LOWER HUTT TRAFFIC MODEL 2009 DEVELOPMENT PROGRAMME

Report for
Hutt City Council

Barclay Traffic Planning
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March 2009

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Cover: View from Dowse Interchange, looking north.

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Contents

1. INTRODUCTION

1.1 Background

Since 1987 Hutt City Council has maintained a computer traffic model. The model was developed initially by Traffic Design Group Limited but in 1989 it was transferred to the Council. Barclay Traffic Planning assumed responsibility for the model in 1996.

A major recalibration was carried out in 1993, and since then land use tables have been updated following each census. The network description has also been kept up to date.

1.2 Scope

As well as reviewing operational performance, this report documents improvements made to the model since the last revision in 2003, including:

- Updating the previous base network and supplementing it with a new base which includes the Dowse interchange and related changes in Korokoro.
- Compilation of fresh land use tables using the 2006 *Census of Population and Dwellings. [1]*.
- Preparation of a future model for the year 2026.

2. REVIEW OF OPERATION

2.1 Investigations

Since the last significant upgrade of in 2002-2003, the model has been used in a number of studies, as set out in Table 1.

Year	Project	Client
2002	Udy St, Cross Valley Link study	MWH / Hutt CC
2003	Stokes Valley Bridge	GHD / Hutt CC
2003	Harbourview Rd extension	Hutt CC
2003-8	Risk assessment evaluation: Melling Bridge, Normandale Bridge, Hutt Rd overbridge	John Wood / Hutt CC
2004	Estimation of turn volumes for intersection design	MWH / Hutt CC
2007	Andrews Ave traffic management	GHD / Hutt CC
2008	Risk assessment: Connolly St flooding	Hutt CC
2009	Puriri St traffic management	Hutt CC

TABLE 1: Modelling studies

Approximately 40 networks were prepared during the course of these investigations.

The work covered a range of issues, including estimation of demand for new roading links, risk assessment, intersection design and traffic management. In most cases investigation issues related to network changes, involving either arterial or local roads. In the past the model has been used extensively for studies of this type and there is considerable experience in their management. The Udy Street-Cross Valley Link study also involved land use changes, for which scenarios had to be carefully developed if there were not to be unrealistic distortions in travel and employment behaviour.

The risk assessment studies were intended to produce order-of-magnitude estimates of the additional travel costs which would apply if particular bridges or roading links became unavailable following an earthquake or flooding event. As might be expected some scenarios involved extreme redistributions of traffic, some of which might not be sustainable in reality. Travel cost predictions should thus be treated as lower or upper bound estimates, however these were adequate for the purpose of determining the expected benefit of reducing the likelihood of particular links failing.

The Puriri Street investigation was the first to be carried out using the updated model, albeit in provisional form.

Although in each case results needed careful interpretation, the model is considered to have performed in line with expectations.

2.2 Software platform

The model runs on the Tmodel software suite, developed in the United States by Tmodel Corporation. The software is a vehicle-based system relatively simple in concept and economical in its use of data, and models can be built fairly quickly and operated with a high degree of transparency. A particular strength has been its ability to focus on intersection behaviour in a way that closely represents urban networks.

In the past it has been widely used within New Zealand, particularly in subregional and provincial cities, and has played an important role in the development of network improvement strategies.

Tmodel software however dates from the 1980s and by modern standards is unsophisticated and poorly integrated with other systems. Although numerous improvements in methodology have been made to reflect new techniques and technology, most input and output processing takes place in a DOS computer environment ("TModel2"), which modern users will find inefficient and limited in scope. The difficulty of producing graphical output without the use of third-party software is a particular concern.

Some core processing is carried out by a Windows-based module ("TModel3") but the package falls well short of providing a seamless and well-integrated interface.

Tmodel's shortcomings have become even more pronounced since 2004 when Tmodel Corporation became part of PTV America Incorporated. PTV has its own modelling software (VISUM and VISSIM) and no new releases of Tmodel have since been made. As time goes by Tmodel is likely to become less and less serviceable and more difficult to use.

Meanwhile, the information base on which the Lower Hutt model is built also has its limitations.

- A long-standing problem has been distortion of node coordinates, which means that links must be manually coded with a logical length, rather than allowing the program to automatically calculate the length from the coordinates of the end nodes.

- There have been numerous changes taking place in the network over the years, and ensuring a consistent network description with

appropriate relativities between the nominal capacities of different types of intersection has not been easy.

- In the 20 years of the model's existence, there have been changes in traffic management and driver behaviour which are not fully incorporated into the model. As an example, roads such as Hutt Road, Cuba Street and Randwick Road are coded with an operating speed of 65 km/h. The Esplanade is assumed to run at 75 km/h. The implementation of flush medians and other speed restraint measures means that these speeds may no longer be appropriate. (Note: if the model is to correctly interpret the roading hierarchy, some differential between arterial and local roads needs to be maintained even if this is not accurate in objective terms.)

- The last full calibration of the model took place in 1993. While this has served well over many years, inevitably the time will come when a further recalibration becomes advisable.

Current development work has been intended to maintain the model in a serviceable and usable form for the short term, but has not attempted to address the longer-term concerns. Eventually, the Council will need to decide whether it should rebuild the model on a different platform.

One option clearly would be to abandon the model, and rely on the regional model of Greater Wellington Regional Council. Past experience however has been that the regional model is not necessarily well set up to focus on local issues, and has needed to be supplemented by subregional models.

At present there is no obvious upgrade path for the Lower Hutt model. Other authorities in the Wellington region have developed models using a variety of software packages, including EMME / 2, Trips, Tmodel, SATURN and TRACKS. The choice of platform will depend not only on technical strengths and weaknesses, but also on the number of users within New Zealand and the availability of support.

