Wingecarribee Shire Council
TRANSPORTATION MODEL
Enterprise Zone Illawarra Model Analysis Report

Prepared by

GABITES PORTER

April 2009
WINGECARRIBEE TRANSPORTATION MODEL

Enterprise Zone Illawarra Model Analysis Report

GABITES PORTER
Traffic & Transportation Engineering & Planning

Prepared by David Hunter
Senior Transportation Engineer

Gabites Porter Consultants Ltd
138 Victoria Street
P O BOX 25 103
Christchurch
New Zealand

Telephone: +64 3 366 9871
Facsimile: +64 3 366 9870

Date: 17 April 2009
Reference: 4339
Status: Draft One
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1 INTRODUCTION

1.1 Report Content

This report is intended to show the methodology used and results obtained from the modelling of the proposed Enterprise Zone using the Regional Illawarra Model.

The intention of using the regional model in this analysis was to understand the regional movement of Heavy Goods Vehicles (HGVs) from the Enterprise Zone so that those movements could be properly interpreted in the detailed Wingecarribee model. The Illawarra Model is a 24hr model with similar trip purposes as those used in the Wingecarribee Model. Its ability to take trips generated by the Enterprise Zone and distribute them regionally, externally to Sydney, Canberra and elsewhere is vital to the understanding vehicle flow to the external zones of the smaller Wingecarribee Model.

1.2 Methodology

Detailed estimates of the expected trip making for the Enterprise Zone were provided by WSC. These estimates involved both employment and service related trips and were broken down into light vehicles, light goods vehicles and heavy goods vehicles for 2010, 2016 and 2031.

This data also detailed the number of employees expected to be employed within the Enterprise Zone for each development year. These estimates were based on the developable areas within the Enterprise Zone for each type of land use expected. This employment data was inserted into the employment land use data used in the Illawarra model for trip generation purposes.

Employment only produces trips associated with normal activity i.e. journey to work, general work related trips, goods delivery etc. The Enterprise zone has an expected trip generation rate far in excess of that typically produced by normal employee related activity. These additional trips are those relating to the regional HGV movements expected to and from the Enterprise Zone as a result of the large-scale Warehousing, Distribution, Truck Depot and Inland Port related activities.

As these trips will nearly all be to locations outside Wingecarribee the Illawarra regional model will be used to attract trips to both other areas within the Illawarra and to external locations such as Sydney and Canberra. The number of these extra and intra regional trips is the difference between the total number of trips calculated for the Enterprise Zone and the number of trips produced by the standard employment production equations.

The employment related trips are distributed in the conventional way set out in the validated Illawarra model. The regional trips are distributed based on a balanced combination of regional jobs and external flows to Sydney and Canberra. It was assumed that these regional trips will primarily be distributed according to the population base. Consequently, an analysis of the 2006 census data for the surrounding area produced an indication of the likely locational split of trips based on population. Attraction coefficients for the regional jobs and model externals were adjusted to reflect this locational split.
In order to provide the Wingecarribee model with the required regional HGV destination split, the Illawarra model form was adjusted to allow a multi-user class assignment. This assignment enabled the destination the HGV’s to be identified directly off a HGV loaded network and therefore the proportion of these trips that exited Wingecarribee at each Wingecarribee model external. Having determined this distribution, the Wingecarribee model was adjusted so that the regional Enterprise Zone trips were attracted to each Wingecarribee model external at the correct proportion.

This process was repeated for each development year so that any change in regional distribution, as a result of population and employment changes, could be transferred to the Wingecarribee model Enterprise Zone modelling.

2 LAND USE DATA

2.1 Illawarra Model Land Use

The Illawarra model has been validated for 2001 and projected for 2026. The Wingecarribee model analysis will be undertaken for 2010, 2016 and 2031 and to create suitable inputs for those years the Illawarra model land use data was interpolated from the 2001/2026 information for 2010 and 2016. The 2031 information was created by extrapolating from 2026 using the expected average growth rate.

Table 1 summarises the land use variables used and the 2001/2010/2016/2031 land use totals that apply to the Illawarra model.
2.2 Enterprise Zone Land Use

The employment related totals detailed in Table 1 include employment relating to the Enterprise Zone. The Zone was represented in the model by two traffic zones to better represent the movement of vehicles to and from the area. The land use at the Enterprise Zone for each of the model years is detailed in Table 2.

