Veitch Lister Consulting Pty Ltd

Greater Melbourne Travel Modelling Report

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Greater Melbourne – Travel modelling report

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1. Introduction

1.1 Background

In April 2014 Veitch Lister Consulting (VLC) was commissioned by Infrastructure Australia (IA) to undertake travel demand forecasts and transport network performance assessments for metropolitan Melbourne (GCCSA) and Geelong for 2011 and 2031. This document presents the results of this work.

The 2031 travel forecasts and transport network performance assessments have been prepared for a low transport investment scenario, which includes the current transport network infrastructure and services (for both road and public transport), as well as future networks and services, limited to committed and "highly likely" transport network enhancements.

The travel estimates and transport system performance measures presented in this report have been generated using VLC's Zenith model - a four-step multimodal model which was developed for Melbourne and regional Victoria.

1.2 Purpose of this investigation

The primary purpose of this consulting commission is to provide input to the Australian Infrastructure Audit (AIA) being conducted by Infrastructure Australia, by:

a) robustly predicting the scale of travel increase in the entire region, where it is likely to occur, as well as the preferred modes of travel;
b) assessing the degree to which the performance of the transport network will deteriorate by 2031 under a *low transport investment* scenario - including identification of those elements of the road network that will, by 2031, be generating large economic costs due to congestion, and sections of the rail network that will be subject to severe over-crowding; and
c) providing travel and transport system performance data suitable for input to the ACIL Allen Tasman economic model of the region.

1.3 Structure of report

The report is structured as follows:

Section 2: Land use assumptions used in the modelling

Section 3: Assumed 2031 base case transport networks and services

Section 4: Other modelling assumptions

Section 5: Methodology

Section 6: Travel demand increase in Melbourne and associated regions 2011-2031

Section 7: Road network performance

Section 8: Public transport system performance

2. Land use assumptions

Land use and transport system operation are linked by complex, yet identifiable relationships which are investigated through transport modelling activities. It is crucial therefore to utilise the most current, rigorous land use dataset available to underpin the traffic modelling.

In this section, we outline the land use and demographic variables underpinning travel behaviour within Victoria, and describe the application of land use projections developed by VLC for the purpose of forecasting travel and the performance of the transport network within the regions.

2.1 Demographic dataset development

VLC has developed a current baseline demographic dataset to underpin traffic forecasting for this project. This dataset contains population, employment, education enrolment and visitor data for a base year of 2011 and future year 2031 appropriate for input into VLC's Zenith model. This demographic dataset, developed for this project contains the most current and rigorous small area demographic projections which form an essential input into transport modelling and traffic forecasting.

Datasets used as inputs in the development of the baseline demographic dataset include, but are not limited to:

- 2011 Australian Bureau of Statistics (ABS) Census of Population and Housing
- ABS Series B population projections and associated age structure data
- State Government household projections
- ABS Estimated Resident Population
- Local government land use data
- Enrolment data for primary, secondary and tertiary institutions
- Planning scheme data
- Tourism forecast data

2.1.1 Base year (2011) data development

Base year data has been derived from the 2011 Census of Population and Housing. Population variables were derived from Estimated Resident Population data, rebased to the 2011 Census.

Base year employment has been derived from Place of Work DZN data, with adjustments made to account for Census under-reporting, and "Not Stated" responses.

Enrolment data has been obtained from The Australian Curriculum, Assessment and Reporting Authority (ACARA), as well as contact with various primary, secondary and tertiary institutions to confirm enrolment figures, and associated employment.

Visitor data, both domestic and international, has been obtained from the 2011 Census of Population and Housing.

2.1.2 Baseline dataset future year land use projection development

Future year projections for the baseline demographic in the various regions' datasets have been developed using the ABS Series B population projections. The population dataset for Melbourne was based on data from Victoria In Futures (VIF14), supplied by the Department of Transport Planning and Local Infrastructure. Base 2031 population projections are adjusted to match ABS Series B 2031 population. ABS population projections are provided at Greater Capital City Statistical Area, therefore the difference between base 2031 projected population and ABS Series B 2031 projected population is apportioned to small areas according to their share of growth between 2011 and 2031.

Future year employment was based on the 2011 Journey to Work statistical relationships. Employment growth was distributed based on knowledge of known future developments and information obtained from local and regional planning instruments.

The ratio of domestic and international visitors to the number of usual residents at the small area level is assumed to be the same in future years and is applied to future years' total residents to forecast the number of domestic and international visitors. These figures are validated at aggregate levels to figures provided by relevant Government authorities.

For future enrolments, an age-cohort model has been used to allocate additional students to existing institutions based on notional capacities of institutions in the future. Any surplus students were then allocated to schools with additional capacity in neighbouring Small Areas at level 2 (SA2s), or new schools allocated to areas of high growth and/or where planning information is available.

Tertiary education centres are expected to experience a capped growth per year.

2.2 The Zenith model and small area demographics

The Zenith model for the regions takes into account information describing the location and scale of various land uses, activities and demographics across the region in reflecting the travel choices of households and firms.

When applying the model, the region is divided into a number of zones whose size depends on the scope of impacts being investigated and the resolution of information available. Forecasts of demographic variables for each zone used in the model include:

- Population – number of persons whose usual place of residence is within a zone
- Households – number of households including occupied private dwellings and group households
- White Collar Workers – persons employed in occupations classified as 'white-collar'
- Blue Collar Workers – persons employed in occupations classified as 'blue-collar'
- Dependants (0-17) – number of non-workers aged up to 17 years
- Dependants (18-64) – number of non-workers aged 18 to 64 years
- Dependants (65+) – number of non-workers aged 65 and over
- Cars – number of private motor vehicles garaged at occupied private dwellings

The model uses this information to generate profiles of households of different structure, the members of which would each make different choices regarding the frequency, purpose, location, period, mode and route of travel.

The model also defines a number of activities for which travel is undertaken. A number of socioeconomic and land use variables are used to determine the level of participation or attraction for each activity in each zone, which influences the number of trips undertaken for a range of purposes.

These activity variables include:

- Employment by industry (14 custom categories based on 1-digit ANZSIC industry divisions)

- Educational enrolment by 3 levels
- Demand information for special generators:
  - Airport passengers (3 categories)
  - Tourism and recreation visitation rates (4 categories)
  - Freight and logistics terminals demand forecasts

VLC have defined a small area cadastre for the region, for which data for all of the land use and demographic variables is maintained for the forecast horizon. This is aggregated as needed to provide an efficient zoning system for application of the Zenith model.

VLC has undertaken extensive data acquisition, research and fieldwork to ensure the accuracy of the demographic and socioeconomic data that underpins the forecasting of travel demand in the region. For the small area cadastre, the data for 2011 is developed from and validated against the Australian Bureau of Statistics Census of Population and Housing.

VLC maintains its own scenarios of land use projections, integrating planning information from various local, state and federal government bureaux, supplemented with its knowledge of proposed developments.

The following sections summarise the population and employment characteristics and forecasts for the region by SA3.

2.3 Population

2.3.1 Population projections for the region

The region as a whole is comprised of 42 SA3's. These areas vary widely in nature, from inner city urban areas with very high population densities to rural-fringe areas characterised by small local centres interspersed with open space and agricultural production areas.

The following sections summarise the population characteristics and projections for SA3's in the region.

Table 2-1 provides population estimates for the region by SA3 for 2011 and 2031.

These tables also show the absolute growth in population and the equivalent average annual growth rate.

The population for metropolitan Melbourne and Geelong in 2011 was approximately 4.4 million, projected to increase to approximately 6.3 million in 2031. The Melbourne metropolitan area accounts for 4.2million in 2011, and is expected to grow to 5.9 million by 2031, which represents 94.1 and 94.4 percent of the total modelled population for 2011 and 2031 respectively.

Figure 2-1 is a spatial depiction of the expected population growth by small area for the Melbourne metropolitan area.

The highest projected rates of growth are expect to occur in the Growth Areas, i.e. Wyndham and Melton in the west and north-west; Hume, and Whittlesea in the north and Casey and Cardinia in the south-east. High population growth is also expected in the Melbourne CBD and the inner suburbs of Melbourne, with Maribyrnong, Brunswick and Yarra exhibiting higher growth rates than the average 1.7% per annum for the region.

In the regional Victoria, population growth in the major regional centres of Geelong, Ballarat and Bendigo is also expected to increase significantly.

Table 2-1: Existing and projected population in the region

SA3	2011	2031	Growth	%	AAGR
Melbourne City	99,830	217,491	+117,661	+118%	+4.0%
Port Phillip	98,287	135,531	+37,244	+38%	+1.6%
Hobsons Bay	83,906	101,861	+17,955	+21%	+1.0%
Maribyrnong	74,362	118,027	+43,665	+59%	+2.3%
Essendon	63,601	83,729	+20,128	+32%	+1.4%
Brunswick - Coburg	83,274	118,395	+35,120	+42%	+1.8%
Yarra	81,332	115,499	+34,166	+42%	+1.8%
Stonnington - West	60,454	79,818	+19,364	+32%	+1.4%
Stonnington - East	41,199	52,222	+11,023	+27%	+1.2%
Glen Eira	145,261	170,491	+25,231	+17%	+0.8%
Bayside	98,003	112,442	+14,439	+15%	+0.7%
Kingston	114,838	134,130	+19,293	+17%	+0.8%
Dandenong	174,741	235,524	+60,783	+35%	+1.5%
Monash	172,164	201,055	+28,891	+17%	+0.8%
Boroondara	170,977	195,700	+24,724	+14%	+0.7%
Darebin - South	49,535	61,809	+12,274	+25%	+1.1%
Darebin - North	93,149	125,719	+32,570	+35%	+1.5%
Moreland - North	69,261	93,561	+24,300	+35%	+1.5%
Keilor	57,627	68,778	+11,152	+19%	+0.9%
Brimbank	184,139	211,855	+27,716	+15%	+0.7%
Banyule	124,877	142,402	+17,525	+14%	+0.7%
Manningham - West	92,122	108,261	+16,139	+18%	+0.8%
Manningham - East	28,039	28,490	+451	+2%	+0.1%
Whitehorse - West	95,894	119,936	+24,041	+25%	+1.1%
Whitehorse - East	61,786	68,562	+6,776	+11%	+0.5%
Maroondah	107,991	129,032	+21,041	+19%	+0.9%
Knox	157,462	177,599	+20,137	+13%	+0.6%
Casey - North	130,860	156,711	+25,851	+20%	+0.9%
Casey - South	131,042	274,971	+143,929	+110%	+3.8%

SA3	2011	2031	Growth	%	AAGR
Cardinia	78,137	165,034	+86,896	+111%	+3.8%
Yarra Ranges	150,393	168,664	+18,270	+12%	+0.6%
Nillumbik - Kinglake	68,943	73,825	+4,882	+7%	+0.3%
Whittlesea - Wallan	175,422	378,333	+202,911	+116%	+3.9%
Tullamarine - Broadmeadows	139,725	223,055	+83,330	+60%	+2.4%
Sunbury	39,209	79,002	+39,793	+101%	+3.6%
Melton - Bacchus Marsh	125,858	271,234	+145,376	+116%	+3.9%
Wyndham	173,690	371,852	+198,162	+114%	+3.9%
Melbourne region	*3,897,393*	*5,570,602*	*+1,673,209*	*+43%*	*1.8%*
Geelong	175,137	228,043	+52,905	+30%	1.3%
Surf Coast - Bellarine Peninsula	74,332	100,125	+25,793	+35%	1.5%
Barwon - West	13,991	23,714	+9,723	+70%	2.7%
Geelong region	*263,460*	*351,882*	*+88,422*	*+34%*	*1.5%*
Mornington Peninsula	151,551	191,280	+39,729	+26%	1.2%
Frankston	132,050	154,021	+21,971	+17%	0.8%
Mornington Peninsula region	*283,601*	*345,301*	*+61,700*	*+22%*	*1.0%*
Total SA3	*4,444,455*	*6,206,085*	*+1,761,631*	*+40%*	*1.7%*

