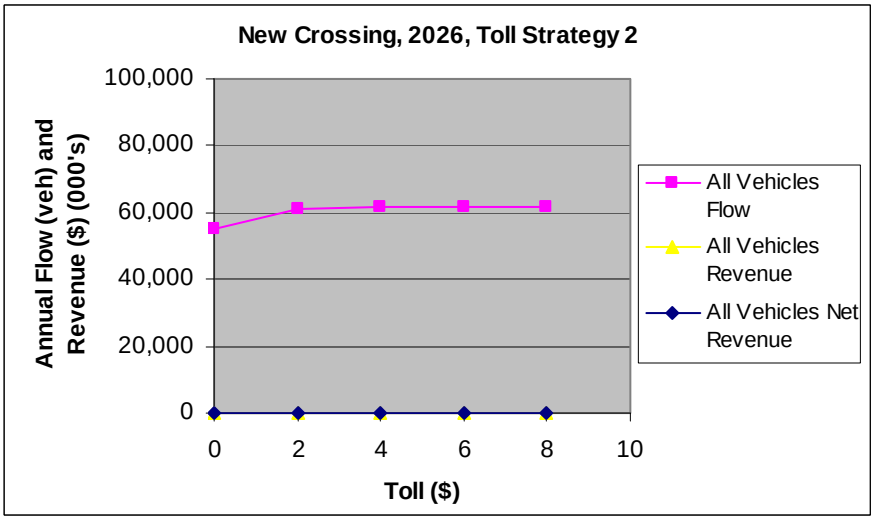

Existing Bridge, 2041, Toll Strategy 1
Annual Flow (veh) and Revenue ($) (000's)
100,000
80,000
60,000
40,000
20,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

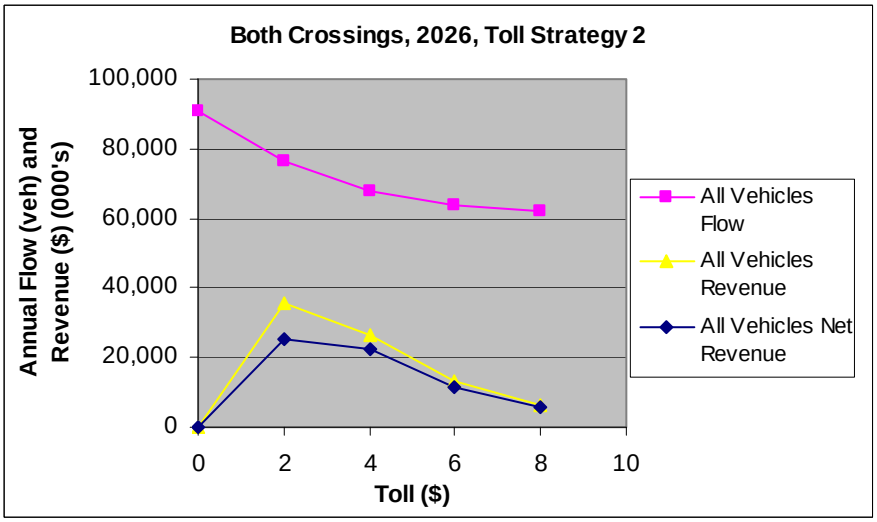

New Crossing, 2041, Toll Strategy 1
Annual Flow (veh) and Revenue ($) (000's)
100,000
80,000
60,000
40,000
20,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

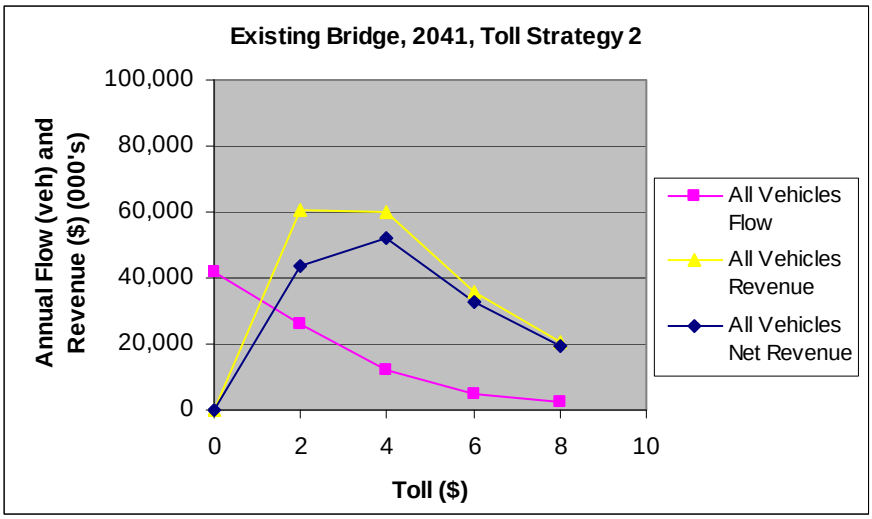

Both Crossings, 2041, Toll Strategy 1
Annual Flow (veh) and Revenue ($) (000's)
100,000
80,000
60,000
40,000
20,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

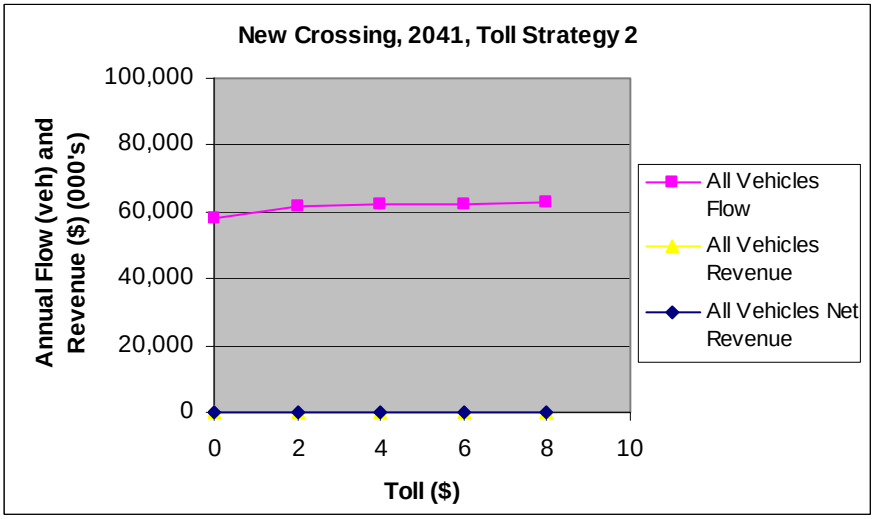
3.2 Toll Strategy 2: Tolling Existing Bridge Only

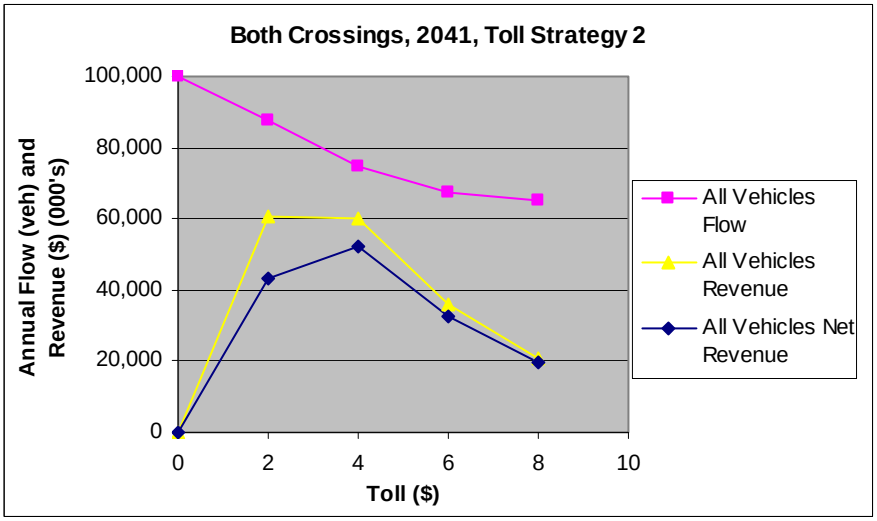




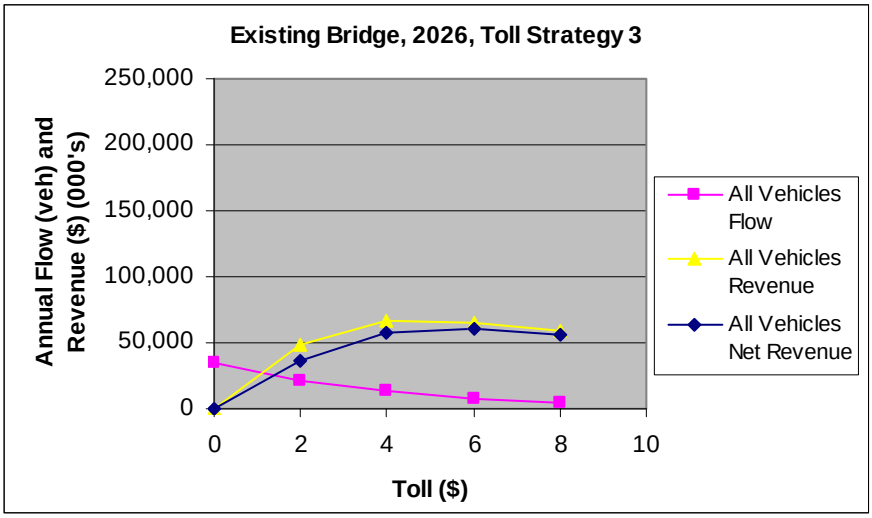


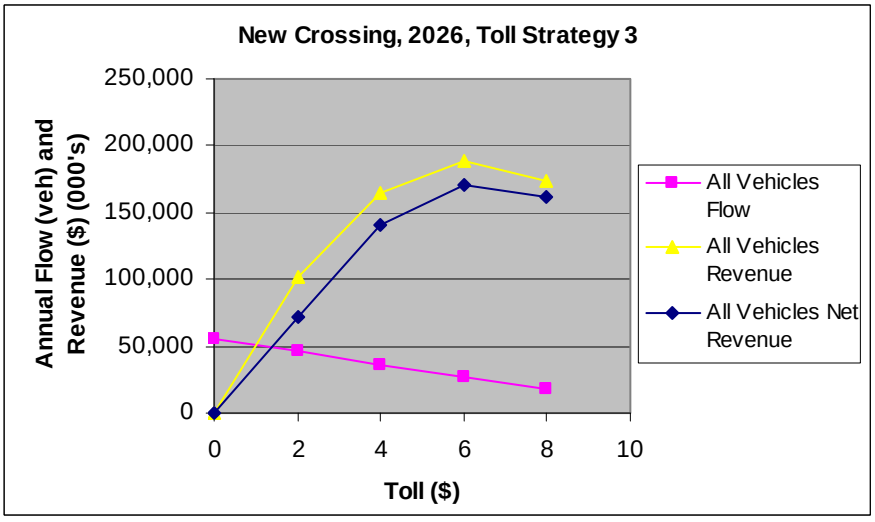

Existing Bridge, 2041, Toll Strategy 2
Annual Flow (veh) and Revenue ($) (000's)
100,000
80,000
60,000
40,000
20,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

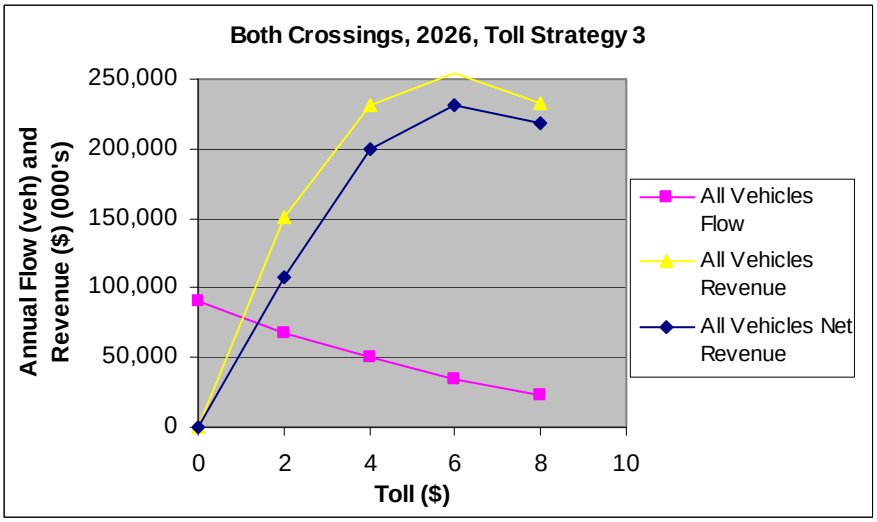

New Crossing, 2041, Toll Strategy 2
Annual Flow (veh) and Revenue ($) (000's)
100,000
80,000
60,000
40,000
20,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

