02

base year modelling (2010)

2.1 MODEL OVERVIEW

The Eurobodalla Shire TRACKS Model was developed by Cardno using the TRACKS software package. The aim was to produce a fully functioning land use/transport model that accurately models the present traffic conditions (2010) within the Northern Area of Eurobodalla Shire for both a morning peak (8AM – 9AM) and evening peak (4PM – 5PM) period in non peak season conditions. It is not intended to represent peak seasonal conditions when the residential population swells significantly.

The Eurobodalla Shire TRACKS Model is a strategic land use model that can be used to adequately simulate traffic conditions on the road network and is a tool for forecasting the effects of any changes to the road network and future land development that may occur. The model was developed as a standard three step model consisting of total vehicle trip generation (based on land use assumptions and trip generation rates), trip distribution and trip assignment.

Included in the model area are the townships of Bateman's Bay to the north and Moruya to the south and the areas in between, generally east of the Princes Highway. The model was built by including the road network as it exists and a zone system based on land uses. Extensive land use data was converted to trip productions and attractions and trip distribution was undertaken. Trip assignment was also carried out until convergence was achieved and equilibrium reached. The model was then robustly calibrated and validated whereby the outputs from the model emerged as being statistically solid representations of the existing situation.

This section discusses the technical development of the existing (2010) transport model for the northern region of the Eurobodalla Shire.

2.1.1 THE MODEL STUDY AREA

The study area represented in this strategic traffic model is located in the northern section of Eurobodalla Shire. The area is generally defined by the suburbs of Long Beach and Maloney's Beach to the North, Moruya to the south, the coastline to the east and the Princes Highway to the west. The study area is shown in Figure 1.1.

2.1.2 THE ROAD NETWORK

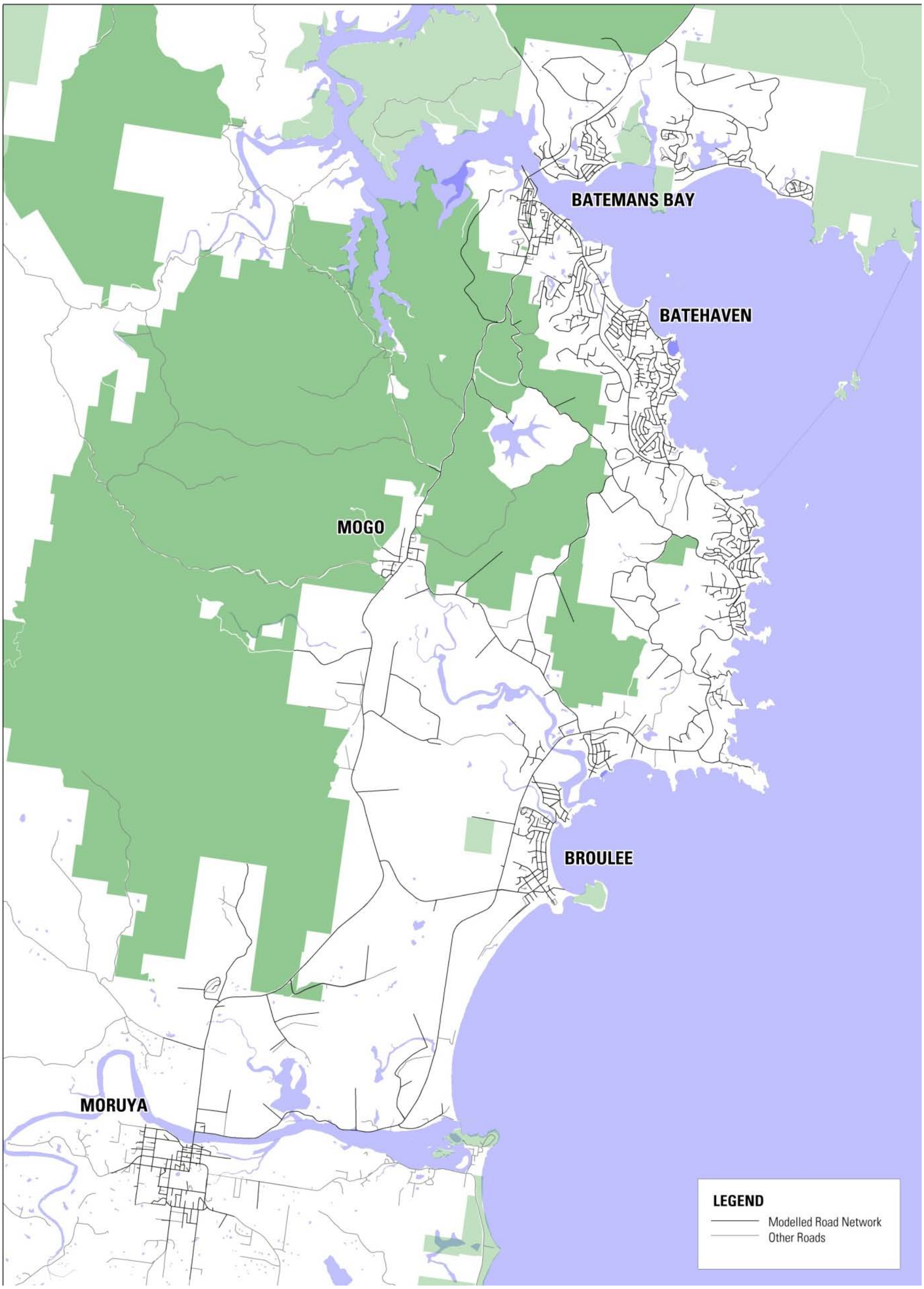
The road network used in the TRACKS model was based on Council's road centreline information which was provided in GIS format. The road centreline data was initially prepared in MapInfo to obtain a suitable form to import into the TRACKS software package. The final modelled network includes a total of 3114 links, 1353 nodes and 305 zone centroid connectors. The modelled road network is shown in Figure 2.1.

The carriageway characteristics were assigned to each link in MapInfo before importing into the TRACKS software, including the link type and link lanes.

Zone centroid connectors were coded in the TRACKS software to correspond to the developed zone system. Intersections were also coded in the TRACKS software. Signals, roundabouts and priority controlled intersections along the main strategic routes (Princes Highway, George Bass Drive and Beach Road), as well as those surveyed for assessment, were coded as per the observations made during site visits. All conflicting movements for intersections not located on the strategic routes were automatically defined in the software package based on the geometry.

It is noted that the morning peak and evening peak models have the same traffic zone system and road network.

Figure 2.1 Study Road Network



2.1.3 THE ZONE SYSTEM

The study area was divided into sub-areas to form a zone system for model development. The model consists of 305 zones, including six (6) external zones, 231 internal zones and 68 spare zones for future model development.

The zone system adopted for the model was based on the 51 collector district (CD) boundaries covering the study area. This allowed for more accuracy in data collection and assignment of land uses to specific zones. The CD boundaries were disaggregated to zone level (231 zones) using weights that were based on visual inspection of building distributions within the CD, zoning plans from the Draft LEP and site inspection of the study area.

The internal model zone boundaries are shown in Figure 2.2. A larger scale map is provided in Appendix 2-A, which identifies the zone numbering.

