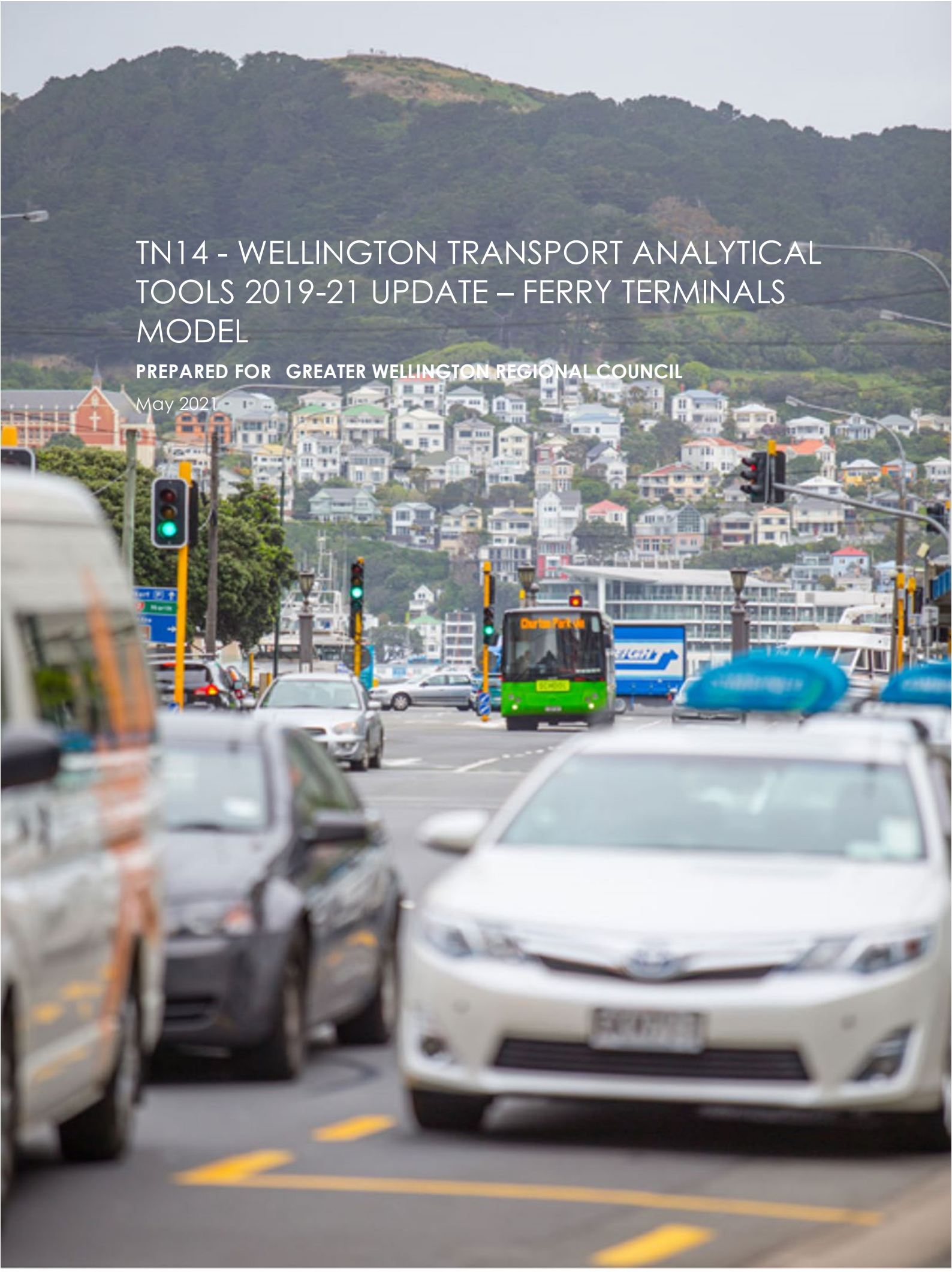

TN14 - WELLINGTON TRANSPORT ANALYTICAL TOOLS 2019-21 UPDATE – FERRY TERMINALS MODEL

PREPARED FOR GREATER WELLINGTON REGIONAL COUNCIL

May 2021

Stantec | JACOBS

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Greater Wellington Regional Council

