Greater Wellington Regional Council

2013 WTSM Update

Technical Note 5:
Model Input Parameters

May 2015

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Greater Wellington Regional Council

2013 WTSM Update

Technical Note

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1. Introduction

This technical note details the process used to update the input parameters into the Wellington transport models (WTSM – Wellington Transport Strategy Model & WPTM – Wellington Public Transport Model), as part of their 2013 update. These parameters are used in WTSM to calculate the generalised costs of travel for all modes (light and heavy vehicles, public transport, and active modes) and therefore impact on the trip distribution, mode choice and route calculation components of the model. In WPTM, they inform the access mode choice, public transport mode choice, and route of public transport users.

The note also documents the methodology adopted to project these parameters in the future when forecasting with both models.

2. WTSM Input Parameters Update

2.1 Summary

The approach used to update the WTSM economic input parameters to 2013 was largely consistent with the methodology used in 2011. For this reason, reference is made to *TN15 – Input Parameters* from the WTSM 2011 update which contains extensive detail on the parameter update methodology, although a brief summary is given of the approach used both in 2006 and 2011 in the sections below for each economic input into the model. The approach used to update these to 2013 is, however, detailed below.

One major difference between the 2006 and 2011 model updates is that the decision was taken in 2011 to rebase all nominal 2011 costs to 2001 dollars, by adjusting for inflation. This was to scale back these costs in a way that the trip distribution and modal split components of WTSM could respond properly to, as the model was calibrated on 2001 values. The adjustments were made using the Consumer Price Index (CPI). The same approach was used for the 2013 update.

2.2 Vehicle Operating Costs

2.2.1 2006 and 2011 Model Updates Methodology

The vehicle operating costs (VoC) in WTSM are based on values from Appendix A5 of the NZTA Economic Evaluation Manual (EEM) and include the following components:

- Base costs: fuel and oil, tyres, maintenance and repairs (M&R), depreciation
- Road surface condition / roughness
- Congestion
- Stoppages (VoC due to bottleneck delay)
- Changes in speed

These costs are then combined into two main categories: fuel-related costs and non-fuel-related costs. Different costs are calculated for light vehicles, light vehicles on 'Employer Business' trip purpose, and heavy vehicles.

Some of these components vary in function of the road category, gradient or speed/congestion, but they are implemented in WTSM as fixed parameters. Therefore and in order to calculate network-wide values, a number of assumptions had to be made regarding average speed, gradient and other parameters. These were adopted for the 2006 model update, and were left unchanged for the 2011 update. However, the monetary values in the EEM are for July 2008 $, and needed to be adjusted to 2011. This was done as follows:

- Consumer Price Index (CPI) was used to adjust non-fuel costs (factor of 1.10)
- CPI petrol was used to adjust fuel component of VoC (factor of 1.18)

CPI values were also used to rebase the final VoC components to 2001, resulting in a deflating factor of 0.76.

More detail on the assumptions and the calculations used to derive the base VoC in 2006 and 2011 can be found in section 3 of *TN15 – Input Parameters* from the 2011 model update.

2.2.2 2013 Model Update

For the 2013 update, the same methodology was adopted. The same values from the EEM and assumptions were used, the only difference being the more up-to-date sources used to uplift 2008 EEM values to 2013 $:

- Consumer Price Index (CPI) used to adjust non-fuel costs led to a factor of 1.11
- CPI petrol used to adjust fuel component of VoC led to a factor of 1.23

Finally the VoC were rebased to 2001 using the CPI values, resulting in a deflating factor of 0.74.

As a result the 2013 values for VoC, both nominal and adjusted to 2001 real values, are as shown in the table below.

Class	WTSM 2013 Nominal VoC Values (c/km)	2013 VoC Adjusted to 2001 (c/km)
Light Vehicles - Employer Business, Fuel	21.70	16.13
Light Vehicles - Employer Business, Non-Fuel	16.76	12.46
Light Vehicles - Employer Business, Total	38.46	28.58
Light Vehicles - Other Purposes	24.41	18.14
Heavy Vehicles, Fuel	132.14	98.22
Heavy Vehicles, Non-Fuel	58.56	43.52
Heavy Vehicles, Total	190.70	141.75

Table 1: WTSM 2013 Vehicle Operating Costs

2.3 Values of Time

2.3.1 2006 and 2011 Model Updates Methodology

The values of time in WTSM are based on values from the EEM expressed by different modes and trip purposes, combined with proportions from the 2001 Wellington Household Travel Survey.

The values of time in the EEM are expressed in July 2002 $. For the 2006 and 2011 updates, these values of time were uplifted to March 2006 and March 2011 using GDP per capita growth from Statistics NZ.

More details on the assumptions and the calculations used to derive the base values of time in 2006 and 2011 can be found in section2 of *TN15 – Input Parameters* from the 2011 model update.

2.3.2 2013 Model Update Methodology

The same method was applied for the 2013 model update, with the EEM values of time allocated to the different trip modes and purposes and the proportion from the 2001 Household Travel Survey used to estimate the WTSM values per trip purpose and car availability. GDP growth per capita was again used to uplift the values of time to March 2013, resulting in an uplift factor of 1.55. The resulting values of time used in the model are shown in the table below.

Purpose	Car Availability	WTSM 2013 Nominal Values of Time (c/min)	WTSM 2013 Values of Time Adjusted to 2001
Home-Based Work	Captive	13.5	10.0
	Competition and Choice	18.1	13.4
	Combined	18.0	13.4
Home-Based Education	Captive	8.9	6.6
	Competition and Choice	13.4	10.0
	Combined	13.3	9.9
Employer Business	Captive	56.2	41.8
	All	60.9	45.3
Other	Captive	11.5	8.5
	Competition and Choice	16.3	12.0
	Combined	16.1	12.1

Table 2: WTSM 2013 Values of Time (c/min)

Note: During 2013, the EEM was revised and one of the main changes was that values of time were changed to be the same for all travel modes, essentially being set equal to values of time for car drivers. The main purpose of this change is to have travel time equity for users of all modes for project benefit calculations. These revised values would however largely differ from the previous values that the model was calibrated on, thereby significantly impacting on the validation of the trip distribution and mode choice components. The original values of time were therefore kept for the 2013 version of WTSM. This however doesn't preclude using the new 'modal equity' values for benefit calculations of projects by post-processing model outputs.

2.4 Wellington CBD Parking

2.4.1 2006 and 2011 Model Updates Methodology

Parking costs are taken into account in WTSM for two Wellington CBD areas, lower and upper, which are shown in the figure below. Different costs are applied for work-related trips and other purpose trips. The actual costs applied in the model is a function of the proportion of trips that pay, derived from the 2001 Household Travel Survey, i.e. they are a weighted average of those that pay and those that don't.

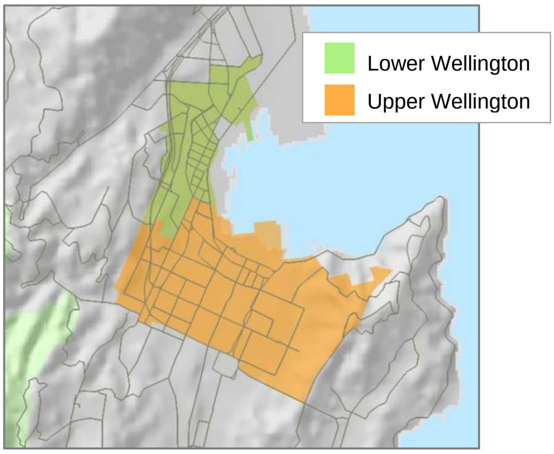


Figure 1: CBD Parking

For the 2011 update, limited information was available on the source of parking costs used in the 2001 and 2006 models. Furthermore, in 2001 Wellington City Council (WCC) operated all parking buildings in the CBD, but these were sold and became privately operated after 2004. Hence it was not possible to obtain information on historical increases from 2001 to 2006, and then to 2011.