2.1.4 TRIP GENERATION

The trip generation process involved converting the land use data to trip productions and trip attractions. Trip generation was calculated for each traffic zone by journey purpose. The journey purposes and their associated generation rates were determined by those used in the 2001 WOLSH (Wollongong and Shellharbour) Transportation model. It should be noted that the model calculates vehicle trips rather than person trips; hence mode choice is not included in this model. This assumption was considered satisfactory due to the low level of public transport usage in the study area. This assumption was subsequently endorsed by Eurobodalla Shire Council.

2.1.5 TRIP DISTRIBUTION

Trip distribution was undertaken through a doubly constrained GRAVITY module implemented in the TRACKS software package. The productions and attractions for each journey purpose were input to the gravity model, which produced matrices of travel demand for each trip purpose based on travel time and distance.

2.1.6 TRIP ASSIGNMENT

Trip assignment was undertaken through the ASSIGN module implemented in the TRACKS software package. The module follows a capacity constrained iterative process in which the interzonal travel times and distances are calculated and inserted back into the Gravity model. The Gravity model then recalculated travel demand matrices for assignment and the loop continued until the model converged and reached equilibrium. The model convergence is based on vehicle hours and vehicle kilometres of travel for the modelled traffic flows.

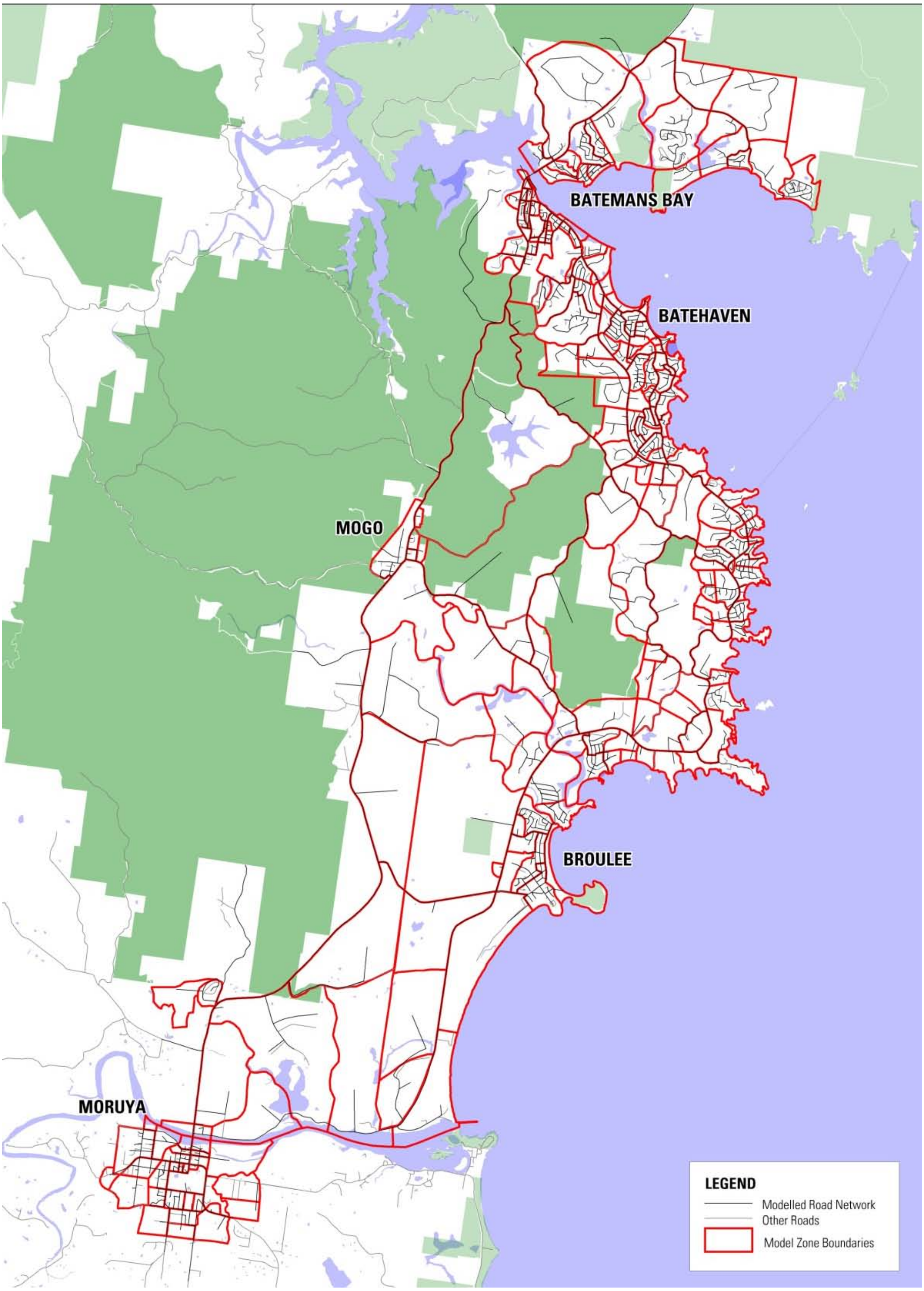
2.1.7 PARKING MODEL

A parking model was built into the transport model allowing the assessment of parking facilities in the Batemans Bay and Moruya town centre areas. The model was developed for the MORNING peak and EVENING peak periods using the CALM and CENTRL modules in the TRACKS software package. The parking model mainly focused on the CBD area of Batemans Bay. Parking survey results were also provided by Council and included the following information:

- On street/off street breakdown.
- Paid/free and time limits.
- Spaces available for the above.

The parking model uses information from the main trip distribution model and allocates vehicle trips to parking zones (as opposed to the larger traffic zones), starting at the closest parking zone to the final destination.

Figure 2.2 Study Zone Boundaries



2.1.8 EXTERNAL TRIPS

The external trips consist of both through movements through the study area (external to external trips) and trips that have one end outside the model area (external to internal and internal to external trips). The through trips were determined by engaging a traffic survey consultant to undertake a number plate (cordon) survey at the extremities of the model network and at key screenline locations. Coupled with full traffic counts at these locations, the number of external trips (external to external, external to internal or internal to external) was derived. These trips were then added to the trip distribution process and distributed to either origins or destinations within the study area.

2.2 LAND USE DATA

2.2.1 2010 LAND USE

The following land use variables were used in developing the Eurobodalla Shire TRACKS Model:

- Vehicles per household.
- Employees per household.
- Households.
- TAFE and University enrolments.
- School enrolments.
- Community Jobs.
- Retail Jobs.
- Finance Jobs.
- Manufacturing Jobs.
- Total Jobs.
- CBD car parking in centres within the model area – namely Batemans Bay and Moruya.

The method used to extract the quantities associated with each of the above variables is discussed in the following sections.

It should be noted that more detailed discussion on the land use assumptions is provided in the Section 1.3. The discussions in this report are a summary of key aspects.

2.2.2 POPULATION BASED VARIABLES

The 2006 Census of Population and Housing provides a detailed description of land use variables at the collection district (CD) level. From this source the number of vehicles, employees and dwellings were extracted for 2006 and adjusted to reflect 2010 conditions:

- Population increase and household size decrease.
- The change in vehicle ownership rates in NSW between 2006 and 2010.
- Changes in workforce participation between 2006 and 2010 for the Illawarra and South Coast regions.

