TN23 - WELLINGTON TRANSPORT ANALYTICAL TOOLS 2019-22 UPDATE – ACTIVE MODES ASSIGNMENT AND GENERALISED COST

PREPARED FOR   GREATER WELLINGTON REGIONAL COUNCIL

August 2022

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
Ali Siddiqui	Julie Ballantyne

PREPARED BY		
Christoph Gerds	....	04/08/22

CHECKED BY		
Julie Ballantyne	....	29/08/2022

REVIEWED BY		
Julie Ballantyne	....	29/08/2022

APPROVED FOR ISSUE BY		
Julie Ballantyne	....	16/12/2022

CHRISTCHURCH
Hazeldean Business Park, 6 Hazeldean Road, Addington, Christchurch 8024
PO Box 13-052, Armagh, Christchurch 8141
TEL +64 3 366 7449, FAX +64 3 366 7780

REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
1	29 Aug 2022	Draft	CG	JEB	JEB	
2		Internal draft				
3	16 Dec 2022	Final	CG	JEB	JEB	JEB

Stantec Jacobs │ TN23 - Wellington Transport Analytical Tools 2019-22 update – Active Modes Assignment and Generalised Cost │ August 2022

Status: Final │ Project No.: 310203597 │ Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Greater Wellington Regional Council

TN23 - Wellington Transport Analytical Tools 2019-22 update – Active Modes Assignment and Generalised CostTN23 - Wellington Transport Analytical Tools 2019-22 update – Active Modes Assignment and Generalised Cost

CONTENTS

LIST OF TABLES

LIST OF FIGURES

No table of figures entries found.

APPENDICES

Stantec Jacobs │ TN23 - Wellington Transport Analytical Tools 2019-22 update – Active Modes Assignment and Generalised Cost │ August 2022

Status: Final │ Project No.: 310203597 │ Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

1. Introduction

1.1 Project Overview

This technical note is part of a series documenting the 2019-2022 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 The Active Modes Module

The Active Modes Module described here is developed as part of the updated Wellington Transport Strategy Model (WTSM).

With an increased focus on sustainable transport, the importance of adequately representing active modes in strategic models is increasing.

On the other hand, a more detailed representation of active modes is best left to more specialised models. Here for instance, a dedicated cycle model for the Wellington Region is being developed independently and in parallel.

The purpose of the Active Modes Assignment and Cost Skim module within WTSM is therefore two-fold:

- Initially it is to determine the Generalised Cost (GC) for active modes that can be passed on to the choice model. This will be period agnostic.
- The Module is set up so that period-specific demands can be passed to the Active Modes Module in order to produce assigned volumes on the network.

Active modes are split into Walking and Cycling for the purpose of this module.

1.3 Purpose of this Report

This report describes the procedures within the Active Modes Module. Importantly, the Appendix includes a comprehensive list of variables, link attributes and output matrices.

2. Methodology

2.1 Overview

Active modes are split into walking and cycling here. Whilst a further split into running, scooter, ebike etc could potentially enable more detailed analysis, this simple distinction is considered adequate for the purpose of strategic modelling.

At a high level, the module consists of the following steps:

1. Copy source scenario into new Active Modes scenario
2. Set modes on links: The assignment uses mode 'a' for walking and also for cycling in separate assignments
3. Volume delay function (VDF) and Turn penalty function (TPF) set to zero for all links
   ➢ VDF and TPF not used during assignment
4. Calculate and set the fixed-cost, which is the non-time components of the GC, and real-time at link level for walking as well as for cycling
   ➢ Fixed-Cost on links used during assignment
5. Assign and skim Generalised Cost (GC), distance and real-time, first for walking and separately for cycling

2.2 Detailed

In this paragraph, the processing steps are described in greater detail:

Run only once per Emmebank:

August 2022 │ Status: Final │ Project No.: 310203597 │ Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 1

- Create dummy demand matrix to assign, and set to 1 for each origin-destination pair (this should be replaced by demand matrices when available)
- Create Volume Delay and Turn Penalty functions fd4 (VDF) = 0 and fp4 (TPF) = 0

Run for each scenario:
- Copy scenario into new Active Modes scenario and set as primary scenario
- This scenario will be used for both walking and cycling, as well as all time periods
- Flag minor approaches to give-way intersections (@minor_flag = 1) for approaches with at least one turn penalty function (tpf) with a value of 80. A turn penalty function of 80 is where minor arm capacities are calculated and this is therefore used to determine the minor arm.
- Create link attributes as listed in Appendix A
- Allow mode 'a' on all walk links, this will be used for assignment of active modes trips
- Add cycle facility flag = 1 to motorways at Petone and Ngauranga in order to enable cycling there
- Remove mode 'a' from motorway links (type 11) (with the exception of links with cycle facility flag = 1)
- Set link attributes as per Appendix A
- Assign and skim Generalised Cost (GC), distance and real-time, first for walking and separately for cycling

In an EMME vehicle assignment, the GC is specified as two components, the first being the time component (which is not fixed during assignment, but varies depending on traffic flows), and the second is the non-time components including distance and any other factors. The second component is referred to as "fixed cost" which varies by origin-destination pair.