A number of other local authorities are in a similar position, including Porirua City, Kapiti Coast District and Palmerston North City, and the challenge is to find a software platform with wide application for the next generation of provincial and subregional models.

3. MODEL DEVELOPMENT

3.1 Network changes

The single largest network change since the 2003 model update has been opening of the new Dowse Interchange. At the time of writing a number of related works in Korokoro have yet to be completed, and it can be expected that the new traffic patterns will not be fully established and stabilised until well into 2010 or 2011.

For this reason, two base networks have been formulated, one representing the existing network without the interchange, the other with the Dowse and Korokoro changes. The networks have been given the names DD10 and DD11 respectively. DD10 has been used for validating the model, but is otherwise of mainly historical interest. From now on DD11 will be the starting point for most investigations. Diagrams of the network are shown in Appendix 1.

DD11 has a similar level of detail as earlier networks, with 523 links and 384 nodes.

Apart from Dowse and Korokoro improvements, few changes to the network have been of a nature to significantly redistribute traffic between alternative routes. Turn prohibitions at two intersections on Hutt Road for example have mainly localised effects. On State Highway 2, closure of the median barrier at Pomare Road and Hebden Crescent has affected the ability to make right turns, however neither intersection is represented in the model and alterations to the coding have not been needed. Two recent intersection improvements have required changes: a new roundabout at the intersection of High Street and Melling Road, and at the intersection of High Street, Daysh Street and Fairway Drive.

Other changes, especially those intended to address safety rather than capacity concerns, will have had little effect on traffic patterns and need not be represented in the model.

3.2 Land use changes

Table

New land use tables for 2006 and 2026 are set out in Appendix 2.

Population and employment

Population and land use trends for the last three censuses are shown in Table 2.

	1996	2001	2006
Population			
Lower Hutt City	95,874	95,121	97,701
Wellington City	157,719	163,824	179,466
Metropolitan area *(1)*	375,516	385,134	410,328
Households			
Lower Hutt City	34,140	34,668	35,727
Mean household occupancy	2.81	2.74	2.73
Employment: full and part time			
Lower Hutt CBD	7,827	7,797	7,776
Lower Hutt City	35,733	35,505	35,406
Wellington CBD	57,960	61,632	69,615
Metropolitan area	163,605	167,985	176,139
Part time employment (%)	21.0	20.8	20.2

Note (1): "Metropolitan area" consists of Wellington, Lower Hutt, Upper Hutt, Porirua Cities and Kapiti District.

TABLE 2: Land use trends 1996-2006

Since 2001 there has been steady population growth across the metropolitan area, with strong growth in Wellington and a small but significant increase in Lower Hutt.

The trend toward smaller households has continued, though more slowly than for the 1996-2001 period.

The number of full and part time jobs in Lower Hutt has remained static, at around 35,000. This suggests that the decline of traditional heavy industry in the Hutt Valley has not yet been replaced by strong growth in the service sector. One surprise is the lack of growth in Central Business District employment, despite opening of the expanded Queensgate mall and development of "big box" retailing toward the north of the CBD. It would appear that the effects of the new developments have been offset by the decline of other retailing, as well as by a slight weakening of other forms of employment such as office activity.

Meanwhile employment in the Wellington CBD has increased markedly, from 61,632 to 69,615. This represents a recovery to levels last seen in the 1980s, and also reflects buoyant economic conditions and an active public sector. It remains to be seen whether the growth will be sustained as New Zealand moves into recession with the prospects of restraint in the growth of public sector employment. In this respect it is somewhat ominous that additional jobs

in the CBD accounted for all employment growth in the metropolitan area. Clearly, if the region's future growth is to be securely based then increases in CBD public sector and service employment need to be complemented by increased industrial and service sector activity in subregional centres such as Lower Hutt.

Previous model reports have commented on a steady increase in the proportion of the workforce engaged in part time work. It is apparent from Table 2 however that the trend has not been sustained, with the proportion levelling off at around 20 per cent.

The last major recalibration of the model in 1993 took a fairly pessimistic view of future employment conditions. In line with economic conditions at the time, a long term unemployment rate of 10 per cent was assumed. This meant that commuter traffic could be expected to increase at a relatively slow rate, with most growth taking place outside the commuter peaks.

Since then the economy has been relatively buoyant, with unemployment well below ten per cent. Outside the Wellington CBD however job numbers have been static, and a continued cautious view of labour conditions appears justified. As the recession deepens, the unemployment rate could well approach ten per cent once more.

Car ownership

Increasing car ownership is an important factor in traffic growth, and is modelled by two categories of household, those with no car or one car, and those with two or more.

The proportion with two or more cars has steadily increased, as Table 3 shows.

Year	**Households with 2 or more cars (%)**
1986	34
1991	37
1996	40
2001	43
2006	46

TABLE 3: Car ownership trends

At this rate a 50 per cent split will be reached by approximately 2012.

3.3 Mode split

As a vehicle-based model, the Lower Hutt model does not attempt to represent changes in the modes by which people travel. It is important therefore to check whether modal splits remain within the scope of assumptions made in the model.

In this respect the most important corridor to monitor is the links between the Hutt Valley and Ngauranga. The relevant information can be obtained from the census Home-to-Work table, and is shown in Table 4 for home-to-work travel in the southward direction.

Travel mode	2001	2006
Mode numbers:		
Train	4,350	5,334
Bus	1,002	816
Private or work car	8,934	9,447
Bicycle	177	162
TOTAL:	*14,463*	*15,759*
Mode proportions (%):		
Train	30	34
Bus	7	5
Private or work car	62	60
Bicycle	1	1

TABLE 4: Mode choice trends

Source data also enable average car occupancy to be calculated. This has increased marginally from 1.13 to 1.14.

The dominant modes are car and train. Both carry increased numbers of people, with trains increasing their market share from 30 to 34 per cent. Car travel has a slightly reduced share, at 60 per cent.