TN14 - Wellington Transport Analytical Tools 2019-21 update – Ferry Terminals Model

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1. Introduction

1.1 Project Overview

This technical note is part of a series documenting the 2019-2021 update of components of the Wellington Regional Transportation Planning Analytical Tools ("Analytical Tools", "Tools"). The higher-level Analytical Tools are maintained and operated by Greater Wellington Regional Council (GWRC), who are the client for this project. This project is being primarily delivered by Stantec and Jacobs, supported by GWRC transport planners.

1.2 Purpose of this Report

This report details the development of a new ferry terminals passenger access module within the Wellington Transport Strategy Model (WTSM).

WTSM currently has no representation of car trips associated with the Interislander (owned and operated by Kiwirail) and Bluebridge ferry terminals, used by ferries linking Wellington to Picton on the South Island across the Cook Strait.

A new model has been developed that estimates the number of passenger vehicle trips generated by both terminals during each time period covered by WTSM. It must be noted that the model only represents ferry passenger arrivals and departures by light vehicles, as freight trips are represented separately in the Heavy Commercial Vehicle Model, as detailed in 'TN11 – Heavy Vehicle Model'. In addition, public transport and walk access is minimal (see section 4.4). Finally, trips related to employment at the terminals are included as part of the overall home-base worked demand in WTSM.

The ferry terminals model development has been constrained by data availability and has prioritised simplicity and transparency over complexity consistent with the WTSM update project overall. However, it was also built in a way that would easily enable refining elements of the model should more data become available in the future, as well as allowing the flexibility to adjust inputs and respond to "what if" questions relating to changes in ferry vessel sizes, timetables, and potential terminal relocations.

The report is organised into the following sections:

- Overall model structure;
- Data sources and analysis;
- Development of the base year demand matrices;
- Forecasting;
- Implementation into WTSM.

2. Overall Model Structure

The ferry terminals model has the following features:

- The model represents travel for a March 2018 base period, representing weekday average, ferry-related passenger demand (excluding staff and heavy vehicle freight);
- The Bluebridge and Interislander terminals are included in two separate zones in the current WTSM 225 zone system (respectively zones 39 and 228), although both of these zones also include other land use activities surrounding the terminals. It is anticipated that this will change in the new version of the model and zones numbers for each terminal can easily be modified as necessary then;
- Matrices of light vehicle passengers to the terminals (i.e. passengers travelling from Wellington to Picton) and trips from the terminals (i.e. travelling from Picton to Wellington) were developed from total passenger data and timetable details, and distributed in the region based on high level passengers surveys and land use data;
- Demand is split by terminal and direction based on observed data, but not further disaggregated by purpose or any other segmentation in the absence of more detailed information;
- Matrices are produced for each of the new WTSM time periods:

- AM peak: 6-9am
- Interpeak (IP): 9am-3pm
- PM peak: 3-6pm
- Overnight (ON): 6pm-6am

- Demand matrices are then added to the WTSM light vehicle matrices prior to assignment.

3. Supporting Data

3.1 Data Sources and Limitations

Data on passenger and vehicle patronage was obtained from Interislander/Kiwirail and Bluebridge, however due to the commercially sensitive nature of the data, some limitations applied. Monthly averages (excluding weekends and holidays) for each sailing were provided instead of data for each trip. This was not considered a significant limitation for this analysis.

The data provided and used for the development of the model, as well as its main limitations are as follows, and summarised in Table 3-1 below:

- Bluebridge provided only monthly averages for 2016 sailings. Data included passengers (foot and vehicle passengers separately) as well as vehicles (light and heavy separately) but for the latter only linear meters were provided instead of vehicle numbers;
- Interislander provided monthly average of vehicles counts (lights and heavy separately) for January 2016 through to April 2018, but passenger counts (foot and passengers) only for January to August 2016.