The active mode assignment is set up differently as travel times for active modes do not depend on flows and hence do not vary throughout the model run for a given link.

So these fixed travel times go into the calculation and form a part of the Fixed-Cost link attributes. For the active modes assignment, these Fixed-Cost link attributes sum up to determine the Generalised Cost (GC) for a trip.

During the assignment, Fixed-Cost link attributes are used to determine paths. Fixed-Cost, Real-Time (actual time) and distance are skimmed during assignment, which are then processed to produce the generalised cost matrices input to the choice module. These attributes were calculated as follows.

Fixed cost for walking, wa_fcost (note that attributes for the cycle facility factor and cycle facility perception addend are used for walking too):

$$\left(\frac{length * 60}{walk\_speed\_kph} + @\text{wa\_delay} \right)$$

Where:

length	length of the link in km
walk_speed_kph	walking speed in kph (default = 5kph)
wa_delay	delay at intersections in minutes

The delay at intersections is simplistic and has a set value of 30 seconds for approaches to signals or roundabouts and 20 seconds for the minor approach at priorities. This is not the same delay as used within the road assignment.

Fixed cost for cycling, cy_fcost:

$$\left(\frac{length * 60}{cycle\_speed\_kph} + @\text{cy\_delay} \right) * @cy\_penalty * @cy\_slope\_factor * @cy\_fac\_factor + @cy\_fac\_addend$$

This is similar to the GC equation for walking, but additionally includes:

cycle_speed_kph	cycling speed in kph (default = 15kph)
@cy_delay	delay at intersections in minutes
@cy_slope_factor	to represent speeding up or slowing down due to the road gradient
@cy_penalty	penalty factor for using rural motorways
@cy_fac_factor	perception factor which defaults to one
@cy_fac_addend	additional perception factor which defaults to zero

August 2022 | Status: Final | Project No.: 310203597 | Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 2

@cy_fac_factor and @cy_fac_addend can be set in order to represent an environment that is more or less attractive to active modes. Only uphill gradients are considered in the slope factor.

The cycle delay at intersections (@*cy_delay*) is currently set to the same values as for walking (@*wa_delay*).

Real time for walking, wa_rtime (the time component of GC):

$$\frac{length * 60}{walk\_speed\_kph} + @\text{wa\_delay}$$

Real time for cycling, cy_rtime (the time component of GC):

$$\frac{length * 60}{cycle\_speed\_kph} + @\text{cy\_delay} * @cy\_slope\_factor$$

3.   Coding of the Existing Cycle Network

The cycle network coded into the model is a simplified version of what is in the Wellington Cycle Model Network tool. Cycle facility IDs, perception factors and additional links were included as appropriate, guided by the tool. The percentage factors by facility type are provided in the following table.

Table 3-1: Perception Factors by Facility Type

No.	Facility Type	Perception Factors
0	None	1
1	Off-road shared path	0.83
2	Off-road cycleway	0.74
3	Off-road trail	0.83
4	On-road unbuffered	0.87
5	On-road protected	0.8
6	Shared zone	0.8
7	Local area traffic	0.91
8	Bus Lanes	0.87

Note that these perception factors are, as per the dedicated Wellington Cycle Model, for a Medium Confident Cyclist on Local Roads.

August 2022 │ Status: Final │ Project No.: 310203597 │ Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 3

Appendices

Appendix A   Variables, Attributes and Output Matrices

A.1   Variables

Variable	Description	Default Value
mw_penalty_fac	Motorway penalty factor	3
walk_speed_kph	Walking speed in kph	4
cycle_speed_kph	Cycling speed in kph	15

A.2   Attributes

Link Attribute	Description	Value(s)
@cy_fac_flag	Cycle Facility Flag: removes cycle penalty on motorways and rural highways	1 if cycle facility present 0 otherwise
@cy_slope_factor	Cycle Slope Factor – factor applied to cycle times depending on slope. Only uphill slopes are considered.	1.0 $0.02 < @slope < 0.015$ 1.1 $0.015 < @slope < 0.03$ 1.2 $0.03 < @slope < 0.06$ 1.4 $0.06 < @slope$
@minor_flag	Flags links that are minor approaches to give-way intersections	1 if at least one j-node turn penalty function (tpf) = 80 0 otherwise
@wa_delay[min] @cy_delay[min]	Walk and Cycle Delay. Delay due to intersections. Currently no difference between walking and cycling	30s for approaches to signalised intersections and roundabouts 20s for minor approaches to give-way intersections
@cy_fac_factor	Cycle Facility Factor. Perception factor for cycle times, included in fcost, but not rtime. Also applied to walk trips	Default: 1
@cy_fac_addend	Cycle Facility Addend. Perception addend for cycle times, included in fcost, but not rtime. Also applied to walk trips.	Default: 0
@cy_penalty	penalty factor for cycling on rural highways and for motorways that allow cycling	mw_penaly_fac
@wa_fcost	Walking fixed cost	$\left(\dfrac{length * 60}{walk\_speed\_kph} + @wa\_delay\right)$
@cy_fcost	Cycling fixed cost	$\left(\dfrac{length * 60}{cycle\_speed\_kph} + @cy\_delay\right)$ $* @cy\_penalty * @cy\_slope\_factor$ $* @cy\_fac\_factor$ $+ @cy\_fac\_addend$