In terms of overall demand for road travel, these figures indicate only marginal shifts in traffic patterns, with no major structural movement. Present model assumptions are therefore likely to remain satisfactory.

3.4 Trip generation

Since 1993 the model has incorporated a steadily increasing rate of trip generation and a varying trip structure, in order to replicate actual growth rates and reflect the slow rate of employment growth.

For the current update, it has been found that good validation is obtained if the generation rates from 2001 are retained. These provide for a rate of 4.9 trips per day for single-car households, and 9.8 for households with two or more vehicles.

3.5 Future model

Previously a future model for the year 2016 was available. 2016 is now only a few short years away, and a model for that year will add little to what can be learnt from the present day model. A new model has thus been developed, representing the year 2026. This is roughly half way through the 30-year project evaluation analysis period, and will be an appropriate design year for many roading projects.

The 2026 model assumes continued slow population growth, with the number of households increasing by only 2.6 per cent. There will be further increases in car ownership, with the proportion of households with two or more cars rising to 52 per cent. These changes imply total growth for internal traffic of 6.8 per cent, or 0.33 per cent per annum from the 2006 base. This is lower than the 1.2 per cent per annum modelled for the years 1996-2001, and allows for slower growth in population, employment and economic development. Should actual growth rates prove to be higher than assumed, then the design year will be reached earlier than 2026.

Faster growth is allowed for trips to and from external zones, in accordance with measured state highway growth rates between 2003 and 2007, as shown in Table 5:

Site	**Growth rate (% p.a.)**
SH2 Petone to Ngauranga (interpeak period)	1.5
SH2 Manor Park	0.8
SH58 Haywards Hill	1.4

TABLE 5: State highway traffic growth *[2]*

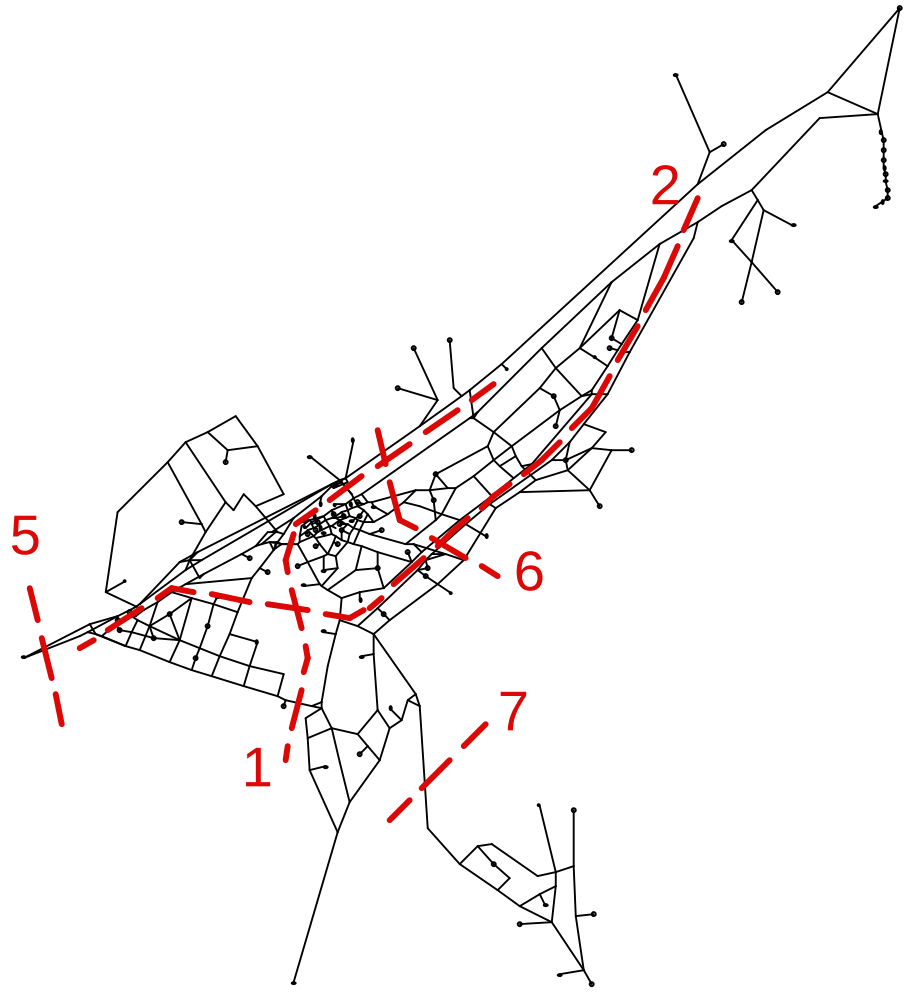
For the future model, external trip growth at the rate of 1.0 per cent per annum has been allowed for. When extrapolated arithmetically for 20 years from the 2006 base, this gives total growth of 20 per cent. This has been applied to all trips for which capacity is unconstrained. Where growth is constrained, for example Petone-Ngauranga at peak periods in the peak direction, nil growth is assumed. An exception is the Upper Hutt bypass section of SH2, where capacity limits are increasingly being felt at peak times. In this case, effective overflow routes are available along Fergusson Drive and Eastern Hutt Road, enabling the increasing demand to be satisfied.

4. VALIDATION

4.1 Screenlines

If there is to be confidence in how a model performs, it is important that its outputs can be reconciled with a set of independent data, such as measured traffic counts.

For the Hutt model, validation makes use of seven screenlines, as shown in Figure 1.



Note: Screenlines 3 and 4 (access to SH2) omitted for clarity.

FIGURE 1: Screenlines

For each screenline, modelled and measured flows for each link crossing the line are compared, as set out in Appendix 3.

It will be seen that in most cases the flows reconcile to within 20 per cent, with many within ten per cent. This compares well with the comparisons of earlier years, as will be seen from Table 6.