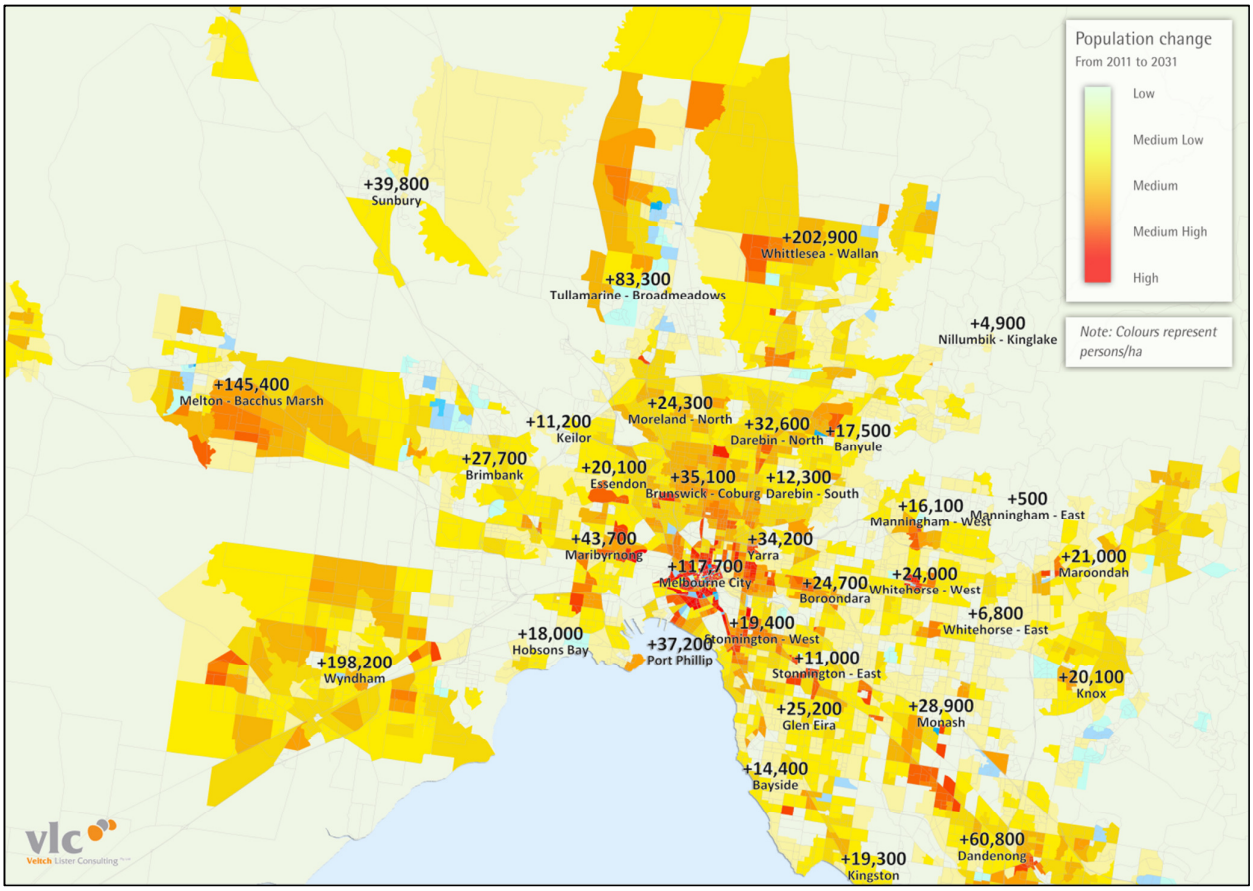

Figure 2-1: Projected population growth in metropolitan Melbourne and Geelong between 2011 and 2031

2.4 Employment

VLC has prepared forecasts for employment, consistent with the population projections constrained to the ABS B series forecast. The employment forecasts are based on projected levels of employment self-containment within each LGA, which recognise the structure planning of local authorities and the longer term infrastructure and development planning by the state government.

2.4.1 Employment characteristics and projections for the region

The Zenith model requires employment estimates and projection across a range of industries and occupations for the region. As well as indicating the number of jobs, this is also indicative of the opportunities to participate in a range of commercial and social activities, such as education, business, shopping, dining and entertainment, health and recreation, as well as activities generating freight.

Table 2-2 summarises existing and projected employment in the region as a whole. Accordingly the employment in Victoria is expected to grow by approximately 2.2 percent per annum over the projection period.

Table 2-2: Existing and Projected Employment in the Region

SA3	2011	2031	Growth	%	AAGR
Melbourne City	406,286	697,363	+291,077	+72%	2.7%
Port Phillip	97,297	122,663	+25,367	+26%	1.2%
Hobsons Bay	35,284	42,439	+7,155	+20%	0.9%
Maribyrnong	35,151	56,097	+20,946	+60%	2.4%
Essendon	21,535	35,339	+13,805	+64%	2.5%
Brunswick - Coburg	21,255	39,761	+18,506	+87%	3.2%
Yarra	69,497	120,717	+51,220	+74%	2.8%
Stonnington - West	32,074	46,659	+14,585	+45%	1.9%
Stonnington - East	23,212	30,754	+7,542	+32%	1.4%
Glen Eira	38,024	55,900	+17,876	+47%	1.9%
Bayside	30,126	41,354	+11,228	+37%	1.6%
Kingston	67,949	95,586	+27,637	+41%	1.7%
Dandenong	99,079	151,802	+52,723	+53%	2.2%
Monash	106,152	156,572	+50,421	+47%	2.0%
Boroondara	74,505	101,817	+27,312	+37%	1.6%
Darebin - South	13,683	13,746	+62	+0%	0.0%
Darebin - North	34,941	57,356	+22,415	+64%	2.5%
Moreland - North	14,724	19,253	+4,529	+31%	1.3%
Keilor	24,206	34,431	+10,225	+42%	1.8%
Brimbank	44,840	81,539	+36,700	+82%	3.0%
Banyule	44,786	65,514	+20,728	+46%	1.9%
Manningham - West	23,373	36,791	+13,418	+57%	2.3%
Manningham - East	5,210	6,981	+1,772	+34%	1.5%
Whitehorse - West	49,009	71,559	+22,550	+46%	1.9%
Whitehorse - East	24,333	39,677	+15,343	+63%	2.5%
Maroondah	44,970	67,466	+22,496	+50%	2.0%
Knox	68,832	84,033	+15,201	+22%	1.0%
Casey - North	35,824	56,335	+20,512	+57%	2.3%
Casey - South	19,057	38,217	+19,160	+101%	3.5%

SA3	2011	2031	Growth	%	AAGR
Cardinia	18,359	35,587	+17,228	+94%	3.4%
Yarra Ranges	43,612	60,216	+16,604	+38%	1.6%
Nillumbik - Kinglake	16,081	22,100	+6,019	+37%	1.6%
Whittlesea - Wallan	41,665	89,044	+47,378	+114%	3.9%
Tullamarine - Broadmeadows	70,181	118,156	+47,975	+68%	2.6%
Sunbury	7,694	14,208	+6,514	+85%	3.1%
Melton - Bacchus Marsh	18,876	46,080	+27,204	+144%	4.6%
Wyndham	46,300	87,918	+41,619	+90%	3.3%
Melbourne region	***1,867,982***	***2,941,032***	***+1,073,051***	***+57%***	***2.3%***
Geelong	103,256	127,907	+24,651	+24%	1.1%
Surf Coast - Bellarine Peninsula	19,749	28,571	+8,821	+45%	1.9%
Barwon - West	4,268	6,097	+1,829	+43%	1.8%
Geelong region	***127,274***	***162,574***	***+35,301***	***+28%***	***1.2%***
Mornington Peninsula	48,193	69,481	+21,288	+44%	1.8%
Frankston	42,353	73,256	+30,903	+73%	2.8%
Mornington Peninsula region	***90,547***	***142,737***	***+52,190***	***+58%***	***2.3%***
Total SA3	***2,085,802***	***3,246,344***	***+1,160,541***	***+56%***	***2.2%***

Similar to the expected population growth the employment opportunities align with the Growth Areas; with high growth further expected in inner Melbourne. Of note is the expected growth in the employment identified in the recently released *Plan Melbourne*, i.e. Parkville, Monash, Dandenong South, La Trobe, Sunshine and East Werribee.

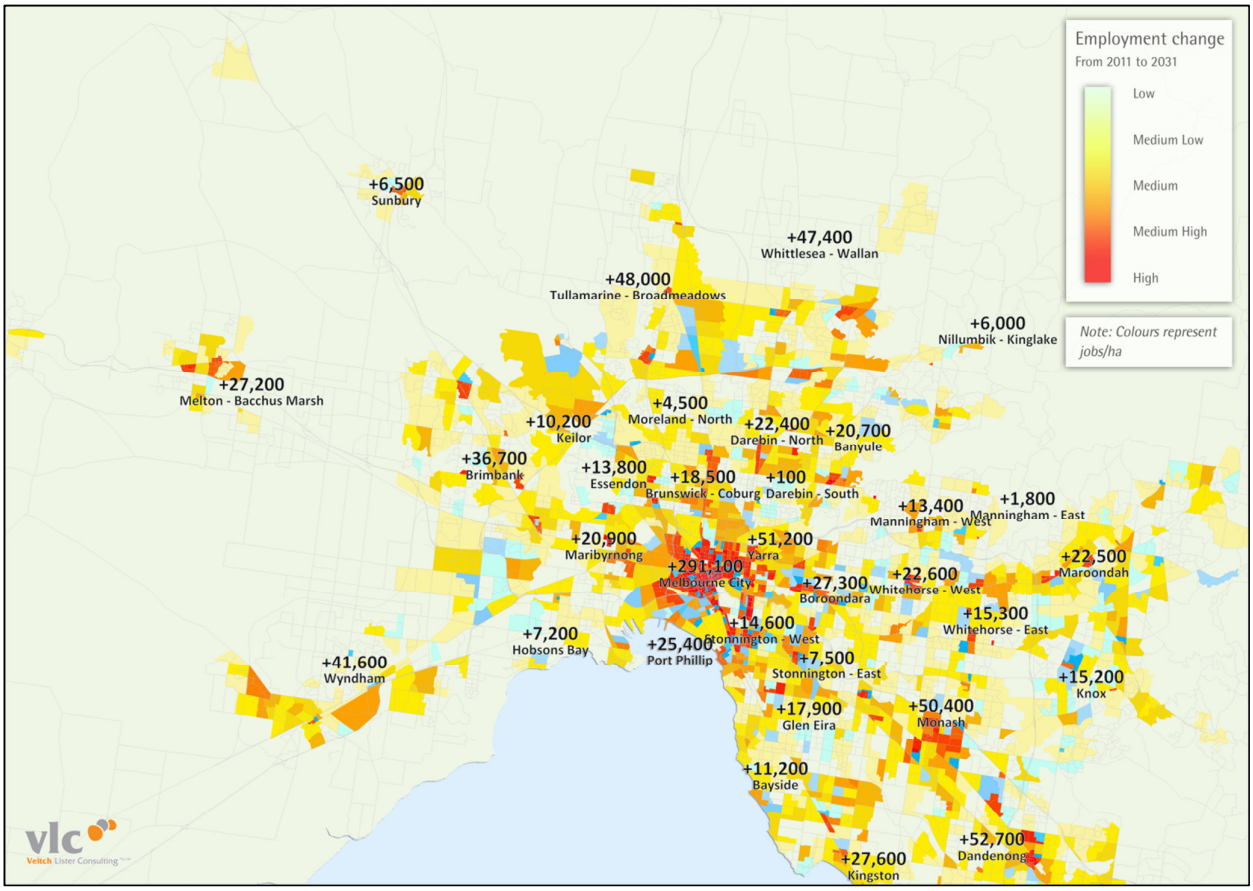

Figure 2-2: Projected employment growth in metropolitan Melbourne and Geelong between 2011 and 2031

3. Assumed base case transport networks

This section of the report describes the transport network and service improvements for metropolitan Melbourne and regional Victoria that have been assumed for the AIA base case networks. In order to appropriately assess the priorities for development of the transport network under the planned strategies for urban growth, the base case assumes a balance of committed future works, as well as those that are required to support the development of urban growth centres.