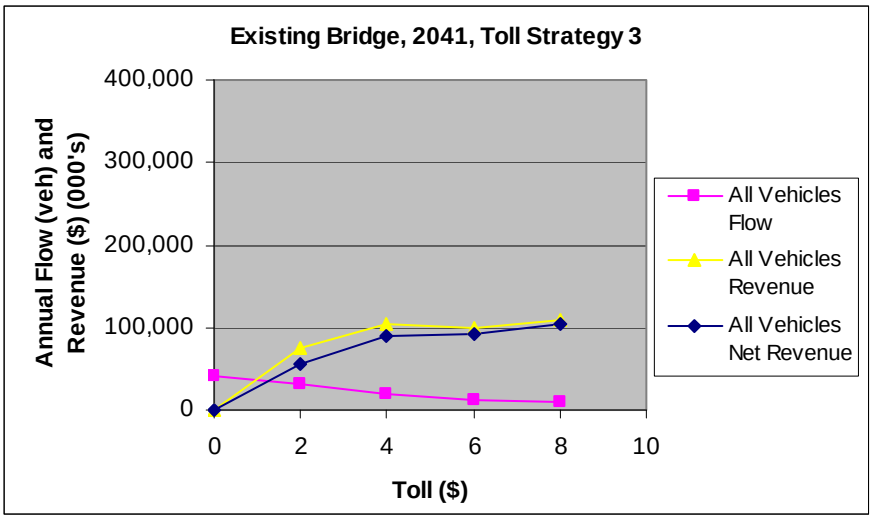

Both Crossings, 2041, Toll Strategy 2
Annual Flow (veh) and Revenue ($) (000's)
100,000
80,000
60,000
40,000
20,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

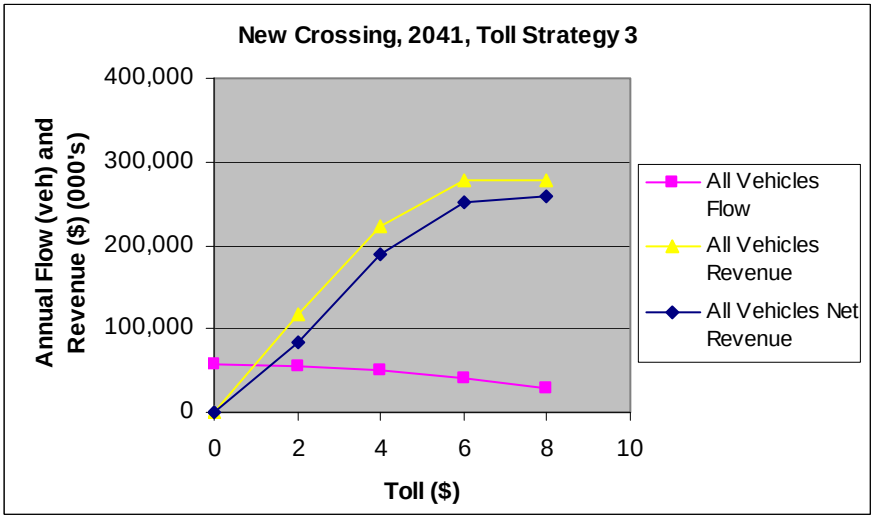
3.3 Toll Strategy 3: Tolling Both Crossings

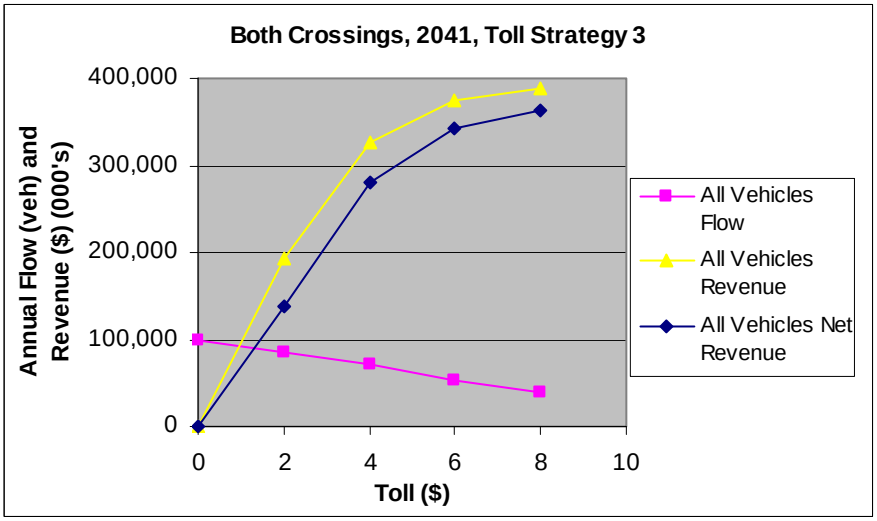







Existing Bridge, 2041, Toll Strategy 3
Annual Flow (veh) and Revenue ($) (000's)
400,000
300,000
200,000
100,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue


New Crossing, 2041, Toll Strategy 3
Annual Flow (veh) and Revenue ($) (000's)
400,000
300,000
200,000
100,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue


Both Crossings, 2041, Toll Strategy 3
Annual Flow (veh) and Revenue ($) (000's)
400,000
300,000
200,000
100,000
0
0
2
4
6
8
10
Toll ($)
All Vehicles Flow
All Vehicles Revenue
All Vehicles Net Revenue

3.4 Flow and Revenue Summary

	2026				2041			
Toll ($)	Annual Flow (000's)	Annual Revenue ($ 000's)	Annual Net Rev ($ 000's)	Diversion	Annual Flow (000's)	Annual Revenue ($ 000's)	Annual Net Rev ($ 000's)	Diversion
Toll Strategy 1: Tolling New Crossing Only								
0	55,316	0	0		58,032	0	0	
2	23,260	48,572	33,452	58%	36,819	78,552	54,620	37%
4	10,065	40,434	33,891	82%	22,938	96,566	81,657	60%
6	4,165	24,995	22,288	92%	10,206	61,992	55,359	82%
8	2,800	22,397	20,577	95%	5,220	41,760	38,367	91%
Toll Strategy 2: Tolling Existing Bridge Only								
0	35,288	0	0		41,947	0	0	
2	15,651	35,621	25,447	56%	25,974	60,396	43,513	38%
4	5,876	26,296	22,477	83%	12,388	60,084	52,032	70%
6	2,118	13,086	11,710	94%	4,973	35,872	32,639	88%
8	812	6,517	5,989	98%	2,301	20,884	19,388	95%
Toll Strategy 3: Tolling Both Crossings								
0	90,604	0	0		99,979	0	0	
2	67,258	151,335	107,617	26%	85,943	194,018	138,155	14%
4	49,781	231,748	199,391	45%	70,767	326,689	280,690	29%
6	34,683	253,946	231,402	62%	51,912	375,705	341,963	48%
8	22,331	233,437	218,922	75%	38,099	387,796	363,031	62%

3.5 Implied Elasticities

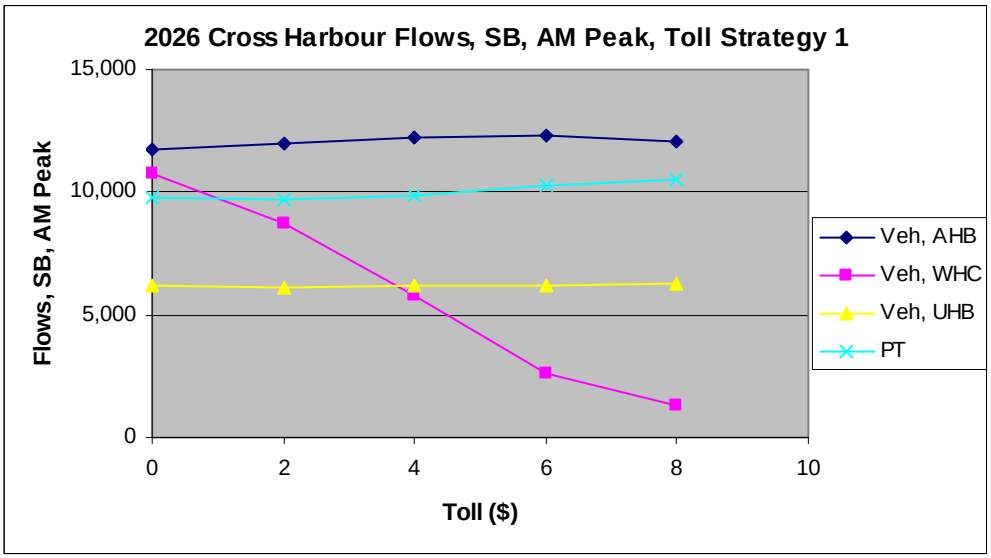
Elasticities for Toll Strategy 3, both crossings tolled.

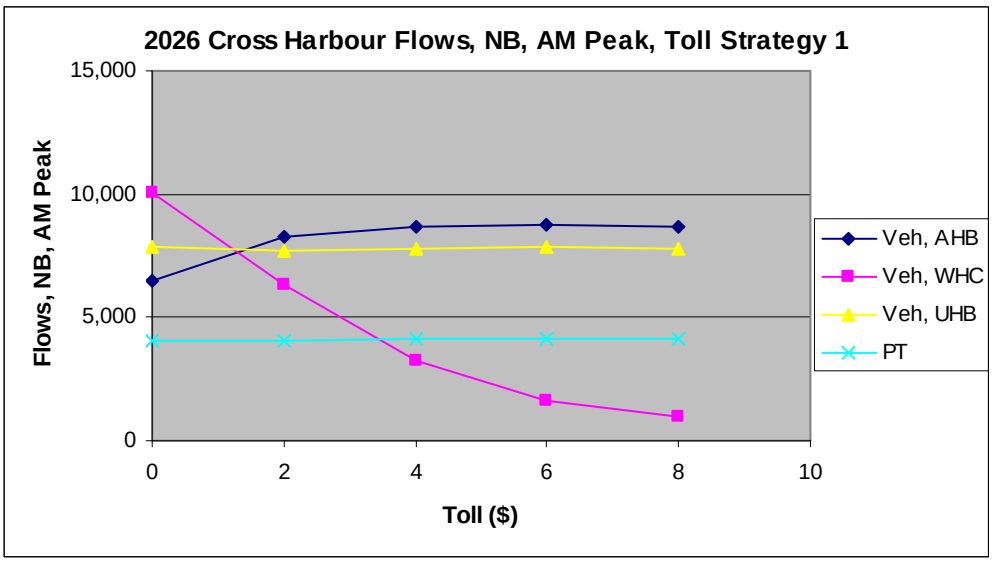
These are within the range of elasticities experienced elsewhere at the lower toll levels but are high at the higher toll levels. For a 2026 value of time of $16/hour (the value for segment 5) an $8 toll equates to 30 minutes travel delay, which is much higher than the 2006 peak delay of about 13 minutes (the difference between the AM peak and Interpeak southbound travel times, Albany to CBD). In this context, therefore, an $8 toll seems unreasonable and we would place less emphasis on the model forecasts.