The dwelling estimates are for occupied private dwellings as at census collection time which coincides with non-peak season. There are additional people that were in occupied non-private dwellings on census, such as hotels, who would have generated some activity and travel demand, and an adjustment was made to include a measure of this in the land use.

This information was then disaggregated to zone level (there are 231 traffic zones based on the 51 CDs in the area) using weights that were based on visual inspection of building distributions within the CD, zoning plans form the Draft LEP and site inspection of the study area. Characteristics of households, such as employees per household and vehicles per household were applied uniformly across all zones within a CD.

Using rates of population growth between 2006 and 2010, at the suburb level, the number of 2006 dwellings was scaled to 2010.

A further adjustment, based on the projected decline in household size was then applied to this estimate to derive dwellings in 2010 by zone.

The rate of vehicles per household in 2006 was applied in 2010 with an adjustment applied to account for the increase in the rate of car ownership in NSW over this period.

Employees per household in 2010 were based on employed persons per household in 2006, with an adjustment applied for the increase in workforce participation rate over this period from 57.7% to 59.0%.

2.2.3 ACTIVITY BASED VARIABLES

Education

TAFE and University enrolments were provided by Eurobodalla Shire Council. These were not adjusted further.

School enrolments were provided for government schools by Eurobodalla Shire Council. Private school enrolments were taken from the My School website. These were either 2009 or 2010 values and were not further adjusted. The zone in which each of the schools is situated was identified from the school's address and maps.

Employment

Jobs were estimated based on their general location and through data provided by Council:

- **Commercial centres** (Batemans Bay and Moruya) – Eurobodalla Shire Council provided land use matrices for these two centres, which identified floor space by general use by town road block. Employment was estimated by applying employment density rates to this floor space. The retail employee density applied at Moruya was lower than that at Batemans Bay.
- **Neighbourhood centres** – from planning documents the floor space and use at these centres was compiled and an employment density applied to estimate employment. These centres were allocated to zones based on maps provided to us by Eurobodalla Shire Council (ESC).
- **Industrial lands** – Batemans Bay (Cranbrook Road and east of the Princes Highway), Batehaven, Moruya North, Moruya South West and Moruya East: the area of land by use was estimated from the available data and employment densities were applied. Due to the variable nature of this type of land use category, as well as the overlap with retail uses, this process provides broad level estimates only.
- **Special centres** – Mogo Zoo, Batemans Bay and Moruya Hospitals, Moruya Airport, Racecourse/Speedway and Council Offices: the employment at each of these was estimated based on the characteristics of the site and Census data.
- **Dispersed employment** – this is small scale employment located through the study area, including home businesses and home-based business, trades and similar. This is assumed to be distributed through the zones, with the level of employment in each zones randomly distributed – some zones had no dispersed employment, others had up to 12 jobs.

- **Nursing home employment** – an estimate of employees working at nursing homes within Eurobodalla Shire is available from the Census as is an estimate of persons living in nursing homes. This information was used to estimate the number of employees per nursing home resident. This number of nursing home residents in each CD was used to:
  - Identify the locations of nursing homes, with cross checking to maps, and allocation to zones.
  - Estimate the number of nursing home employees in the relevant zones.
- Education employment was estimated in a similar manner by identifying the number of school employees within the Shire and comparing this with the number of students, to provide a rate of employees per student. From the enrolment data, estimates of school employment were allocated to the relevant zones.
- For TAFE and University an estimate was made based on observations of the operation of another UOW satellite campus.

Where practical our estimates were compared with Census estimates by industry for jobs within Eurobodalla Shire to ensure they were broadly within control 'totals'.

Employment totals were adjusted from 2006 to 2010 using simple factors, 2% for all categories except for:

- Nursing homes – 4%.
- Education employment – no growth as they are contemporary estimates.

Parking

Car parking numbers were provided by Eurobodalla Shire Council.

2.2.4 LAND USE SUMMARY

A summary of the 2010 land use variables and their associated quantities are shown in Table 2.1.

Table 2.1 Summary of 2010 Land Use Variables

Land Use Variable	Study Area Total
Employees per Household	0.975
Vehicles per Household	1.604
Households	9009
TAFE and University Enrolments	450
School Enrolments	4468
Community Jobs	2127
Retail Jobs	2794
Finance Jobs	1839
Manufacturing Jobs	533
Total Jobs	8203
CBD Car Parking	3303

2.3 TRIP END GENERATION

2.3.1 PRIVATE TRIP END PRODUCTIONS

A category model approach to trip generation has been adopted for the Eurobodalla Shire TRACKS Model. Since a household travel survey does not exist for the Eurobodalla region, the parameters of the category model have been adopted from the 2001 WOLSH traffic model.

Morning Peak Private Trip End Productions

Private car trips were produced using the category model for trip end generation for the morning peak two hours (7am to 9am). These were disaggregated into 1-hour for the peak periods in the model. A summary of the morning peak trip rates used in the model for trips 'from home' and 'to home' are provided in Table 2.2 and Table 2.3 respectively, where the terms used are defined as:

- Emp/HH = Employees per Household.
- Car/HH = Cars per Household.
- HBW = Home Based Work.
- HBB = Home Based Business.
- HBO = Home Based Other.
- NHB = Non-home Based.
- WBH = Work Based Home.
- BBH = Business Based Home.
- OBH = Other Based Home.

Table 2.2 Morning Peak Trip Rates – From Home

Category	Emp/HH	Car/HH	Trip Purpose – From Home			
			HBW	HBB	HBO	NHB
1	0	0	0.000	0.000	0.000	0.000
2		1	0.010	0.070	0.010	0.006
3		2+	0.048	0.123	0.046	0.054
4	1	0	0.000	0.000	0.000	0.140
5		1	0.335	0.056	0.072	0.204
6		2+	0.429	0.190	0.145	0.344
7	2+	0	0.000	0.000	0.000	0.150
8		1	0.424	0.080	0.140	0.352
9		2+	0.493	0.310	0.130	0.414

Table 2.3 Morning Peak Trip Rates – To Home

Category	Emp/HH	Car/HH	Trip Purpose – To Home		
			WBH	BBH	OBH
1	0	0	0.000	0.000	0.000
2		1	0.000	0.054	0.024
3		2+	0.000	0.056	0.033
4	1	0	0.000	0.000	0.000
5		1	0.032	0.018	0.007
6		2+	0.038	0.038	0.085
7	2+	0	0.000	0.000	0.000
8		1	0.078	0.110	0.000
9		2+	0.024	0.100	0.055

Each traffic zone has been assigned vehicles per household and persons per household data based on the ABS Census. The proportion of households in each category is determined through probability curves established for other TRACKS models in the Illawarra and south coast regions.

Evening Peak Private Trip End Productions

Similar to the morning peak period, the evening peak period trip end generation was undertaken for the two hours 3pm to 5pm and disaggregated into 1-hour for the peak periods in the model. A summary of the evening peak trip rates used in the model for trips 'from home' and 'to home' are provided in Table 2.4 and Table 2.5 respectively.