After some investigation it appeared that parking costs were updated for 2006 using information available from WCC, assuming a 25% increase in cost for commuter parking and a 50% increase for other purpose parking. In addition, an assumed 20% increase in the proportion of cars that pay for parking compared with 2001 was applied.

For the 2011 update, a further 50% increase in the cost of commuter parking was applied, which led to costs that were consistent with parking charges applied by the main private parking operator in Wellington. For other purpose trips, the costs were left unchanged as metered on-street parking charges had not changed since 2006.

Parking costs were then deflated to 2001, using the same factor of 0.76 as for other parameters.

2.4.2 2013 Model Update Methodology

For the 2013 WTSM update, no change to the proportion of people paying for parking was assumed. Comparison of private operator (Wilson) charge increases between 2011 and 2013 was used to uplift the cost of commuter parking, which showed increases of 7% for all day and 2% for 2-hour parking. Metered on-street parking was identical to 2011.

The resulting parking charges, nominal and deflated to 2001 are shown in the table below.

Parking Sector	WTSM 2013 Nominal Parking Cost Per Trip	WTSM 2013 Parking Cost Adjusted to 2001
Home-Based Work – Lower Wellington	$5.77	$4.29
Home-Based Work – Upper Wellington	$9.33	$6.93
Employer Business – Lower Wellington	$0.98	$0.73
Employer Business – Upper Wellington	$1.75	$1.30
Other Purposes – Lower Wellington	$0.81	$0.60
Other Purposes – Upper Wellington	$1.61	$1.20

Table 3: WTSM 2013 Parking Charges

2.5 PT Fares

2.5.1 2006 and 2011 Model Updates Methodology

For the 2006 WTSM update, the public transport fare matrix was adjusted by applying a simple 10% increase in rail fares. As PT demand for all modes is aggregated, this was done by applying this uplift factor only for TA to TA movements with a high rail mode share.

For the 2011 update, it was decided not to use the 2001 PT fare matrix with further adjustment, as fare regions had changed since 2001. Instead, a new fare matrix was produced which mirrored the Metlink fare zones and structure, common to all PT modes. This approach also allowed a more dynamic process, with the potential to easily recalculate the fare matrix for different transit lines or fare policies when forecasting, including integrated fares.

As for the other input parameters the full methodology is detailed in section 5 of *TN15 – Input Parameters* from the 2011 model update, but in summary, the approach was as follows:

- 1 – Metlink fare regions were implemented in WTSM for all 225 zones, and for all links and nodes in the network using new extra attributes;
- 2 – The number of boardings and fare region boundary crossings was calculated for each Origin-Destination (O-D) pair. This included the exception within Wellington City (zones 1 to 3) where fares within this area are capped at 3 fare zones maximum;
- 3 – The full fare (adult cash fare) for each O-D was calculated for both the AM and Inter peak periods, based on the number of services boarded and zone boundaries crossed, and on the 2011 Metlink tariffs;
- 4 – Discount factors were applied to the full fare, to take into account the various types of Metlink fares and the proportion of passengers paying each type, for both the AM and Inter peak periods. A weighted average was calculated, using the fare category and patronage numbers from the Electronic Ticketing Machine (ETM) data and rail survey. This was carried out for both bus and rail and was calculated for every number of fare region crossings, to take into account the variations in fare

structure depending on the journey length. Final discount factors per zones travelled were calculated using the weighted average of bus and rail factors and were applied to the full fares calculated in the previous step to obtain the final discounted fare for each O-D.

2011 nominal fare matrices were then adjusted to 2001 levels using the factor of 0.76 derived from Statistics NZ CPI data.

2.5.2 2013 Model Update Methodology

For the 2011 update, this matrix calculation was a "one-off", carried out once during the update to recalculate the fare matrix but not included in the course of subsequent model runs. However during analysis subsequently carried out with WTSM applied to produce forecasts for some specific projects, the matrix calculation was included as part of a model run, in order to allow taking into account the impact of changes to the PT network or the fare structure (e.g. integrated ticketing) on fares.

For the 2013 version of the model, this feature has now been fully included as part of a standard model run. As a result, the PT fare matrix is always an accurate representation of the average fare paid for each O-D pair on the network.

Metlink tariffs were updated, so that the full fare paid (step 3 in the previous section) was uplifted to March 2013. In addition, although the full detail of proportion of ticket types (adult/child, cash/ePurse, etc) for each zone was not available, unlike during the 2011 update, some adjustments were made to reflect the larger uptake of Snapper card use in 2013, and the corresponding decrease in cash payment. Factors of 18% reduction in cash use during the morning peak and 13% during the inter peak were obtained from analysis of the Go Wellington ETM data, which is detailed in a separate technical note (ETM Comparison 2011-2013, 4 December 2014). Bus verses rail patronage proportions during the AM Peak and Inter Peak were also updated using Metlink patronage data.

Finally, PT fares were deflated to 2001, using the same factor of 0.74 as for other parameters.

The resulting PT full fares and discount coefficients for both the AM peak and Inter peak are shown in the table overleaf (in 2013 dollars)

No. of Zones	Full Fare	AM Peak Discount Coeff.	Inter Peak Discount Coeff.
0	$2.00	0.90	0.78
1	$2.00	0.82	0.78
2	$3.50	0.76	0.69
3	$5.00	0.68	0.61
4	$5.50	0.64	0.68
5	$6.50	0.69	0.71
6	$8.00	0.68	0.67
7	$9.00	0.67	0.76

No. of Zones	Full Fare	AM Peak Discount Coeff.	Inter Peak Discount Coeff.
8	$10.50	0.67	0.70
9	$11.50	0.69	0.70
10	$12.50	0.70	0.70
11	$14.50	0.67	0.70
12	$15.50	0.67	0.70
13	$17.00	0.67	0.70
14	$18.00	0.67	0.70

Table 4: WTSM 2013 PT Full Fares and Discount Coefficients

2.6 Travel Demand Management

2.6.1 2006 and 2011 Model Updates Methodology

Travel Demand Management (TDM) in WTSM mostly relates to workplace travel initiatives. It consists of two parameters:

- Percentage reduction in Home-Based Work trips by car to the Wellington CBD
- Percentage of these trips that transfer to PT for the same O-D, with the remainder not travelling or using active modes

These parameters are used for forecasting but are set to zero for the base year, i.e. no TDM is assumed to be occurring.

2.6.2 2013 Model Update Methodology

Without new information on TDM measures being collected or clear evidence of it occurring, the same approach was used for 2013 with both parameters set to zero.

3. WPTM Input Parameters Update

3.1 Values of Time

Values of time in WPTM are derived from WTSM, with the same breakdown per trip purpose and car availability. However, during the Public Transport Spine Study analysis, it was found that the values of time that are expressed in WTSM in cents/minutes were mistaken for $/hour during the development of WPTM.

Analysis of the impact of this inconsistency showed that it had only a negligible impact on the results and consequently it was decided to leave the values unchanged. However as part of the model update, there is an opportunity to correct this error.

Additionally, it was decided to update the values of time in WPTM to use the values in the new EEM revised in July 2013, which are now based on equity between modes (Table A4.1(b)in EEM), i.e. the values are the same for car drivers and passengers, PT users or pedestrians.

Finally an inconsistency was noted in the EEM 'user' or 'perceived' values of time (Table A4.1 in EEM) which are used to derive the values of time in the models and were found to actually be expressed in 'resource' cost units. According to Table A11.1 in the EEM, user cost should be 15% higher than resource cost for non-work purposes (not including commuting to/from work). The values of time in the WPTM were therefore increased by 15% for resource cost correction.