(%)	Morning peak		Interpeak		Afternoon peak	
	Forward	Return	Forward	Return	Forward	Return
2001						
1. River bridges	12	27	22	14	24	14
2. Railway	17	3	19	5	27	4
3. Eastern access	25	-12	26	9	9	7
4. Western access	44	18	48	30	4	15
5. Petone-N'ranga	-1	7	3	-3	6	-3
6. Northern CBD	-8	56	-11	17	40	-14
7. W'mata Hill	28	14	-10	37	-12	49
2006						
1. River bridges	-3	-7	-4	-2	-8	4
2. Railway	-20	7	-3	-7	5	-3
3. Eastern access	8	1	24	19	1	16
4. Western access	10	19	39	31	29	-8
5. Petone-N'ranga	4	2	1	3	3	1
6. Northern CBD	-26	44	3	14	16	-17
7. W'mata Hill	12	5	24	52	-1	46

TABLE 6: Screenline comparisons (summary)

Results for Screenline 5 (SH2 Petone-Ngauranga) should perhaps be discounted as the modelled flow was derived from the counts. Model results are therefore not independent of the measured counts.

A test of individual link fit is the Coefficient of Variation. The closer the figure is to 1.000, the better the fit. Results for screenlines in the model are shown in Table 7.

The results are variable. In many cases the coefficient exceeds 0.8 or 0.9, but in other cases the figure is much lower. This indicates that some route choices within the model are highly sensitive, with volatile results.

	Morning peak		**Interpeak**		**Afternoon peak**	
	Forward	Return	Forward	Return	Forward	Return
2006						
1. River bridges	0.862	0.445	0.342	0.011	0.772	0.112
2. Railway	0.854	0.742	0.869	0.910	0.839	0.887
3. Eastern access	0.953	0.850	0.876	0.950	0.883	0.943
4. Western access	0.969	0.960	0.902	0.929	0.982	0.963
5. Petone-N'ranga	-	-	-	-	-	-
6. Northern CBD	0.381	0.820	0.880	0.911	0.852	0.526
7. W'mata Hill	-	-	-	-	-	-

TABLE 7: Coefficients of variation

4.2 *Economic Evaluation Manual [3]*

The *Economic Evaluation Manual* (EEM) produced by New Zealand Transport Agency includes procedures for checking the validity of transport modelling outputs. Documentation is set out in Worksheets 8.1 to 8.5.

While much of the required or recommended information needs to be compiled in the context of a particular project evaluation, some general information can be summarised briefly as set out in Table 8.

These results are reasonably satisfactory, and indicate that the model can be used to investigate travel behaviour with confidence, provided the output is interpreted with care.

Work-sheet	Content	Comment
8.1	Coarse check on outputs	To be completed for individual projects.
8.2	Detailed checks: (a) link speeds (b) intersection delay (c) journey components (d) journey totals	To be completed for individual projects.
8.3	Model specification: A. General information B. Data sources C. Matrices	 As documented elsewhere in this report. Compiled from RAMM network data, census land use data. No interface to regional model. Trip matrices derived from gravity distribution and assignment, validated against screenline counts (refer Section 4.1 above)
8.4	Base year assignment	Screenline totals as set out in Section 4.1 and Appendix 3. Coefficient of Variation meets 0.85 minimum in many cases, but outliers also exist.
8.5	Strategic checks	Model has been used in strategic studies over a period of 20 years, with comprehensive documentation of structure and content.

TABLE 8: EEM worksheet information

5. CONCLUSIONS

5.1 Model effectiveness

The development programme has consisted of updating the model's network description and compiling fresh land use tables based on data from the 2006 *Census of Population and Dwellings.* A new future model nominally for the year 2026 has also been prepared.

Although it is now some years since the last major calibration, the model can be regarded as being still very serviceable, with reasonably satisfactory screenline comparisons and coefficients of variation. Inevitably however there are limitations, and results need to be interpreted with care.

5.2 Future development

A particular feature of the Lower Hutt model is its representation of Park and Ride travel to and from the Petone, Melling and Waterloo railway stations. Although the volume of travel is not large in relation to overall traffic flows, the number of movements can be significant at particular locations, especially at Petone and Melling. These were compiled from surveys last carried out in 2000, and as soon as usage patterns stabilise following highway improvements at Korokoro, there will be value in updating the Park and Ride matrices. This can be done using Greater Wellington Regional Council survey data, supplemented by specific surveys as required.

Recent commissioning of the Dowse Interchange and the imminent completion of highway improvements at Korokoro represent a major structural change to the network, and mean that the updated model has been validated against a network which no longer exists. At some point after the 2011 census when flows have stabilised, it would be useful to revalidate the model against the new network. This will also provide an opportunity to review predictions made by the model in the past.

Although the model in its present form could be maintained for some years to come, Tmodel software is dated and relatively inefficient. At some point the Council will need to decide on a new platform, and decide whether or not to rebuild the model.

REFERENCES

(1) *Census of Population and Dwellings*

Published and custom data

Statistics New Zealand

(2006-2008)

(2) *State Highway Traffic Data Booklet 2003-2007*

Transit New Zealand

(2008)

(3) *Economic Evaluation Manual Volume 1*, Worksheets 8.1-8.5

Land Transport New Zealand (now New Zealand Transport Agency)

(October 2006)