Table 2.4 Evening Peak Trip Rates – From Home

Category	Emp/HH	Car/HH	Trip Purpose – From Home			
			HBW	HBB	HBO	NHB-S
1	0	0	0.000	0.000	0.000	0.000
2		1	0.000	0.041	0.078	0.130
3		2+	0.000	0.077	0.100	0.000
4	1	0	0.000	0.000	0.000	0.000
5		1	0.043	0.066	0.094	0.246
6		2+	0.034	0.137	0.106	0.484
7	2+	0	0.000	0.000	0.000	0.000
8		1	0.000	0.049	0.149	0.502
9		2+	0.000	0.167	0.246	0.712

Table 2.5 Evening Peak Trip Rates – To Home

Category	Emp/HH	Car/HH	Trip Purpose – To Home		
			WBH	BBH	OBH
1	0	0	0.000	0.000	0.000
2		1	0.012	0.066	0.143
3		2+	0.046	0.130	0.222
4	1	0	0.000	0.000	0.000
5		1	0.128	0.206	0.160
6		2+	0.233	0.293	0.328
7	2+	0	0.000	0.000	0.000
8		1	0.355	0.127	0.374
9		2+	0.265	0.403	0.408

Total Trips

When the established morning and evening peak trip generation rates were applied to the demographic data for the Eurobodalla study area a total of 7,692 trips were generated in the morning peak and 7,332 trips generated in the evening peak. The private vehicle generation is summarised in Table 2.6.

Table 2.6 Private Vehicle Trip Generation

Trip Type*	Total Morning Trips (1 hour)	% Morning Trips	Total Evening Trips (1 hour)	% Evening Trips
Internal				
Private	5261	68.40%	4740	64.65%
LGV	710	9.23%	790	10.77%
HGV	194	2.52%	217	2.96%
Total Internal	6165	80.15%	5747	78.38%
External Trips				
Through	160	2.08%	193	2.63%
IE/EI	1367	17.77%	1392	18.99%
Total External	1527	19.85%	1585	21.62%
Total Trips	7692	100.00%	7332	100.00%

* LGV = Light Goods Vehicle, HGV = Heavy Goods Vehicle, IE = Internal to External, EI = External to Internal

2.3.2 PRIVATE TRIP END ATTRACTIONS

In order to determine the number of trips attracted to each traffic zone (the corresponding destination of the trips generated in the section above) coefficients are applied to key demographic variables for each trip purpose. These coefficients are based primarily on those derived for the 2001 WOLSH traffic model, with some minor fine tuning during the calibration process to suit the Eurobodalla region.

The trip attraction equations used in the morning peak are as follows:

- HBW = 0.251RET + 0.13TOT.
- HBB = 0.036HH + 0.184RET + 0.184FIN + 0.012TOT.
- HBO = 0.011HH + 0.025TER + 0.025SCH +0.043COMM.
- NHB = 0.072HH + 0.368SCH + 0.368RET + 0.024TOT.

The trip attraction equations used in the evening peak are as follows:

- HBW = 0.251RET + 0.170TOT.
- HBB = 0.036HH + 0.184RET + 0.032TOT.
- HBO = 1.52HH + 2.92COMM + 0.68RET + 0.61TOT.
- NHB = 1.48HH + 2.62COMM + 9.336RET.

Where:

- HH = Households.
- RET = Retail Employment.
- FIN = Finance Employment.
- COMM = Community Employment.
- TOT = Total Employment.
- TER = Tertiary Enrolments.
- SCH = School Enrolments.

For home based trips, the total attractions are scaled to total productions, so that total productions equals total attractions. Similarly non-home based trip attractions are also scaled to productions.

2.3.3 GOODS VEHICLE TRIPS

The following equations were used to determine the trip end generation for goods vehicles.

- Morning Peak:
  - LGV = 0.057HH + 0.431FIN.
  - HGV = 0.012HH + 0.016COMM + 0.063RET + 0.071TOT.
- Evening Peak:
  - LGV = 0.070HH + 0.528FIN.
  - HGV = 0.015HH + 0.019COMM + 0.078RET + 0.088TOT.

These equations are based on similar equations from the 2001 WOLSH traffic model.

2.3.4 EXTERNAL TRIPS

External traffic can be categorized as either through trips (trips that have both origin and destination outside the study area, i.e. external to external trips), internal to external trips (where the origin is within the study area) or external to internal trips (where the destination is within the study area. An origin-destination (OD) survey was undertaken with stations on each road at the study area boundary. This survey primarily informed the external vehicle component of the model.

Through Trips

Through trips were derived directly from number plate matching of the OD survey and are summarized in Table 2.7 and Table 2.8 for the morning peak and evening peak, respectively.

Table 2.7 Morning Peak External Through Trips

Zone	Description	Inbound Trips		Outbound Trips	
		Traffic Count	Through Trips	Traffic Count	Through Trips
300	Princes Highway – North of Batemans Bay	191	59	152	20
301	King's Highway	113	19	101	33
302	Princes Highway – South of Moruya	460	26	225	54
303	Francis Street	50*	12	20*	10
304	Dwyers Creek Road	65*	19	30*	7
305	South Head Road	226	25	58	36
All External Zones		1105	160	586	160

*based on Average Daily Traffic (ADT) data

Table 2.8 Evening Peak External Through Trips

Zone	Description	Inbound Trips		Outbound Trips	
		Traffic Count	Through Trips	Traffic Count	Through Trips
300	Princes Highway – North of Batemans Bay	182	40	238	74
301	King's Highway	131	48	131	26
302	Princes Highway – South of Moruya	272	52	374	46
303	Francis Street	20*	14	50*	8
304	Dwyers Creek Road	30*	17	65*	11
305	South Head Road	58	22	228	28
All External Zones		693	193	1086	193

*based on ADT data

Internal to External and External to Internal Trips

Internal to external and external to internal trips are controlled to totals observed in the OD survey. For the internal to external purpose the trip attractions (i.e. those trips departing the study area) are the control and for the external to internal purpose the trip productions (i.e. those trips entering the study area) are the control.

The equation for internal to external attractions and external to internal productions is as follows:

- IntExt = 1 x Text – 1 x Thru.

Where:

- IntExt = the number of internal to external (or external to internal) trips.
- Text = the total trips departing/entering the study area.
- Thru = through trips departing/entering the study area.

Therefore, for each external traffic zone the quantum of internal to external trips departing the study area is given as the total trips departing the study area minus the through traffic component. Similarly for the external to internal purpose the number of trips entering the study area with a destination in the study area is given by the total trips entering at the external point minus the through traffic component.

The total trips entering and departing the study area and the through traffic component passing through the study area at each external traffic zone is defined in the demographic input file and outlined in Table 2.9 and Table 2.10.

Table 2.9 Morning Peak Internal/External Trips

Zone	External Inbound Trips	External to Internal Trips	External Outbound Trips	Internal to External Trips
300	191	132	152	132
301	113	94	101	78
302	460	434	225	171
303	50	38	20	10
304	65	46	30	23
305	226	201	58	22

Table 2.10 Evening Peak Internal/External Trips

Zone	External Inbound Trips	External to Internal Trips	External Outbound Trips	Internal to External Trips
300	182	142	238	164
301	131	83	131	105
302	272	220	374	328
303	20	6	50	42
304	30	13	65	54
305	58	26	228	200

For internal to external trips, the trip production equation is as follows:

- Morning Peak:
  - ExtP = 0.036HH + 0.184RET +0.032TOT.
- Evening Peak:
  - ExtP = 0.07TER + 0.251RET + 0.17TOT.

For external to internal trips the trip attraction equation is as follows:

- Morning Peak:
  - ExtA = 0.07TER + 0.251RET + 0.17TOT.
- Evening Peak:
  - ExtA = 0.036HH + 0.184RET + 0.032TOT.