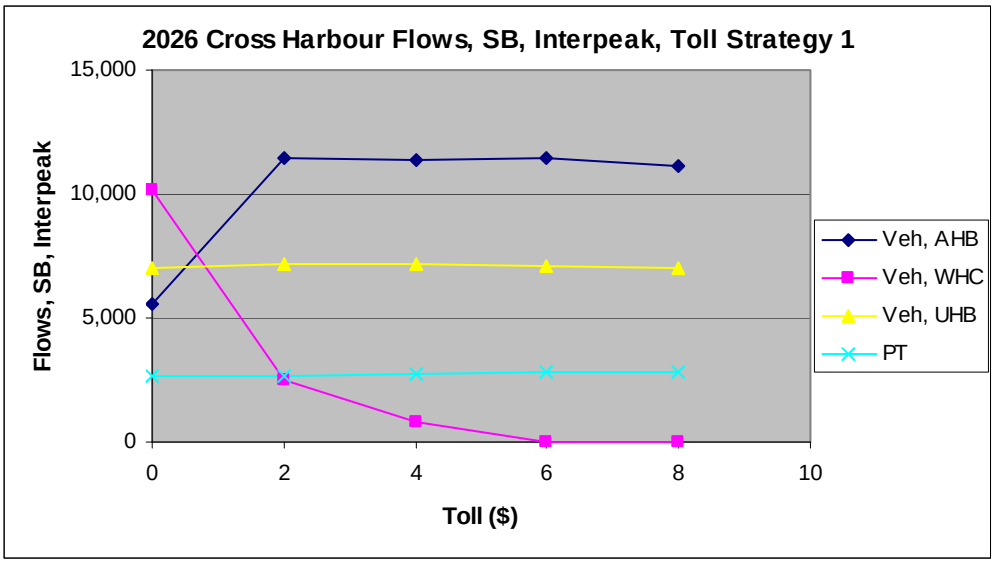
	2026		2041	
Toll ($)	Annual Flow (000's)	Implied Elasticity	Annual Flow (000's)	Implied Elasticity
2	67,258		85,943	
4	49,781	-0.26	70,767	-0.18
6	34,683	-0.61	51,912	-0.53
8	22,331	-1.07	38,099	-0.80

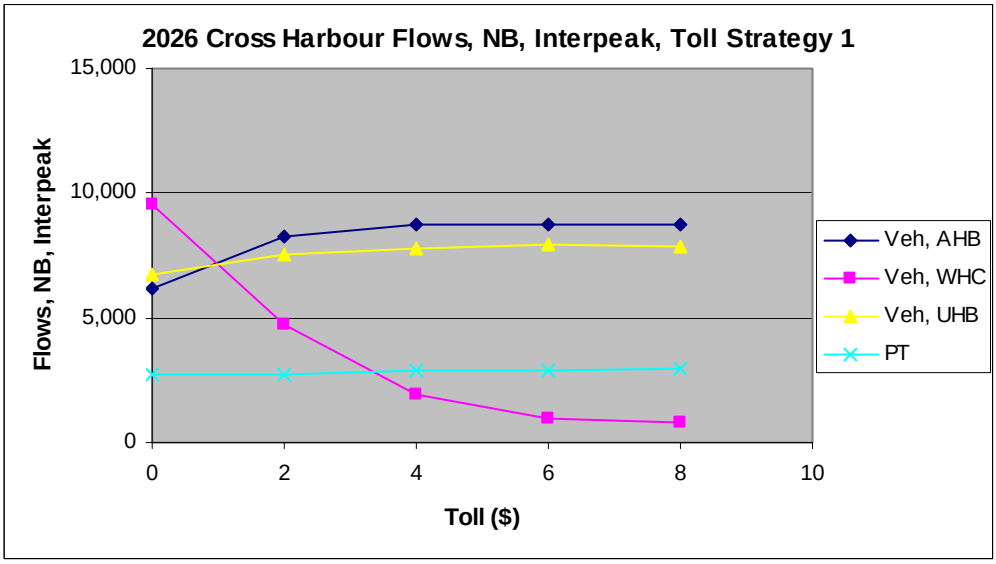
4 Cross Harbour Flows

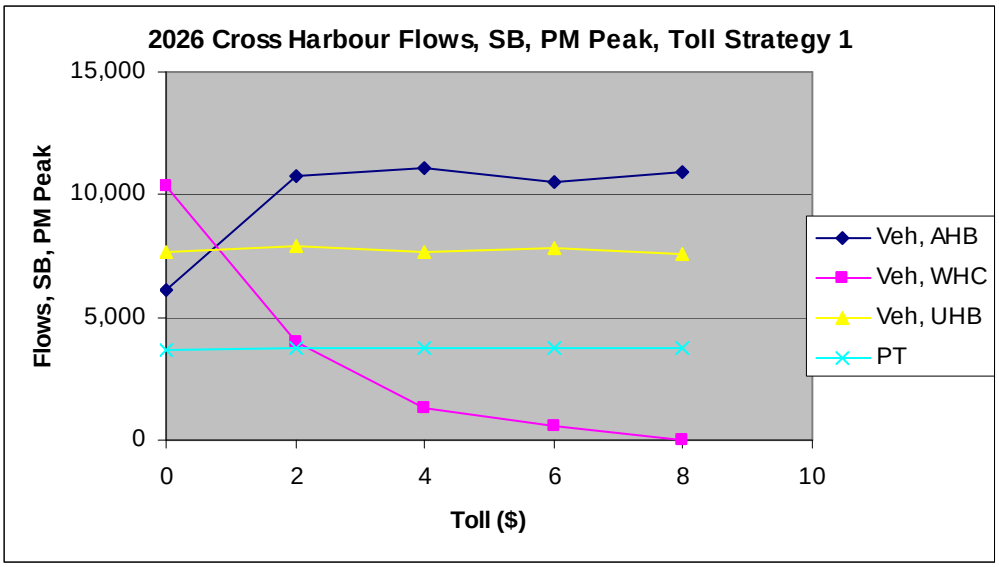
4.1 Toll Strategy 1: Tolling New Crossing Only

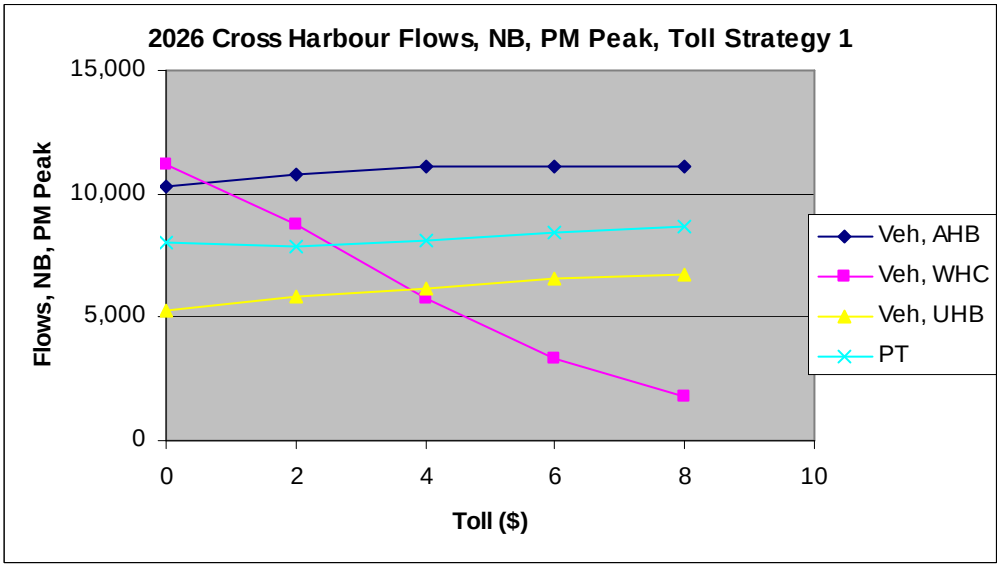




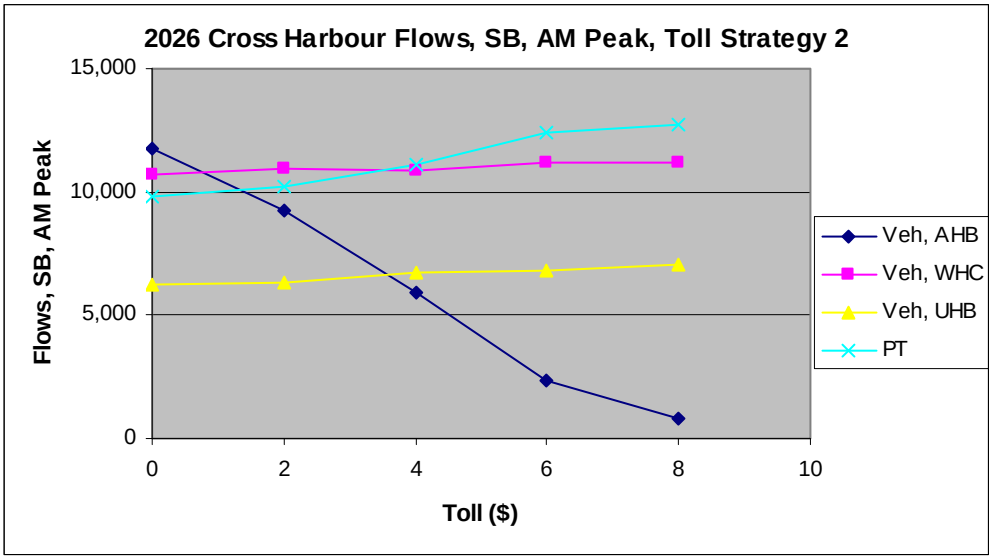

2026 Cross Harbour Flows, SB, Interpeak, Toll Strategy 1
Flows, SB, Interpeak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

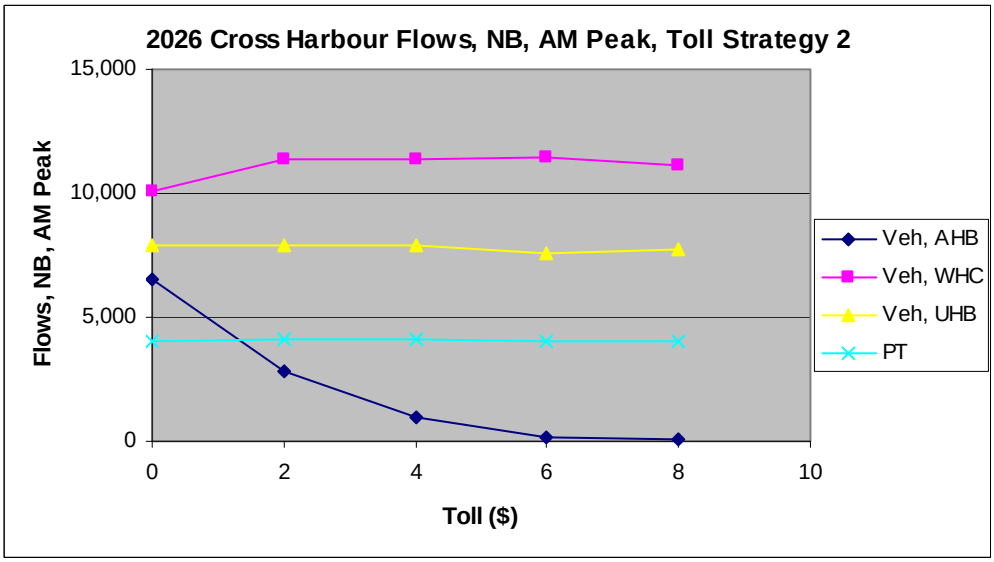

2026 Cross Harbour Flows, NB, Interpeak, Toll Strategy 1
Flows, NB, Interpeak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

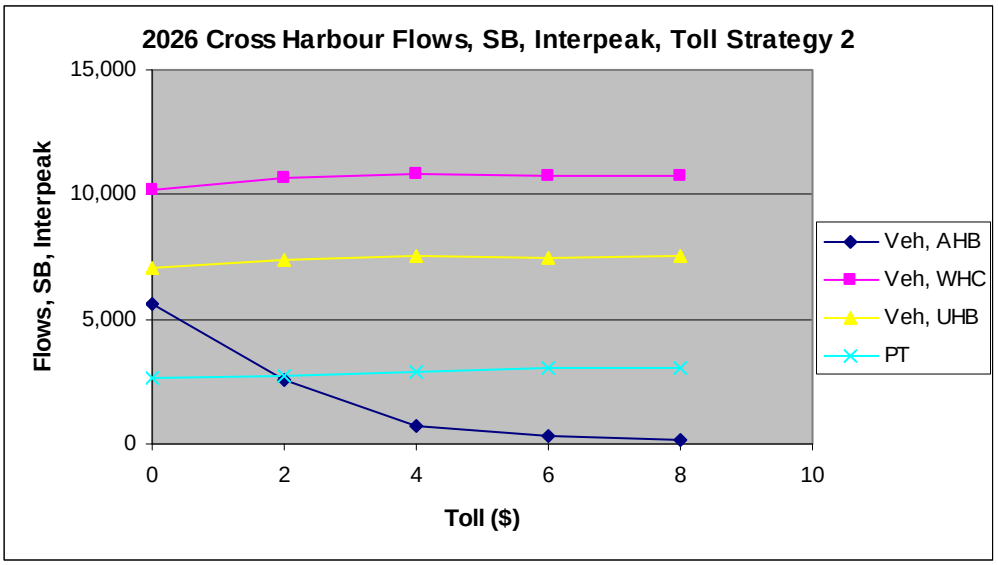

2026 Cross Harbour Flows, SB, PM Peak, Toll Strategy 1
Flows, SB, PM Peak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