Table 3-1 summarises the major funded and committed works across the region. A full listing of all works (i.e. including minor projects) is provided in Appendix A of the report. Figure 3-1 clearly indicates the location of each of the proposed projects.

3.1 Road network assumptions

Table 3-1: Major new transport infrastructure included in the 2031 low investment scenario

Project Nr	Project Description
1.	Cranbourne-Pakenham Rail Corridor project
2.	M80 Ring Rd upgrade (widening)
3.	Western Hwy duplication – Ballarat to Stawell
4.	Metro Level Crossing Blitz - Blackburn Rd | Burke Rd | North Rd
5.	Metropolitan grade separations - Mitcham Rd & Rooks Rd | Springvale Rd
6.	Princes Hwy duplication project – Winchelsea to Colac
7.	Main Road Level Crossing Removal
8.	Western Hwy realignment – Anthonys Cutting (Melton to Bacchus Marsh)
9.	Goulburn Valley Nagambie Bypass
10.	Princes Hwy East – Traralgon to Sale duplication
11.	Princes Hwy West Stage 1 - Waurn Ponds to Winchelsea
12.	Dingley Bypass - Warrigal Rd to Westall Rd
13.	Geelong Ring Rd Stage 4C – Geelong Ring Rd to Surf Coast Hwy
14.	Calder Hwy interchange at Ravenswood
15.	Koo Wee Rup Bypass
16.	Breakwater Road – upgrade
17.	Geelong Ring Rd Stage 4B – Anglesea Rd to Princes Hwy West
18.	Peninsula Link
19.	Port-Rail shuttle (metropolitan intermodal system)
20.	Clyde Rd duplication – High St to Kangan Dr
21.	Narre Warren Cranbourne Rd duplication - Pound Rd to Thompson Rd

Project Nr	Project Description
22.	South Gippsland Hwy upgrade – Sale to Longford
23.	Bass Hwy duplication Stage 7 – Woolmer Rd to Phillip Island Rd

Note: The full list of projects is included as Appendix A.
CityLink widening was announced after the modelling assessment

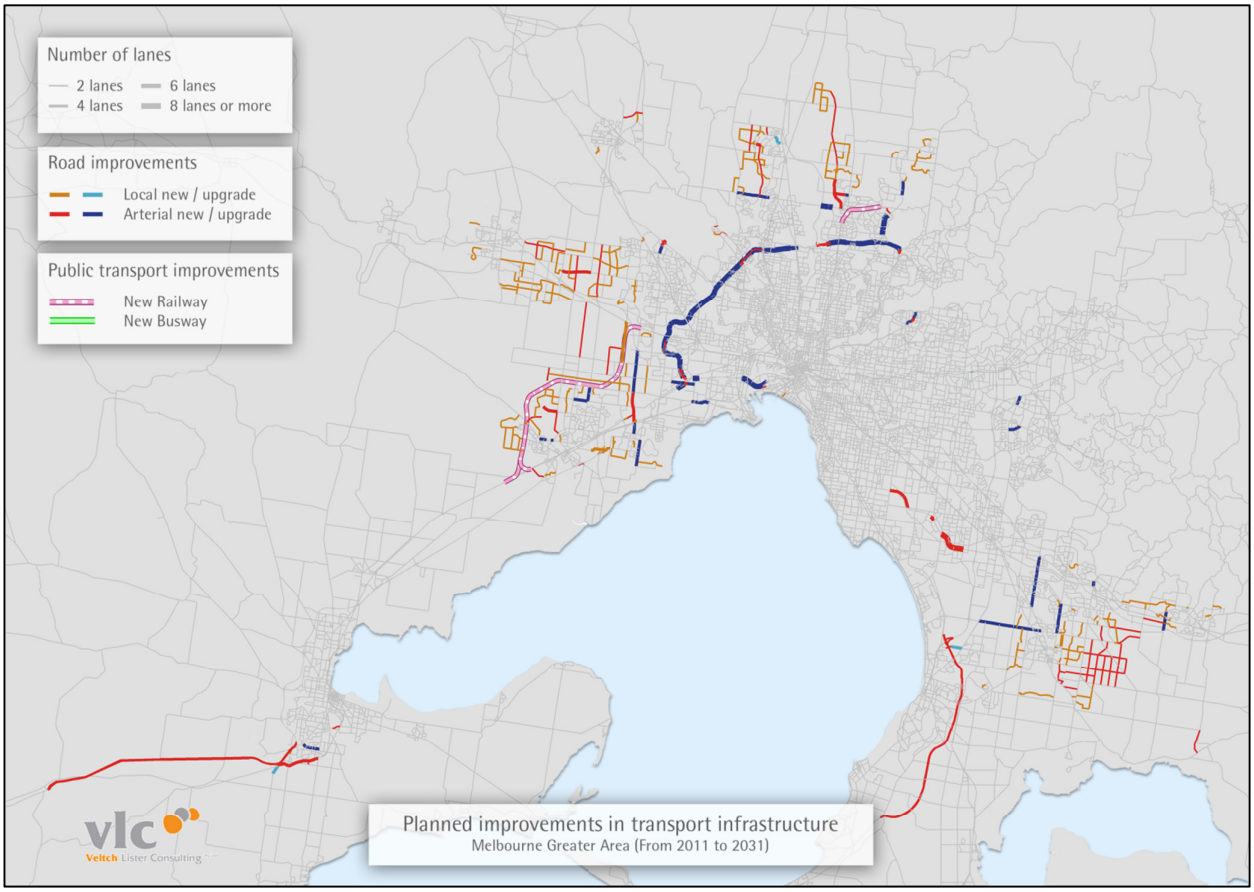

Figure 3-1: New transport infrastructure included in 2031 base case network

3.2 Public transport network assumptions

The major public transport infrastructure enhancements are listed in Table 3-2.

Table 3-2: Major new public transport infrastructure included in the 2031 network

Item	Description
Rail	Cranbourne-Pakenham Rail Corridor project
PT002	Regional Rail Link (Tarneit and Manor Lakes Station)
PT004	Sunbury Electrification and Extension (Calder Park Station) - Stage 1
PT005	South Morang Extension
PT006	Maryborough Line improvements (Talbot Station)
PT010	New Stations to existing lines (Cardinia Rd, Lynbrook & Williams Landing)
PT018	Growth Area Bus Infrastructure

4. Pricing and behavioural assumptions

When individuals make choices regarding how, when and where to travel, they take into account the costs and convenience of each of the options available. These considerations may include the value of time spent travelling, the cost of fuel, public transport fares, parking charges and tolls, as well as longer term costs associated with vehicle ownership and use. Likewise firms that schedule commercial travel take into account the costs associated with operation and maintenance of the vehicle and labour costs of the driver or crew, as well as the efficiency of travel on each route and the cost of tolls.

The modelling of future travel in Victoria for the Australian Infrastructure Audit makes certain assumptions about how these costs will change, and how preferences affecting travel behaviour may evolve over time. These assumptions are based on available evidence and are intended to reflect the current policies of all levels of government.

4.1 Value of travel time

The value of time spent travelling and its influence on travel behaviour depends on a range of factors, such as the reason for travel, and the use to which the time might otherwise be put. The modelling of travel choices reflects preferences that imply different values of travel time for each trip purpose and for each mode of travel, including walking and waiting associated with using public transport and the use of toll roads.

There is a significant volume of behavioural research that suggests values of travel time increase with increasing income. For the purposes of the modelling on this project VLC has assumed that values of travel time remain at current levels in the future. The one exception is in relation to peoples' increased willingness to pay tolls in the future, as a result of increasing real average weekly earnings. In this case (i.e. predicting whether people will choose a tolled or untolled route) we have adopted the UK Department for Transport recommendation that an elasticity of 0.8 be used between the value of time and increases in real average weekly earnings. In other words, if real average weekly earnings go up by 10% then it should be assumed that the value of time will go up by 8%.

4.2 Fuel costs

There are a number of influences, including both global and local conditions, which impact the unit cost of fuel in urban transport. The most significant influences on the costs of fuel include:

- real increases in the price of transport fuels
- reduction in the rate of fuel consumption due to improved vehicle efficiency and increased use of more efficient fuels within the vehicle fleet

These two factors act to counter each other, and with insufficient evidence to indicate which will dominate in future, may well result in no real change in the average unit costs of fuel. The base case for the AIA has therefore assumed no real change in the unit of costs of fuel in future.

4.3 Public transport fares

While there have been real increases in public transport fares during recent years, there is a growing concern to maintain prices and provide off-peak discounts to encourage greater use of public transport. In order to maintain a neutral position on pricing, the base case for the AIA has assumed no real change in public transport fares.

4.4 Parking charges and supply

The availability and cost of parking can have a strong influence on the choice of destination or mode used for travel, particularly to CBD destinations, where high parking costs and a high level of public transport accessibility contribute to public transport being relatively attractive.

There are however, strong pressures on price arising from increasing demand and constrained supply of parking in the CBD and major activity centres.

With increasing demand and constrained supply of parking spaces, it is reasonable to expect that parking costs within the CBD and at major activity centres in the metropolitan area will experience real increases of 1-2% per annum. The base case modelling for the AIA has assumed a real annual increase of 1.5% in parking charges.

4.5 Toll prices

Table 4-1 summarises the existing level of tolls and those anticipated to prevail in 2031.