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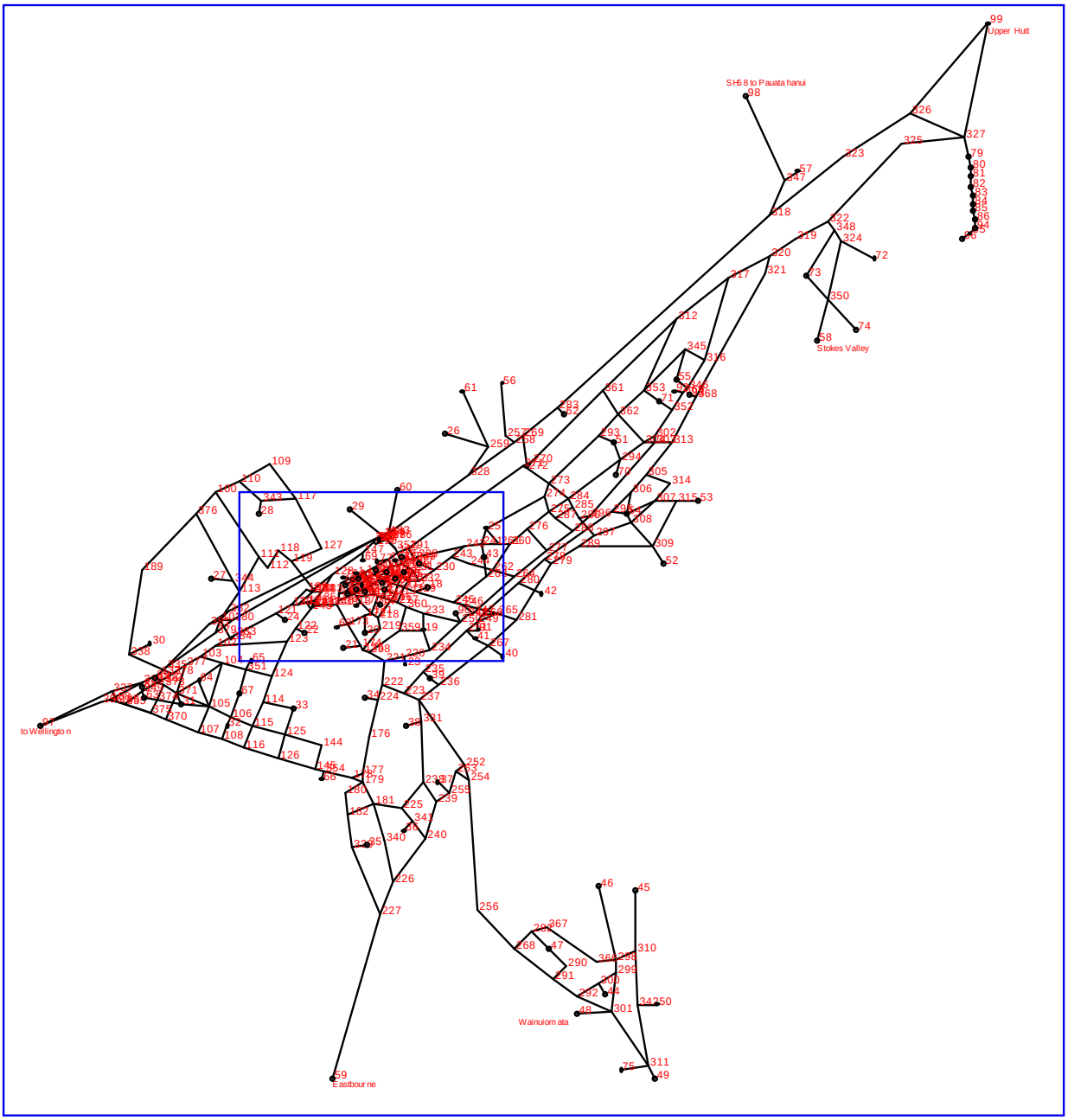
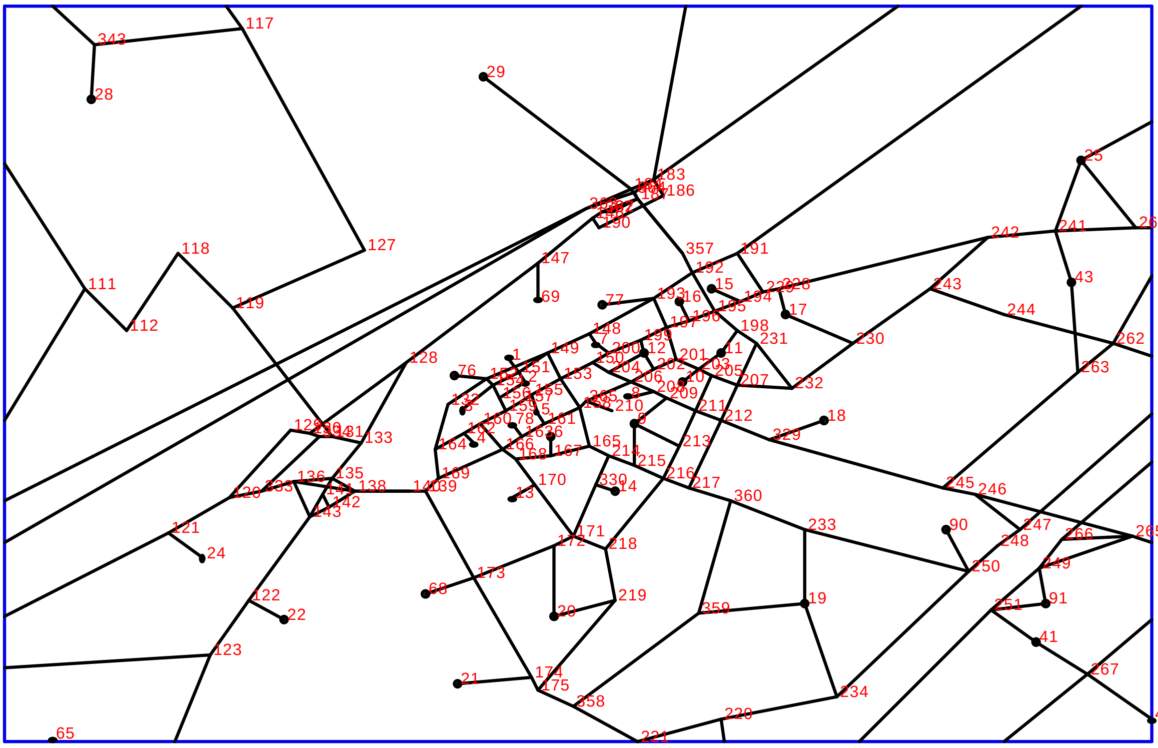
APPENDIX 1