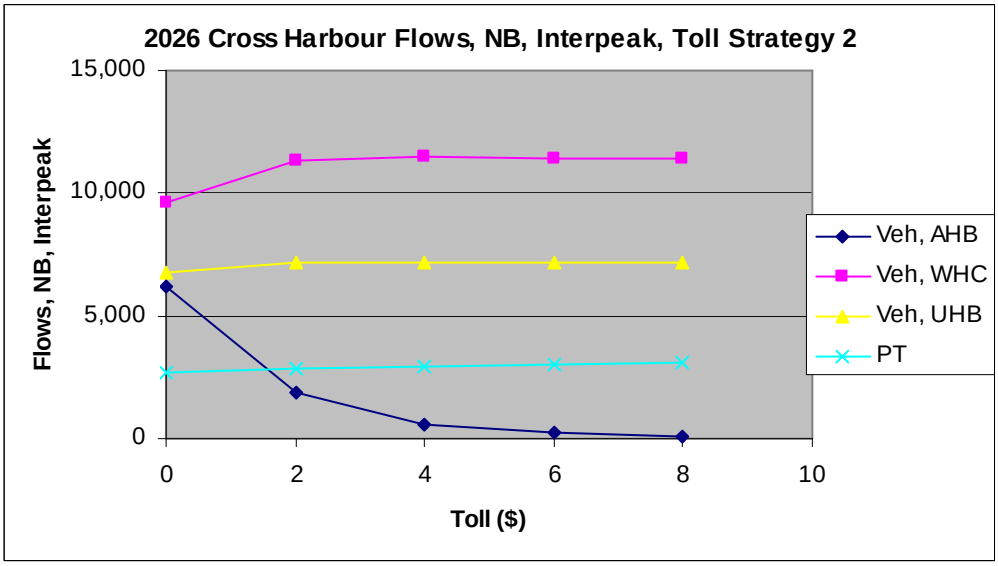

2026 Cross Harbour Flows, NB, PM Peak, Toll Strategy 1
Flows, NB, PM Peak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

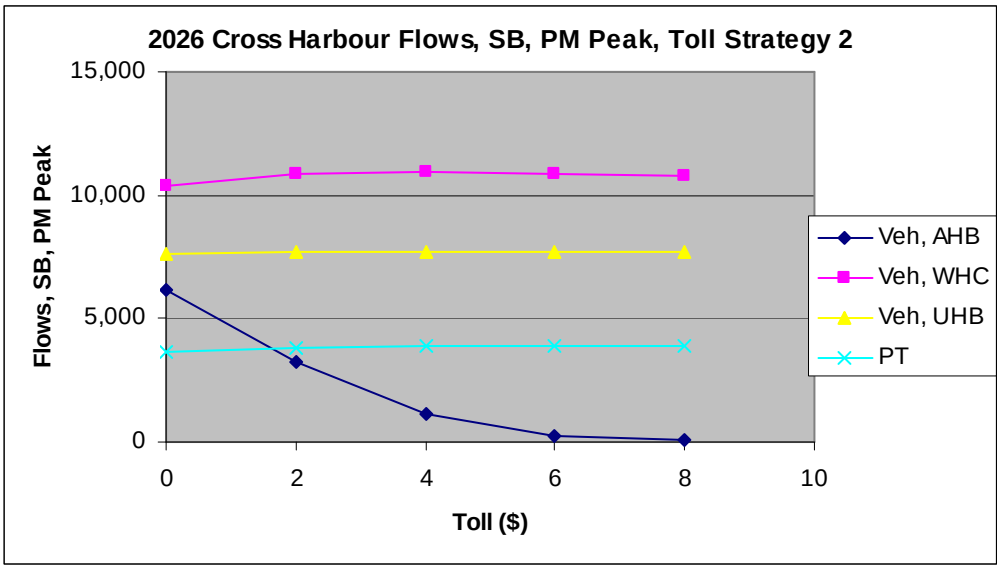
4.2 Toll Strategy 2: Tolling Existing Bridge Only

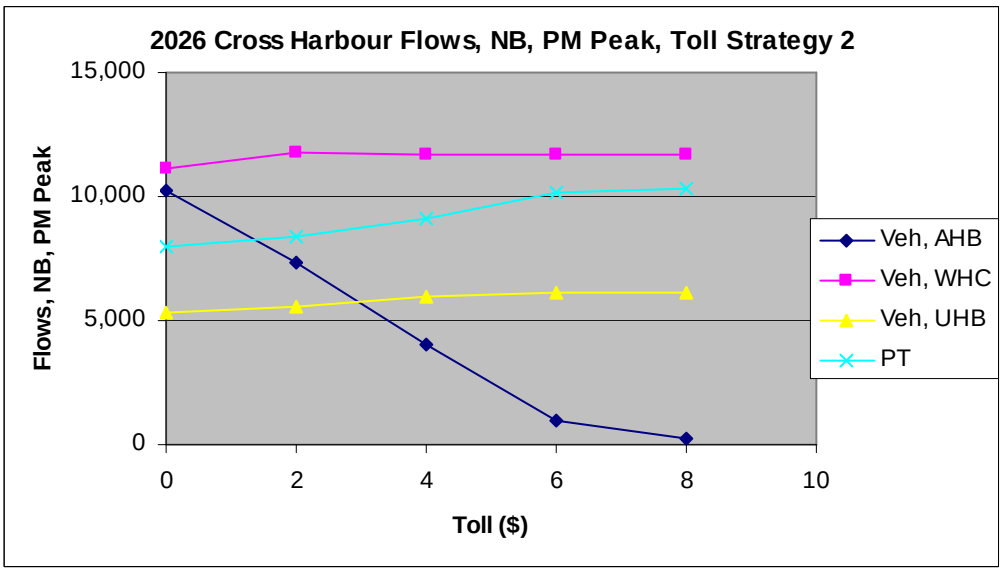




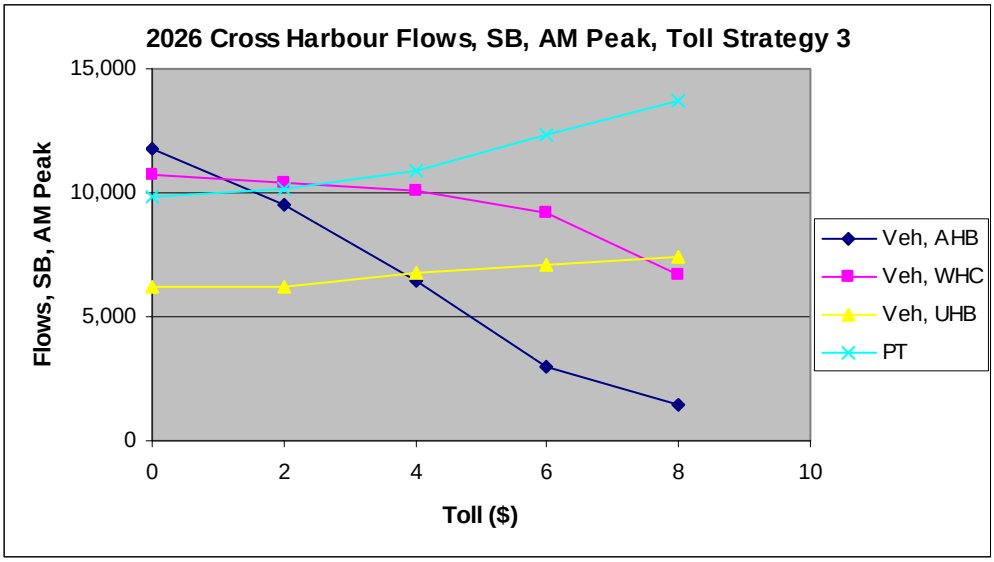

2026 Cross Harbour Flows, SB, Interpeak, Toll Strategy 2
15,000
10,000
5,000
0
Flows, SB, Interpeak
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

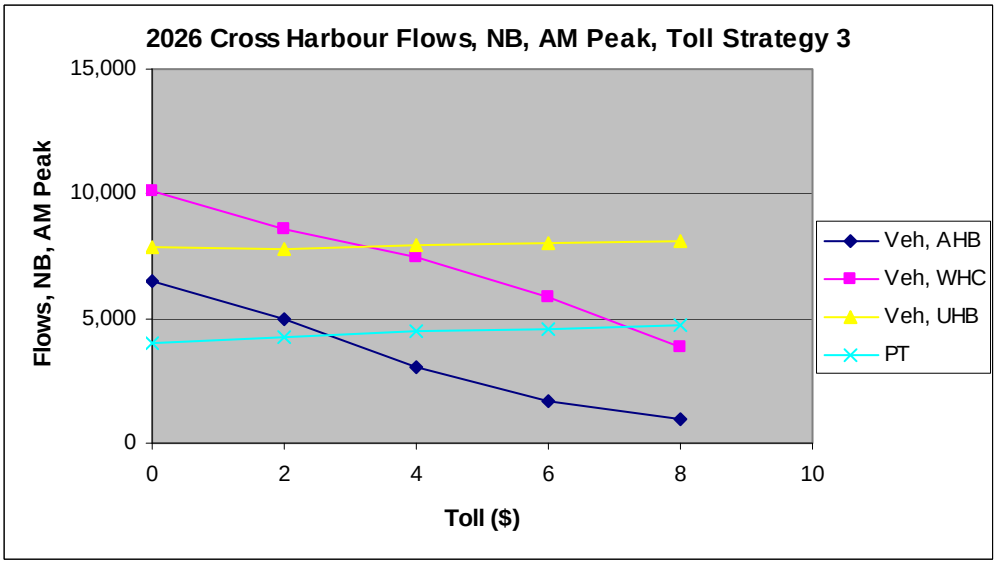

2026 Cross Harbour Flows, NB, Interpeak, Toll Strategy 2
15,000
10,000
5,000
0
Flows, NB, Interpeak
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

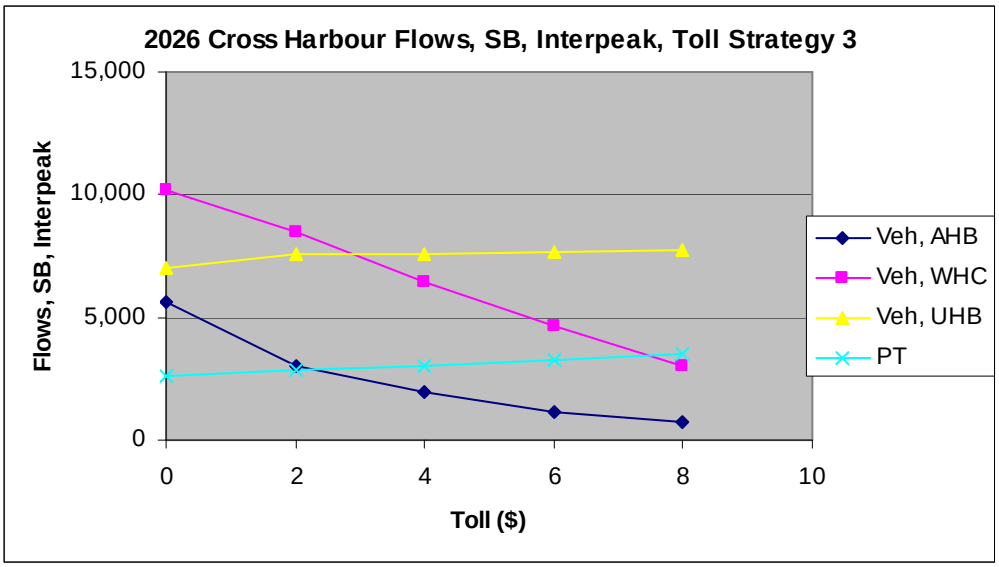

2026 Cross Harbour Flows, SB, PM Peak, Toll Strategy 2
Flows, SB, PM Peak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

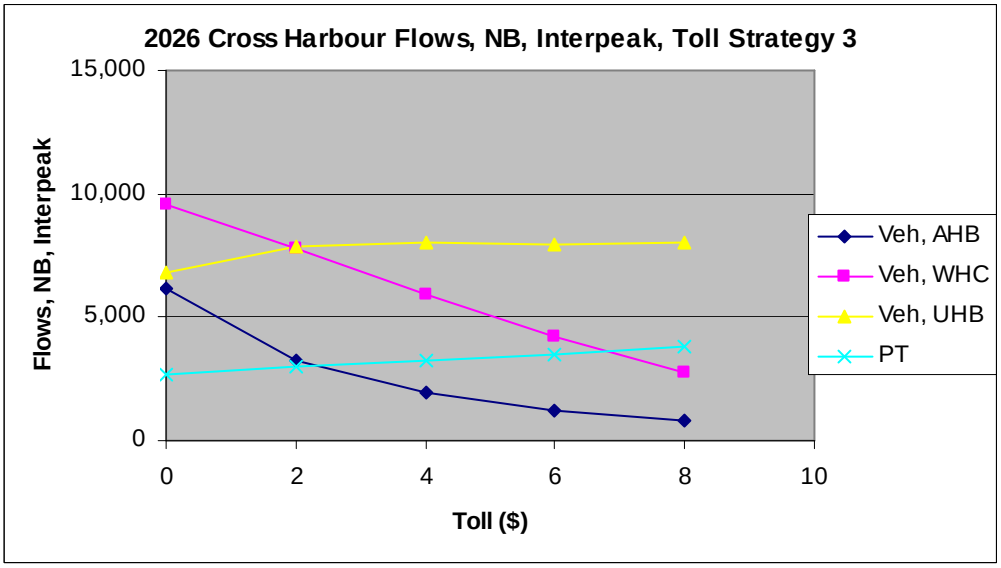

2026 Cross Harbour Flows, NB, PM Peak, Toll Strategy 2
Flows, NB, PM Peak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