Table 4-1: Toll prices in 2011 dollars

Toll Plaza	Toll Point	Cars	LCV	HCV
City Link	Gantry 1A:	173	276	329
	Gantry 1B:	173	276	329
	Gantry 2A:	173	276	329
	Gantry 2B:	173	276	329
	Gantry 3A:	216	346	411
	Gantry 3B:	216	346	411
	Gantry 4A:	173	276	329
	Gantry 4B:	281	449	534
	Gantry 5A & 5B:	389	623	739
	Gantry 6A:	173	276	329
	Gantry 6B:	173	276	329
	Gantry 7A:	173	276	329
	Gantry 8A:	108	173	205
	Gantry 8B:	108	173	205
	Gantry 9A:	108	173	205
	Gantry 9B:	390	623	739
EastLink	Boronia Rd to Burwood Hwy:	33	52	88
	Burwood Hwy to High St:	33	52	88
	Canterbury Rd to Boronia Rd:	33	52	88
	Dandenong Bypass to Greens Rd:	50	80	132
	Ferntree Gully Rd to Wellington Rd:	50	80	132

Toll Plaza	Toll Point	Cars	LCV	HCV
EastLink	Greens Rd to Thompson Rd:	115	185	307
	High Street to Ferntree Gully Rd:	50	80	132
	Maroondah Hwy to Canterbury Rd:	33	52	88
	Monash Fwy to Princes Hwy:	50	80	132
	Princes Hwy to Cheltenham Rd:	50	80	132
	Springvale Rd to Maroondah Hwy:	228	366	605
	Thompson Rd to Frankston Fwy:	115	185	307
	Wellington Rd to Monash Fwy:	50	80	132

The 2011 toll values are those which prevailed at the time; the 2031 tolls are those that apply in 2014 (i.e. existing tolls levels are assumed to be maintained).

4.6 Airport passenger demands

Travel demands associated with the region's airports are based upon forecasts of passenger demand by BITRE, categorised according to whether travel is for business, and for non-business travel, whether by residents of the region, or visitors.

The passenger demand estimates and forecasts assumed within the base case are provided in Table 4-2.

Table 4-2: Air passenger demand estimates and forecasts (average weekday)

Terminal	Year	Business	Local	Visitors	Total
Melbourne Domestic	2011	31,800	8,800	16,400	57,000
	2031	57,800	15,900	29,800	103,500
	(% increase)	82%	81%	82%	82%
Melbourne International	2011	3,700	4,000	6,300	14,000
	2031	10,200	10,800	17,200	38,200
	(% increase)	176%	170%	173%	173%
Avalon	2011	200	2,000	2,000	4,200
	2031	1,900	10,500	10,500	22,900
	(% increase)	850%	425%	425%	445%

5. Methodology

The use of VLC's Zenith Travel model provides insights into urban transport at a high level of aggregation. In order to allow for detailed analyses of the vast amount of data a number of spreadsheets have been created to inform the National Audit of Urban Infrastructure at different levels of data aggregation:

- Metrics from SA3 to SA3
- Key Model Statistics
- Corridor analysis
- Rail demand and supply analysis

This chapter describes the methodology.

5.1 Description of metrics

The Zenith model contains a wealth of information. This section describes the metrics and where applicable the calculations to generate these metrics.

5.1.1 Network (lane) kilometres

The Zenith model describes travel demands on individual links (sections of road) for roads generally carrying over 3,000 vehicles per day. The total number of kilometres this network encompasses is described in this metric. A link that can be travelled in both directions will be accounted for in each direction.

Network lane kilometres describe a similar metric but also take into account the number of lanes for each link and direction.

5.1.2 Demand

Demand is measured in trips. Depending on the mode of travel these trips can be either vehicular trips (car, light or heavy goods vehicles) or person trips (car driver or car passenger, public transport and active transport).

5.1.3 Speeds

Speeds can either be reported under free-flow or under congested conditions. The free-flow speeds are the input speeds to the travel model whereas the congested speeds are a result of traffic impeding other traffic.

5.1.4 Vehicle Kilometres Travelled (VKT), Passenger Kilometres Travelled (PKT)

The number of vehicle kilometres travelled is a key part of the network performance indicators. This metric is calculated by multiplying the demand on a link by the length of this link. In a similar way passenger kilometres travelled can be calculated.

5.1.5 Vehicle Hours Travelled (VHT), Passenger Hours Travelled (PHT) and Hours of Delay

The number of Vehicle Hours Travelled is calculated by multiplying the vehicle demand on a link by the time to traverse that link in the network. This metric can be reported either under free-flow or congested conditions. The difference between the Vehicle Hours Travelled under free-flow and congested conditions results in the Hours of Delay metric. Passenger Hours Travelled is a similar metric which is based on the passenger demand on a link.

5.1.6 Traffic Volume over Capacity Ratios

Volume over Capacity ratios or V/C ratios in short are calculated by dividing the vehicular demands by the capacity of a link. For peak periods the maximum peak hour demand is used to calculate the V/C ratios. In the off-peak situation the average demand is used. It is worth noting that goods vehicles are weighted the same as cars. This might cause lower than actual V/C ratio's on roads with high volumes of goods vehicles. However the weighting of goods vehicles would also be included the capacity of a road, the magnitude of difference therefore is expected to be generally limited. A public transport trip that utilises a car to access a stop is excluded from the vehicular demands. Buses are also excluded from the vehicular demands. This could potentially result in understated V/C ratios around stations and bus corridors but generally not to any significant degree.

5.1.7 Public Transport Volume over Capacity Ratios

Determining V/C ratios for public transport take into account the number of passengers on a particular service and the capacity of the vehicle used for that service. This capacity can either be expressed as seated or crush capacity. The seated capacity is total number of seats in a vehicle. The absolute maximum number of passengers a vehicle can (legally) carry is the crush capacity. Depending on the metric either the seated or crush capacity is used. The method to determine seated and crush capacities is described in Appendix C.

5.1.8 Level of Service (LOS)

An LOS analysis provides an indication of where the road network would fail to meet desired standards of service under the travel demands and traffic volumes forecast. By extension, it illustrates where such behavioural changes are likely to impact on forecasts to some degree, if these levels of congestion result in a change in travel behaviour.

The ability of a road to maintain high levels of service under increasing traffic levels depends upon its design standard and access controls, junction operation and coordination, degree of separation of conflicting movements, as well as its local environment and relation to connecting roads. Higher standards of roads, junctions and network management are able to provide better performance under similar levels of congestion (ratio of volume to capacity) than those of a lower standard. Austroads defines six threshold levels for standardised performance assessment, for which we describe how this affects driver behaviour, and provide typical threshold levels of congestion for three standards of roads.

Table 5-1: AustRoads Level of Service (LOS) definitions

Level of service		Threshold ratio of volume to capacity		
		Motorway	Arterial	Local
A	Drivers may travel at desired speed, and manoeuvre freely, experiencing no delay due to other traffic	0.50	0.40	0.35
B	Drivers will incur occasional minor delays and restrictions to manoeuvre due to other traffic	0.65	0.60	0.50
C	Drivers will experience interrupted travel, with minor delays and stops, but with network operating efficiently providing predictable travel times	0.85	0.75	0.65
D	Drivers will experience occasional major delays, with variable travel times due to conflicting traffic and volumes approaching capacity	1.00	0.90	0.80
E	Drivers will experience frequent major delays, with volumes at or exceeding capacity for short periods, unpredictable travel times	1.15	1.05	0.95
F	Drivers will experience severe congestion and delays, with volumes exceeding capacity for long periods, strong influence on route choice			

5.1.9 Fuel Consumption and Greenhouse Gas Emissions

Vehicle fleet mix can be expected to change reflecting the entry of hybrid, plug in hybrids and electric vehicles challenging the dominant market position of vehicles powered by an internal combustion engine (ICE). Most evidence available today is about hybrid vehicles. Hybrid cars use an ICE engine as well as electrical generators and motors. They are very fuel efficient using around 50 per less fuel in normal use than ICE powered cars and a similar amount less in GHG emissions, with performance differing by make.

The fuel efficiency and fleet mix assumptions used when estimating Greenhouse Gas Emissions in 2011 and 2031 are presented in Tables 5-2 and 5-3.

Table 5-2: Relative fuel intensity assumptions

Year	Mode	ICE	Hybrid	PHEV	Electric
2011	Cars	94.9%	87.1%	42.8%	0.0%
	Commercial vehicles	94.9%	88.4%	42.8%	0.0%
2031	Cars	76.9%	61.4%	22.8%	0.0%
	Commercial vehicles	76.9%	66.3%	22.8%	0.0%

Table 5-3: Fleet mix composition assumptions

Year	ICE	Hybrid	PHEV	Electric
2011	100.0%	0.0%	0.0%	0.0%
2031	80.5%	18.0%	1.5%	0.0%

5.2 Metrics by SA3 to SA3

This analysis disaggregated urban transport activity according to the origin and destination of trips to and from a pair of SA3s (ABS level 3 statistical areas).

Table 5-4 shows an example of the format of the data provided. Metrics are presented in matrix format where the horizontal rows contain the origin SA3 sectors and the vertical columns contain the destination SA3 sectors. A visual representation of the SA3 sectors is provided in Appendix C. For each origin & destination pair metrics are provided for 2011 and 2031 together with the absolute and relative growth between 2011 and 2031. Subtotals for the region are available together with a grand total for the modelled area.

The full matrix is available at:

vlc_yymmdd_01_MEL_Tables by SA3.xlsx

Table 5-4: Example of metrics by SA3 to SA3 (weekday person trips)

To SA3 sector

From SA3 sector	Melbourne City				Port Phillip			
	2011	2031	Diff	%Diff	2011	2031	Diff	%Diff
Melbourne City	496,647	921,664	+425,017	+86%	59,654	86,450	+26,796	+45%
Port Phillip	59,577	86,475	+26,898	+45%	146,646	214,491	+67,845	+46%
Hobsons Bay	21,651	25,068	+3,417	+16%	7,047	8,026	+979	+14%
Maribyrnong	27,618	40,756	+13,138	+48%	5,899	7,688	+1,788	+30%
Essendon	29,242	35,952	+6,710	+23%	3,473	3,707	+233	+7%
Brunswick - Coburg	29,197	38,068	+8,870	+30%	4,138	4,697	+559	+14%
Yarra	56,915	79,391	+22,476	+39%	11,339	14,266	+2,927	+26%
Stonnington - West	24,912	34,090	+9,178	+37%	24,668	30,230	+5,563	+23%
Stonnington - East	8,789	10,479	+1,691	+19%	7,024	7,159	+135	+2%
Glen Eira	30,416	36,308	+5,892	+19%	24,681	27,866	+3,185	+13%
Bayside	18,278	20,797	+2,519	+14%	14,354	15,229	+875	+6%
Kingston	12,802	16,984	+4,182	+33%	5,853	5,395	-458	-8%
Dandenong	12,131	16,172	+4,040	+33%	3,863	3,831	-32	-1%
Monash	20,105	23,298	+3,193	+16%	7,385	7,021	-365	-5%
Boroondara	44,619	49,215	+4,595	+10%	12,397	12,015	-382	-3%
Darebin - South	12,787	14,620	+1,833	+14%	2,270	2,311	+41	+2%

Full table continues down and to the right

All metrics are available for the morning peak (7-9am), the evening peak (4-6pm), interpeak and daily. Certain metrics are only available for certain activity and mode combinations. Table 5-5 details the availability of metrics by activity and mode combination.

Table 5-5: Availability of metrics by activity and mode combination

Metric	Activity	Modes
Demand, VKT, VHT	Work, Business, Other, Total	Car, Person Car, (Light, Heavy) Commercial Vehicles, Public Transport, Active Transport
Hours of Delay	Work, Business, Other, Total	Car
	Total	Commercial Vehicles
Fuel, Green House Gas Emissions	Total	Car, Commercial Vehicles

5.3 Corridor Analysis

All of the more major road corridors in Melbourne were identified and subjected to more detailed analysis in terms of how they perform in 2011 and 2031. Some corridors include more than one road route when routes are competing. For example, EastLink, Springvale Rd, and Stud Rd.