<table>
<thead>
<tr>
<th>Land Use Variable</th>
<th>2001</th>
<th>2010</th>
<th>2016</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Jobs</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Retail Jobs</td>
<td>0</td>
<td>40</td>
<td>109</td>
<td>190</td>
</tr>
<tr>
<td>Finance Jobs</td>
<td>0</td>
<td>96</td>
<td>264</td>
<td>461</td>
</tr>
<tr>
<td>Manufacturing Jobs</td>
<td>0</td>
<td>299</td>
<td>822</td>
<td>1435</td>
</tr>
<tr>
<td>Total Jobs</td>
<td>0</td>
<td>960</td>
<td>2640</td>
<td>4608</td>
</tr>
<tr>
<td>Enterprise Zone Regional</td>
<td>0</td>
<td>10154</td>
<td>29456</td>
<td>51168</td>
</tr>
</tbody>
</table>

3 Trip Generation

3.1 General

The basis of this analysis is the Illawarra Regional Model. The model building and validation of that model has been reported in detail in the “Illawarra Regional Model Building Report”.

Private trips (those that involve normal employment related activities) have been defined as one of four trip purposes described below depending on the land use and activity at the trip ends.

**Home Based Work (HBW)**

All trips with one end at home and the other at own work place, or on employer’s business.

**Home Based Business (HBB)**

All trips with one end at home and the other an activity of Shopping or Personal Business.

**Home Based Other (HBO)**

All trips with one end at home and the other being:

- An activity of Social/Recreation including visiting other residences socially.
- Serve Passenger with a land use relating to social or community activities or services.

**Non Home Based (NHB)**

All trips without one end at home.
Data to derive private trips are gathered during Household Interview Surveys. This determines the proportion of trips in each purpose and the time period in which each trip was made.

Other non-private trips within the analysis are made up of:

- Light Good Vehicles (LGV)
- Heavy Good Vehicles (HGV)
- External (EXT)
  - through trips, external to external
  - internally generated, i.e. internal to external or external to internal.

Regional Enterprise Zone trips

3.2 All Day Trip End Productions

3.2.1 Private Trips

The category model used in the Illawarra model involved the two variables of employees per household and vehicle availability per household to determine the total number of vehicle trips made within the study area on an average week day. Nine categories were used - three employee categories by three vehicle availability categories. The curves describing the percentage of households within each category for a specific household composition are shown on Figure 1.

The All Day trip rates shown in Table 3 are for the four household based and category model generated purposes shown below. The generation rates used have come from the Sydney Home Interview Survey.

\[
\begin{array}{ll}
\text{HBW} & = \text{Home Based Work} \\
\text{HBO} & = \text{Home Based Other} \\
\text{HBB} & = \text{Home Based Business} \\
\text{NHB} & = \text{Non Home Based}
\end{array}
\]

For any particular zone the average number of vehicles per household and number of employees per household were provided in the land use zone files. The proportion of households in each category was established from the combined probability curves shown in Figure 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Employees</th>
<th>Vehicles</th>
<th>Trip Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>HBW</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0.022</td>
</tr>
<tr>
<td>3</td>
<td>2+</td>
<td>0.206</td>
<td>1.478</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0.677</td>
<td>1.093</td>
</tr>
<tr>
<td>6</td>
<td>2+</td>
<td>0.997</td>
<td>2.218</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>2+</td>
<td>0.796</td>
<td>2.04</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1.093</td>
<td>2.206</td>
</tr>
</tbody>
</table>
3.2.2 Good Vehicle Trips

Regression equations were used to provide both productions and attractions for good vehicles (light goods and heavy goods). The LGV and HGV equations used were those used in recent studies and are representative of the intra-regional goods vehicle movements and do not include those that leave the Illawarra and therefore form part of the internal generation. The resulting equations were:

\[ \text{LGV} = 0.20 \text{HH} + 0.34 \text{COM} + 1.45 \text{RET} + 0.38 \text{MAN} \]
\[ \text{HGV} = 0.11 \text{HH} + 0.14 \text{COM} + 0.56 \text{RET} + 0.63 \text{MAN} \]

3.2.3 External Trips

For vehicle trips entering or leaving the study area there were 12 external cordon stations. The road flow at each external controls the traffic volume. Of that volume, some is through traffic and the rest is internal to external or external to internal traffic.

Through Trips

Through trips are those travelling between the south and the north, i.e., between Canberra and Sydney via the Hume Highway. The vehicle trips were measured during a number plate survey carried out by the RTA for the 1991 model and have been factored up to match the external traffic increase along the Hume Highway between 1991 and 2001. The through trip matrices for 2010, 2016 and 2031 were estimated by either interpolating or extrapolating the 2001 and 2026 Illawarra through matrices. All through trips are later deducted from the external traffic generation to maintain the observed external traffic flow.