More details on these adjustments, including their impact on travel patterns can be found in *Appendix A – WPTM Values of Time Correction*.

Once the values of time were corrected, they were uplifted to 2013 using GDP per capita growth. This resulted in a 2% increase from 2011 values. The final values of times for WPTM are shown in the table overleaf.

Vehicle Occupant	Car Availability	2011 WPTM Vot Base ($/H)	2011 Vot With Unit Fixed ($/H)	2011 Vot With Modal Equity And Resource Cost Correction ($/H)	Vot WPTM 2013 ($/H)
AM Work	CA	17.36	10.42	13.38	13.65
	NCA	12.95	7.77	13.38	13.65
AM Education	CA	12.90	7.74	11.83	12.07
	NCA	8.50	5.10	11.83	12.07
AM Other	CA	15.66	9.40	11.83	12.07
	NCA	11.02	6.61	11.83	12.07
AM Child	All	9.80	5.88	11.83	12.07
IP Work	CA	17.36	10.42	13.38	13.65
	NCA	12.95	7.77	13.38	13.65
IP Education	CA	12.90	7.74	11.83	12.07
	NCA	8.50	5.10	11.83	12.07
IP Other	CA	15.66	9.40	11.83	12.07
	NCA	11.02	6.61	11.83	12.07
IP Child	All	10.15	6.09	11.83	12.07

Table 5: WPTM 2013 Values of Time ($/hr)

3.2 PT Fares

The public transport fare structure hasn't changed between 2011 and 2013, with the same zones, boundaries and rules still in place. As mentioned in Section 2.5 however, there has been a general price increase over all fare products, with the uplift varying slightly depending on the number of zones travelled or ticket types, but increasing in average by circa 6%.

Due to the way WPTM operates, this fairly consistent increase in fare does not have a significant impact as the model is more concerned with the relative difference in cost between PT modes. As noted in *TN1 – Network Preparation* from the 2011 WPTM development:

> *"The relative difference in fares would need to be recalculated only if the fare changes varied by operator. Otherwise WTSM would deal with fare increases, resulting in a different PT mode share dependent on whether the fare increases were greater than any changes in vehicles operating costs."*

Nevertheless, it was decided to apply the 6% average increase to all fares in WPTM for consistency with WTSM. This nominal fare increase was however deflated using CPI growth, resulting in a 3% fare uplift.

In terms of ticket types, ticket products in 2013 are the same as in 2011, which were used to calculate average fares on the network. Analysis of Electronic Ticketing Machine (ETM) data for bus and rail ticket sales data showed that patronage per ticket type is also mostly constant, with two exceptions:

- An increase in usage of Snapper card for bus (69% of all boardings in 2011, up to 73% in 2013), with a corresponding reduction in other payment, especially cash.
- A 21% increase in Gold Pass users for rail, resulting in a total share of ticket types increasing from 9.5% to 11.5%.

These trends are not deemed likely to have a significant impact as they only result in small changes to the make-up of fare products and have a negligible effect on the differential between bus and rail costs. As a result, and because updating the average fare calculation would be too onerous a task for such a limited difference, it was decided to disregard these trends.

Finally, the coding of fares in WPTM for public transport assignments was modified during the Public Transport Spine Study to enable modelling of integrated ticketing. Specifically, the flagfall component of the fare had to be changed from being line specific only to a combination of line and node specific for buses (more details can be found in *TN3 – Development of Base Year Networks* from the 2011 update, sections 4.2.2 and 4.2.4).

This modification has now been fully included as part of the WPTM. The resulting 2013 boarding and zone boundary crossing fares are shown in the following table, along with 2011 for comparison.

		2011		2013		2013 (with line /node split)		
		Flagfall	Boundary	Flagfall	Boundary	Flagfall Line	Flagfall Node	Boundary
AM Adult	Bus	1.89	-	1.95	-	0.00	1.95	-
	Flyer	4.07	-	4.19	-	2.25	1.95	-
	Rail	1.89	0.01	1.95	0.01	1.95	-	0.01
	Ferry	8.39	-	8.64	-	8.64	-	-
AM Child	Bus	1.28	-	1.32	-	0.00	1.32	-
	Flyer	3.16	-	3.25	-	1.94	1.32	-
	Rail	0.99	-	1.02	-	1.02	-	-
	Ferry	8.39	-	8.64	-	8.64	-	-
IP Adult	Bus	1.57	-	1.62	-	0.00	1.62	-
	Flyer	4.07	-	4.19	-	2.58	1.62	-
	Rail	1.96	0.13	2.02	0.13	2.02	-	0.13
	Ferry	8.39	-	8.64	-	8.64	-	-
IP Child	Bus	1.29	-	1.33	-	0.00	1.33	-
	Flyer	3.16	-	3.25	-	1.93	1.33	-
	Rail	0.9	-	0.93	-	0.93	-	-
	Ferry	8.39	-	8.64	-	8.64	-	-

Table 6: WPTM 2013 PT Fares ($)

4. WTSM Input Parameters Forecasting

4.1 Summary

As for the base year economic input parameters, the approach used to forecast these parameters for future years was largely consistent with the methodology used in the 2011 update.

The following figure shows the resulting growth factors for all WTSM economic input parameters.

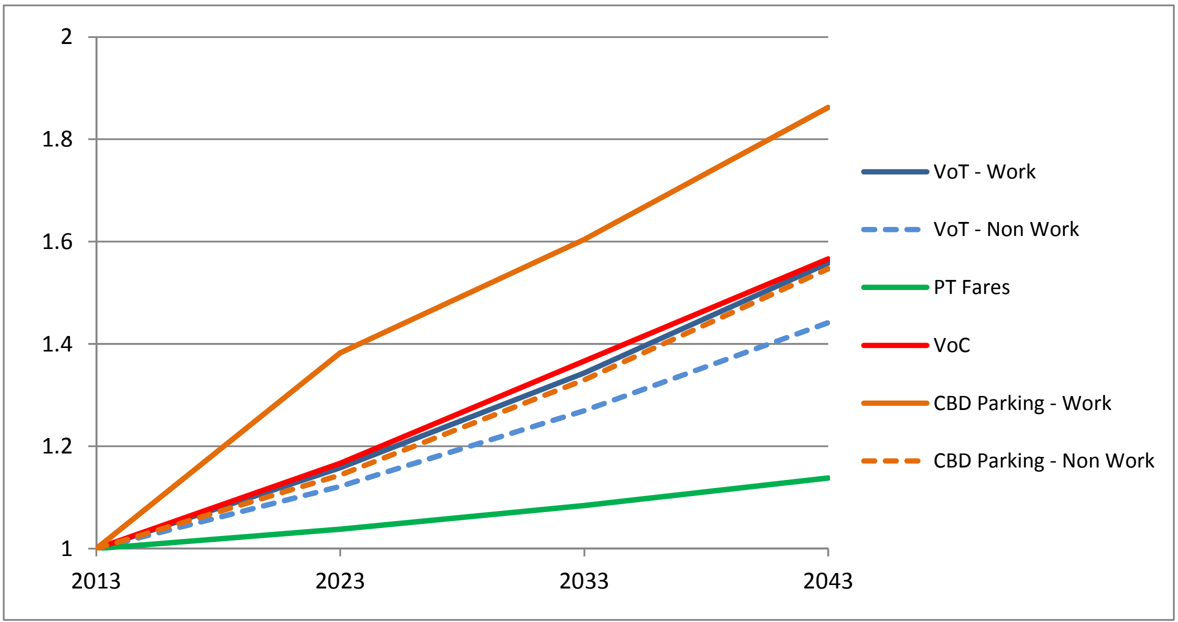


Figure 2: WTSM Economic Input Parameters Real Growth Indexed to 2013

Detail on the assumptions used to forecast these parameters is given in the following sections.