Where:

- ExtP = the number of internal to external trips (trip productions).
- ExtA = the number of external to internal trips (trip attractions).

2.4 TRIP DISTRIBUTION

With each traffic zone now having a certain number of trips generated from it (productions) and attracted to it (attractions), the next step in the strategic modelling process was to determine how many trips travel from each traffic zone to every other traffic zone. This process is known as trip distribution.

The trip distribution is based on a doubly constrained gravity model, which broadly states that the number of trips going from zone i to zone j (Tij) is proportional to activity at zone j and inversely proportional to the cost of travel between i and j.

The gravity model formulation has been adopted from the 2001 WOLSH traffic model. This distribution is based on the time taken to travel between two zones. The distribution function values are shown in Table 2.11 for each trip purpose.

Table 2.11 Distribution Function Values

Trips Purpose	Morning Peak	Evening Peak
Home Based Work (HBW)	0.200	0.200
Home Based Business (HBB)	0.200	0.200
Home Based Other (HBO)	0.200	0.200
Non Home Based Long (NHB-L)	0.200	0.245
Light Goods Vehicles (LGV)	0.220	0.220
Heavy Goods Vehicles (HGV)	0.220	0.220
External Inbound	2.500	1.800
External Outbound	1.600	1.600

2.4.1 CALM PARKING MODEL

The purpose of the CALM parking model is to more realistically represent the pattern of travel in CBD and town centre environments where the destination of trips is generally parking facilities and not necessarily the final destination of the trip (i.e. people will park in a parking facility and walk to their destination). The CALM model takes the purpose matrices determined in the trips distribution model described above and undertakes a further distribution of those trips destined for CBD zones.

The CALM model parameters have been adopted directly from the 2001 WOLSH traffic model, with only the inventory of parking supply developed specifically for Batemans Bay and Moruya town centres. The parking inventory is given in Table 2.12.

Table 2.12 Eurobodalla Town Centres Parking Inventory

Zone	Location	On-street Parking Inventory			Off-street Parking Inventory			
		Unrestricted	One Hour	Two Hour	Unrestricted	Two Hour	Three Hour	Pay
1	Batemans Bay Town Centre			35			91	
2	Batemans Bay Town Centre			10				30
3	Batemans Bay Town Centre			35	66			92
4	Batemans Bay Town Centre				187		646	
5	Batemans Bay Town Centre				16			
6	Batemans Bay Town Centre				249			
7	Batemans Bay Town Centre	160			135			
8	Batemans Bay Town Centre	40			24			
9	Moruya Town Centre	50			274			
10	Moruya Town Centre	140			16	15		
11	Moruya Town Centre				32			
12	Batemans Bay Town Centre				54			
13	Moruya Town Centre				36			
14	Moruya Town Centre				40			
15	Moruya Town Centre	20			50			
16	Batemans Bay Town Centre				120			
17	Moruya Town Centre	30			20			
18	Batemans Bay Town Centre	40	20		200			
19	Moruya Town Centre	30	15		20	41		
20	Moruya Town Centre				24			
21	Batemans Bay Town Centre	40			100			
22	Batemans Bay Town Centre	30						
23	Moruya Town Centre	30						
Total		610	35	80	1663	56	637	122

It should be noted that the above parking inventory was used in the modelling process to model traffic movement in these business districts. The figures do not represent all the parking available within the CBD areas of Batemans Bay and Moruya.

2.5 TRIP ASSIGNMENT

The trip assignment technique undertaken for the Eurobodalla Shire TRACKS Model is an incremental time dependant assignment, as implemented in the 2001 WOLSH traffic model. The assignment process runs through multiple iterations, loading a proportion of the matrix onto the network in each of the iterations. The loading profile for the morning peak and evening peak assignments is given in Table 2.13 and Table 2.14 respectively.

Table 2.13 Morning Peak Loading Profile

Assignment Increment	% Trip Matrix Loaded	Load Profile % of Hourly Flow	Steady State Time Period (Minutes)	Perceived Assignment Cost
1	9.39			
2	9.39			
3	9.39			
4	9.39			
5	9.39			
6	9.39			
7	9.39	65	15	36.73c/min 19.00c/km
8	5.60			
9	5.60			
10	5.60			
11	5.60	88	30	
12	3.94	92	45	
13	7.93	100	60	

Table 2.14 Evening Peak Loading Profile

Assignment Increment	% Trip Matrix Loaded	Load Profile % of Hourly Flow	Steady State Time Period (Minutes)	Perceived Assignment Cost
1	8.70			
2	8.70			
3	8.70			
4	8.70			
5	8.70			
6	8.70			36.73c/min 19.00c/km
7	8.70			
8	8.70			
9	8.70			
10	8.70	87	15	
11	4.9	92	30	
12	5.55	97	45	
13	2.53	100	60	

2.5.1 NETWORK LINKS

The travel time between each traffic zone pair is determined primarily by link times (the time taken to traverse a link) and intersection delays. Each link in the network is allocated a link type which defines the characteristics of the link and refers to a volume-delay curve which determines how travel time increases when volumes increase (i.e. congestion).

Table 2.15 shows the various link types used in coding the model and their corresponding characteristics.

Table 2.15 Link Type Descriptions

	Link Types / Equivalent Free Flow Speeds									
Link Type	1	2	3	4	5	6	7	8	9	10
Free Flow Speed (Km/Hr)	10	20	30	40	50	60	70	80	90	100

2.5.2 NETWORK INTERSECTIONS

Since travel times can be made up of both time on links and time delays at intersections, the TRACKS modelling software allows for the coding of intersection controls which then influence delays experienced at intersections. Each approach to every intersection in the network is coded as one of the following:

- Type 0 – Not controlled, has priority.
- Type 1 – No controls marked non priority (minor leg).
- Type 2 – Merge.
- Type 3 – roundabout.
- Type 4 – Give Way.
- Type 5 – Stop.
- Types 6 to 9 – Signals.

Additionally for each signalised intersection, the intersection form and signal phasing has been coded in SIDRA 2.1 and tied to the corresponding intersection in TRACKS. The assignment module then draws on this data for determining delays at signalised intersections.

2.6 MODEL CONVERGENCE

An important aspect of determining the stability of a traffic model is confirming model convergence. Since time and distance matrices are required as input to the trip distribution model and the final assignment of a demand matrix to the network generates new time and distance matrices, it is possible to compare the two in order to determine if the model has converged or reached an equilibrium state.

The model is run a number of times (or iterations) and the time and distance matrices generated by the assignment are subsequently used as input to the next iteration. Table 2.16 shows the Total Vehicle Minutes and Total Vehicle Kilometres for both the morning peak and evening peak periods.

Table 2.16 Total Vehicle Minutes Travelled (VKT) / Total Vehicle Kilometres Travelled (VKT)

	Morning VKT	Morning VMT	Evening VKT	Evening VMT
Previous Run	56,823	58,017	53,722	56,565
Final Run	56,807	58,006	53,815	56,655
Difference	16	11	93	90
% Difference	0.0003%	0.0002%	0.002%	0.002%

The percentage difference between the final run of the model and the previous run of the model should be less than 1%. Since less than 1% difference or both VMT and VKT was achieved for both the morning peak and evening peak models, the model can be said to be in convergence hence indicating stability.