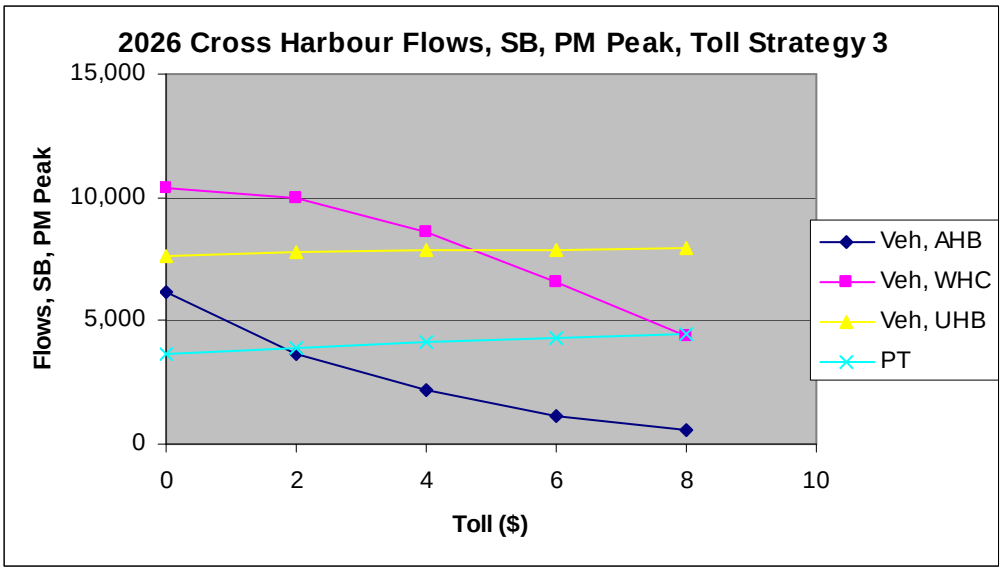
4.3 Toll Strategy 3: Tolling Both Crossings

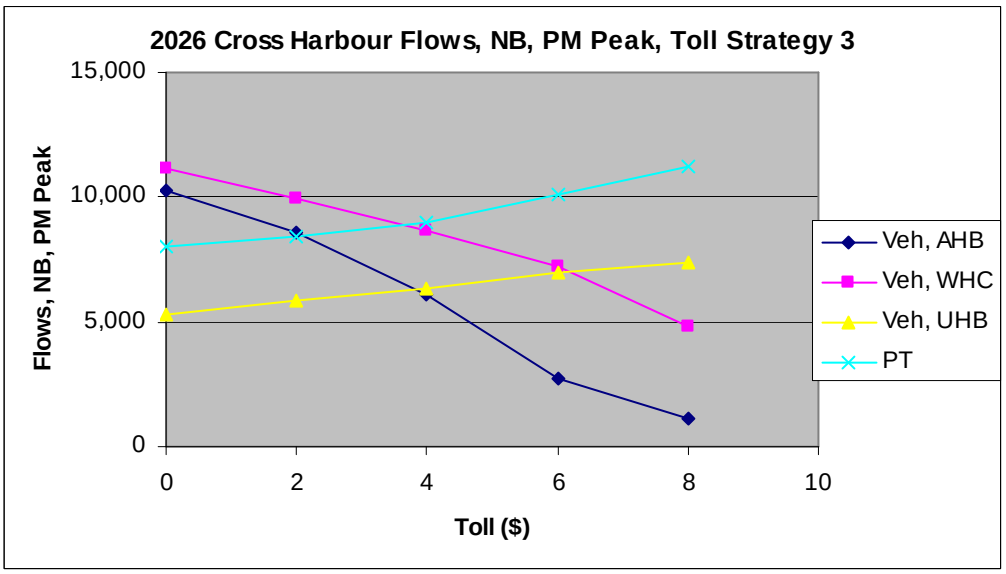





2026 Cross Harbour Flows, SB, Interpeak, Toll Strategy 3
Flows, SB, Interpeak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

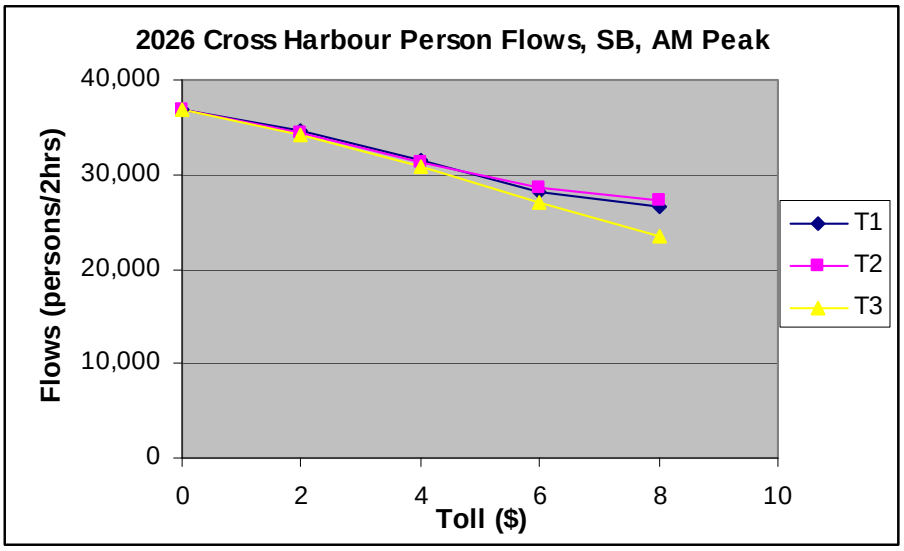

2026 Cross Harbour Flows, NB, Interpeak, Toll Strategy 3
Flows, NB, Interpeak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

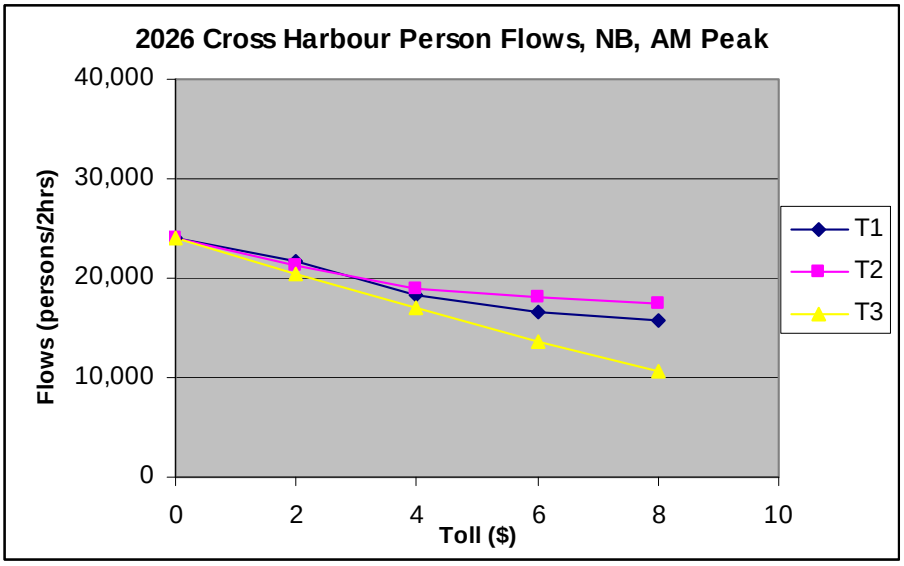

2026 Cross Harbour Flows, SB, PM Peak, Toll Strategy 3
Flows, SB, PM Peak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

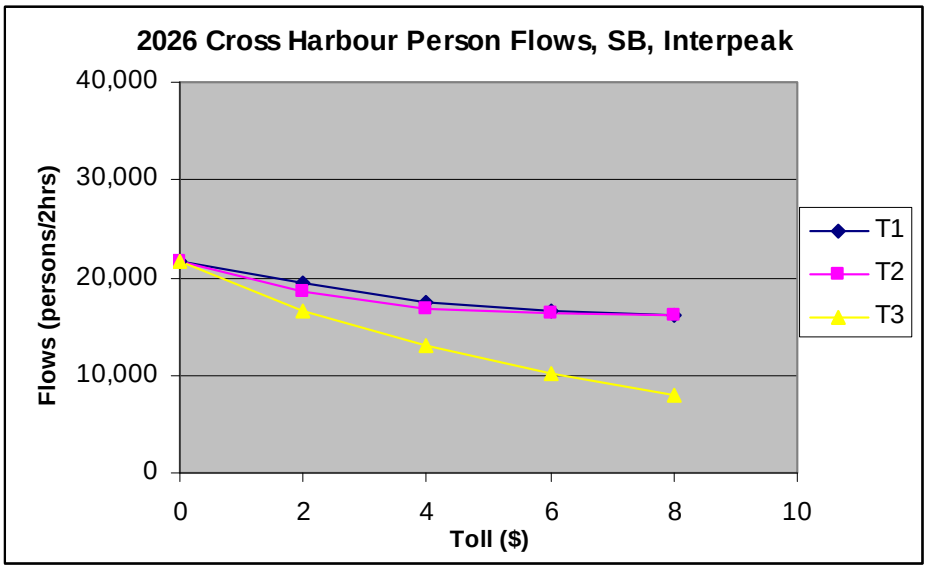

2026 Cross Harbour Flows, NB, PM Peak, Toll Strategy 3
Flows, NB, PM Peak
15,000
10,000
5,000
0
0
2
4
6
8
10
Toll ($)
Veh, AHB
Veh, WHC
Veh, UHB
PT

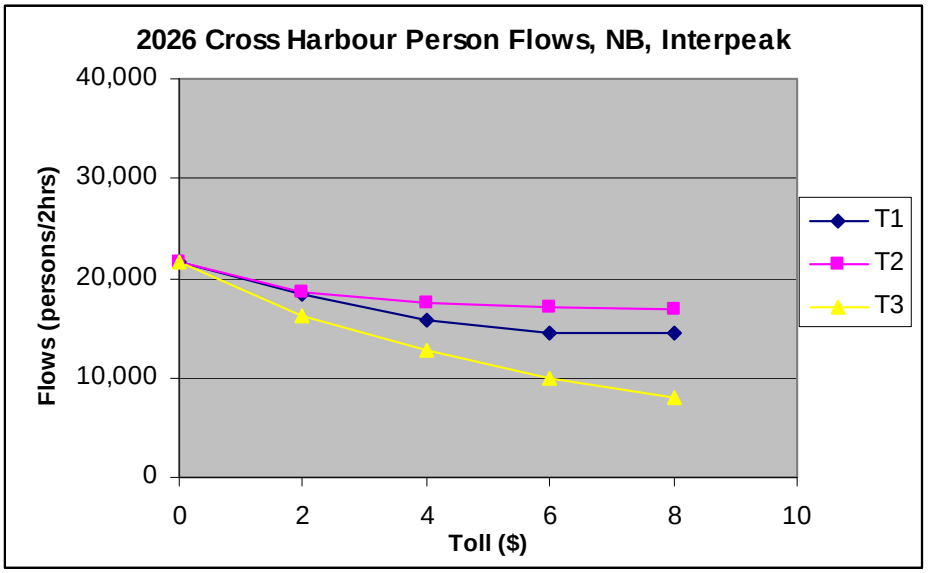
4.4 Cross Harbour Person Flows

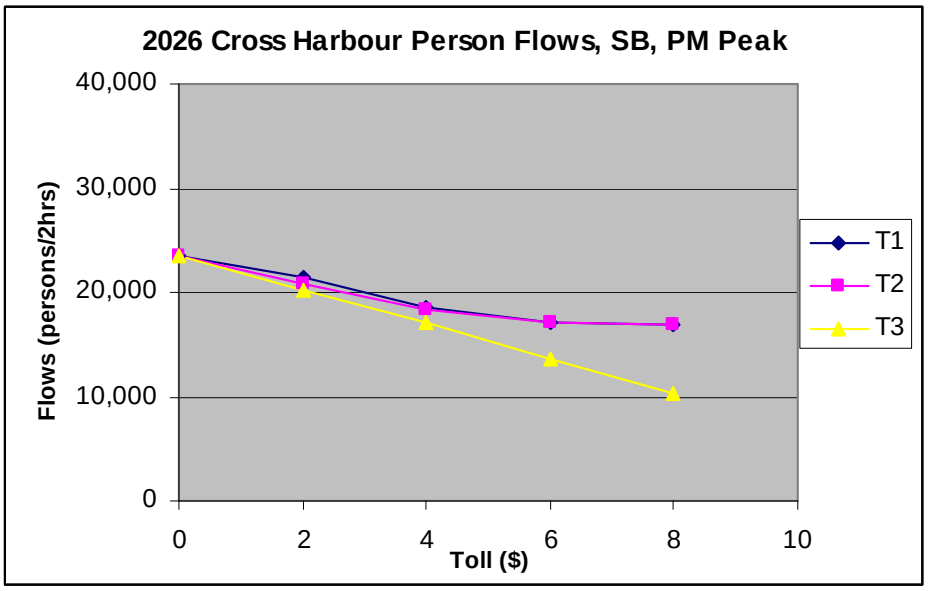
2026 person flows across the existing and new bridge. Persons = vehicles *1.2 + PT trips