4.2 Values of Time

As for the 2011 update, the forecasted values of time were derived by applying projected increase in real GDP / labour force indexed to 2013, obtained from the NZ Treasury Fiscal Model forecasts[1]. For non-work purposes, an elasticity factor of 0.8 was applied. This is the same approach used in the Auckland strategic transport models.

The resulting growth for both work and non-work purposes is illustrated in the figure below.

[1] http://www.treasury.govt.nz/government/longterm/fiscalmodel

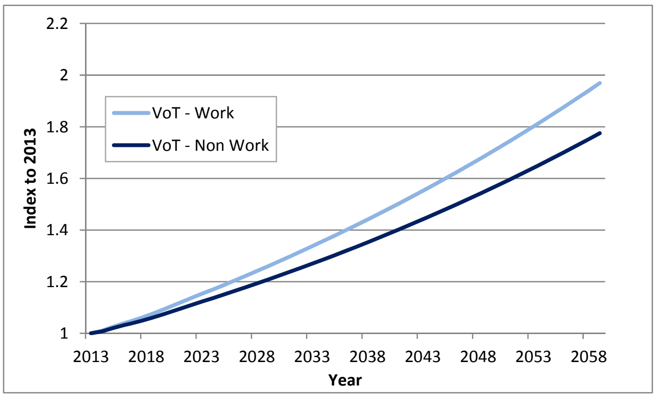


Figure 3: Values of Time Indexed to 2013

The forecasting adjustments factors and resulting values of time below have therefore been used for forecasting in WTSM.

Purpose	Car Availability	Forecasting Increase Factors			Values of Time Adjusted to 2001 (c/min)			
		2023	2033	2043	2013	2023	2033	2043
Home-Based Work	Captive	1.15	1.34	1.55	10.0	11.6	13.4	15.6
	Competition and Choice	1.15	1.34	1.55	13.4	15.5	18.0	20.9
	Combined	1.15	1.34	1.55	13.4	15.4	17.9	20.8
Home-Based Education	Captive	1.12	1.27	1.44	6.6	7.4	8.4	9.5
	Competition and Choice	1.12	1.27	1.44	10.0	11.2	12.7	14.4
	Combined	1.12	1.27	1.44	9.9	11.1	12.5	14.2
Employer Business	Captive	1.15	1.34	1.55	45.3	52.1	60.5	70.2
	All	1.15	1.34	1.55	41.8	48.1	55.8	64.8
Other	Captive	1.12	1.27	1.44	8.5	9.6	10.8	12.3
	Competition and Choice	1.12	1.27	1.44	12.1	13.6	15.4	17.5
	Combined	1.12	1.27	1.44	12.0	13.4	15.2	17.3

Table 7: WTSM Values of time forecast

4.3 Vehicle Operating Costs

Forecasting approach for vehicle operating costs is different for their fuel-related and non-fuel-related components. Non-fuel related costs are assumed to grow in line with CPI, and since CPI is also used to discount costs to 2001 $, they consequently stay flat.

For fuel-related cost, the approach was largely consistent with the 2011 update. Fuel cost increase is dependent on two conflicting parameters: oil price increase and vehicle efficiency improvements. The same sources as for the 2011 update were used for both indicators.

Oil price forecasts were obtained from the Ministry of Economic Development (MED) energy outlook[2], and the "Oil price high" scenario was used. The reasons for this choice is detailed in *TN15 – Input Parameters* (Section 3.10.1), but as a summary it was deemed that this scenario led to the most intuitively correct increase in fuel costs, relative to other costs in the model (PT fare, VoT, etc). Other MED scenarios are however available and can easily be implemented in the parameter calculation should this assumption be revisited. The MED Reference, Low and High oil price forecast are shown in Figure 4 below for reference.

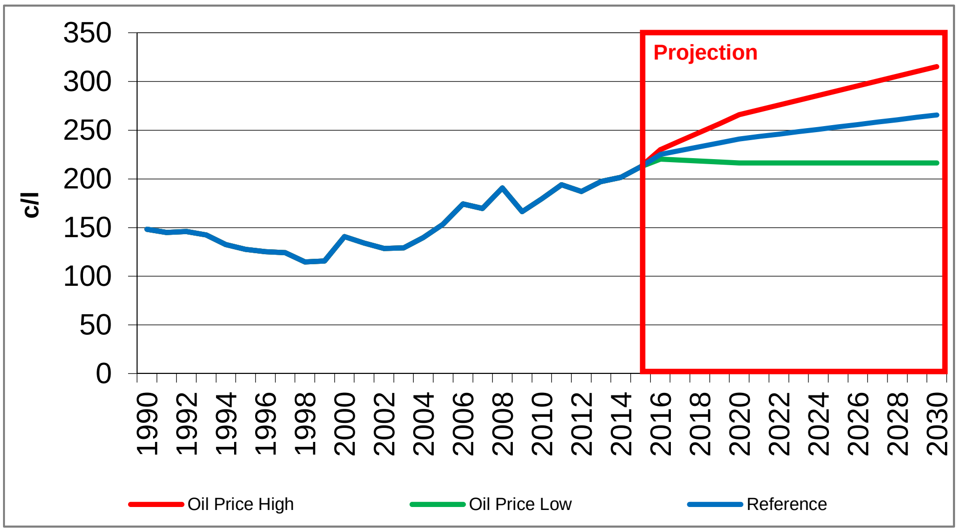


Figure 4: MED Retail Petrol Price (c/l, including carbon, real 2010)

Fuel efficiency forecasts were based on the same Ministry of Transport fleet emission model data as during the 2011 update, obtained via Auckland Council. The increase in efficiency from the model was applied for 2023 and 2033, but then kept constant to 2043 as it was thought improbable that engine efficiency would be ever increasing.

However, one issue encountered with the 2011 version of WTSM when using this approach to forecast vehicle operating costs was that it led to a strong increase in fuel costs to 2021, and then a slowing down for following years. Due to the weight of this component in calculation of generalised costs, this resulted in a strong response from the model, especially regarding mode choice with a rapid increase in public transport use to 2021, and then flattening or even decreasing after that.

This outcome being counter-intuitive and somewhat undermining the credibility of some of the forecasts, it was decided to adjust this approach for the 2013 update. Growth factors for 2023 were therefore interpolated from 2013 and 2033 values, while other years were left untouched. Given the uncertainty regarding evolution of oil prices, this alteration was considered acceptable.

The table overleaf shows the resulting forecasting factors applied to fuel-related vehicle operating costs. For 2023, values are shown both before and after adjustments.

[2] http://www.med.govt.nz/sectors-industries/energy/energy-modelling/modelling/new-zealands-energy-outlook-reference-scenario

	2023	2023 Adjusted	2033	2043
Fuel-related VoC adjustment factors	1.31	1.15	1.34	1.56

Table 8: WTSM Fuel-related VoC Forecasts

4.4 Wellington CBD Parking

The same approach used in the Auckland model and for the 2011 update of WTSM was retained, with parking charges adjusted based on GDP per capita increase, applying an elasticity of 1.2 for commuter travel (home-based work purpose) and 1.0 for other purposes.

Table 9 below shows the resulting Wellington CBD parking prices used for forecasting in WTSM.

Car Availability	Forecasting Increase Factors			Wellington CBD Parking Cost Adjusted to 2001 ($)		
	2023	2033	2043	2023	2033	2043
Home-based work - Lower Wellington	1.38	1.60	1.86	5.93	6.88	7.98
Home-based work – Upper Wellington	1.38	1.60	1.86	9.59	11.12	12.91
EB Lower Wellington	1.15	1.34	1.55	0.84	0.98	1.13
EB Upper Wellington	1.15	1.34	1.55	1.50	1.74	2.02
Other Lower Wellington	1.15	1.34	1.55	0.69	0.80	0.93
Other Upper Wellington	1.15	1.34	1.55	1.38	1.60	1.86

Table 9: WTSM Wellington CBD Parking Cost Forecast

4.5 PT Fares

PT fare increases were estimated using forecasted growth in GDP per capita from NZ treasury, and applying an elasticity of 0.25 obtained from analysis carried out by Ian Wallis. More detail on this methodology can be found in *TN15 – Input parameters* (section 5.3) from the 2011 WTSM update.