Internal/External Traffic

Due to the size of the study area and the significance of the escarpment as a geographical barrier, some specific treatments were necessary for the external road flows. That is to say not all of the remaining external traffic could be treated equally. Accordingly there are four types of internal/external traffic generation, namely:-

- Internally Generated Trips
- Southern Highland External Generation
- Northern Coastal External Generation
- Southern Coastal External Generation
- Enterprise Zone Regional Generation

These trips are determined by the level of traffic at each of the external locations and are attracted to activity within the Illawarra. In the case of the Enterprise Zone generation these trips are the calculated regional/external HGV trips and are attracted to internal development and externals based on population. See Section 3.3.2.

Internally Generated Trips

These are produced from the private trip generation discussed earlier. For example for the Home to Work trip purpose, some of the trips generated have destinations in Sydney and Canberra. Accordingly, the external zones have been allocated total jobs to attract such trips. The underlying distribution of external attractions was used to attract 20% of Home based Work trips, 10% of Home based Business trips and 5% of Home
based Other. To maintain the observed external road flow the resulting trip attractions were later deducted from the total road flow.

3.3 Trip Attractions

3.3.1 Private Trips

Home Based Trips

Attractions were derived by regression equations according to various weightings of land use information. The attraction equations used were based upon previous studies in both New Zealand and Australia and tuned in the validation process to closely model local traffic flows and behaviour, as follows:

\[
\begin{align*}
\text{HBW} & = 0.79 \text{RET} + 0.54 \text{TOT} + 0.8538 \text{SYJ} \\
\text{HBB} & = 0.332 \text{COM} + 3.925 \text{RET} + 0.5591 \text{SYJ} \\
\text{HBO} & = 1.52 \text{HH} + 2.92 \text{COM} + 0.68 \text{RET} + 0.61 \text{TOT} + 0.8724 \text{SYJ}
\end{align*}
\]

where:  
HH = Households  
RET = Retail Employment (ASIC 6)  
TOT = Total Employment (ASIC 1-12)  
COM = Community Jobs (ASIC 10-12)  
SYJ = Sydney Job Equivalents

Non-Home Based

The attraction equation for non-home based trips is:

\[
\text{NHB} = 0.74 \text{HH} + 1.31 \text{COM} + 4.668 \text{RET}
\]

where:  
HH = Households  
COM = Community Jobs (ASIC 10-12)  
RET = Retail Employment (ASIC 6)

Note that for home based trips (HBW, HBB, HBO) attractions were scaled to equal productions, with the trip end distribution among the zones being the same as that generated at each zone by the category model. NHB attractions were also scaled to equal total productions, but the regression derived attraction distribution was accepted for both ends of the trip.

3.3.2 External Trips

Southern Highland Generation

Traffic travelling on the Hume Highway and adjacent externals is deemed to predominantly have destinations adjacent to the highway, i.e. west of the escarpment. These trips have therefore been attracted to zones with household values titled “Southern Highland Households” with the residual attracted to zones east of the escarpment and to the north of Shoalhaven which are titled “Northern Coastal Households”.

The attraction equation is:

\[
1.00 \text{SHH} + 0.10 \text{NCHH}
\]
where: \( SHH = \) Southern Highland Households  
\( NCHH = \) Northern Coastal Households

**Northern Coastal Generation**

The attractions of trips from those externals are distributed solely to households in zones east of the escarpment and to the north of Shoalhaven which are titled “Northern Coastal Households”.

The attraction equation is:

\[
1.00NCHH + 0.10SHH
\]

where: \( SHH = \) Southern Highland Households  
\( NCHH = \) Northern Coastal Households

**Southern Coastal Generation**

The attractions of trips from those externals are distributed to jobs in all parts of the model i.e., the Coastal Jobs and Southern Highlands Jobs. In the validation process attracting the trips from the southern externals to a weighted function of total jobs instead of households provided a better fit with respect to traffic counts and the origin-destination survey reported later. The weighting of attractions to jobs is heavily biased towards Southern Coastal jobs (i.e. those in the vicinity of Ulladulla).

The attraction equation is:

\[
0.50SCJ + 0.05NJ
\]

where: \( SCJ = \) Southern Coastal Jobs  
\( NJ = \) Nowra Jobs

**Enterprise Zone Generation**

The Enterprise Zone regional trips are distributed based on a balanced combination of regional jobs and external flows to Sydney and Canberra. It was assumed that these regional trips will primarily be distributed according to the population base. Consequently, an analysis of the 2006 census data for the surrounding area produced an indication of the likely locational split of trips based on population.