Table 3-1: Summary of Ferry Operators Data

Operators	Type	Year		
		2016	2017	2018
Bluebridge	Passengers – Foot and car	✓	X	X
	Vehicles – Light and heavy	✓ (in linear meters)	X	X
Interislander	Passengers – Foot and car	✓ (Jan to Aug)	X	X
	Vehicles – Light and heavy	✓	✓	✓ (Jan to Apr)

In addition, survey data was provided by Interislander showing the passengers' origin Region (before journey) and destination Region (after journey), with Regions being groups of various Territorial Authorities.

A number of important limitations apply to this dataset:

- Only percentages were provided and the sample size is therefore unknown;
- The survey is based on questionnaires on board ships which passengers can pick up and fill in. As a result there is no way to estimate potential biases in terms of sample, i.e. international vs domestic, tourism vs other, etc;
- There is no clear definition as to what Region after journey and before journey means. For example, someone driving from Auckland to Wellington and spending the night in a hotel in Wellington before boarding a ferry would likely fill the 'Region before' as being Auckland. However for the purpose of the model the origin would be Wellington as this is where the trip directly to the terminal started.

Nevertheless, in the absence of any other data regarding origins and destinations of trips related to the ferry terminal, this data was used as high level checks of the assumptions made for trip distribution for 'Regions' within the Wellington Region area.

3.2 Time Series Analysis

During the scoping report, it was noted that March 2018 might be atypical due to the port and ferry terminals having been impacted by recent earthquakes. In addition it was observed that although WTSM is representative of a March weekday average, passenger ferry demand is highly seasonal and it would be important to have an understanding of how March compares with the rest of the year.

It must be noted that only limited data was provided for March 2018 so this mitigates the earthquake issue as data from other periods were largely used and March 2018 demand was estimated (see Section 4.1). However Figure 3-1 below compares time series of the various datasets available indexed to March, to estimate seasonality and how March 2018 may differ from other years.