The resulting PT fare increase factors, which get applied to the whole fare matrix calculated in section 2.5.2, are shown in Table 10 below.

	2023	2033	2043
PT Fare adjustment factors (using 0.25 elasticity)	1.04	1.08	1.14

Table 10: WTSM PT Fares increase forecast

4.6 Travel Demand Management

Travel demand management assumptions for the first forecast year (2023) were set the same as in the 2011 version of WTSM, in the absence of new information on the effect of TDM being collected: 3% of Home-based work car trips to the CBD during the AM Peak period (and from the CBD during the PM Peak period) are removed from car total demand, of which 90% are reallocated to PT, with the remaining 10% assumed to be work from home or walking/cycling. For following years, this was set to 4% reduction in 2033 and 5% in 2043, to reflect the increase in TDM uptake and efficiency.

5. WPTM Input Parameters Forecasting

5.1 Values of Time

Values of times in WPTM were uplifted to future years using the same approach as for WTSM, described in section 4.2. The increase in real GDP / labour indexed to 2013 was applied, with an elasticity factor of 0.8 for non-work purposes. This resulted in the following increase factors.

Car Availability	Forecasting Increase Factors		
Work	1.15	1.34	1.55
Non-work	1.12	1.27	1.44

Table 11: WPTM Values of Time Forecast

5.2 PT Fares

PT Fares were uplifted to future years similarly to WTSM, using forecasted growth in GDP per capita and applying a 0.25 elasticity.

	2023	2033	2043
PT Fare adjustment factors (using 0.25 elasticity)	1.04	1.08	1.14

Table 12: WPTM PT Fares Increase Forecast

Appendix A

WPTM Values of Time Corrections

DATE 21/01/2014

AUTHOR Geoffrey Cornelis

SUBJECT WPTM Values of Time Correction

A.1 Introduction

This note presents a summary analysis of the impact of amending the Values of Time in the Wellington Public Transport Model (WPTM). During the Public Transport Spine Study, it was found that the values of time from the WTSM (Wellington Transport Strategy Model) expressed in cents/minute were mistaken for $/hour values during the development of the WPTM and used as is in the new model. This is equivalent to these values being too high by a factor of 67%.

An initial test was carried out, where the WPTM was run with the correct values of time, and high level analysis of the results showed that due to the way the model operates and the limited choice between competing public transport modes in the Wellington region, this error was estimated to have a negligible impact on results, particularly in the context of the Spine Study. One further argument to keep the values of time unchanged was that the WPTM being a behavioural model, whatever values of time lead to an accurate representation of observed behaviours are by essence correct, in which case this 1.67 factor would be acting as a scaling factor.

However, with the update of the Wellington Transport models, there is an opportunity to revisit this assumption and potentially correct these values of time.

Furthermore, validation of WPTM showed that although the model generally achieved a very close fit with observed patterns, the share of walk vs PT for access/egress to rail was slightly less accurate, particularly for egress at Wellington station. With the upcoming integrated ticketing study which is likely to have a significant impact on walk / PT egress mode split at Wellington Station, it is important to have a good understanding of the impact of this discrepancy on access/egress mode choice in the current conditions.

Note: All observed values in this note are from 2011 surveys carried out for the WPTM development.

A.2 Impact on Egress Mode Share at Wellington Station

The table below shows the observed share of mode used by rail passengers arriving at Wellington Station to reach their final destination, as well as the same values from WPTM both with the current ("Old") and updated ("New") values of time.

Egress Mode	Egress Mode Share at Wellington Station		
	Observed	Modelled Old VoT	Modelled New VoT
	90%	79%	87%
	10%	21%	13%

Results show that updating the values of time considerably improves the split of bus and walk share for rail passengers to reach their destination in the CBD.

A.3 Impact on Mode Share for Access to Rail

The table below shows the total number of rail trips in the Wellington region, both observed and modelled (with the new and old values of time), as well as the breakdown per access mode.

		Number of Rail Trips per Access Mode				
		PR	KR	Walk	Bus	Total
AM	Observed	4,904	975	5,259	687	**11,825**
	Modelled Old VoT	4,647	949	4,268	1,352	**11,215**
	Modelled New VoT	4,400	846	4,493	1,257	**10,997**
IP	Observed	284	49	1,173	190	**1,696**
	Modelled Old VoT	242	42	785	65	**1,134**
	Modelled New VoT	215	36	799	54	**1,105**

It can be noted that there is a general decrease in total rail passengers of about 2%. The resulting effect on access mode share is illustrated in the following section. Results are presented for levels 1 and 2 of the Mode Choice model (i.e. choice between car and other, and between Park & Ride and Kiss & Ride), as well as choice between walk access and bus access which is carried out through the assignment.

A.3.1 Mode Choice – Level 1 (Car / Other Access)

This is the first level of the access mode choice, which separates total PT demand into 'Car Access' and 'Other'. At this level, the value of time is used to convert PT fares, vehicle operating costs and potential parking costs into generalised minutes.

Results below show that the modelled split with the Old values of time was a very good fit in the morning peak, slightly less so in the interpeak. With the new values of time, the proportion of car access decreases slightly in both periods, which means that the validation deteriorates to some extent in the morning. In the interpeak, it actually leads to an improvement but due to much lower demand in this period, the interpeak is comparatively less important in terms of validation.

		Percentage Mode Share - Level 1	
		Car Access	Other
AM	Observed	50%	50%
	Modelled Old VoT	50%	50%
	Modelled New VoT	48%	52%
IP	Observed	20%	80%
	Modelled Old VoT	25%	75%
	Modelled New VoT	23%	77%

A.3.2 Mode Choice – Level 2 (Park & Ride / Kiss & Ride)

This is the second level of the access mode choice, which separates Car demand into 'Park & Ride' and 'Kiss & Ride'. At this level, the value of time is used to convert PT fares, vehicle operating costs and potential parking costs into generalised minutes.

Again, the original split is a good fit to observed patterns, and applying the updated values of time lead to a small deterioration, although the difference is small for both time periods.

		% Mode Share - Level 2	
		PR / Car	KR / Car
AM	Observed	83%	17%
	Modelled Old VoT	83%	17%
	Modelled New VoT	84%	16%
IP	Observed	85%	15%
	Modelled Old VoT	85%	15%
	Modelled New VoT	86%	14%

A.3.3 Non Car Choice through Assignment (Walk / Bus)

The choice between 'Walk' and 'Bus' access is carried out through the PT assignment, where the value of time is used to convert the PT fares into generalised time. Results below show that the fit with the original values of time is acceptable, although not as close as results from the Access Choice Model. The updated values of time lead to a small improvement in the morning peak and a minor deterioration in the inter peak.

		% Mode Share - Assignment	
		Walk / Other	Bus / Other
AM	Observed	88%	12%
	Modelled Old VoT	76%	24%
	Modelled New VoT	78%	22%
IP	Observed	86%	14%
	Modelled Old VoT	92%	8%
	Modelled New VoT	94%	6%

A.3.4 Resulting Mode Share for Access to Rail

The table below shows the total mode share for access to rail, resulting from the Access Choice Model and the PT assignment. Results show that updating the values of time does not impact significantly on the final split.