2.7 MODEL VALIDATION

In order for any transport model to be regarded as useful, it first needs to be validated against existing conditions for the area being modelled. Given that the purpose of a base year transport model, for existing conditions is to provide a good representation of those conditions, a set of validation criteria have been used to determine the extent to which the model provides a goodness of fit.

A widely used and effective measure for determining whether a model is validated is to carry out measurements along screenlines; this is called Network Screenline Validation.

Once it was established that the validation was robust, independent verification was also achieved using the travel time data for vehicles travelling between Clyde River Bridge in the north and Moruya River Bridge in the south in both directions.

2.7.1 NETWORK SCREENLINE VALIDATION

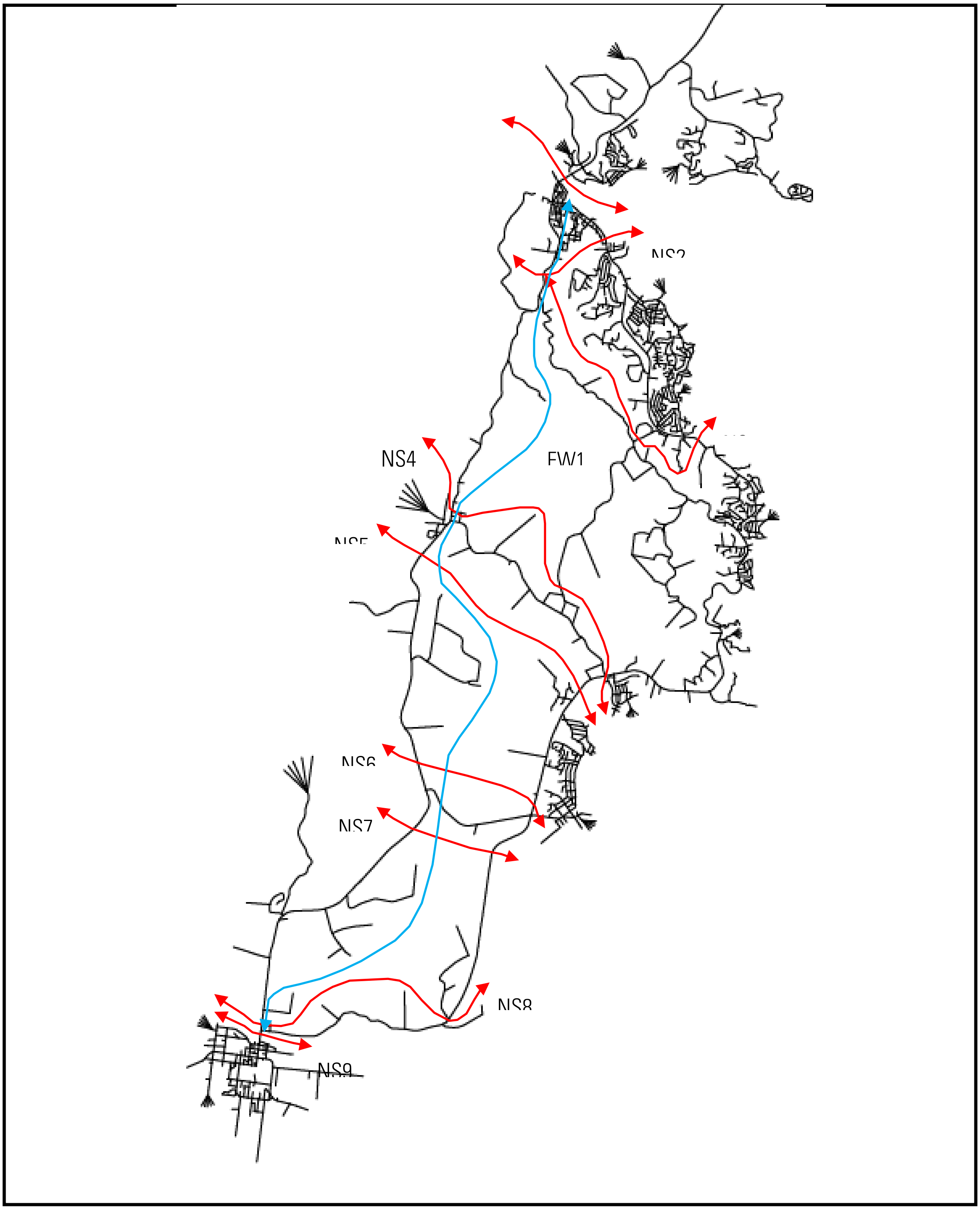
This validation process is carried out using the GEH statistic, which was specifically developed for use in validation of traffic and transport models. This GEH value, which is a type of Chi Squared statistic, is widely used in the UK and Australia during the validation process.

- In reality, traffic volumes vary from day to day and from location to location. The GEH statistic was developed to cope with these types of different ranges in flows. Instead of comparing absolute or relative flow differences therefore; a wide range of flows can confidently be deemed as being statistically accurate using the GEH formula. For example, where an absolute difference of 100 vehicles/hr can be important in a flow of 200 vehicles/hr, it is largely irrelevant in a flow of several thousand vehicles/hr.

For the validation in this TRACKS modelling, several screenlines were drawn in a way which collected the significant traffic patterns and volumes through the model area and compared them against the recorded ‘actual’ flows. The screenlines collected this information for north-south, south-north, east-west and west-east movements on the screenlines and compared to ascertain the goodness of fit, or realism, of the model.

The screenlines prepared for the model validation are as illustrated in Figure 2.3. The traffic count data was obtained through traffic surveys and tube counts.

Figure 2.3 Model Validation Screenlines



As mentioned earlier, the GEH statistic was used as one of the main determinants for degree of fit for the model. Additional measures which were compared were:

- Measurements of links and turns.
- Measurements of total trips over each screenline.
- Percentage differences.
- GEHs.
- Correlation Coefficient.
- Travel Times.

The GEH formula is shown following:

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where: M = Assigned (or modelled) hourly traffic flow (vehicles/hour)

C = Observed traffic flow (vehicles/hour) or real-world hourly traffic count

A GEH of less than 5 is deemed as being a good fit to existing conditions.

2.7.2 SCREENLINE VALIDATION RESULTS

The total actual flow volumes across the screenline based on counts and the total modelled volumes across the screenline for the 10 screenlines are summarised in Table 2.17.