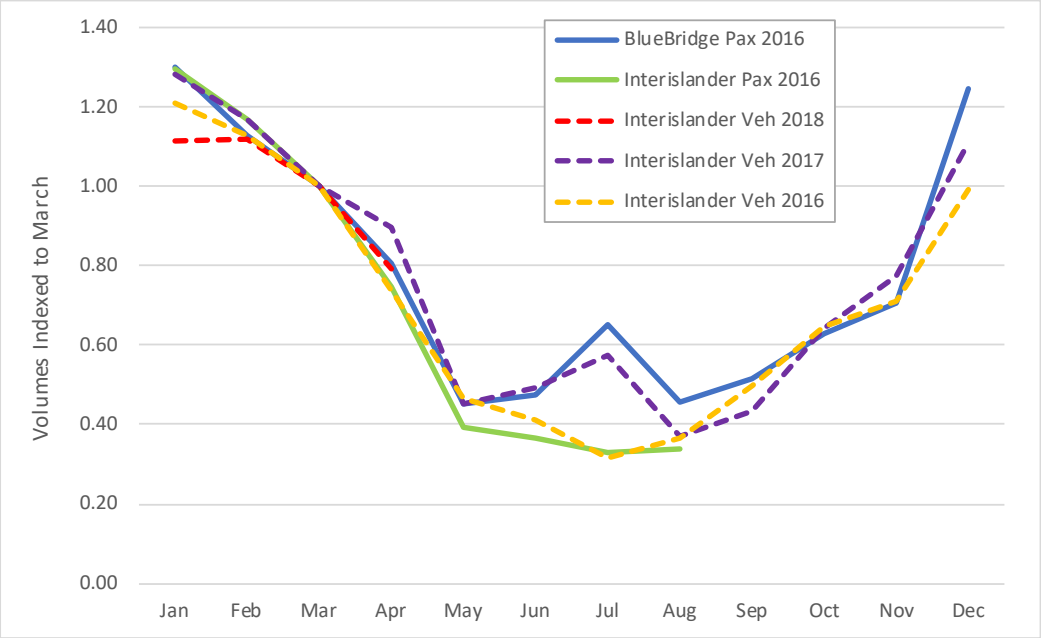

Figure 3-1: Monthly Volumes Indexed to March

The trend is generally very consistent with volumes increasing during Spring, peaking in December and January with the summer holiday and then decreasing during Autumn. The only notable variation occurs in July where a smaller mid-winter peak occurs (coinciding with the school holidays) in some data series but not others.

Data is only available from January to April for 2018, but the trend appears similar to other years, with the possible exception of January. No earthquake impact is discernible in March.

Based on this data and depending on the series, annual averages indexed to March range between 0.71 and 0.78, or conversely March is generally between 28% and 41% higher than the annual average.

4. Trip Generation

4.1 Factoring to March 2018

The ferry terminals model is representative of March 2018 weekday demand, however passenger data for this period was not provided for either ferry operators and had to be estimated based on the available data.

For Interislander, March 2018 passenger demand can be estimated in two different ways:

- Using growth in vehicle demand between 2016 and 2018, applied to 2016 passenger numbers:

$$Pax_{2018} = Pax_{2016} * Veh_{2018} / Veh_{2016}$$

- Using number of vehicle demand from 2018 and applying estimated occupancies from 2016 (assuming they stay constant, calculations for occupancies are detailed in section 4.5):

$$Pax_{2018} = Veh_{2018} * Occupancy_{2016}$$

Both were found to return similar levels of demand (see comparison in Figure 4-1 below) but the second approach was used as it was found to lead to slightly more consistent results.

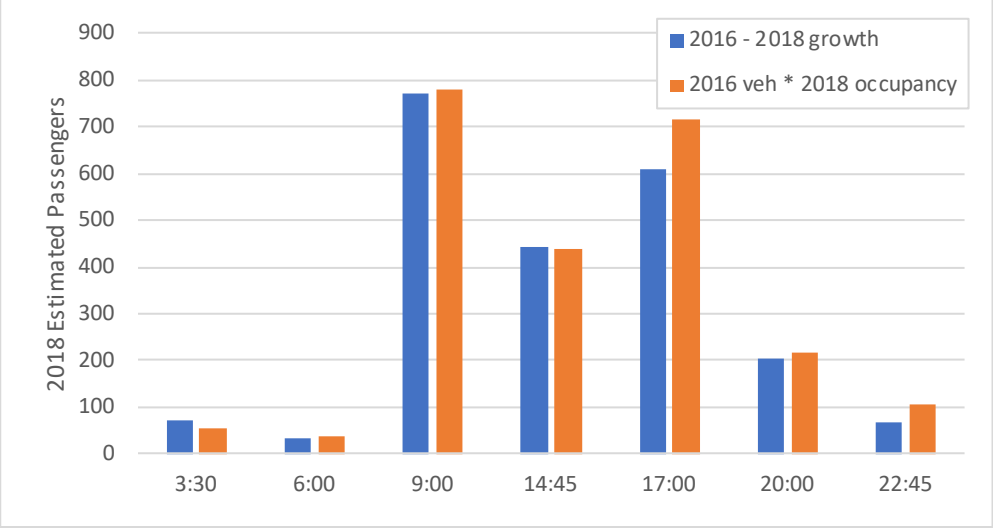

Figure 4-1: Interislander Estimated 2018 Passenger Demand

For Bluebridge demand, only 2016 data was available, and overall March 2016-2018 growth from Interislander was applied. This is therefore assuming that both operators would have experienced the same levels of growth during this period. In reality this may not be the case, and there may well have been more growth for one operator to the detriment of the other, but there is no data available to substantiate this.

The resulting daily passenger demand for March 2018 is shown in Table 4-1 below.