		% Mode Share - Final			
		PR	KR	Walk	Bus
AM	Observed	41%	8%	44%	6%
	Modelled Old VoT	41%	8%	38%	12%
	Modelled New VoT	40%	8%	41%	11%
IP	Observed	17%	3%	69%	11%
	Modelled Old VoT	21%	4%	69%	6%
	Modelled New VoT	19%	3%	72%	5%

This confirms that the new values of time lead to an increase in walk trips in the morning peak and therefore a better fit for the split between walk and bus in assignment, and a deterioration in the interpeak but demand is much lower during this period.

On the other hand the impact on the choice model is slightly detrimental (especially Level 1) with less access by car in the morning peak when most of the demand occur, but does improve the interpeak.

A.4 Impact on Total Demand by Access Mode

The table below shows the total PT demand (including bus and rail) by access mode. P&R and K&R access are for rail trips only whereas walk and bus access are for both bus and rail.

Results clearly show a decrease in car access, to the benefit of walk / bus access to rail, but also to non-rail trips.

	AM Peak			Inter Peak		
	Old	New	% change	Old	New	% Change
Park & Ride	5,129	4,878	-5%	242	216	-11%
Kiss & Ride	1,108	990	-11%	43	37	-14%
Walk / Bus	17,993	18,360	2%	5,319	5,352	1%
Total	24,230	24,228	0%	5,604	5,604	0%

A.5 Impact on Bus / Rail Split from North to CBD

The table overleaf shows the PT demand through a screenline directly to the north of the CBD, which includes the rail line Wellington Station, Thorndon Quay and Murphy Street. Results confirm that there is a slight decrease in rail trips to the benefits of bus.

Mode	Observed	*% Mode*	Modelled Old VoT	*% Mode*	Modelled New VoT	*% Mode*
Bus	2,977	*21%*	3,051	*22%*	3,248	*23%*
Rail	11,366	*79%*	11,033	*78%*	10,878	*77%*
Total	14,343		14,084		14,126	

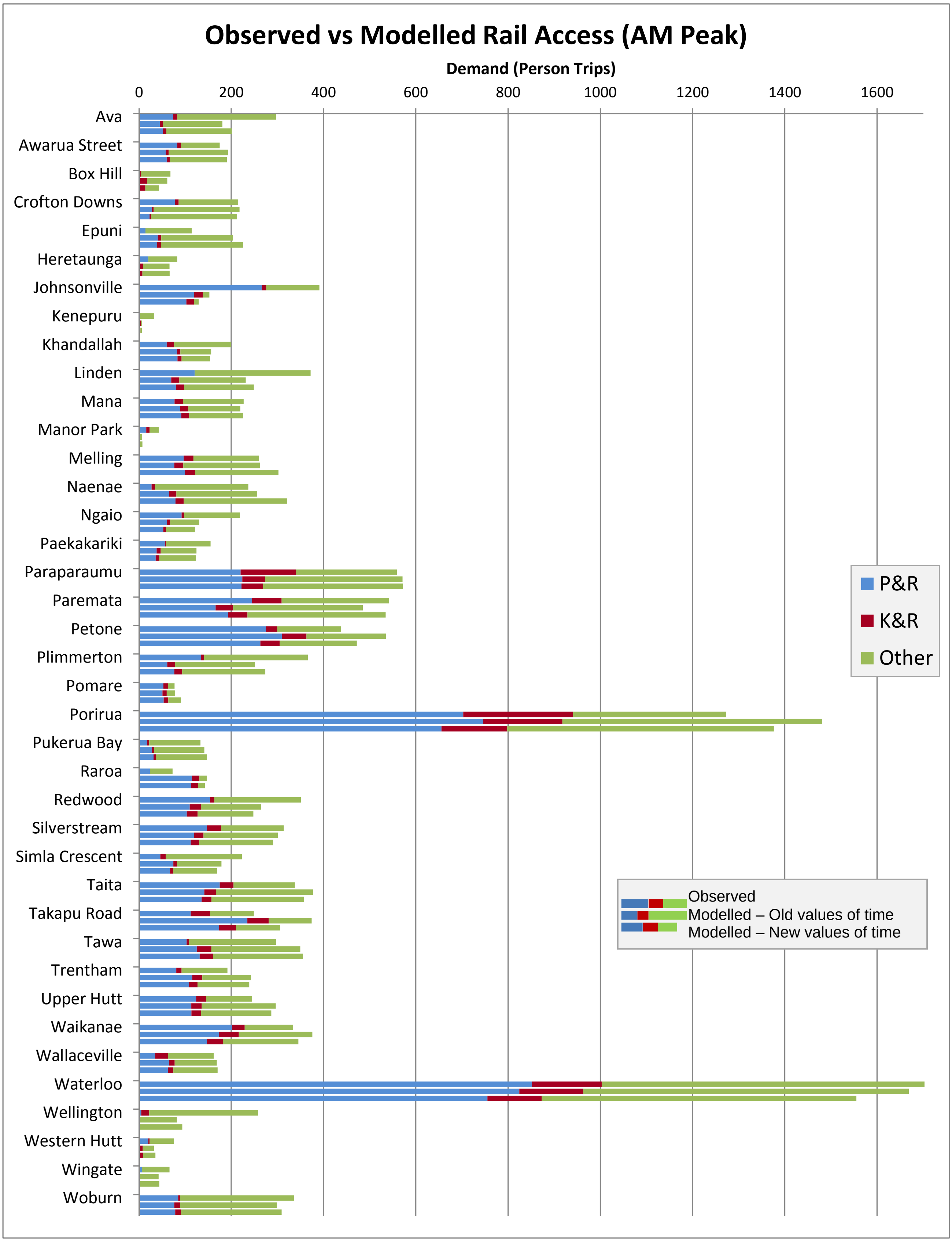
A.5.1 Impact on Rail Station Choice

The table below shows the impact of the change in values of time on station choice (level 3 of the choice model) for total patronage. It highlights how many stations out of the 40 surveyed experience changes of 5, 10, 20 and 30%, as well as the result on validation compared with observed patronage.

Change in Total Patronage	AM Peak	Inter Peak
Station with <5% change	18/40	20/40
Station with <10% change	27/40	29/40
Station with <20% change	38/40	36/40
Station with <30% change	40/40	39/40
Stations with improved fit with observed	20/40	21/40

About half of the stations experience changes of less than 5%, with 36 stations out of 40 experiencing changes of less than 20%. This doesn’t actually impact significantly on the validation for total patronage as about half of the stations improve as a result and the other half deteriorate.

The figure on the following page shows the patronage by access mode for all station, for observed, modelled with original values of time and new values of time. Again, some stations improve as a result and other get worse but there is no clear pattern, apart from a slight decrease in total rail patronage.



A.6 Impact on Assigned Volumes

Below are a number of screenshots from WPTM showing the differences in transit and auxiliary transit. They show that the assigned volumes are generally close to the original model with the exception of egress from Wellington Rail Station where a sizable number of rail users have switched from bus to walk to access their destination. The plots also confirm that there is a slight decrease in rail patronage (and ferry), with some users switching to bus.