Network diagrams



DD11 network with
Dowse Interchange



CBD inset

APPENDIX 2

Land use tables

LAND USE TABLES			**2006**				**2026**			
Zones			Households		Employment		Households		Employment	
No.	Name	Description	0-1	2+	Retail	Non-ret	0-1	2+	Retail	Non-ret
1	CBD	Dudley-Daly block	0	0	159	114	0	0	159	114
2	CBD	Dudley-High block	1	0	159	113	1	0	159	113
3	CBD	Andrews-High-rbk	1	0	159	114	1	0	159	114
4	CBD	High-Queens-Laings	1	0	159	113	1	0	159	113
5	CBD	High-Queens-Margaret	0	0	159	114	0	0	159	114
6	CBD	Queens-Myrtle-Laings	1	0	158	113	1	0	158	113
7	CBD	High-Rutherford-Queens	0	0	159	114	0	0	159	114
8	CBD	Queensgate	0	0	159	113	0	0	159	113
9	CBD	Queensgate	1	0	159	114	1	0	159	114
10	CBD	Waterloo-Queens-Kings	1	1	20	378	1	1	20	378
11	CBD	Pretoria-Kings-High	17	19	20	379	17	20	20	379
12	CBD	Osborne Pl	2	2	20	378	2	2	20	378
13	CBD	HCC buildings	0	0	159	113	0	0	159	113
14	CBD	Bloomfield-Myrtle	15	16	19	379	15	17	19	379
15	CBD	High-Rutherford-LINK	1	1	20	378	1	1	20	378
16	CBD	Queens-High-Rutherford	1	1	20	379	1	1	20	379
17	CBD	Pretoria-High-Kings	109	122	20	378	108	130	20	378
18	CBD	Epuni-Knights	283	319	19	379	280	340	19	379
19	CBD	Knights-Bellevue	177	198	20	378	175	211	20	378
20	CBD	Huia-Myrtle-Hutt Rec	26	28	20	379	26	30	20	379
21	Waiiti Cr	Ludlam Cr catchment	67	29	0	1	66	31	0	1
22	Tama St	Victoria catchment	339	227	117	387	336	242	117	387
23	Penrose St	Woburn N AU	176	277	9	171	175	295	9	171
24	Hutt Rd	N of railway	116	77	117	390	115	82	117	390
25	Boulcott	Part AU	486	420	73	574	481	448	73	574
26	Park Rd	Park Rd catchment	98	235	12	70	97	251	12	70
27	Dowse Dr	Maungaraki AU	526	788	33	234	521	841	33	234
28	N'dale Rd	Part Normandale AU	152	313	0	90	151	334	0	90
29	Harbourview	Harbourview catchment	91	188	0	90	90	201	0	90
30	Korokoro	Korokoro AU	220	281	25	355	217	300	25	355
31	Gear site		6	3	63	216	6	3	63	216
32	Esplanade W	Part Esplanade AU	495	245	45	57	490	261	45	57
33	Wilford E	Part AU (E of Cuba)	556	292	0	178	551	312	0	178
34	Randwick Cr	Moera AU	425	177	33	402	422	189	33	402
35	Port Rd	W of Seaview	3	4	49	1065	3	4	49	1065
36	Hutt Pk Rd	Seaview-Hutt Park Rd	1	0	59	1655	1	0	59	1655
37	Grfld Rd	Part AU	8	8	96	1042	8	9	96	1042
38	Waiwhetu S	AU	584	400	27	672	578	427	27	672
39	Waiwhetu N	AU	357	183	46	140	354	195	46	140
40	Waterloo E	Part AU	914	712	49	745	906	759	49	745
41	Waterloo W	Part AU	200	136	33	153	198	145	33	153
42	Fairfield	Epuni E AU	647	481	57	207	640	513	57	207
43	Epuni W	AU	706	470	48	1698	699	501	48	1698