Table 4-1: 24hr Weekday Passenger Demand – March 2018

Direction	Mode	Bluebridge	Interislander
Wellington – Picton	Foot	172	792
	Vehicle	467	1145
	Total	638	1,937
Picton – Wellington	Foot	140	588
	Vehicle	454	1,203
	Total	594	1,791

It is noted that there is an imbalance per direction with about 8% more passengers in the southbound direction than northbound, for both Interislander and Bluebridge. While it fluctuates throughout the year, this imbalance can be observed for most months. The reason for this is unclear, potential explanations include more international tourists travelling southbound (starting their journey in Auckland and finishing in Christchurch) or one more sailing southbound during weekdays with the reverse trip occurring during the weekend. This was not deemed to have a significant impact on results overall.

4.2 Time Periods

Demand per sailing times were grouped into the 4 time periods used in WTSM:

- AM peak: 6-9am
- Interpeak (IP): 9am-3pm
- PM peak: 3-6pm
- Overnight (ON): 6pm-6am

It must be noted that this model aims to represent the vehicle trips associated with each ferry crossing. Therefore times were adjusted to account for vehicles arriving in advance of the sailing time for trips from Wellington to Picton by removing 1 hour, and by adding the 3.5 hour duration of the ferry crossing for trips from Picton to Wellington.

Table 4-2: Sailings Per Time Period

Time Period	Interislander		Bluebridge	
	Wellington–Picton	Picton-Wellington	Wellington–Picton	Picton-Wellington
AM	09:00	-	08:00	-
IP	14:45	09:05 10:45	13:30	08:00
PM	17:00	14:15	-	14:00
ON	03:30 06:00 20:00 22:45	01:05 02:45 18:45 22:15	02:30 20:45	02:15 19:00

4.3 Ferry Operator / Terminal Share

Using demand aggregated by time period, the ratio of passengers per ferry operator and therefore terminal was estimated for each time period and direction, as shown in Table 4-3 below.

Table 4-3: Market Share

Time Period	Wellington – Picton		Picton - Wellington	
	% Bluebridge	% Interislander	% Bluebridge	% Interislander
AM	21%	79%	-	-
IP	41%	59%	22%	78%
PM	0%	100%	27%	73%
ON	36%	64%	26%	74%
Total	25%	75%	25%	75%

4.4 Mode Share

Both ferry terminals are mostly accessed by car, either for passengers travelling with their car on the ferry or foot passengers being dropped-off or picked-up. There is no public transport from or to the Interislander terminals (although there is a Shuttle service between the terminal and the rail station). During the Scoping Workshop, there was discussion that some people walk from CBD locations to access the Interislander ferry terminal. In theory, representing PT and walk access would require a full 4-step model with mode choice to reflect travel behaviour. Given the small magnitude of these trips and the lack of observed data however, it was agreed that only car trips would be explicitly modelled. An adjustable input parameters has been incorporated that allows reducing the number of short car trips to and from the CBD by a set amount if required (set to 0 by default), reflecting more walk-in trips when forecasting. The walk trips are not explicitly modelled, i.e. no assignment.

The mode share of light vehicle passengers versus foot passengers was obtained from the data provided, by operator, time period and direction.

Although this could not be confirmed, it was assumed that the number of passengers data does not include heavy commercial vehicle drivers. This appears sensible as some overnight sailings show a total number of vehicles including heavy commercial higher than the number of passengers.

The resulting light vehicles percentage shares for passengers (as opposed to foot passengers) are shown in Table 4-4 below.

Table 4-4: Light Vehicle Mode Share

Time Period	Wellington – Picton				Picton - Wellington			
	Bluebridge		Interislander		Bluebridge		Interislander	
	% Foot	% Car	% Foot	% Car	% Foot	% Car	% Foot	% Car
AM	34%	66%	53%	47%	-	-	-	-
IP	25%	75%	42%	58%	17%	83%	27%	73%
PM	-	-	18%	82%	28%	72%	43%	57%
ON	16%	84%	25%	75%	24%	76%	23%	77%
Total	27%	73%	41%	59%	24%	76%	33%	67%

4.5 Vehicle Occupancy

Light vehicle occupancy is required to convert the number of ferry passengers into vehicle trips, for both car users and foot passengers. Average occupancy for car users was derived from Interislander 2016 data which was provided for both ferry passengers and vehicles. As noted above, it was assumed that heavy vehicle drivers were not included in the passenger totals.