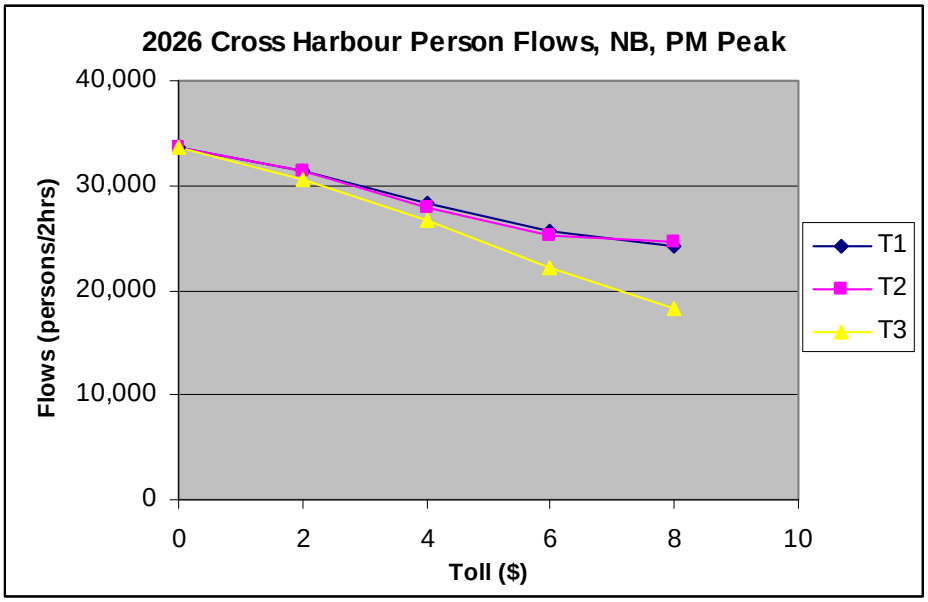





2026 Cross Harbour Person Flows, SB, Interpeak
40,000
30,000
20,000
10,000
0
Flows (persons/2hrs)
0
2
4
6
8
10
Toll ($)
T1
T2
T3


2026 Cross Harbour Person Flows, NB, Interpeak
40,000
30,000
20,000
10,000
0
Flows (persons/2hrs)
0
2
4
6
8
10
Toll ($)
T1
T2
T3


2026 Cross Harbour Person Flows, SB, PM Peak
Flows (persons/2hrs)
40,000
30,000
20,000
10,000
0
0
2
4
6
8
10
Toll ($)
T1
T2
T3


2026 Cross Harbour Person Flows, NB, PM Peak
Flows (persons/2hrs)
40,000
30,000
20,000
10,000
0
0
2
4
6
8
10
Toll ($)
T1
T2
T3

5 Screenline Flows

5.1 Toll Strategy 1: Tolling New Crossing

Flows with no toll and % difference from no toll for each toll level

	2026					2041				
Toll Level	**$0**	**$2**	**$4**	**$6**	**$8**	**$0**	**$2**	**$4**	**$6**	**$8**
AM Peak Vehicle										
Hibiscus NB	6,383	-3%	-6%	-6%	-6%	7,542	2%	1%	-1%	-3%
Hibiscus SB	11,107	0%	-2%	-1%	-1%	11,413	0%	2%	2%	2%
North Shore NB	15,479	-4%	-7%	-8%	-9%	15,818	0%	-1%	-3%	-5%
North Shore SB	17,477	-1%	-3%	-6%	-8%	18,579	0%	2%	-2%	-7%
Harbour NB	25,627	-8%	-18%	-24%	-27%	27,157	-3%	-11%	-22%	-27%
Harbour SB	29,308	-6%	-15%	-26%	-31%	30,368	-3%	-8%	-21%	-31%
Central Isthmus NB	58,561	0%	-1%	-2%	-2%	60,831	0%	-1%	-2%	-2%
Central Isthmus SB	39,408	0%	0%	-2%	-3%	44,884	1%	1%	-1%	-4%
CBD IN	38,211	6%	9%	9%	8%	43,812	2%	4%	5%	5%
CBD OUT	33,249	9%	15%	18%	18%	37,922	4%	5%	9%	12%
AM Peak PT										
Hibiscus NB	226	0%	-1%	0%	0%	581	2%	1%	1%	1%
Hibiscus SB	2,161	0%	1%	4%	4%	3,127	-2%	-2%	-1%	1%
North Shore NB	3,711	2%	4%	5%	6%	3,975	1%	2%	4%	6%
North Shore SB	6,539	0%	3%	6%	9%	8,082	0%	-1%	3%	5%
Harbour NB	5,243	1%	2%	3%	2%	6,355	1%	1%	1%	3%
Harbour SB	12,517	-1%	2%	5%	8%	16,582	0%	1%	5%	6%
Central Isthmus NB	29,829	1%	1%	2%	2%	37,470	1%	1%	1%	1%
Central Isthmus SB	6,469	0%	1%	1%	2%	6,868	0%	1%	3%	3%
CBD IN	32,584	0%	1%	2%	2%	39,391	1%	2%	2%	3%
CBD OUT	11,287	0%	2%	3%	4%	12,855	0%	1%	2%	4%

5.2 Toll Strategy 2: Tolling Existing Crossing

Flows with no toll and % difference from no toll for each toll level

	2026					2041				
Toll Level	**$0**	**$2**	**$4**	**$6**	**$8**	**$0**	**$2**	**$4**	**$6**	**$8**
AM Peak Vehicle										
Hibiscus NB	6,383	-1%	-2%	-1%	-1%	7,542	0%	1%	1%	1%
Hibiscus SB	11,107	1%	0%	-1%	-1%	11,413	1%	2%	1%	0%
North Shore NB	15,479	-3%	-3%	1%	0%	15,818	0%	0%	-1%	-1%
North Shore SB	17,477	-1%	-4%	-8%	-10%	18,579	-1%	1%	-7%	-9%
Harbour NB	25,627	-9%	-17%	-20%	-21%	27,157	-7%	-21%	-23%	-24%
Harbour SB	29,308	-7%	-18%	-28%	-33%	30,368	-5%	-22%	-31%	-33%
Central Isthmus NB	58,561	0%	0%	0%	0%	60,831	-1%	-1%	-1%	-1%
Central Isthmus SB	39,408	0%	-1%	-3%	-4%	44,884	-1%	1%	-1%	-2%
CBD IN	38,211	-4%	-6%	-9%	-10%	43,812	-3%	-10%	-13%	-13%
CBD OUT	33,249	-4%	-8%	-12%	-14%	37,922	-4%	-10%	-13%	-15%
AM Peak PT										
Hibiscus NB	226	0%	-1%	0%	-1%	581	2%	4%	4%	2%
Hibiscus SB	2,161	3%	5%	8%	10%	3,127	1%	3%	6%	9%
North Shore NB	3,711	2%	4%	5%	5%	3,975	3%	6%	8%	8%
North Shore SB	6,539	4%	9%	18%	21%	8,082	1%	7%	17%	21%
Harbour NB	5,243	2%	2%	-1%	-2%	6,355	3%	4%	3%	3%
Harbour SB	12,517	3%	11%	23%	26%	16,582	3%	16%	23%	26%
Central Isthmus NB	29,829	1%	2%	3%	3%	37,470	1%	2%	3%	3%
Central Isthmus SB	6,469	1%	2%	4%	4%	6,868	2%	4%	6%	6%
CBD IN	32,584	2%	4%	7%	8%	39,391	2%	6%	8%	9%
CBD OUT	11,287	2%	4%	5%	6%	12,855	3%	6%	7%	7%

5.3 Toll Strategy 3: Tolling Both Crossings

Flows with no toll and % difference from no toll for each toll level

	2026					2041				
Toll Level	**$0**	**$2**	**$4**	**$6**	**$8**	**$0**	**$2**	**$4**	**$6**	**$8**
AM Peak Vehicle										
Hibiscus NB	6,383	-4%	-8%	-10%	-13%	7,542	0%	-1%	0%	-1%
Hibiscus SB	11,107	0%	0%	-1%	-1%	11,413	1%	0%	2%	2%
North Shore NB	15,479	-5%	-8%	-9%	-11%	15,818	-1%	0%	-6%	-9%
North Shore SB	17,477	-1%	-5%	-7%	-11%	18,579	0%	0%	-7%	-14%
Harbour NB	25,627	-12%	-23%	-34%	-44%	27,157	-5%	-22%	-39%	-48%
Harbour SB	29,308	-8%	-18%	-32%	-44%	30,368	-3%	-22%	-42%	-52%
Central Isthmus NB	58,561	-1%	-2%	-2%	-2%	60,831	0%	-1%	-3%	-3%
Central Isthmus SB	39,408	-1%	-1%	-1%	-2%	44,884	-1%	1%	-2%	-5%
CBD IN	38,211	-2%	-3%	-7%	-9%	43,812	1%	-6%	-10%	-9%
CBD OUT	33,249	-3%	-7%	-12%	-12%	37,922	1%	-7%	-14%	-13%
AM Peak PT										
Hibiscus NB	226	0%	0%	-1%	-1%	581	1%	4%	6%	6%
Hibiscus SB	2,161	2%	5%	9%	13%	3,127	0%	3%	3%	5%
North Shore NB	3,711	5%	10%	15%	20%	3,975	3%	7%	14%	19%
North Shore SB	6,539	4%	9%	16%	27%	8,082	0%	6%	17%	22%
Harbour NB	5,243	5%	9%	11%	13%	6,355	3%	4%	8%	14%
Harbour SB	12,517	3%	10%	22%	34%	16,582	2%	18%	27%	30%
Central Isthmus NB	29,829	1%	2%	4%	5%	37,470	1%	3%	3%	3%
Central Isthmus SB	6,469	1%	2%	5%	7%	6,868	1%	4%	7%	8%
CBD IN	32,584	2%	4%	8%	10%	39,391	2%	7%	9%	10%
CBD OUT	11,287	3%	6%	10%	15%	12,855	2%	7%	12%	14%

6 Vehicle and PT Demands by Sector

6.1 Toll Strategy 1: Tolling New Crossing

AM Peak, Vehicle

2026	$0	T1					
		1	2	3	4	5	6
Rodney	1	37,662	8,563	3,081	970	2,539	979
North Shore	2	4,233	72,438	4,694	5,650	10,491	3,136
Waitakere	3	2,300	7,182	48,927	3,843	17,008	3,652
CBD	4	309	2,322	1,088	8,956	18,351	1,845
Isthmus	5	1,198	7,620	9,475	19,239	107,693	18,106
South	6	865	3,799	2,948	3,647	27,249	149,792

2026	$4	T1					
Difference		1	2	3	4	5	6
Rodney	1	238	156	-1	-111	-214	-48
North Shore	2	82	3,570	-243	-1,241	-2,072	-284
Waitakere	3	-54	-760	454	-23	141	-61
CBD	4	-20	-682	-8	279	503	43
Isthmus	5	-107	-1,862	18	284	1,432	68
South	6	-62	-593	-70	118	408	336

% Difference		1	2	3	4	5	6
Rodney	1	1%	2%	0%	-11%	-8%	-5%
North Shore	2	2%	5%	-5%	-22%	-20%	-9%
Waitakere	3	-2%	-11%	1%	-1%	1%	-2%
CBD	4	-6%	-29%	-1%	3%	3%	2%
Isthmus	5	-9%	-24%	0%	1%	1%	0%
South	6	-7%	-16%	-2%	3%	1%	0%

AM Peak, PT

2026	$0	T1					
		1	2	3	4	5	6
Rodney	1	772	1,402	146	1,178	370	46
North Shore	2	172	6,823	330	6,973	1,894	285
Waitakere	3	45	1,093	2,996	4,850	2,537	257
CBD	4	22	1,161	308	1,964	1,957	269
Isthmus	5	20	1,627	1,678	12,870	9,930	1,726
South	6	22	1,055	460	6,661	4,634	8,361