A total of 29 important corridors were identified, as shown in Figure 5-1.

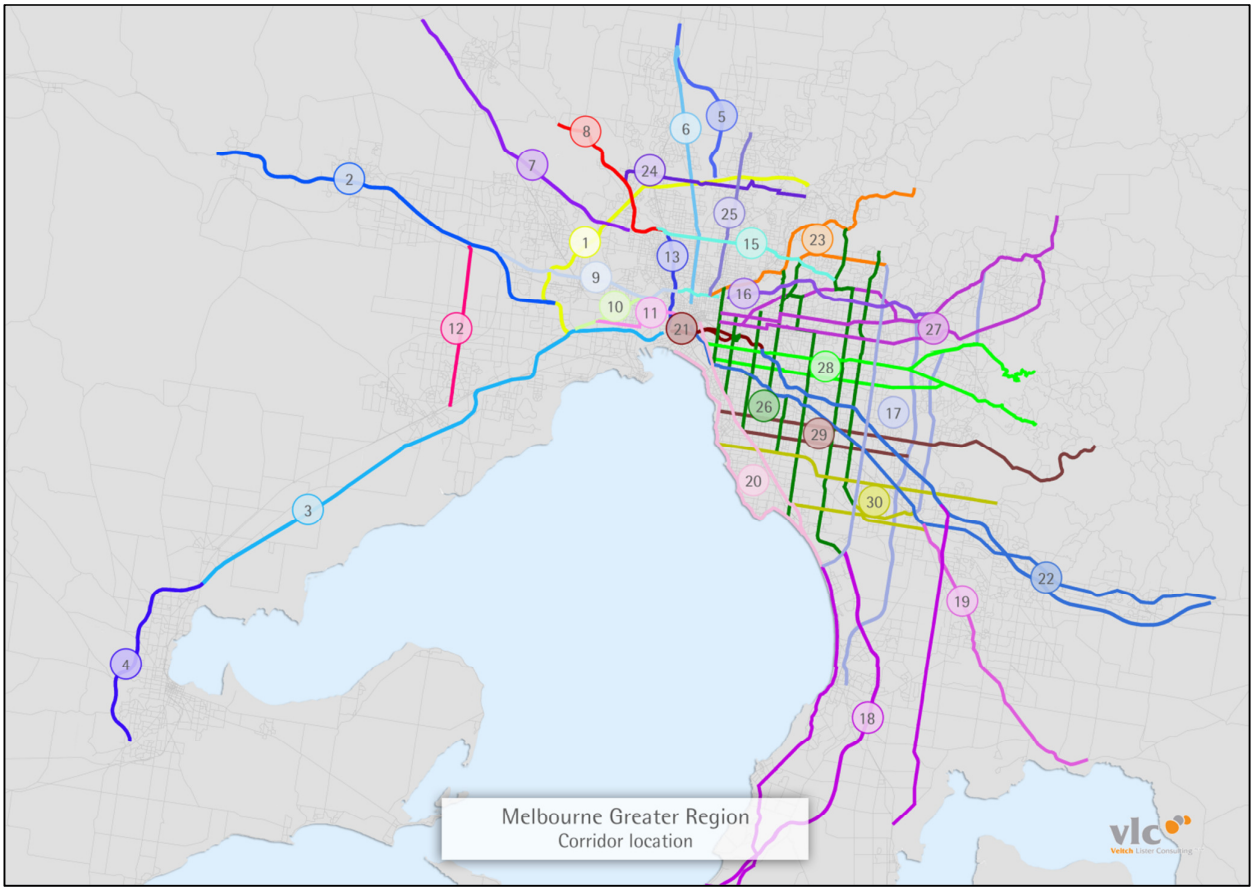

Figure 5-1: Corridor locations: Melbourne region

Each of the major roads in each corridor was then divided up into subsections, based on variations in the road's characteristics - such as the number of traffic lanes, posted speed and likely changes in traffic demand. How the roads in the inner southern corridor (the Nepean Hwy, Beach Road and the Esplanade) were split into subsections is shown in Figure 5-2.

The Zenith model has then been used to produce a number of metrics that, in combination, help define the importance of the various section of Melbourne's higher order road network, their economic contribution and how efficiently they perform in 2011 and 2031. Such information is important, as it guides transport planners to those portions of the road network that will in the future be generating large economic cost due to congestion, yet still be making a large economic contribution as a result of the number of vehicle-kilometres of travel they accommodate each weekday.

The full set of metrics produced for each subsection of road in each corridor are listed in Table 5-6.

The spreadsheet containing the metrics by road subsection for all the identified corridors in Melbourne is titled **vlc_yymmdd_02_MEL_Corridor Analysis.xlsx**

Figure 5-2: Subsections in Corridor 20 - Nepean Hwy and Beach Rd and Esplanade

Table 5-6: Metrics reported for major road subsections

Type	Metric
Corridor Type	Corridor Type
Length	Total Length (km)
Capacities (veh/hr)	Average Hourly Capacity per km
Traffic volumes weighted by vehicle kilometers (busiest peak hour)	Average Peak Hour Traffic Volumes Average Peak Hour CV Volumes % Average Peak Hour CV Volumes
Traffic speeds under freeflow (modelled) and congested conditions	Average Speed Freeflow (kph) Average Speed Congested (kph)
Travel Times under freeflow (modelled) and congested conditions	Total Travel Time Freeflow (min) Total Travel Time Congested (min)
Network performance daily	Total Vehicle Kilometers Travelled (km) Total Vehicle Hours Travelled Congested (hrs) Total Vehicle Hours Travelled Freeflow (hrs) Total hours of delay (hrs)
Level of Service (Traffic) (busiest peak hour)	Minimum Level of Service Average Level of Service Maximum Level of Service
Traffic V/C (busiest peak hour)	Weighted V/C Traffic

5.4 Rail analysis

Based on the seating capacity and crush capacity of Melbourne's trains (as described in Appendix B), the Zenith model has been used to assess the degree of crowding and overcrowding across the entire rail network.

Passenger loading profiles have been produced for all lines in both the AM and PM peaks for both 2011 and 2031. Examples for the Pakenham Line are presented in Figures 5-3 and 5-4.

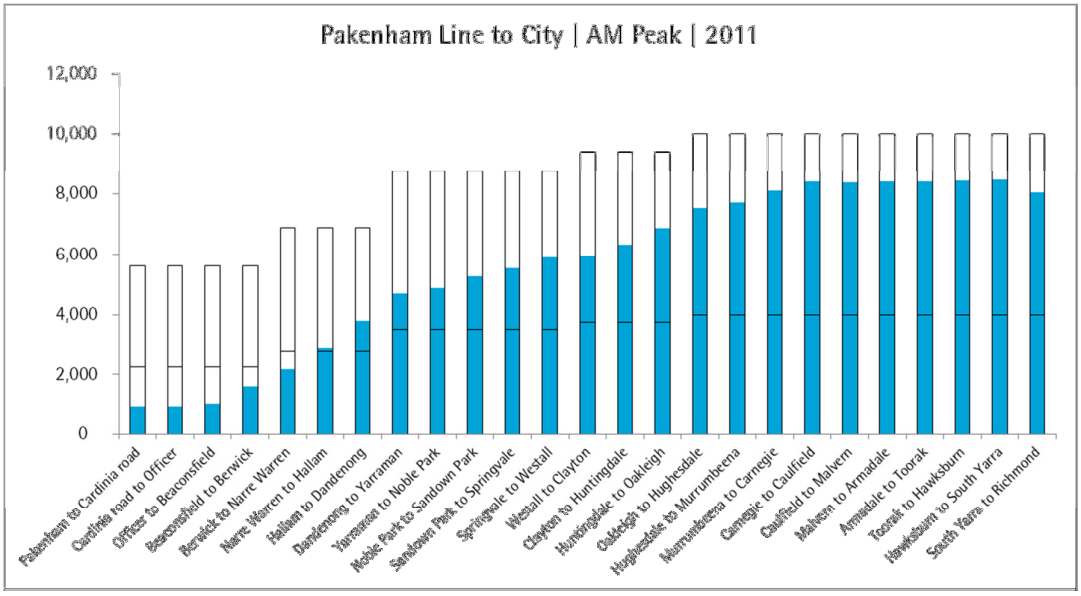

Figure 5-3: Passenger loading profile - Pakenham Line in the AM peak (2011)

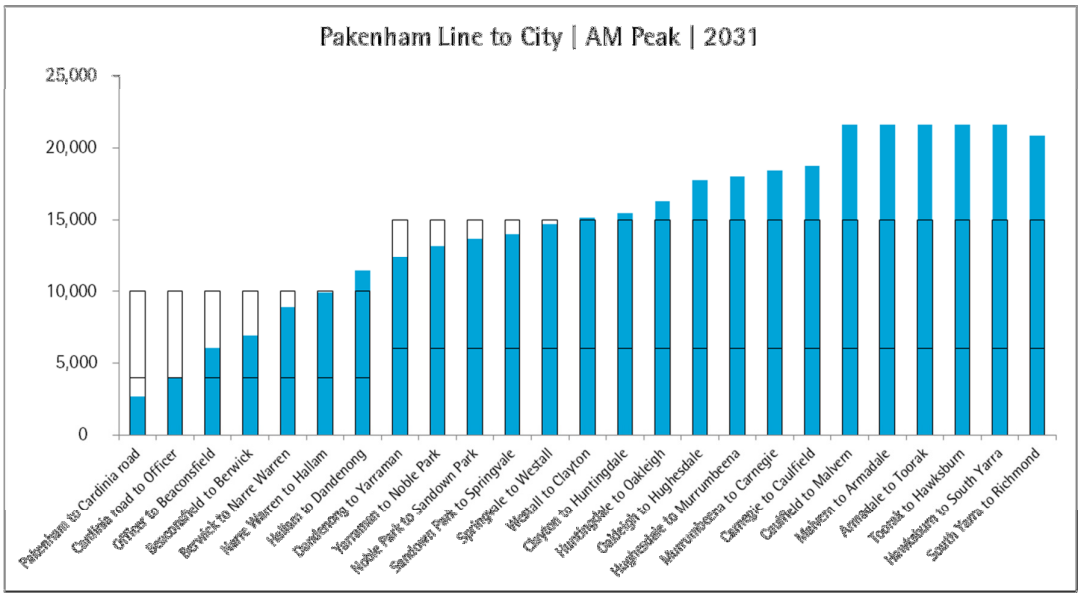

Figure 5-4: Passenger loading profile - Pakenham Line in the AM peak (2031)

6. Changes in travel demand

6.1 Introduction

This section of the report provides the Zenith model's travel estimates and forecasts for 2011 and 2031 for metropolitan Melbourne and Geelong, as well as the model's high level assessment of the performance of the transport network for these two time horizons under a *low transport network investment* scenario. More detailed information on travel demand and network performance at specific locations in the road and public transport networks is provided in Sections 7 and 8 of the report.

6.2 Forecast growth in person travel by mode (2011-2031)

Table 6-1 summarises the model's estimates of person trips by mode and by time of day for the modelled area.