While average occupancies were found to vary between months, sailing times and directions, the variations did not appear meaningful and apart from some outliers most values are comprised between 2 and 2.5. The overall average of 2.2 was therefore used for all sailing times and both directions.

Foot passengers being picked-up and dropped-off are effectively generating two car trips, as the 'empty' trip including only the driver carrying out the pick-up/drop-off also needs to be represented. In the absence of data an average group size of 2.2 was used to convert foot passengers into car trips, based on the group size for car users (i.e. car occupancy).

4.6 Summary

The following table summarises the trip generation calculations.

Table 4-5: Trip Generation Summary

	To Ferry Terminals				From Ferry Terminals			
	24hr Passenger Demand							
	2,576				2,384			
	Factor to Time Period							
AM	1,236				0			
IP	618				954			
PM	361				1,001			
ON	361				429			
	Split by Operator							
	Bluebridge		Interislander		Bluebridge		Interislander	
AM	260		977		0		0	
IP	253		365		210		744	
PM	0		361		270		731	
ON	130		231		112		318	
	Apply Mode Share (no short trips reduction applied)							
	Bluebridge		Interislander		Bluebridge		Interislander	
	Foot Pax	Car Users	Foot Pax	Car Users	Foot Pax	Car Users	Foot Pax	Car Users
AM	88	171	513	459	0	0	0	0
IP	64	190	153	212	36	174	197	543
PM	0	0	65	296	76	195	317	417
ON	21	109	58	173	27	85	73	245

	Convert to Car Trips			
	Bluebridge	Interislander	Bluebridge	Interislander
AM	118	442	40	233
IP	132	255	124	406
PM	35	308	123	363
ON	71	138	60	171

5. Trip Distribution

It was noted during the scoping workshop that no information regarding origin and destination on the Wellington side of the trip of ferry passengers was available, and that a common-sense approach would be required with distribution of trips based on regional population and employment.

A limited set of data was however provided with the origin-destination passengers surveys which are described, together with their limitations, in section 3.1. This was used to check the validity of assumptions regarding trip distribution at a high level. The survey results, showing percentage of trips from/to separate Wellington region areas as well as the rest of the North Island, are shown in Table 5-1.

Table 5-1: Passenger Origin-destination Survey

Region	Origin before Journey	Destination after Journey
Wellington, Porirua	56%	52%
Wairarapa	3%	4%
Hutt Valley	10%	12%
Kapiti Coast	5%	6%
Rest of North Island	25%	26%

At a sector level and in the Wellington region, this distribution was found to be a very good match with 'Services' employment from the 2013 census, as shown in the following table.

Table 5-2: Passenger Origin-destination Survey (Wellington only) vs Service Employment

Region	Origin before Journey	Destination after Journey	Service Employment
Wellington, Porirua	75%	70%	73%
Wairarapa	5%	5%	5%
Hutt Valley	14%	16%	18%
Kapiti Coast	7%	8%	5%

While it is understood that this good fit at a sector level may not match as well at a zonal level, it appears intuitively sensible that the 'Services' employment categories which includes tourism would be the most appropriate to use for distribution of trips in the Wellington region. However in order to also represent trips linked to population, it was decided that a proportion of distribution would be based on total zonal population. A split of 0.8 based on Services employment and 0.2 based on population was used, but this proportion should be updated if more information becomes available regarding trip distribution, purposes or segmentation (e.g. Wellington-based, rest of NZ or International).