2026	$4	T1					
Difference		1	2	3	4	5	6
Rodney	1	4	5	5	44	18	2
North Shore	2	-2	151	-4	222	70	8
Waitakere	3	0	11	22	114	47	4
CBD	4	0	52	1	35	43	5
Isthmus	5	0	100	-9	195	84	4
South	6	-1	-14	-7	64	16	15

% Difference		1	2	3	4	5	6
Rodney	1	1%	0%	3%	4%	5%	4%
North Shore	2	-1%	2%	-1%	3%	4%	3%
Waitakere	3	0%	1%	1%	2%	2%	2%
CBD	4	0%	4%	0%	2%	2%	2%
Isthmus	5	0%	6%	-1%	2%	1%	0%
South	6	-5%	-1%	-2%	1%	0%	0%

6.2 Toll Strategy 2: Tolling Existing Crossing

AM Peak, Vehicle

2026	$0	T2					
		1	2	3	4	5	6
Rodney	1	37,662	8,563	3,081	970	2,539	979
North Shore	2	4,233	72,438	4,694	5,650	10,491	3,136
Waitakere	3	2,300	7,182	48,927	3,843	17,008	3,652
CBD	4	309	2,322	1,088	8,956	18,351	1,845
Isthmus	5	1,198	7,620	9,475	19,239	107,693	18,106
South	6	865	3,799	2,948	3,647	27,249	149,792

2026	$4	T2					
Difference		1	2	3	4	5	6
Rodney	1	112	231	30	-100	-169	-41
North Shore	2	138	3,745	-74	-2,283	-2,181	-169
Waitakere	3	-51	-559	216	46	99	-45
CBD	4	-46	-1,109	17	377	717	23
Isthmus	5	-98	-1,854	-13	581	1,247	35
South	6	-32	-230	-62	71	231	138

% Difference		1	2	3	4	5	6
Rodney	1	0%	3%	1%	-10%	-7%	-4%
North Shore	2	3%	5%	-2%	-40%	-21%	-5%
Waitakere	3	-2%	-8%	0%	1%	1%	-1%
CBD	4	-15%	-48%	2%	4%	4%	1%
Isthmus	5	-8%	-24%	0%	3%	1%	0%
South	6	-4%	-6%	-2%	2%	1%	0%

AM Peak, PT

2026	$0	T2					
		1	2	3	4	5	6
Rodney	1	772	1,402	146	1,178	370	46
North Shore	2	172	6,823	330	6,973	1,894	285
Waitakere	3	45	1,093	2,996	4,850	2,537	257
CBD	4	22	1,161	308	1,964	1,957	269
Isthmus	5	20	1,627	1,678	12,870	9,930	1,726
South	6	22	1,055	460	6,661	4,634	8,361

2026	$4	T2					
Difference		1	2	3	4	5	6
Rodney	1	-1	1	5	118	30	4
North Shore	2	-1	96	14	1,085	243	31
Waitakere	3	-1	-22	2	195	62	4
CBD	4	0	70	6	72	70	7
Isthmus	5	0	88	-15	337	73	0
South	6	-1	-56	-8	135	4	-3

% Difference		1	2	3	4	5	6
Rodney	1	0%	0%	3%	10%	8%	9%
North Shore	2	-1%	1%	4%	16%	13%	11%
Waitakere	3	-2%	-2%	0%	4%	2%	2%
CBD	4	0%	6%	2%	4%	4%	3%
Isthmus	5	0%	5%	-1%	3%	1%	0%
South	6	-5%	-5%	-2%	2%	0%	0%

Toll Strategy 3: Tolling Both Crossings

AM Peak, Vehicle

2026	$0	T3					
		1	2	3	4	5	6
Rodney	1	37,662	8,563	3,081	970	2,539	979
North Shore	2	4,233	72,438	4,694	5,650	10,491	3,136
Waitakere	3	2,300	7,182	48,927	3,843	17,008	3,652
CBD	4	309	2,322	1,088	8,956	18,351	1,845
Isthmus	5	1,198	7,620	9,475	19,239	107,693	18,106
South	6	865	3,799	2,948	3,647	27,249	149,792

2026	$4	T3					
Difference		1	2	3	4	5	6
Rodney	1	215	372	44	-113	-200	-47
North Shore	2	138	4,516	-332	-1,793	-2,187	-313
Waitakere	3	-73	-1,071	614	40	138	-54
CBD	4	-34	-973	14	300	816	47
Isthmus	5	-127	-2,234	-14	681	1,631	106
South	6	-58	-550	-68	160	501	247

% Difference		1	2	3	4	5	6
Rodney	1	1%	4%	1%	-12%	-8%	-5%
North Shore	2	3%	6%	-7%	-32%	-21%	-10%
Waitakere	3	-3%	-15%	1%	1%	1%	-1%
CBD	4	-11%	-42%	1%	3%	4%	3%
Isthmus	5	-11%	-29%	0%	4%	2%	1%
South	6	-7%	-14%	-2%	4%	2%	0%

AM Peak, PT

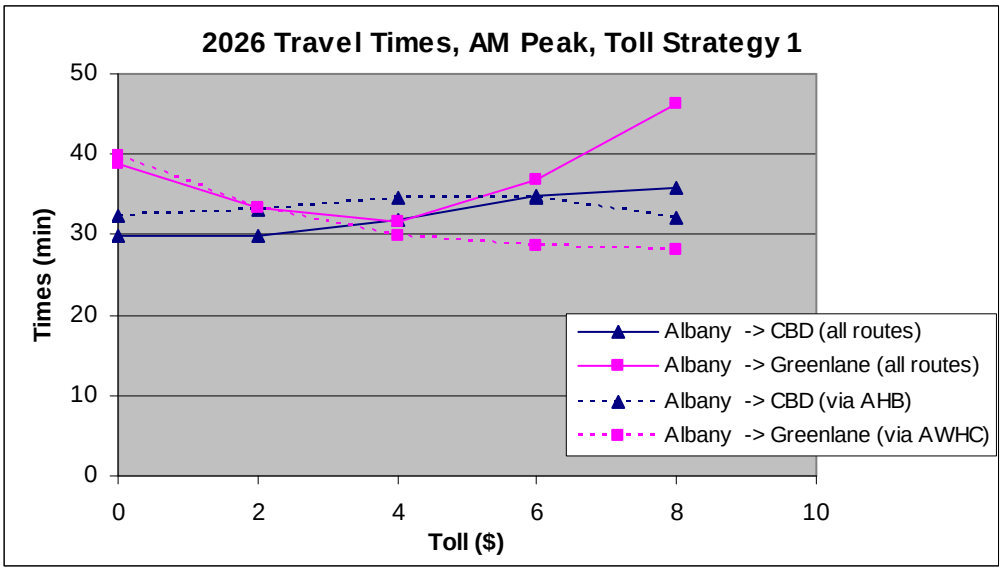
2026	$0	T3					
		1	2	3	4	5	6
Rodney	1	772	1,402	146	1,178	370	46
North Shore	2	172	6,823	330	6,973	1,894	285
Waitakere	3	45	1,093	2,996	4,850	2,537	257
CBD	4	22	1,161	308	1,964	1,957	269
Isthmus	5	20	1,627	1,678	12,870	9,930	1,726
South	6	22	1,055	460	6,661	4,634	8,361

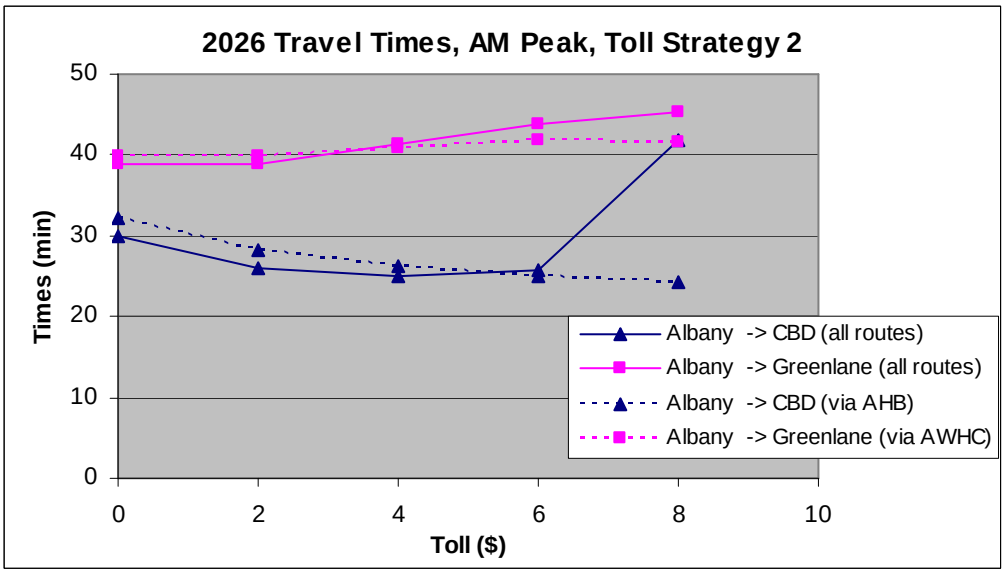
2026	$4	T3					
Difference		1	2	3	4	5	6
Rodney	1	0	22	7	113	34	4
North Shore	2	-1	191	6	903	219	29
Waitakere	3	0	23	30	181	77	7
CBD	4	1	138	4	39	51	4
Isthmus	5	0	262	-4	211	109	7
South	6	-1	27	-7	55	28	17

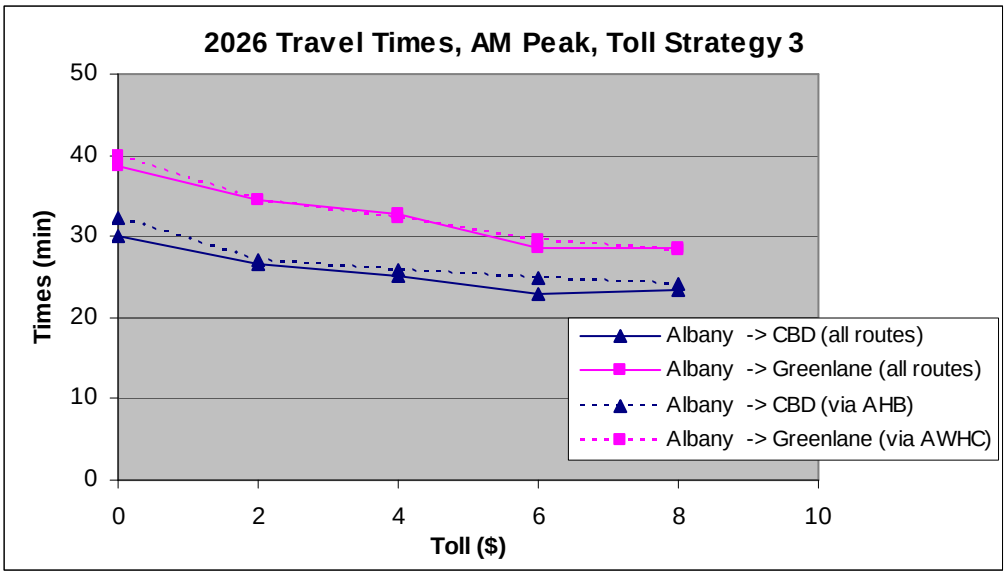
% Difference		1	2	3	4	5	6
Rodney	1	0%	2%	5%	10%	9%	9%
North Shore	2	-1%	3%	2%	13%	12%	10%
Waitakere	3	0%	2%	1%	4%	3%	3%
CBD	4	5%	12%	1%	2%	3%	1%
Isthmus	5	0%	16%	0%	2%	1%	0%
South	6	-5%	3%	-2%	1%	1%	0%

7 Travel Times

The following graphs show the 2026 AM peak travel times from Albany to the CBD and Greenlane in two ways: the average times using all routes (weighted by the trips that use each route), and on specified routes (via AHB to the CBD, and via the new crossing to Greenlane). While the times on the tolled route improve (due to lower traffic volumes), the average times on all routes does not necessarily improve as trips are made to avoid the toll on longer alternative routes.