Table 2.17 Full Screenline Validation Results

	AM		PM	
	Northbound	**Southbound**	**Northbound**	**Southbound**
Screenline 1 – NS1				
Traffic Count	471	779	704	555
Modelled Volume	481	793	921	517
Difference	-10	-14	-217	38
% Difference	-2%	-2%	-31%	7%
GEH	0.5	0.5	7.6	1.6
Correlation Coefficient	-	-	-	-
Screenline 2 – NS2				
Traffic Count	1370	635	764	1081
Modelled Volume	1163	586	579	1075
Difference	207	49	185	6
% Difference	15%	8%	24%	1%
GEH	5.8	2.0	7.1	0.2
Correlation Coefficient	1.000	1.000	1.000	1.000
Screenline 3 – NS3				
Traffic Count	793	520	483	725
Modelled Volume	684	534	448	652

	AM		PM	
	Northbound	**Southbound**	**Northbound**	**Southbound**
Difference	109	-14	35	73
% Difference	14%	-3%	7%	10%
GEH	4.0	0.6	1.6	2.8
Correlation Coefficient	0.941	0.998	0.980	0.992
Screenline 4 – NS4				
Traffic Count	628	605	623	487
Modelled Volume	626	724	561	598
Difference	2	-119	62	-111
% Difference	0%	-20%	10%	-23%
GEH	0.1	4.6	2.5	4.8
Correlation Coefficient	0.991	0.962	0.683	0.973
Screenline 5 – NS5				
Traffic Count	547	540	395	450
Modelled Volume	540	650	160	490
Difference	7	-110	-65	-40
% Difference	1%	-20%	-16%	-9%
GEH	0.3	4.5	3.1	1.8
Correlation Coefficient	1.000	1.000	1.000	1.000
Screenline 6 – NS6				
Traffic Count	437	506	449	394
Modelled Volume	500	698	530	469
Difference	-63	-192	-81	-75
% Difference	-14%	-38%	-18%	-19%
GEH	2.9	7.8	3.7	3.6
Correlation Coefficient	0.999	0.841	0.137	0.906
Screenline 7 – NS7				
Traffic Count	392	470	453	343
Modelled Volume	474	673	497	436
Difference	-82	-203	-44	-93
% Difference	-21%	-43%	-10%	-27%
GEH	3.9	8.5	2.0	4.7
Correlation Coefficient	1.000	1.000	1.000	1.000
Screenline 8 – NS8				
Traffic Count	431	569	532	362
Modelled Volume	546	651	499	476
Difference	-115	-82	33	-114
% Difference	-27%	-14%	6%	-31%

	AM		PM	
	Northbound	Southbound	Northbound	Southbound
GEH	5.2	3.3	1.5	5.6
Correlation Coefficient	1.000	1.000	1.000	1.000
Screenline 9 – NS9				
Traffic Count	415	553	515	345
Modelled Volume	552	651	501	479
Difference	-137	-98	14	-134
% Difference	-33%	-18%	3%	-39%
GEH	6.2	4.0	0.6	6.6
Correlation Coefficient	-	-	-	-
Screenline 10 – EW1				
Traffic Count	755	1542	1404	1035
Modelled Volume	621	1361	1273	852
Difference	134	181	131	183
% Difference	18%	12%	9%	18%
GEH	5.1	4.8	3.6	6.0
Correlation Coefficient	0.951	0.978	0.967	1.000

The results show a model which is robustly validated in the AM and PM, based on GEH values and volumes over screenlines; the GEH results for the modelling exceed the standards with 70% of the AM peak screenline volumes achieving a GEH <5 and 75% of the PM peak screenline volumes achieving a GEH of <5. It can also be noted that the correlation coefficient is greater than 0.9 for all screenlines in the AM peak and most of the screenlines for the PM peak. This is well above standard requirements and combined with all the other validation criteria, is robust.

A summary of the validation results is shown in Table 2.18.

Table 2.18 Summary Validation Results

Model Peak	GEH < 5	GEH < 10	GEH > 10
Morning	70%	100%	0%
Evening	75%	100%	0%

These results indicate that the model is s good representation of the observed flows.

2.7.3 VALIDATION VERIFICATION WITH INDEPENDENT DATA

The validation verification process was carried out by comparing the average travel times between two of the most northern and southern locations in the model:

- Clyde River Bridge in the north.
- Moruya River Bridge in the south.

There are two main routes for vehicles travelling between these locations, one via George Bass Drive, the other via Princes Highway.

The observed travel times were provided using the travel time information carried out with the OD survey and compared against the averaged model travel times between Clyde River Bridge and Moruya River Bridge; these averages took into account weightings associated with using George Bass Drive and also Princes Highway. It was determined that 70% of trips between both bridges would be on Princes Highway with the remaining 30% using George Bass Drive, given that it is a slower route

The criteria used to determine whether the validation verification was ascertained, was that the average travel times in both directions had to be within:

- Either 1 minute or 15%, whichever is higher, of the observed travel time.

The results follow, reinforcing the validation with strong verification using independent data, which to that point had previously been unused at any stage of the modelling process.

Figure 2.4 AM Travel Times Validation Verification (Modelled and Observed Comparison)

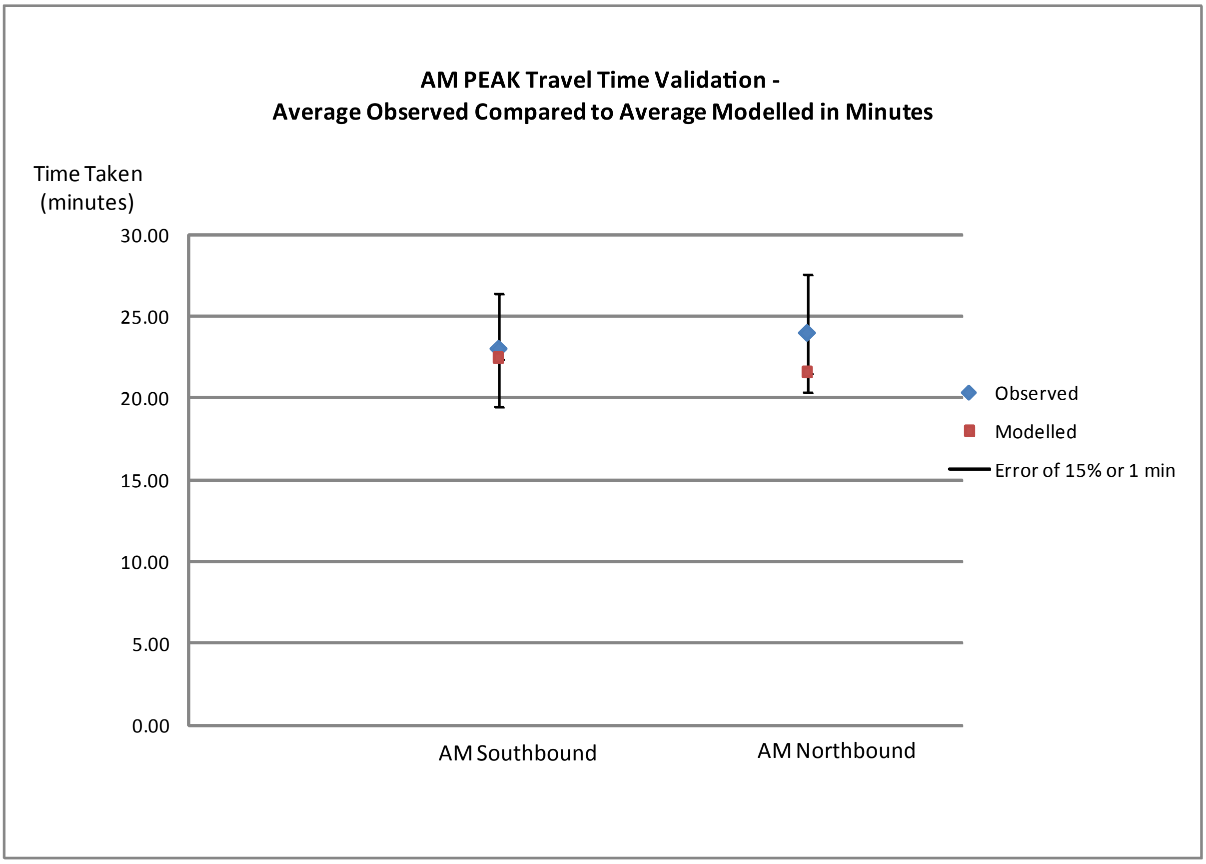


Figure 2.5 PM Travel Time Validation Verification (Modelled and Observed Comparison)