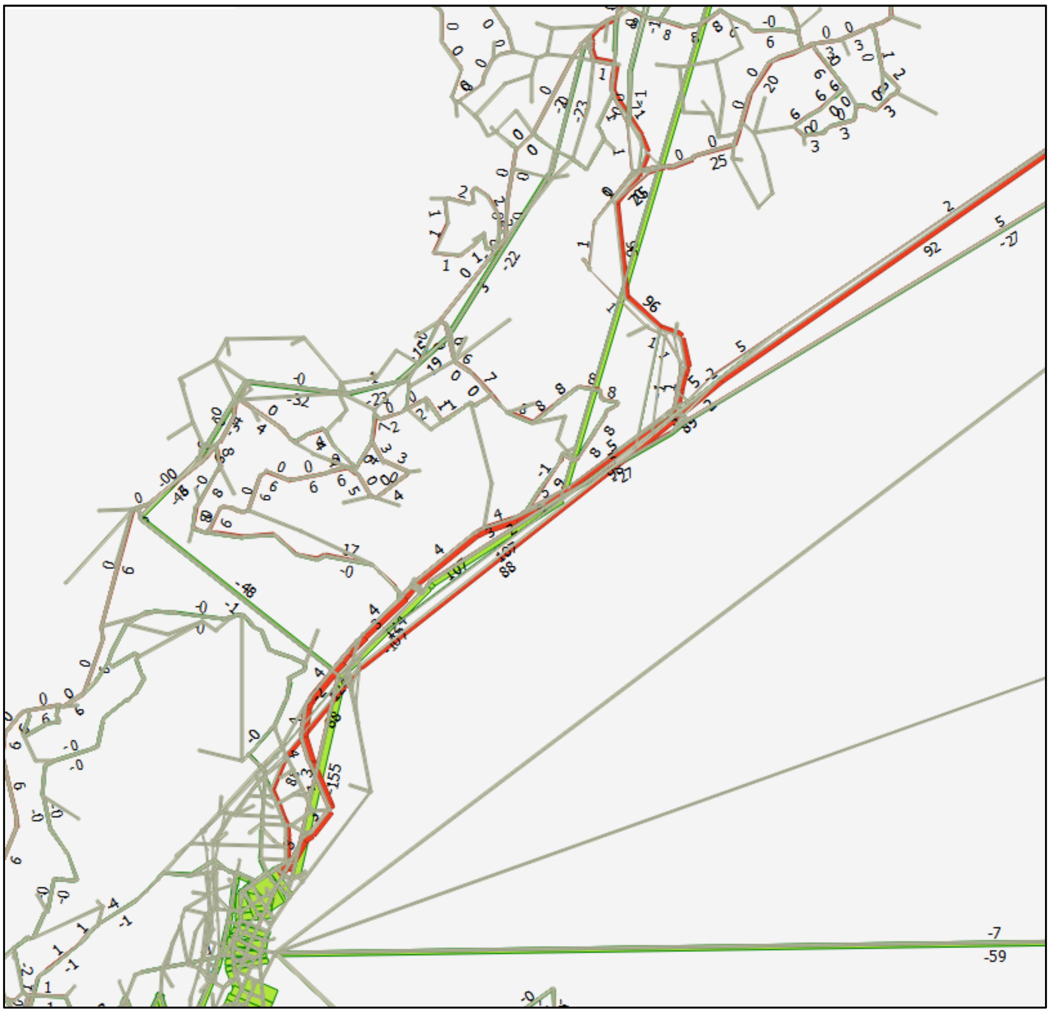


Figure A1: PT Volume Changes (AM Peak)

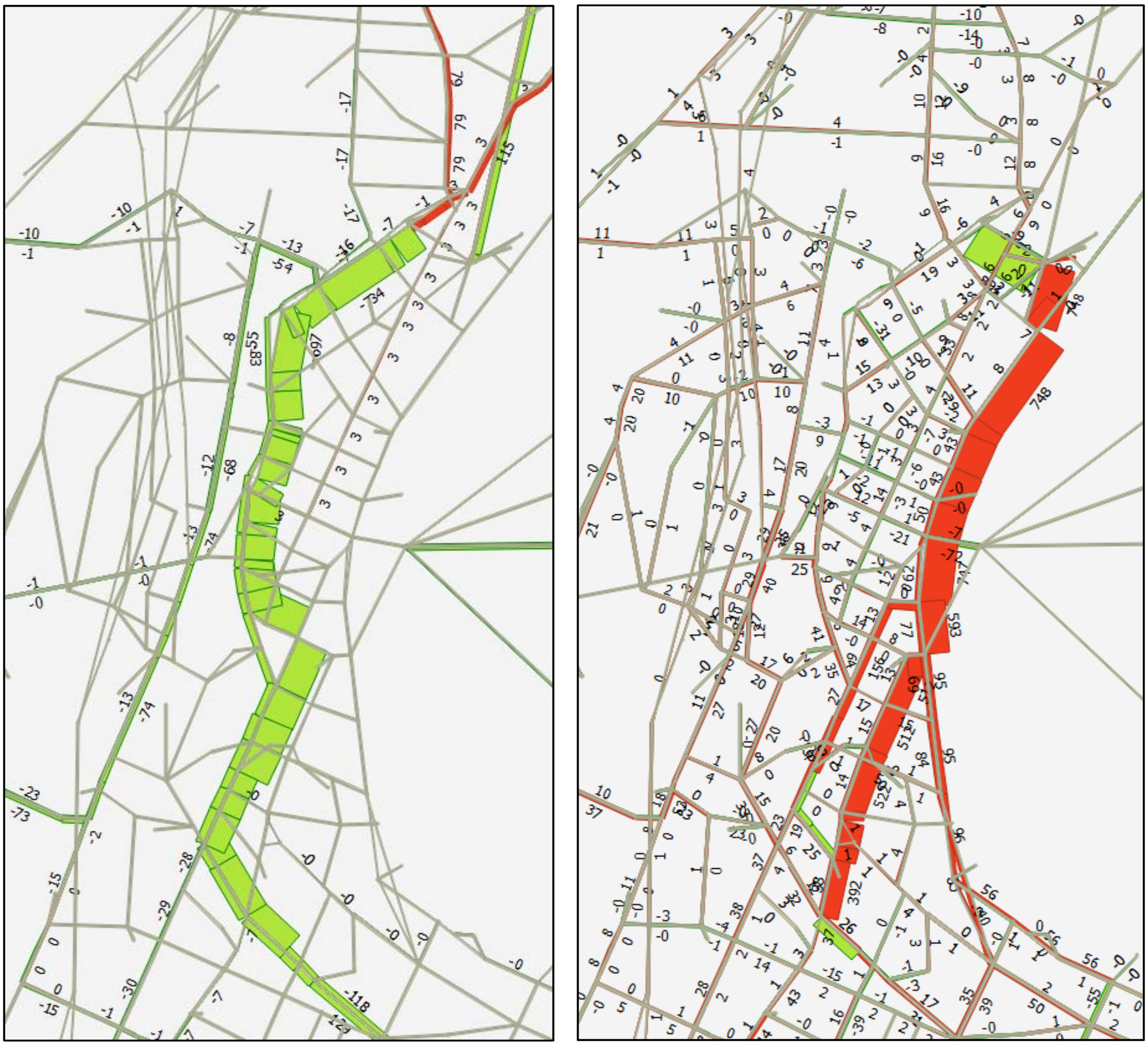


Figure A2: PT and Auxiliary Volume Changes (AM Peak)

A.7 Conclusions

The analysis has highlighted that updating the values of time used in WPTM so that they are expressed in the correct value has no major impact on the validation of the model, but does have a small but noticeable effect on access mode and as a result on the split between bus and rail.

The updated values generally lead to a better fit for the split between bus and walk, which is carried out through the assignment. This is particularly noticeable for rail passengers egressing at Wellington railway station.

It does however impact to some extent on the access choice model, mostly by resulting in car access being less attractive, which in turns lead a slight decrease in rail trips, to the benefits of bus.

The impact on rail station choice for P&R and K&R shows no clear pattern apart from the general reduction in rail trips. Some stations benefit from it in terms of validation while others deteriorate. A more thorough analysis might be needed to identify the consequences in more details.

These conclusions indicate that adopting the new values of time would not affect critically the overall validation of the model, but would largely improve on the imbalance observed for egress at Wellington station. It would however be worthwhile to investigate the complexity and amount of work required to adjust the access choice model to restore the split for 'Car' vs 'Non-Car' access (Level 1) closer to its original state. If adjusting a global scaling parameter or constant for the entire region could fix this discrepancy, the resulting WPTM would offer a good improvement on the already high level of validation of the original model.