LAND USE TABLES *(continued)*										
Zones			**2006**				**2026**			
			Households		Employment		Households		Employment	
No.	Name	Description	0-1	2+	Retail	Non-ret	0-1	2+	Retail	Non-ret
44	Wainui Cent	Wainui CBD	0	0	338	258	0	0	338	258
45	Wise St	Glendale AU	579	564	9	129	574	602	9	129
46	Wellington Rd	Arakura AU	469	395	6	63	465	421	6	63
47	Parkway	AU less CBD	515	484	0	281	510	517	0	281
48	Fernlea	Fernlea AU	335	328	36	120	331	350	36	120
49	Coast Rd	Pencarrow AU	51	138	20	122	51	147	20	122
50	Homedale E	AU	478	533	27	177	470	569	27	177
51	Avalon	Part AU	579	411	38	278	573	439	38	278
52	Naenae S	AU less comm. zone	761	484	0	0	754	516	0	0
53	Rata St	Naenae N AU	1073	508	84	471	1062	542	84	471
54	Naenae shops	comm. zone	0	0	102	867	0	0	102	867
55	Taita N	AU	642	300	36	420	636	320	36	420
56	Kelson	AU	352	596	18	255	349	635	18	255
57	Manor Park	AU	58	83	11	128	58	88	11	128
58	Delaney	AU	475	335	8	95	471	357	8	95
59	Eastbourne	AU	843	999	121	658	835	1066	121	658
60	Tirohanga Rd	Tirohanga-Pomare Rds	75	178	0	76	74	190	0	76
61	Hill Rd	Hill Rd catchment	57	136	0	76	56	145	0	76
62	Owen St	Owen St catchment	33	79	0	0	33	84	0	0
63	NZ Post		0	0	18	171	0	0	18	171
64	Hutt Rd	Hutt Rd Jackson-rly	186	115	868	3823	184	123	868	3823
65	Petone N	N of Bouverie	16	10	55	622	16	11	55	622
66	Waione St	Espl. AU E of Jessie	133	66	75	693	132	70	75	693
67	Petone Rec	Wilford AU W of Cuba	311	164	135	767	308	175	135	767
68	HVHS etc	Market - Waiiti	61	26	0	17	60	28	0	17
69	Melling	AU	168	84	139	685	166	90	139	685
70	Naenae W	AU	587	298	54	417	581	318	54	417
71	Taita S	AU	687	351	80	1073	680	375	80	1073
72	Tawhai	AU	529	602	29	236	524	643	29	236
73	Holborn	AU	320	373	108	219	317	398	108	219
74	Manuka	AU	214	392	12	108	212	418	12	108
75	Homedale W	AU	458	430	16	130	452	460	16	130
76	R'bank S	carpark	0	0	20	378	0	0	20	378
77	R'bank N	carpark	0	0	20	378	0	0	20	378
78	Plaza carpark	carpark	0	0	159	114	0	0	159	114
79	Melling P & R	carpark								
80	Petone P & R	carpark								
81	Waterloo W P&R	carpark								
82	Waterloo E P&R	carpark								
83	Wellington	External zone								
84	Porirua	External zone								
85	Upper Hutt	External zone								
	TOTALS		*18855*	*16115*	*5420*	*29817*	*18670*	*17193*	*5420*	*29817*

APPENDIX 3

Screenline analysis

(vph)

SCREENLINE *(Forward direction: E or N)*	Morning				Interpeak				Afternoon			
	FORWARD		RETURN		FORWARD		RETURN		FORWARD		RETURN	
	Meas.	Model	Meas.	Model	Meas.	Model	Meas.	Model	Meas.	Model	Meas.	Model
1. River bridges												
Kennedy-Good Bridge	**671**	**967**	**1114**	**1004**	**510**	**920**	**562**	**906**	**1158**	**1070**	**878**	**1106**
Melling Bridge	**764**	**875**	**1332**	**1163**	**810**	**776**	**831**	**988**	**1232**	**889**	**997**	**1264**
Ewen Bridge	**1864**	**1444**	**1754**	**1462**	**1432**	**1154**	**1254**	**953**	**1996**	**1836**	**1441**	**1224**
Estuary Bridge	**945**	**849**	**1247**	**1448**	**1036**	**781**	**1061**	**789**	**1350**	**1500**	**1032**	**923**
TOTAL	*4244*	*4135*	*5447*	*5077*	*3788*	*3631*	*3708*	*3636*	*5736*	*5295*	*4348*	*4517*
Differences:		*-109*		*-370*		*-157*		*-72*		*-441*		*169*
% difference		*-3*		*-7*		*-4*		*-2*		*-8*		*4*
Coeff. of variation		*0.862*		*0.445*		*0.342*		*0.011*		*0.772*		*0.112*
2. Railway												
High St (Taita)	**218**	**312**	**783**	**1311**	**403**	**383**	**359**	**393**	**1039**	**1259**	**358**	**368**
Wingate overbridge	**414**	**130**	**446**	**438**	**305**	**102**	**358**	**142**	**321**	**412**	**448**	**176**
Naenae overbridge	**807**	**646**	**774**	**952**	**523**	**705**	**558**	**741**	**799**	**898**	**804**	**805**
Waterloo Rd overbridge	**373**	**199**	**819**	**761**	**456**	**402**	**402**	**420**	**872**	**735**	**456**	**370**
Whites Line overbridge	**642**	**357**	**1207**	**927**	**610**	**539**	**591**	**530**	**1204**	**1009**	**770**	**428**
Randwick Rd overbridge	**898**	**806**	**533**	**539**	**541**	**531**	**667**	**577**	**657**	**559**	**1027**	**1023**
Cuba St overbridge	**864**	**597**	**630**	**320**	**641**	**407**	**728**	**469**	**653**	**424**	**839**	**830**
Hutt Rd overbridge	**1193**	**806**	**714**	**822**	**682**	**779**	**645**	**585**	**666**	**1084**	**1113**	**1058**
Koro Cr	**384**	**597**	**462**	**171**	**350**	**194**	**367**	**254**	**343**	**176**	**504**	**677**
Petone off-ramp	**1605**	**1496**	**0**	**0**	**1007**	**1304**	**0**	**0**	**1508**	**1944**	**0**	**0**
Petone on-ramp	**0**	**0**	**1230**	**1885**	**0**	**0**	**1167**	**1337**	**0**	**0**	**1563**	**1905**
TOTAL	*7397*	*5946*	*7597*	*8126*	*5518*	*5346*	*5842*	*5448*	*8061*	*8500*	*7882*	*7640*
Differences:		*-1451*		*529*		*-172*		*-394*		*439*		*-242*
% difference		*-20*		*7*		*-3*		*-7*		*5*		*-3*
Coeff. of variation		*0.854*		*0.742*		*0.869*		*0.910*		*0.839*		*0.887*
3. Eastern access												
Owen St	**17**	**10**	**60**	**60**	**27**	**50**	**24**	**49**	**65**	**65**	**29**	**29**
Kennedy-Good Bridge	**671**	**967**	**1114**	**1004**	**510**	**920**	**562**	**906**	**1158**	**1070**	**878**	**1106**
Block Rd	**863**	**922**	**268**	**235**	**292**	**475**	**313**	**358**	**284**	**502**	**890**	**646**
Melling Bridge	**764**	**875**	**1332**	**1163**	**810**	**776**	**831**	**988**	**1232**	**889**	**997**	**1264**
Koro Cr	**384**	**411**	**462**	**171**	**350**	**194**	**367**	**254**	**343**	**176**	**504**	**677**
Petone Park & Ride	**106**	**94**	**18**	**0**	**18**	**16**	**14**	**16**	**18**	**0**	**69**	**84**
Petone off-ramp	**1605**	**1496**	**0**	**0**	**1007**	**1304**	**0**	**0**	**1508**	**1944**	**0**	**0**
Petone on-ramp	**0**	**0**	**1230**	**1885**	**0**	**0**	**1167**	**1337**	**0**	**0**	**1563**	**1905**
TOTAL	*4409*	*4775*	*4485*	*4518*	*3014*	*3735*	*3277*	*3908*	*4608*	*4646*	*4931*	*5711*
Differences:		*366*		*33*		*721*		*631*		*38*		*780*
% difference		*8*		*1*		*24*		*19*		*1*		*16*
Coeff. of variation		*0.953*		*0.850*		*0.876*		*0.950*		*0.883*		*0.943*