The Enterprise Zone has a large Inland Port component which has a “direct connection” with Port Kembla. This connection meant that the Wollongong area needed to attract a disproportionate level of traffic than population would suggest. This resulted in an effective doubling of attraction to Wollongong.

The effective population of each area was obtained from Census data and its initial proportion and redistributed proportion are as follows:

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
<th>Pop Split</th>
<th>Adjusted for Inland Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>2,100,000</td>
<td>72%</td>
<td>66%</td>
</tr>
<tr>
<td>ACT</td>
<td>420,000</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Wollongong</td>
<td>210,000</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Illawarra (rest)</td>
<td>200,000</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,930,000</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To achieve this distribution the following attraction equation is:

\[ 0.14\text{SHJ} + 0.65\text{SHEx} + 0.17\text{NCJ} + 0.14\text{SCJ} + 0.14\text{NJ} \]

where:

- \text{SHJ} = \text{Southern Highland Jobs}
- \text{SHEx} = \text{Southern Highland Externals}
- \text{NCJ} = \text{Northern Coastal Jobs}
- \text{SCJ} = \text{Southern Coastal Jobs}
- \text{NJ} = \text{Nowra Jobs}

The overall generation produced by the Enterprise Zone for each of the analysis periods is shown in Table 4.

<table>
<thead>
<tr>
<th>Enterprise Zone Generation</th>
<th>2010</th>
<th>2016</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internally Generated</td>
<td>2716</td>
<td>7532</td>
<td>13394</td>
</tr>
<tr>
<td>Externally Generated</td>
<td>11322</td>
<td>29456</td>
<td>51168</td>
</tr>
<tr>
<td>Total</td>
<td>14038</td>
<td>36988</td>
<td>64562</td>
</tr>
</tbody>
</table>

Table 4
4 MODEL CONVERGENCE

4.1 Assignment and Distribution Loop

Time and distance matrices are required as inputs for trip distribution. As assigning the trips to the network generates these matrices, after each assignment the trip distribution needs to be re-run and the trips re-assigned until the time and distances matrices converge.

The assignment and distribution steps are run iteratively until the totals of both the time and distance matrices between successive runs remain close to each other and relatively constant.

The totals for the time and distance matrices for successive runs are shown below in Table 5.

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>2010 Kilometres</th>
<th>2010 Minutes</th>
<th>2016 Kilometres</th>
<th>2016 Minutes</th>
<th>2026 Kilometres</th>
<th>2026 Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Run</td>
<td>25520444</td>
<td>29558910</td>
<td>29696276</td>
<td>34218935</td>
<td>35915980</td>
<td>41900747</td>
</tr>
<tr>
<td>Final Run</td>
<td>25520176</td>
<td>29555434</td>
<td>29697681</td>
<td>34213654</td>
<td>35915918</td>
<td>41900117</td>
</tr>
<tr>
<td>Difference</td>
<td>268</td>
<td>3476</td>
<td>1405</td>
<td>5281</td>
<td>62</td>
<td>630</td>
</tr>
<tr>
<td>% Difference</td>
<td>0.001%</td>
<td>0.012%</td>
<td>0.005%</td>
<td>0.015%</td>
<td>&lt;0.001%</td>
<td>0.002%</td>
</tr>
</tbody>
</table>

The percentage change in generalised user cost between consecutive loops should be less than 1% but Gabites Porter prefers to have this set to 0.1%. As the total vehicle minutes and total vehicle kilometres are not changing between runs, absolute convergence has successfully been achieved.

4.2 Assignment Outputs

The primary purpose of this analysis is to create a distribution of trips to and from the Enterprise Zone that leave the Wingecarribee Shire. These trips are a combination of trips that go to other areas in the Illawarra and leave the Illawarra for Sydney or ACT.

The assignment used a multi-user class assignment to create a loaded network containing only those trips created by the Enterprise Zone. This network was windowed to represent the boundaries of the existing Wingecarribee shire-wide model so that trips to and from each of the Wingecarribee model externals could be identified.

Having identified the trips to the Wingecarribee externals from the Illawarra model, the distribution of Enterprise Zone regional trips created specifically by the Wingecarribee model could therefore be correctly attracted to each external in the Wingecarribee model and therefore properly represents the likely region-wide movement of HGV’s. The use and results of this distribution is detailed in the Wingecarribee Enterprise Zone report.