A.8 Addendum – New EEM Equity-Based Values of Time and Resource Cost Correction

Following the analysis above, another way forward was suggested which was to update the values of time in WPTM to use the values in the new Economic Evaluation Manual (EEM) revised in July 2013. One of the main revisions of the EEM is that values of time for travel time benefits calculation are now based on equity between modes (Table A4.1(b)), i.e. the values are the same for car drivers and passengers, PT users or pedestrians.

Furthermore, an inconsistency was noted in the EEM where 'users' or 'perceived' values of time (Table A4.1) which are used to derive the VoT in the models, were found to actually be expressed in 'resource' cost units (Julie Ballantyne mentioned that TDG already contacted NZTA about this issue for the 2006 Christchurch model and this discrepancy was confirmed by Sandy Fong from NZTA). According to Table A11.1 in the EEM, user cost should be 15% higher than resource cost for non-work purposes (not including commuting to/from work). The resulting VoT in the WPTM were therefore increased by 15% for resource cost correction.

Two tests were carried out, first with values of time based on modal equity, and then with values also including resource cost correction. This last set of values of time is suggested to be used for the updated 2013 WPTM.

The resulting changes on values of time in WPTM are illustrated in the following table.

Vehicle Occupant	Car Availability	VoT WTPM Base ($/h)	VoT With Unit Fixed ($/h)	VoT With Unit Fixed and Modal Equity ($/h)	VoT with Modal Equity and Resource Cost Correction ($/h)
AM Work	CA	17.36	10.42	11.63	13.38
	NCA	12.95	7.77	11.63	13.38
AM Education	CA	12.90	7.74	10.29	11.83
	NCA	8.50	5.10	10.29	11.83
AM Other	CA	15.66	9.40	10.29	11.83
	NCA	11.02	6.61	10.29	11.83
AM Child	All	9.80	5.88	10.29	11.83
IP Work	CA	17.36	10.42	11.63	13.38
	NCA	12.95	7.77	11.63	13.38
IP Education	CA	12.90	7.74	10.29	11.83
	NCA	8.50	5.10	10.29	11.83
IP Other	CA	15.66	9.40	10.29	11.83
	NCA	11.02	6.61	10.29	11.83
IP Child	All	10.15	6.09	10.29	11.83

These new values of time being higher than the original EEM ones, this offsets the lowering effect of correcting the unit issue and they therefore end up closer to the initial erroneous ones used in the base WPTM.

The following tables detail the impact of using both sets of values on the model validation, presented alongside the results from the section above.

A.8.1 Impact on Egress Mode Share at Wellington Station

Egress Mode	Egress Mode Share				
	Observed	Modelled Old VoT	Modelled New VoT	Modelled Equity VoT	Modelled Equity + Resource VoT
Walk	90%	79%	87%	83%	80%
Bus / Train	10%	21%	13%	17%	20%

A.8.2 Impact on Mode Share for Access to Rail

		Number of Rail Trips per Access Mode				
		PR	KR	Walk	Bus	Total
AM	Observed	4,904	975	5,259	687	**11,825**
	Modelled Old VoT	4,647	949	4,268	1,352	**11,215**
	Modelled New VoT	4,400	846	4,493	1,257	**10,997**
	Modelled Equity VoT	4,474	942	4,376	1,305	**11,096**
	Modelled Equity + Resource VoT	4,552	967	4,369	1,355	**11,242**
IP	Observed	284	49	1,173	190	**1,696**
	Modelled Old VoT	242	42	785	65	**1,134**
	Modelled New VoT	215	36	799	54	**1,105**
	Modelled Equity VoT	229	42	792	63	**1,126**
	Modelled Equity + Resource VoT	236	43	788	64	**1,131**

A.8.3 Mode Choice – Level 1, 2 and Assignment

		% Mode share - Lvl 1		% Mode Share - Lvl 2		% Mode Share - Assignment	
		Car Access	Other	PR / Car	KR / Car	Walk / Other	Bus / Other
AM	Observed	50%	50%	83%	17%	88%	12%
	Modelled Old VoT	50%	50%	83%	17%	76%	24%
	Modelled New VoT	48%	52%	84%	16%	78%	22%
	Modelled Equity VoT	49%	51%	83%	17%	77%	23%
	Modelled Equity + Resource VoT	49%	51%	82%	18%	76%	24%
IP	Observed	20%	80%	85%	15%	86%	14%
	Modelled Old VoT	25%	75%	85%	15%	92%	8%
	Modelled New VoT	23%	77%	86%	14%	94%	6%
	Modelled Equity VoT	24%	76%	84%	16%	93%	7%
	Modelled Equity + Resource VoT	25%	75%	84%	16%	93%	7%

A.8.4 Resulting Mode Share for Access to Rail

		% Mode Share - Final			
		PR	KR	Walk	Bus
AM	Observed	41%	8%	44%	6%
	Modelled Old VoT	41%	8%	38%	12%
	Modelled New VoT	40%	8%	41%	11%
	Modelled Equity VoT	40%	8%	39%	12%
	Modelled Equity + Resource VoT	40%	9%	39%	12%
IP	Observed	17%	3%	69%	11%
	Modelled Old VoT	21%	4%	69%	6%
	Modelled New VoT	19%	3%	72%	5%
	Modelled Equity VoT	20%	4%	70%	6%
	Modelled Equity + Resource VoT	21%	4%	70%	6%

A.8.5 Impact on Total Demand by Access Mode

	AM Peak					Inter Peak				
	Old	New	% Diff	Equity + Resource	% Diff	Old	New	% Diff	Equity + Resource	% Diff
PR	5,129	4,878	-5%	5,042	-2%	242	216	-11%	236	-3%
KR	1,108	990	-11%	1,128	2%	43	37	-14%	44	4%
Walk	21,549	21,915	2%	21,615	0%	7,711	7,743	0%	7,716	0%
Total	27,786	27,783	0%	27,785	0%	7,996	7,996	0%	7,996	0%

A.8.6 Impact on Bus / Rail Split from North to CBD

Mode	Observed	% Mode	Modelled Old VoT	% Mode	Modelled New VoT	% Mode	Equity + Resource	% Mode
Bus	2,977	21%	3,051	22%	3,248	23%	3,001	21%
Rail	11,366	79%	11,033	78%	10,878	77%	11,076	79%
Total	14,343		14,084		14,126		14,077	

A.8.7 Impact on Rail Station Choice

	New VoT		Equity VoT		Equity + Resource VoT	
Change in Total Patronage	**AM Peak**	**Inter Peak**	**AM Peak**	**Inter Peak**	**AM Peak**	**Inter Peak**
Station with <5% change	18/40	20/40	29/40	31/40	34/40	38/40
Station with <10% change	27/40	29/40	37/40	34/40	39/40	39/40
Station with <20% change	38/40	36/40	40/40	40/40	40/40	39/40
Station with <30% change	40/40	39/40	-	-	-	-
Stations with improved fit	20/40	21/40	23/40	21/40	21/40	20/40

A.9 Recommendations

Using the new Equity-based VoT with resource cost correction mitigates the effect of correcting the original wrong unit issue. This leads to improvements for some validation criteria compared with observed behaviours, while other criteria deteriorate slightly, but in all cases the results are very close to the original validated model.

Therefore it is suggested that these values are used in the updated 2013 WPTM. Although it can be argued that they are principally intended for economic evaluation while they are here used in a behavioural model, using these values would allow correcting the original issue of values of time being expressed in the wrong unit, while minimizing the impact on the model validation. It will also ensure a greater consistency with the EEM for economic evaluation of PT schemes in the future.