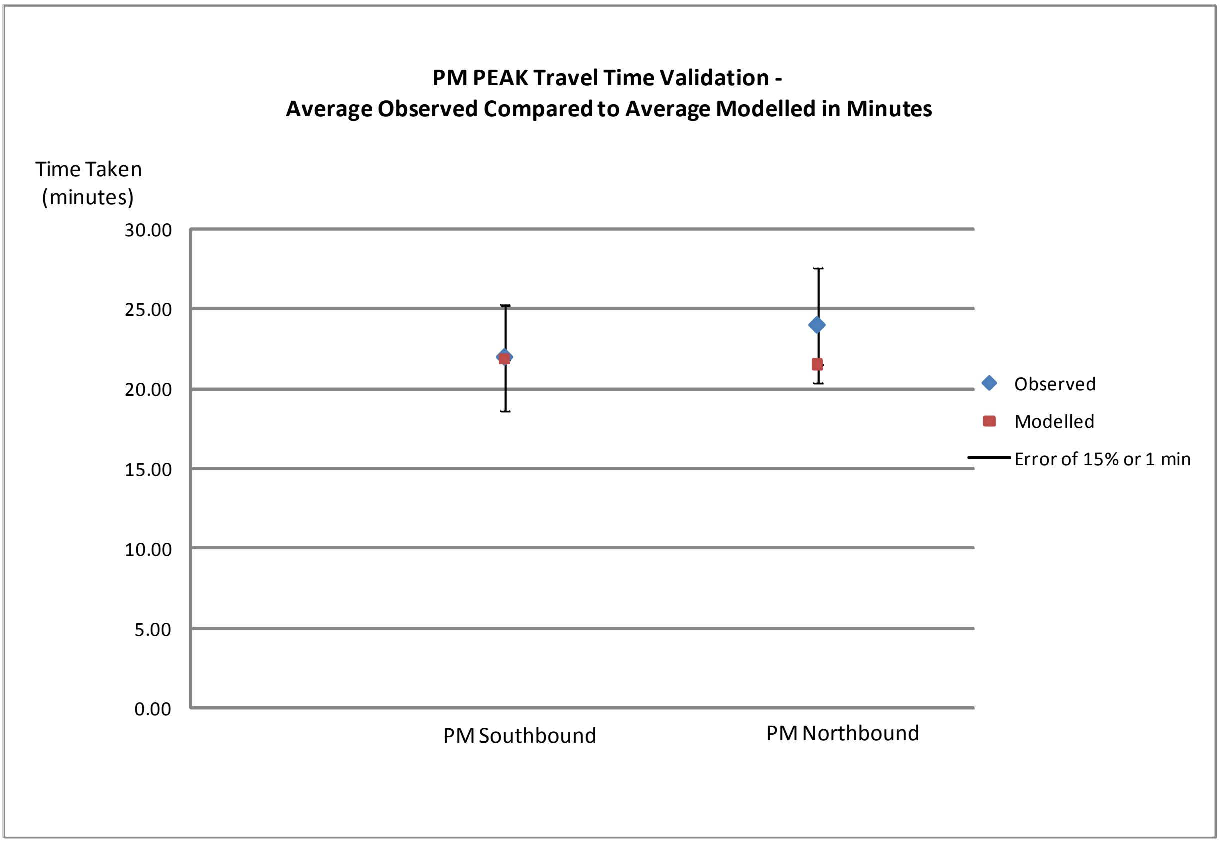


Table 2.19 Summary Table - Travel Time Validation Results

TRAVEL TIME VALIDATION		
Southbound Through The Model		
From Clyde River Bridge to Moruya River Bridge	**AM**	**PM**
Averaged Observed Time (mins)	23.00	22.00
Averaged Model Time (mins)	22.48	21.86
Averaged Difference (mins)	0.52	0.15
Averaged Travel Time Difference (%)	**2.27%**	**0.66%**
Northbound Through The Model		
From Clyde River Bridge to Moruya River Bridge	**AM**	**PM**
Averaged Observed Time (mins)	24.00	24.00
Averaged Model Time (mins)	21.60	21.53
Averaged Difference (mins)	2.41	2.47
Averaged Travel Time Difference (%)	**10.02%**	**10.30%**
Travel times to be within 1 minute or 15% (whichever is higher) of the observed travel times		

Given also that there was also good turn count data which was available and NOT used in any calibration/validation of the TRACKS model, a further spot verification of the validation was also carried out. This check resulted in more than 60% of turn count GEHs showing a value of below 5 and more than 95% of turn count GEHs showing a value of less than 10. This is a solid GEH result, especially for a model which is purpose built at the strategic level, and it further reinforces the consistency in the robust validation results. The summary turn volume validation results are shown in Table 2.20.

Table 2.20 Summary Table – Turn Volume Validation Results

Model Peak	GEH < 5	GEH < 10	GEH > 10
Morning	66%	97%	0%
Evening	62%	95%	0%

2.8 CONCLUSION

2.8.1 SUMMARY AND DISCUSSION

The Eurobodalla Shire TRACKS Model has been built to provide a good representation of average conditions in the study area for the base year of 2010, and has been robustly validated whereby the outputs from the model emerged as being statistically solid. The entire process was also carried out with very close communications with Eurobodalla Shire Council to ensure a robust and transparent process.

It should also be noted that any model which represents traffic and transport conditions is just an approximation of an existing situation, or what's often referred to as 'actual conditions'. As such, models always have inherent in them some degree of inaccuracy and in fact a proper model will never actually replicate exact conditions; instead a good model will provide a useful representation of actual conditions.

These actual conditions being modelled vary from one day of the week to the next, from month to month and from season to season. Therefore, in order to calculate a reasonable representation of what the actual conditions to be modelled are, significant amounts of data need to be collected for the time periods being assessed. This data is collected on a day which is regarded as being representative of the area being modelled and for the purpose of the study. Such data often includes counts, origin and destination (O/D) data and travel times, and these were also collected for this modelling study.

The reality is that counts, queues and travel times vary from hour to hour, from day to day and from month to month, depending on a large host of influencing factors. In addition, driver behaviour also varies significantly from day to day, and never will there be the exact same traffic occurrences form one day to the next. The purpose of traffic and transport modelling is to produce a useful tool which is valuable and effective for planning and/or engineering purposes. In the case of Eurobodalla Shire, the models which have been produced and robustly validated, are useful tools which can inform Eurobodalla Shire Council's planning process regarding network planning and also determining appropriate developer contributions.

2.8.2 LIMITATIONS AND FURTHER USE

Although the models built for this study are good representations of existing conditions; as with any model there are some limitations to be aware of. There was no Household Travel Survey Data available for the area which could be used in model construction and validation; this has impacted the model to the extent that some trip information was less robust than we would have liked.

In light of the above, it is recommended that for future possible extensions of these existing models, HTS surveys be carried out.

In conclusion, the validated TRACKS models presented here are useful tools which are ready for use in the Council's planning process, and suitable to be further developed for future tests.