(vph)

SCREENLINE *(Forward direction: E or N)*	Morning FORWARD Meas.	Morning FORWARD Model	Morning RETURN Meas.	Morning RETURN Model	Interpeak FORWARD Meas.	Interpeak FORWARD Model	Interpeak RETURN Meas.	Interpeak RETURN Model	Afternoon FORWARD Meas.	Afternoon FORWARD Model	Afternoon RETURN Meas.	Afternoon RETURN Model
4. Western Access												
SH58	**702**	**843**	**857**	**989**	**471**	**429**	**458**	**417**	**810**	**905**	**731**	**743**
Major Dr	**403**	**430**	**156**	**131**	**156**	**265**	**179**	**265**	**182**	**222**	**466**	**440**
Grounsell Cres	**250**	**292**	**155**	**104**	**94**	**195**	**141**	**188**	**110**	**178**	**382**	**310**
Tirohanga Rd	**193**	**137**	**82**	**52**	**64**	**100**	**68**	**99**	**64**	**85**	**153**	**148**
Harbourview Rd	**148**	**140**	**20**	**58**	**64**	**115**	**55**	**115**	**61**	**94**	**150**	**160**
Dowse Dr	**354**	**466**	**58**	**125**	**146**	**229**	**148**	**218**	**151**	**183**	**406**	**420**
London Rd	**265**	**231**	**29**	**153**	**86**	**172**	**71**	**169**	**77**	**209**	**193**	**251**
TOTAL	*2315*	*2539*	*1358*	*1612*	*1082*	*1505*	*1121*	*1471*	*1454*	*1876*	*2480*	*2472*
Differences:		*224*		*254*		*423*		*350*		*422*		*-8*
% difference		*10*		*19*		*39*		*31*		*29*		*0*
Coeff. of variation		*0.969*		*0.960*		*0.902*		*0.929*		*0.982*		*0.963*
5. SH2 Petone-Ngauranga												
SH2 Ngauranga-Petone	**2743**	**2860**	**0**	**0**	**2510**	**2527**	**0**	**0**	**3595**	**3711**	**0**	**0**
SH2 Petone-Ngauranga	**0**	**0**	**3868**	**3949**	**0**	**0**	**2440**	**2504**	**0**	**0**	**3048**	**3086**
TOTAL	*2743*	*2860*	*3868*	*3949*	*2510*	*2527*	*2440*	*2504*	*3595*	*3711*	*3048*	*3086*
Differences:		*117*		*81*		*17*		*64*		*116*		*38*
% difference		*4*		*2*		*1*		*3*		*3*		*1*
6. Northern CBD												
S H 2 (N of Melling)	**972**	**1133**	**1733**	**2755**	**1272**	**1673**	**1033**	**1681**	**2459**	**2464**	**1130**	**1478**
Connolly St	**767**	**60**	**168**	**721**	**279**	**114**	**264**	**181**	**294**	**655**	**829**	**146**
High St (Brunswick St)	**450**	**196**	**575**	**692**	**515**	**318**	**482**	**362**	**682**	**548**	**550**	**369**
Kings Cr	**337**	**118**	**435**	**247**	**335**	**108**	**264**	**80**	**591**	**311**	**317**	**90**
Witako St	**204**	**195**	**322**	**98**	**162**	**167**	**183**	**147**	**207**	**157**	**192**	**207**
Oxford Tce	**221**	**357**	**364**	**972**	**195**	**264**	**160**	**241**	**429**	**958**	**197**	**318**
Cambridge Tce	**276**	**329**	**660**	**819**	**244**	**458**	**308**	**443**	**504**	**868**	**337**	**389**
Waiwhetu Rd	**748**	**556**	**609**	**686**	**460**	**456**	**426**	**418**	**663**	**776**	**724**	**549**
TOTAL	*3975*	*2944*	*4866*	*6990*	*3461*	*3558*	*3120*	*3553*	*5829*	*6737*	*4276*	*3546*
Differences:		*-1031*		*2124*		*97*		*433*		*908*		*-730*
% difference		*-26*		*44*		*3*		*14*		*16*		*-17*
Coeff. of variation		*0.381*		*0.820*		*0.880*		*0.911*		*0.852*		*0.526*
7. Wainuiomata Hill												
Wainuiomata Hill Rd	**454**	**507**	**1796**	**1880**	**544**	**675**	**512**	**780**	**1570**	**1561**	**478**	**698**
TOTAL	*454*	*507*	*1796*	*1880*	*544*	*675*	*512*	*780*	*1570*	*1561*	*478*	*698*
Differences:		*53*		*84*		*131*		*268*		*-9*		*220*
% difference		*12*		*5*		*24*		*52*		*-1*		*46*