Table 6-1: Change in person travel in the modelled area (2011 - 2031)

Modal Statistics		2011	2031	Change	% change
Person car trips	AM	1,724,532	2,310,086	+585,554	+34%
	OP[1]	8,008,307	11,130,809	+3,122,502	+39%
	PM	1,677,538	2,239,849	+562,311	+34%
	24H	11,410,377	15,680,744	+4,270,367	+37%
PT trips	AM	329,200	575,820	+246,619	+75%
	OP	792,401	1,511,347	+718,946	+91%
	PM	274,347	487,599	+213,252	+78%
	24H	1,395,949	2,574,766	+1,178,818	+84%
Walk/cycling trips	AM	250,537	361,126	+110,590	+44%
	OP	1,412,112	2,053,440	+641,328	+45%
	PM	250,791	359,710	+108,919	+43%
	24H	1,913,439	2,774,276	+860,836	+45%
Total trips	AM	2,304,269	3,247,031	+942,762	+41%
	OP	10,212,819	14,695,596	+4,482,777	+44%
	PM	2,202,676	3,087,158	+884,482	+40%
	24H	14,719,765	21,029,786	+6,310,021	+43%

The table indicates that while the total number of trips are projected to increase by 43 percent, the greatest increase is expected in public transport (84 percent) and active transport trips (45 percent).

[1] OP refers to the off-peak, which includes both the interpeak and the evening peak periods

Table 6-2 gives an indication of the relative mode share for 2011 and 2031.

Table 6-2: Change in mode share (2011 – 2031)

Mode share		2011	2031
Person car trips	AM	75%	71%
	OP	78%	76%
	PM	76%	73%
	24H	78%	75%
PT trips	AM	14%	18%
	OP	8%	10%
	PM	12%	16%
	24H	9%	12%
Walk/cycling trips	AM	11%	11%
	OP	14%	14%
	PM	11%	12%
	24H	13%	13%

Private car travel dominates the person trips both in 2011 and 2031, with more than 70 percent of person trips undertaken by car. However the mode share decreases, from 78 percent in 2011 to 75 percent in 2031 for the daily trips.

The public transport mode share increases marginally over this period, from 9 to 12 percent for daily travel, with higher mode shares in the peak periods (14 and 18 percent in the AM Peak in 2011 and 2031 respectively) reflecting higher levels of service in the peaks and relative road congestion.

6.3 Growth in vehicular travel and road network performance in 2011 and 2031

Growth in vehicular travel is summarised in Table 6-3 overleaf. The results indicate that:

a) 94 percent of all vehicular trips in 2011 are car trips; this stays relatively constant to 2031.

b) Overall daily car trips increase by 36 percent; from approximately 8.6 million trips to 11.7 million in 2011 and 2031 respectively.

c) The anticipated increase in trips is similar for the off-peak and slightly lower for the peak periods (38 and 32 percent respectively).

d) Vehicle hours increase considerably reflecting a significant decline in average network speeds across the network.

e) The decline is most pronounced in the peak periods with an increase of 64 percent during the AM peak.

Table 6-3: Growth in vehicular travel in the Modelled Area

Traffic statistics		2011	2031	% change
Car trips	AM	1,288,939	1,702,669	+32%
	OP	5,949,305	8,215,687	+38%
	PM	1,318,717	1,736,994	+32%
	24h	8,556,961	11,655,350	+36%
Car kilometres	AM	16,172,853	22,059,722	+36%
	OP	74,069,166	106,319,641	+44%
	PM	16,634,050	22,835,031	+37%
	24h	106,876,069	151,214,393	+41%
Car hours	AM	401,989	659,054	+64%
	OP	1,427,039	2,190,677	+54%
	PM	389,386	636,448	+63%
	24h	2,218,414	3,486,178	+57%
Car Average assigned speed (kph)	AM	40.2	33.5	-17%
	OP	51.9	48.5	-6%
	PM	42.7	35.9	-16%
	24h	48.2	43.4	-10%
Commercial Vehicle trips	AM	74,238	96,161	+30%
	OP	358,875	464,800	+30%
	PM	86,835	113,153	+30%
	24h	519,948	674,115	+30%
Commercial Vehicle kilometres	AM	1,234,285	1,682,484	+36%
	OP	6,623,789	9,050,099	+37%
	PM	1,402,726	1,933,140	+38%
	24h	9,260,800	12,665,723	+37%
Commercial Vehicle hours	AM	25,745	40,935	+59%
	OP	112,924	164,535	+46%
	PM	28,449	45,185	+59%
	24h	167,118	250,655	+50%

Traffic statistics		2011	2031	% change
Commercial Vehicle Average assigned speed (kph)	AM	47.9	41.1	-14%
	OP	58.7	55.0	-6%
	PM	49.3	42.8	-13%
	24h	55.4	50.5	-9%
Total trips	AM	1,363,177	1,798,830	+32%
	OP	6,308,180	8,680,487	+38%
	PM	1,405,552	1,850,147	+32%
	24h	9,076,909	12,329,465	+36%
Total kilometres	AM	17,407,138	23,742,206	+36%
	OP	80,692,955	115,369,739	+43%
	PM	18,036,776	24,768,171	+37%
	24h	116,136,869	163,880,116	+41%
Total hours	AM	427,733	699,988	+64%
	OP	1,539,964	2,355,212	+53%
	PM	417,835	681,633	+63%
	24h	2,385,532	3,736,833	+57%
Total Average assigned speed (kph)	AM	40.7	33.9	-17%
	OP	52.4	49.0	-7%
	PM	43.2	36.3	-16%
	24h	48.7	43.9	-10%

6.4 Growth in public transport ridership (2011-2031)

Table 6-4 overleaf summarises the modelled base year and the 2031 public transport trips for the modelled area in terms of patronage and network supply indicators by mode and by time of day.

The following points are notable:

a) Total public transport boardings are expected to nearly double (+95%) over the period. This is slightly higher than the 84 percent increase in public transport trips, thus indicating a higher level of interchanging.

b) The highest growth is expected on the regional services (+271%) doubling its share of total rail trips from 4 to 8 percent over the period.

c) The rate of growth for rail boardings is higher than the total public transport increase, i.e. 103 percent, while the increase for tram boardings is lower at 77 percent. The increase in bus boardings is on par with the increase in total boardings at 97 percent.

d) The high increase in regional passengers could be an indication of the expected growth in regional Victoria and the continued interdependency between the regional towns and Melbourne.

Table 6-4: Predicted growth in public transport ridership (2011-2031)

Public transport statistics		2011	2031	% change
Total PT boardings	AM	474,056	874,804	+85%
	OP	1,184,406	2,385,208	+101%
	PM	424,509	792,863	+87%
	24h	2,082,970	4,052,875	+95%
In-vehicle passenger kilometres	AM	6,045,338	12,510,188	+107%
	OP	12,617,805	29,370,471	+133%
	PM	5,346,958	11,230,529	+110%
	24h	24,010,100	53,111,188	+121%
In-vehicle passenger hours	AM	158,974	327,730	+106%
	OP	359,127	810,718	+126%
	PM	138,098	285,290	+107%
	24h	656,199	1,423,738	+117%
Total VLine boardings	AM	13,068	46,536	+256%
	OP	19,674	76,010	+286%
	PM	11,683	42,452	+263%
	24h	44,425	164,998	+271%
Total metropolitan rail boardings	AM	250,288	445,225	+78%
	OP	488,830	1,032,445	+111%
	PM	220,865	398,570	+80%
	24h	959,984	1,876,239	+95%
Total Rail boardings	AM	263,357	491,761	+87%
	OP	508,503	1,108,455	+118%
	PM	232,548	441,022	+90%
	24h	1,004,408	2,041,237	+103%

Public transport statistics		2011	2031	% change
Total Bus boardings	AM	107,079	206,601	+93%
	OP	331,196	653,197	+97%
	PM	73,535	148,442	+102%
	24h	511,811	1,008,240	+97%
Total Tram boardings	AM	103,620	176,442	+70%
	OP	344,706	623,557	+81%
	PM	118,426	203,399	+72%
	24h	566,752	1,003,398	+77%

Table 6-5 shows the change in mode share for public transport trips from 2011 to 2031. The level of mode share is not expected to change much, although slight increases are anticipated for rail and bus while the tram mode share is expected to decrease slightly

Table 6-5: Change in public transport mode share (2011 – 2031)

Public transport mode split		2011	2031
VLine	AM	3%	5%
	OP	2%	3%
	PM	3%	5%
	24h	2%	4%
Metropolitan rail	AM	53%	51%
	OP	41%	43%
	PM	52%	50%
	24h	46%	46%
Total rail	AM	56%	56%
	OP	43%	46%
	PM	55%	56%
	24h	48%	50%
Bus	AM	23%	24%
	OP	28%	27%
	PM	17%	19%
	24h	25%	25%
Tram	AM	22%	20%
	OP	29%	26%
	PM	28%	26%
	24h	27%	25%

Table 6-6 shows the extent to which in-service public transport vehicle-kilometres are expected to increase between 2011 and 2031.

It should be noted that, under the *low transport network investment* scenario, only committed plans and short term service frequency improvements have been assumed. This together with the committed extensions of the rail network and expansion of bus services in the growth areas, as described in Section 3 of this report, results in the following increases of the in-service public transport vehicle-kilometres between 2011 and 2031.

Table 6-6: Increase in in-service public transport vehicle-kilometres (2011-2031)

Public transport statistics		2011	2031	% change
In-Service Kilometres by VLine Rail	AM	5,411	9,543	+76%
	OP	20,477	47,371	+131%
	PM	5,125	9,543	+86%
	24h	31,013	66,456	+114%
In-Service Kilometres by metropolitan Rail	AM	10,889	12,163	+12%
	OP	38,541	58,639	+52%
	PM	9,972	12,165	+22%
	24h	59,402	82,967	+40%
In-Service Kilometres by Rail	AM	16,299	21,706	+33%
	OP	59,018	106,010	+80%
	PM	15,098	21,707	+44%
	24h	90,415	149,423	+65%
In-Service Kilometres by Bus	AM	61,380	92,216	+50%
	OP	273,022	522,903	+92%
	PM	61,050	92,835	+52%
	24h	395,451	707,954	+79%
In-Service Kilometres by Tram	AM	9,653	11,863	+23%
	OP	46,873	70,312	+50%
	PM	10,568	12,069	+14%
	24h	67,094	94,244	+40%

Points to note from the above tables are the following:

a) While the rail and bus in-service kilometres increase by more than 60 percent (65 percent and 79 percent respectively), the increase in tram service kilometres is lower, at 40 percent.

b) Increases in bus kilometres are driven by the increase in services, especially in the growth areas, while the increases in the regional rail services are due to projects such as the introduction of the Regional Rail Link and the Maryborough line improvements.

7. Road network performance

7.1 Introduction

This section of the report presents the Zenith model's predictions as to how traffic demand in metropolitan Melbourne and Geelong will increase between 2011 and 2031, and how these predicted increases will affect the performance of the road network under a *low road network investment* scenario that assumes only committed and "highly likely" road projects will be initiated in the future.

7.2 Travel demand on the major road network

Figure 7-1and Figure 7-2 show the daily traffic volumes on the major network for 2011 and 2031 including the percentage on commercial vehicles on the route.