August 2022 │ Status: Final │ Project No.: 310203597 │ Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 5

Link Attribute	Description	Value(s)
@wa_rtime	Walking real time	$\dfrac{length*60}{walk\_speed\_kph} + @wa\_delay$
@cy_rtime	Cycling real time	$\dfrac{length*60}{cycle\_speed\_kph} + @cy\_delay$ $* @cy\_slope\_factor$
@wa_vol_am @wa_vol__ip @wa_vol__pm @wa_vol__on @wa_vol__dy	Walk volumes by period/daily	Result from assignment
@cy_vol_am @cy_vol__ip @cy_vol__pm @cy_vol__on @cy_vol__dy	Cycle volumes by period/daily	Result from assignment

A.3   Output Matrices

<mat_id> is the matrix-prefix specific to each scenario

<period> is for each of [am, ip, pm, on, daily]

Matrix Name	Description	
<mat_id>_<period>_wa_Time	Walk time skim	
<mat_id>_<period>_wa_GenCost	Walk generalised cost skim	
<mat_id>_<period>_wa_Dist	Walk distance skim	
<mat_id>_<period>_cy_Time	Cycle time skim	
<mat_id>_<period>_cy_GenCost	Cycle generalised cost skim	
<mat_id>_<period>_cy_Dist	Cycle distance skim	

August 2022 | Status: Final | Project No.: 310203597 | Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 6

Appendix B   Client Comment and Consultant Response

No.	Comment By	Comment	Response
1	Andrew Ford	I can't really provide too much feedback at this stage until it is implemented in the full model and we can sense check / validate the outputs. Generally, however, the approach appears reasonable for the purpose of passing GC for active modes onto the choice model	Noted.
2		It is probably documented elsewhere, but does the choice model split out trips into car / PT / walk / cycle, or car / PT / active with the walk / cycle split done in a sub-model? Clarification of this point would be useful in the active modes TN even if it will be more fully covered in the choice model TN	This will be documented with the mode choice model.
3		Walk speed of 4kph – is this a bit slow, given that delays at intersections are assumed at 30s and 20s respectively? Some simple 'sense' checks of key routes could be used to validate this assumption	Changed walk speed to 5kph
4		Cycle speed of 15kph seems broadly reasonable, but perhaps on slow side due to same reason outlined for walking? Again, something to sense check / validate at a high level, and perhaps have the ability to change this for forecasting to (maybe) reflect e-bikes?	Agreed to use 15kph initially. Can be changed easily.
5		With most cycle trips being round trips, is there an argument (even more so now with e-bikes) that slope factors might balance out and therefore the gradient may be less of a factor in perceived GC than is currently assumed?	Agreed to include factors for uphill slopes only, as they are more likely to influence behaviour.
6		A thematic map showing the slope factor would be useful to understand where this has been applied	The slope factors for have been simplified so this is not considered necessary.
7		As the TN notes, there will be more detailed cycle tools available and therefore the 80:20 rule is important when it comes to implementing the active mode module in WTSM	Agreed and noted.
8	Ian Clark in response to AF	This TN relates only to the active mode component within a multi modal regional model – so should not be as complex as would be required for a detailed active modes model.	Noted

August 2022 | Status: Final | Project No.: 310203597 | Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 7

No.	Comment By	Comment	Response
9	Ian Clark in response to AF	The precise parameters can be sense checked as the model is developed.	Noted
10	Ian Clark in response to AF	As an example, I understand from Michael Jongeneel (active modes specialist at Flow) that we generally use 5 kph as an average walk speed and 15 kph for cycling. So as Andy suggests, the walk speed currently proposed may be slightly slow	As above, changed walk speed to 5kph
11	Ian Clark	It is probably fine for the base model to consider only walking and cycling, but do we expect the future models to also consider scooters and e-bikes, as both of these have different speed and distance characteristics?	It will be possible to change future cycle speeds in order to emulate ebikes.
12	Ian Clark	Talking of distance, I don't think I have seen any discussion around the maximum length of walk and cycle trips. The maximum cycle trip length may not be much of an issue in the future due to the greater distance range enabled by e-bikes, but can we somehow check that we are not predicting lots of long distance walk trips. If we are not, due to the slow speed of walk trips, then we don't need to spend too much time around fixing a problem we don't have. But checks to make sure we don't have a problem would be useful.	This is addressed in the generalised costs calculations for walk and cycle which apply a cap of 10km for walk and 30km for cycle, to prevent longer trips.
13	Ian Clark	On a point of detail, a couple of cycle factors also are also applied to the walking fixed cost. So should these cycle factors be renamed, to avoid confusion? (ie it confused me for a minute, until I saw the explanation of certain cycle factors being also applied to walking)	Removed cycle factors from walk cost calculation.

August 2022 | Status: Final | Project No.: 310203597 | Our ref: TN23 - Wellington Analytical Tools 2019-21 Update - ACTIVE MODESv3.docx

Page 8