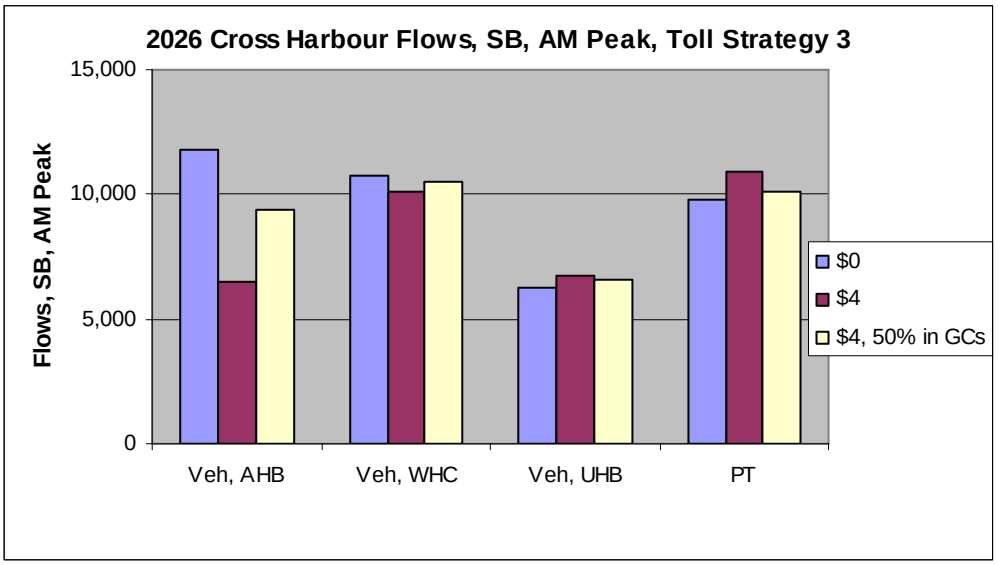



2026 Travel Times, AM Peak, Toll Strategy 3
Times (min)
50
40
30
20
10
0
0
2
4
6
8
10
Toll ($)
Albany -> CBD (all routes)
Albany -> Greenlane (all routes)
Albany -> CBD (via AHB)
Albany -> Greenlane (via AWHC)

8 Test of Demand Response to Tolls

Test using Toll Strategy 3: Tolling Both Crossings, comparing the demand response of a $4 toll with that of a $4 toll with 50% of the toll (i.e. $2) used in the generalised costs for the distribution and mode split models.

8.1 2026 AM Peak Southbound, Cross Harbour Flows



8.2 2026 AM Peak, Harbour Screenline Vehicle Flows

Flows with no toll and % difference from no toll for each toll level

Toll Level	$0	$4	$4, 50% in GCs
AM Peak Vehicle			
Harbour NB	25,627	-23%	-12%
Harbour SB	29,308	-18%	-8%
AM Peak PT			
Harbour NB	5,243	9%	7%
Harbour SB	12,517	10%	2%

8.3 2026 AM Peak, Sector Demands

Demands with no toll and % difference from no toll for $4 and $4 with 50% in GCs

2026	$0	T3					
		1	2	3	4	5	6
Rodney	1	37,662	8,563	3,081	970	2,539	979
North Shore	2	4,233	72,438	4,694	5,650	10,491	3,136
Waitakere	3	2,300	7,182	48,927	3,843	17,008	3,652
CBD	4	309	2,322	1,088	8,956	18,351	1,845
Isthmus	5	1,198	7,620	9,475	19,239	107,693	18,106
South	6	865	3,799	2,948	3,647	27,249	149,792

2026	$4	T3					
% Difference		1	2	3	4	5	6
Rodney	1	1%	4%	1%	-12%	-8%	-5%
North Shore	2	3%	6%	-7%	-32%	-21%	-10%
Waitakere	3	-3%	-15%	1%	1%	1%	-1%
CBD	4	-11%	-42%	1%	3%	4%	3%
Isthmus	5	-11%	-29%	0%	4%	2%	1%
South	6	-7%	-14%	-2%	4%	2%	0%

2026	$4	T3	$4 with 50% in GCs				
		1	2	3	4	5	6
Rodney	1	0%	1%	0%	1%	-5%	-5%
North Shore	2	3%	3%	-8%	-12%	-6%	-3%
Waitakere	3	-3%	-13%	2%	-1%	0%	-2%
CBD	4	-1%	-27%	1%	3%	3%	2%
Isthmus	5	-5%	-11%	0%	3%	1%	0%
South	6	-5%	-3%	-4%	2%	1%	0%

David Young

Appendix L Benefit-Cost Analysis

This note sets out the methodology and parameters used for the conventional benefit-cost analysis (BCA) of a new bridge and tunnel crossing. It generals follows the process previously set out in the Scoping Report.

1. Overall Approach

Benefit cost ratios (BCRs) have been calculated using the procedures in the Economic Evaluation Manual (EEM) as far as possible, but in a simplified manner in order to fit with the project timelines. A variable demand matrix-based approach has been used, encompassing both roading and passenger transport, using the ART3 model outputs.

The transport modelling forecasts were in years 2026 and 2041 and the benefits extracted for each. The modelled periods are 2-hour AM peak, Interpeak and PM peak periods. Annualisation factors were developed to expand the benefits in these periods to annual benefits.

The whole of the ART3 modelled area has been used for the evaluation, that is, the Auckland region plus Pokeno and Tuakau towns in the south.

2. Benefits

The private vehicle benefits have been split into those for light vehicles and M/HCVs. The base travel time and vehicle operating cost (VOC) benefits have been determined as per the EEM, while the additional congestion and reliability benefits are estimated by applying global factors to the base benefits. CO2 benefits are estimated from VOC benefits.

For the private vehicle benefits, time and distance skims for each purpose and M/HCVs were extracted and the benefits for each determined in conjunction with the demands (trip matrices) for each, before applying the values of time and VOC external to the model.

For the PT benefits only the perceived user benefits have been included (refer EEM A11.12), and these have been split into benefits excluding fares (which include GST), and benefits associated with fares (which exclude GST).

Excluded from the evaluation are accident benefits, walking and cycling benefits, and any other environmental benefits (other air emissions, noise, etc). Agglomeration and other wider economic benefits were separately considered by the Business Case team.

Both the do minimum and option demands have come directly from ART3.

3. Input Values

The values of time and vehicle operating costs are given in the following tables along with their EEM reference. The values of time have been updated to 2010 values with the factors shown; the update factor given in the EEM for the 2008 VOC values is 1.0.

For the PT benefits excluding fares the values of time include GST, whereas for the fare component of the PT benefits GST or 15% is included.

The VOC table also includes the percentage of perceived costs for each purpose, perceived costs being applied to the VOC and the difference between the perceived and full costs being applied to the resource cost correction for non-work purposes.

Purpose	Time	PT Excl Fares	Fares
	Table A4.1	Table A4.1	Table A4.1
2002 Values	$/hr	$/hr	$/hr
Work - driver	23.85	21.70	18.45
Work - passenger	21.70		
Commute - driver	7.80	5.65	4.80
Commute - passenger	5.85		
Other - driver	6.90	3.65	3.10
Other - passenger	5.20		
HCV	20.10		
Update Factor	1.31	1.31	1.31
2010 Values	$/hr	$/hr	$/hr
Work (driver + passenger)	33.80	28.43	24.16
Commute (driver + passenger)	10.98	7.40	6.29
Other (driver + passenger)	11.76	4.78	4.06
HCV	26.33		

Purpose	Vehicle Operating Costs	Resource Cost Correction	% of Perceived Costs
	Tables A5.0-4	Tables A5.0-4	Table A5.0
2008 Values	$/km	$/km	
Work	0.25		100.0%
Commute	0.12	-0.13	49.1%
Other	0.12	-0.13	49.1%
HCV	0.98		100.0%

4. Annualisation

The annualisation factors used are given in the following table. These were derived from traffic counts on SH1 in the vicinity of AHB, and were applied to all benefits.

Periods	Factors
Peak Periods/weekday	1
IP Periods/weekday	3.507
OP Periods/weekday	2.174
Weekdays/year	245
Weekend	6.810
Weekends/year	120
Annual Factors	
AM	245
IP	2209
PM	245

5. Costs

The time series of the capital costs over the construction periods, and the operating and maintenance costs after that were provided by the Environment and Planning Team.

PT operating costs have not been considered as these are common to the Do Minimum and the Option.

6. Evaluation Period

Time zero is 2010 and the opening year for the new crossing, be it bridge or tunnel, is year 2029. The construction time for a bridge is 5 years and for a tunnel is 6.5 years.

Time zero is 2010 and the opening year for the new crossing, be it bridge or tunnel, is year 2029. The construction time for both has been asseumed to be 6 years. Hence the evaluation period starts in year 2023 and finishes in year 2052.

The benefit streams are straight-line interpolations and extrapolations of those in the modelled years. The time streams of benefits and costs have been discounted at 8% p.a. to time zero.

7. Estimation of Congestion, Reliability and CO2 Benefits

These have been estimated as proportions of calculated benefits:

- Congestion: 26% of base travel time benefits (based on benefits from a recent evaluation in Auckland),
- Reliability: 3% of base travel time benefits (based on benefits from a recent evaluation in Auckland),

- CO2: 4% of VOC benefits (as per EEM).

8. Sensitivity Tests

A series of sensitivity tests have been undertaken for the Business Case team involving:

- Extension of the evaluation period beyond 30 years,
- Lower discount rates: 6% and 4%.

The results of these are included in Appendix M.

David Young

Appendix M Benefit-Cost Analysis Results

1. Introduction

The tables below have the final results of the cost-benefit analysis of the bridge and tunnel options:

- Employers business (EB) and all purposes NPV benefits by category
- NPV capital and maintenance and operating costs
- BCR

The main (or base) results are provided along with the results of a series of sensitivity tests as requested via the memo from John Yeabsley dated 16 September, and the subsequent email from Chris Parker (20/09/2010) requesting EB/HCV benefits.

The methodology to produce the first set of results is in line with that set out in the combined Scoping Report (for the 30-year evaluation period results).

The capital and maintenance and operating costs are the 100% costs as provided by Beca.

The opening year is 2029 and construction period for both bridge and tunnel is 6 years.

2. Base Results

Bridge

Benefits

EB	Time	Congestion	Reliability	VOC	RCC	CO2	Total
Car	74,458,247	19,359,144	2,233,747	10,047,777	0	401,911	106,500,826
PT							4,553,863
Total							111,054,689

All	Time	Congestion	Reliability	VOC	RCC	CO2	Total
Car	290,639,247	75,566,204	8,719,177	42,962,867	-68,833,321	1,718,515	350,772,690
HCV	13,596,545	3,535,102	407,896	3,975,261		159,010	21,673,815
PT							26,202,280
Total	304,235,793	79,101,306	9,127,074	46,938,129	-68,833,321	1,877,525	398,648,785

Costs	Capital	1,106,876,703
	M&O	51,071,367
	Total	1,157,948,069

BCR	0.34

Tunnel

Benefits

EB	Time	Congestion	Reliability	VOC	RCC	CO2	Total
Car	74,458,247	19,359,144	2,233,747	10,047,777	0	401,911	106,500,826
PT							4,553,863
Total							111,054,689

All	Time	Congestion	Reliability	VOC	RCC	CO2	Total
Car	290,639,247	75,566,204	8,719,177	42,962,867	-68,833,321	1,718,515	350,772,690
HCV	13,596,545	3,535,102	407,896	3,975,261		159,010	21,673,815
PT							26,202,280
Total	304,235,793	79,101,306	9,127,074	46,938,129	-68,833,321	1,877,525	398,648,785

Costs	Capital	1,483,045,967
	M&O	86,605,926
	Total	1,569,651,893

BCR	0.25

3. Sensitivity Tests

The tests involve:

- 6% and 4% discount rate, combined with
- Three cost and benefit tests:
    a) Costs and benefits are extended beyond 30 years with the benefits linearly extrapolated,
    b) Costs and benefits are extended beyond 30 years with zero growth in benefits from year 2052, and
    c) Costs and benefits to year 2052 (the same as the main BCA);
- Use of the bridge and tunnel cost profiles provided by NZIER for a) and b); these are to year 2083 for both options.
- Extraction of EB+HCV benefits for the above; EB being both car and PT benefits for employers business purpose.

- **Table 34 Benefits, present value, $m**

Discount rate	Scenario a	Scenario b	Scenario c
6%	$857,077,410	$841,043,974	$704,485,963
4%	$1,641,180,520	$1,602,507,717	$1,278,509,384

- **Table 35 Costs of tunnel, present value, $m**

Discount rate	Scenario a	Scenario b	Scenario c
6%	$2,127,935,405	$2,127,935,405	$2,109,049,188
4%	$2,910,917,714	$2,910,917,714	$2,866,556,526

- **Table 36 Costs of bridge, present value, $m**

Discount rate	Scenario a	Scenario b	Scenario c
6%	$1,557,629,257	$1,557,629,257	$1,548,366,099
4%	$2,114,281,677	$2,114,281,677	$2,092,443,487

- **Table 37 BCRs of tunnel and bridge**

	Scenario a	Scenario b	Scenario c
Tunnel 6%	0.40	0.40	0.33
Tunnel 4%	0.56	0.55	0.45
Bridge 6%	0.55	0.54	0.45
Bridge 4%	0.78	0.76	0.61

- **Table 38 EB+HCV Benefits, present value, $m**

Discount rate	Scenario a	Scenario b	Scenario c
6%	$282,988,966	$277,949,057	$233,825,821
4%	$539,916,973	$527,760,663	$423,073,616

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