The proportion of trip from / to each zone in the Wellington region is therefore derived as:

$$Prop_{Zone} = \frac{0.2 * Pop_{Zone} + 0.8 * ServiceEmp_{Zone}}{0.2 * Pop_{Total} + 0.8 * ServiceEmp_{Total}}$$

Trips from and to the SH1 and SH2 externals are also based on proportions from the passenger surveys, with trips aggregated to each external based on their origin/destination in the rest of the North Island.

This leads to the following distribution aggregated at a sector level and externals.

Table 5-3: Modelled Distribution

Region	Distribution per sector
Wellington, Porirua	51%
Wairarapa	4%
Hutt Valley	15%
Kapiti Coast	4%
SH1	22%
SH2	3%

This distribution is applied to trips in both directions.

6. Forecasting

Information sourced from the ferry operators was used to develop a simple forecast scenario, which quoted a projected overall growth of 1.9% per annum. This growth was applied to both operators to produce estimated daily passengers in both directions for all anticipated WTSM forecast years (2028, 2038 and 2048), as shown in the following table.

Table 6-1: Forecasted Ferry Passenger Demand

Direction	2018	2028		2038		2048	
	Trips	Trips	% Incr	Trips	% Incr	Trips	% Incr
Wellington - Picton	2,576	3,109	21%	3,753	46%	4,530	76%
Picton - Wellington	2,384	2,878	21%	3,474	46%	4,193	76%
Total	4,960	5,987	21%	7,227	46%	8,724	76%

However, forecasting ferry passenger demand is heavily dependent on a number of parameters such as fleet size or operators timetables. In particular, Kiwirail is investigating the upgrade of its Interislander fleet with larger ships operating by 2025. This would be likely to have a number of effects on demand:

- Capacity increase due to the larger size of the ships, with potentially more demand during the peak months;
- Changes in timetable, with fewer crossings but higher loads;
- Potential shift in demand between operators;
- The ships are likely to be designed with dual deck, speeding up the loading and unloading and thereby increasing their impact on the network. Given the longer duration of time periods modelled in WTSM this is not expected to make a noticeable difference however.

This would produce a step change in demand, and it is likely Bluebridge will also introduce larger vessels in following years.

The ferry terminals model as it has been set up can be used to model these changes and other what-if scenarios. This would be done first through spreadsheet analysis to translate the assumed changes in supply and resulting effect on demand to derive new daily passenger totals, factors to time periods and market shares between operators, and potentially car mode share and additional walk trips from/to the CBD. The model parameters can then be modified accordingly to reflect the new assumptions.

The zone each terminal is located in is also specified and can easily be adjusted, to reflect one or both terminals changing locations or potentially merging.

7. Implementation in WTSM

The ferry terminal model was first developed in a spreadsheet and was then implemented in EMME using a stand-alone python script, with an emphasis on the script being clear and readable. It has now been incorporated in WTSM, with the process being checked through scenario testing. The model is called only once during a WTSM run, before the main model loop as it is not dependent on travel times on the network.

All parameters are stored in an external file to allow the user to manually input changes in parameters to explore various 'what if' scenarios and their impact on the transport system. The parameter file includes the following:

- Zones for each terminal an externals;
- Total daily passengers by direction;
- Factors to time period, by direction;
- Vehicle mode share, by operator, and time period;
- Light vehicle occupancy;
- Trips rates for population and employment and proportion of trips to / from SH1 and SH2 externals;
- Reduction in car trips to / from the CBD to account for walk trips or other active modes (set to 0 by default);
- Future year growth by operator.

8. Summary

This technical note has described the development of a new module to represent car access for passengers to the Interislander and Bluebridge ferry terminals within WTSM.

The methodology and adopted form of model were highly dependent on data availability, particularly regarding trip distribution, and no data was available to validate the results apart from a high level passenger survey. While the model will allow for a representation of the impact of traffic associated with Cook Strait Ferries directly on the local network, these limitations must be kept in mind if looking at origin and destination of trips further in the region.

It is recommended that the model is refined if more detailed data is available, or specifically collected for this purpose.

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