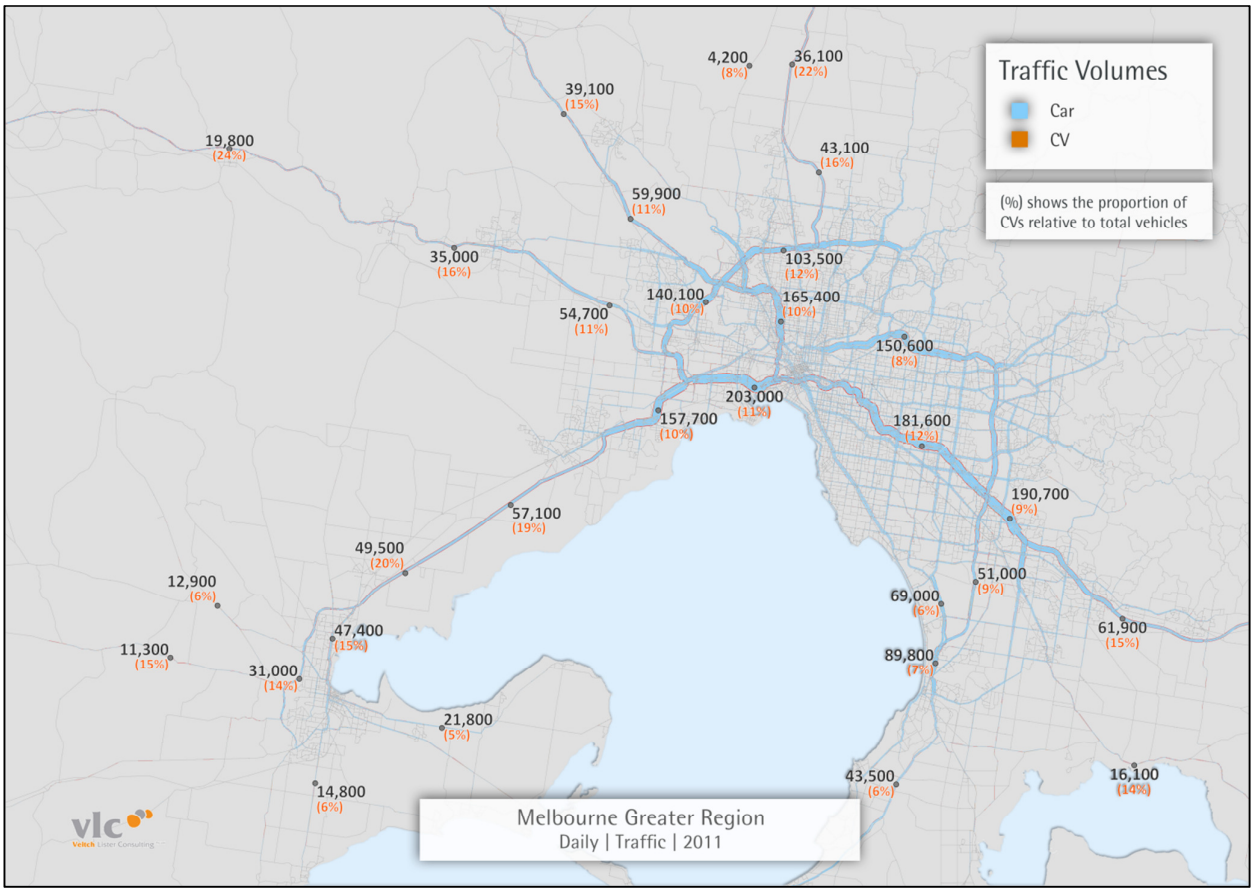

Figure 7-1: Daily Demand - 2011

Accordingly in 2011 the West Gate Freeway carries more than 200,000 vehicles per day; while the Monash Freeway, CityLink, the Eastern Freeway and the Princess Freeway carry in excess of 150,000 vehicles daily.

The percentage commercial vehicles differ markedly, with high percentages experienced on the major roads to regional centres, including

- Princess Freeway to Geelong (19%)
- Western Freeway to Ballarat (16%)
- Calder to Bendigo (15%)
- Hume to Wodonga and Sydney (16%)
- Monash – Narre Warren (15%)

The percentage commercial vehicles on the metropolitan freeways are generally around 10 – 12 percent.

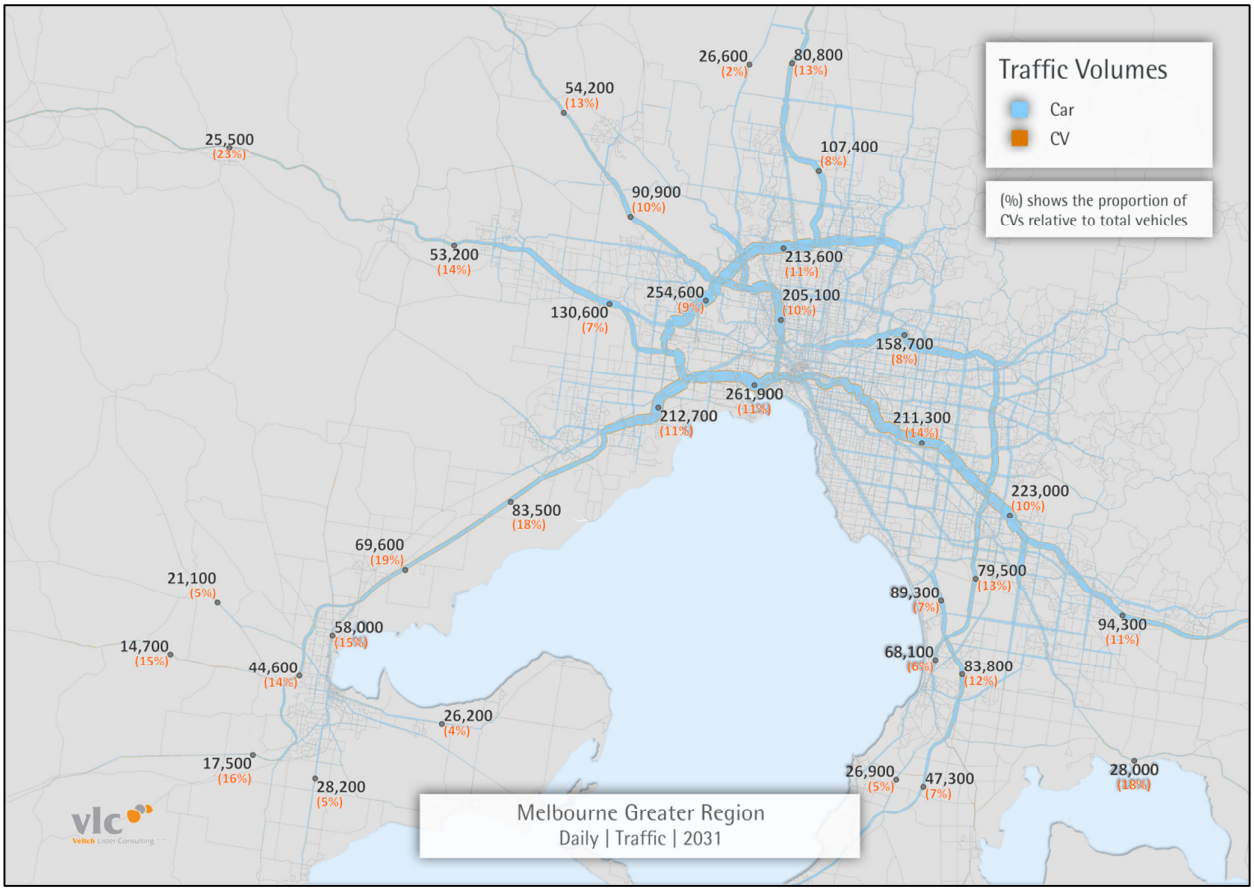

Figure 7-2: Daily demand – 2031

In 2031 it is expected that the West Gate Freeway and the Western Ring Road carry in excess of 250,000 vehicles daily; while CityLink, the Monash Freeway and Princess Freeway are expected to carry volumes in excess of 200,000 vehicles daily.

With the increase of car traffic going towards the growth centres the percentage of commercial vehicles on the major roads to regional centres in these areas decline. In established areas the percentage of commercial vehicles on the network is expected to stay reasonably unchanged in this period with similar patterns to the 2011 scenario.

7.3 Increase in traffic (2011-2031)

Figure 7-3 shows the Zenith model's predicted increases in weekday traffic flows in Melbourne (shown in dark green) between 2011 and 2031.

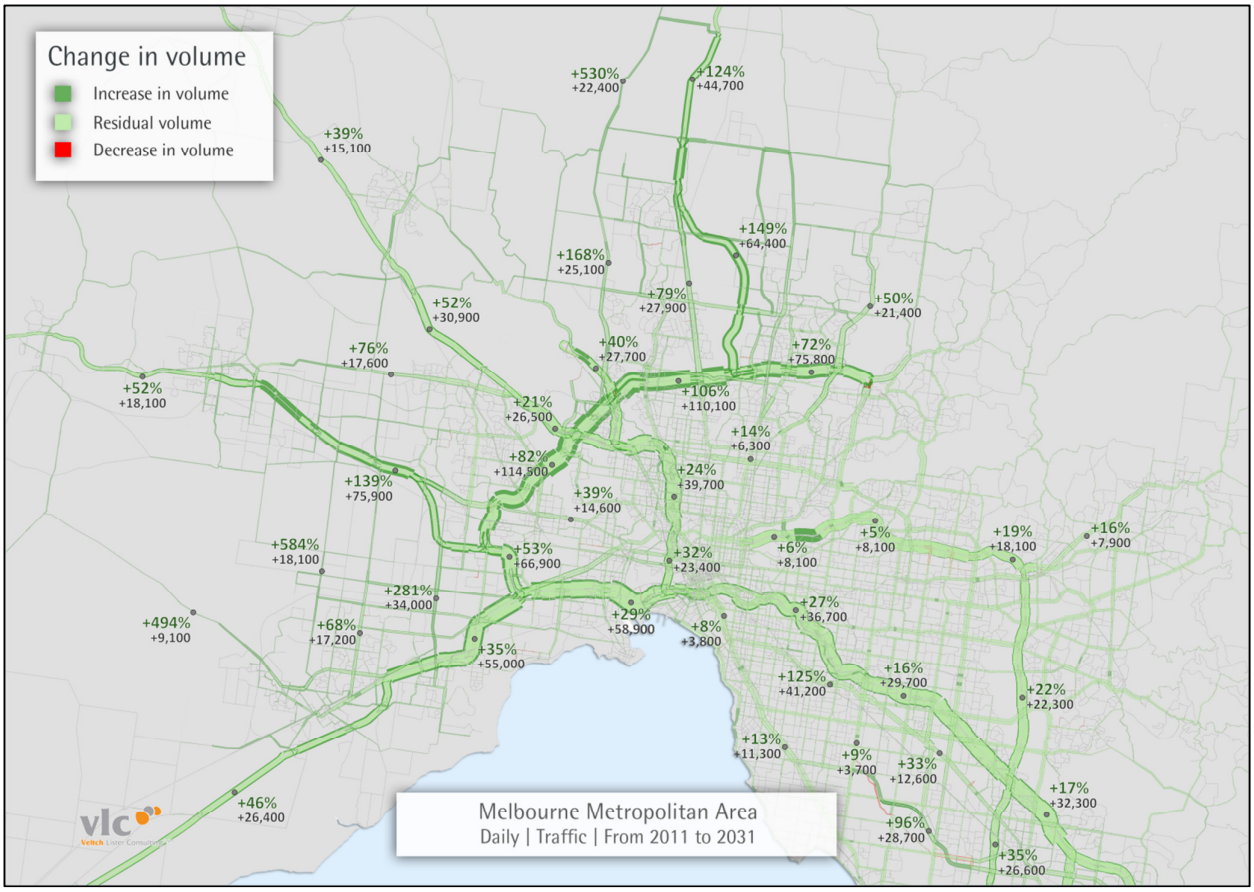

Figure 7-3: Predicted increase in central Melbourne weekday traffic (2011-2031)

The weekday daily traffic demand is forecast to increase significantly (2011-2031) on the metropolitan freeway network, especially along the Western Ring Road (M80), the Tullamarine Freeway to the airport and the Hume and Western Freeways heading into the growth centres.

Moderate to high increases are projected for the M1 (Monash and Westgate Freeways) and CityLink.

Freeways connecting Melbourne to the major regional towns of Ballarat, Bendigo and Geelong, i.e. the Western Freeway, Calder and Princess Freeways also enjoy increased traffic demand, as well as the Hume Freeway, which is the main road corridor to Wodonga and Sydney.

See Figure 7-4 for an indication of the changes of traffic demand in the wider Melbourne area, including Geelong.

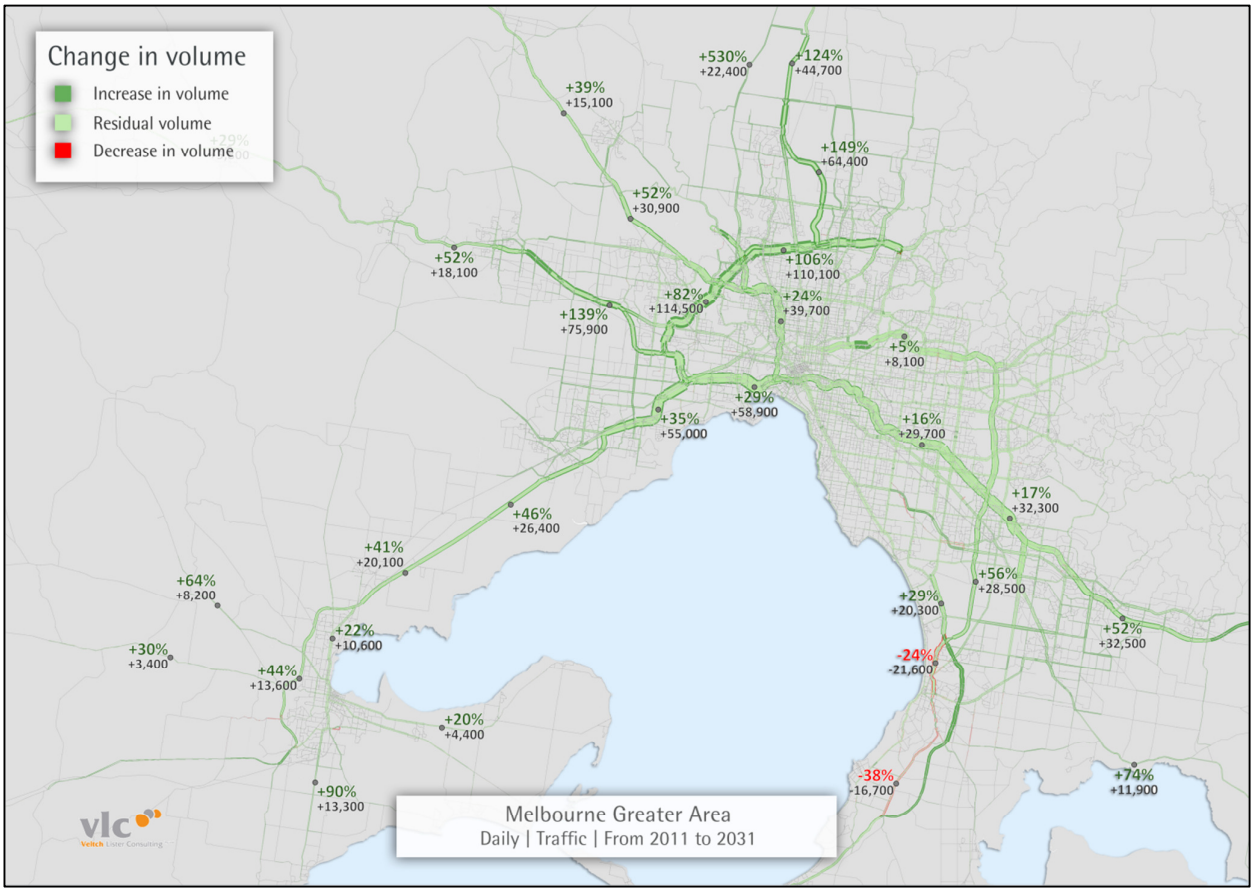

Figure 7-4: Predicted increase in metropolitan Melbourne and Geelong weekday traffic (2011-2031)

In a regional context the same increases are expected on the major network, including the new links of Peninsular Link, south of the EastLink in Frankston (including the resultant decrease in traffic volumes on the Moorooduc Hwy), the Dingley Bypass in the southeast and the Geelong Ring Road 4c, southwest of Geelong.

The predicted changes in traffic volume (2011-2031) for the AM and PM peaks are shown Figure 7-5 through to Figure 7-8. These show similar patterns as the daily volumes.

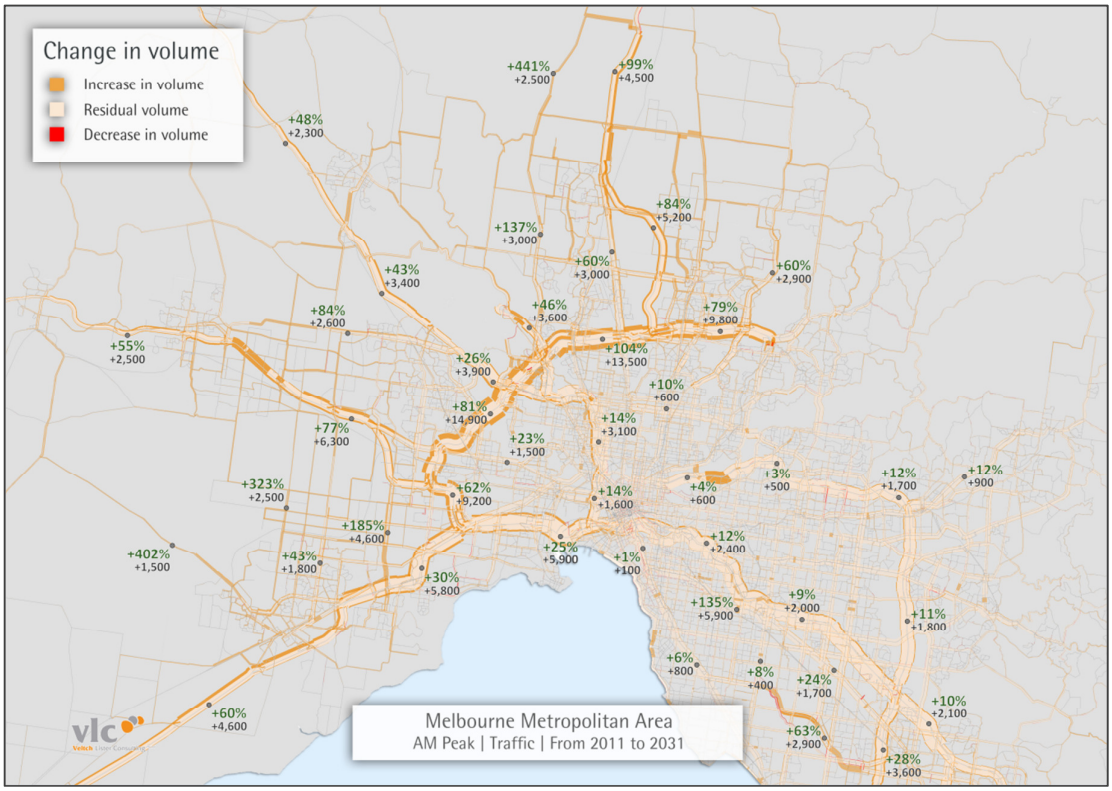

Figure 7-5: Predicted increase in central Melbourne weekday AM peak traffic (2011-2031)

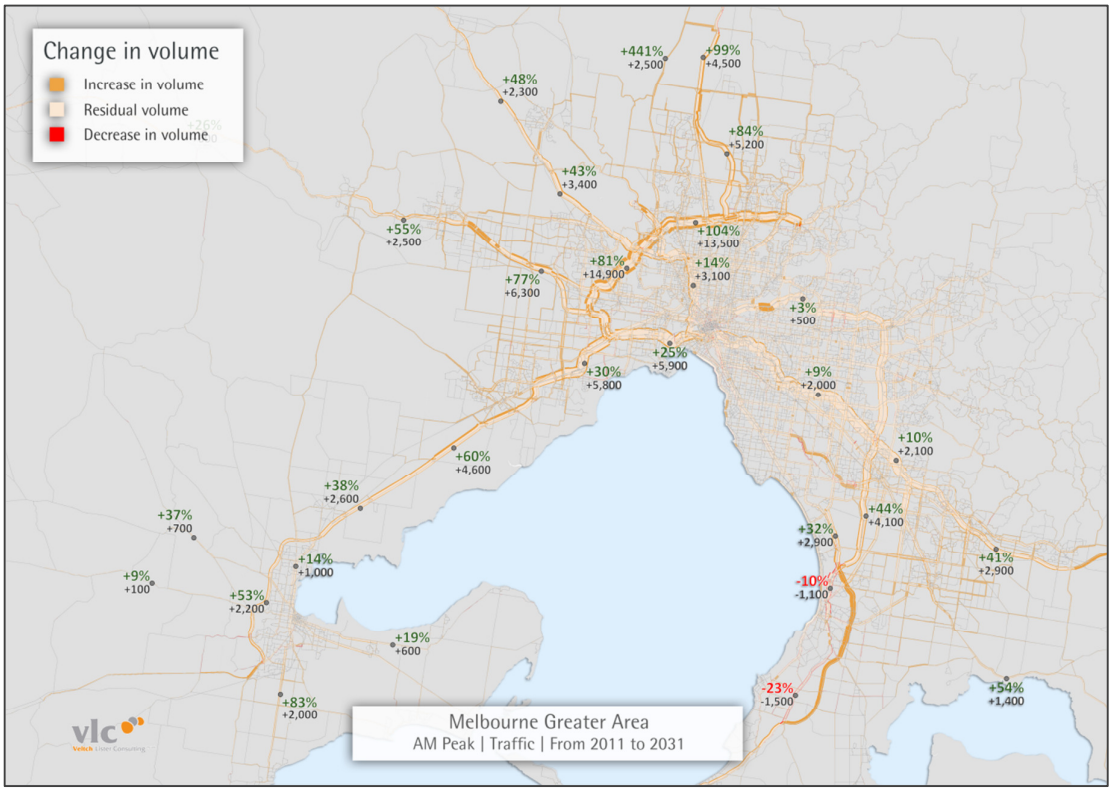

Figure 7-6: Predicted increase in metropolitan Melbourne and Geelong AM peak traffic (2011-2031)

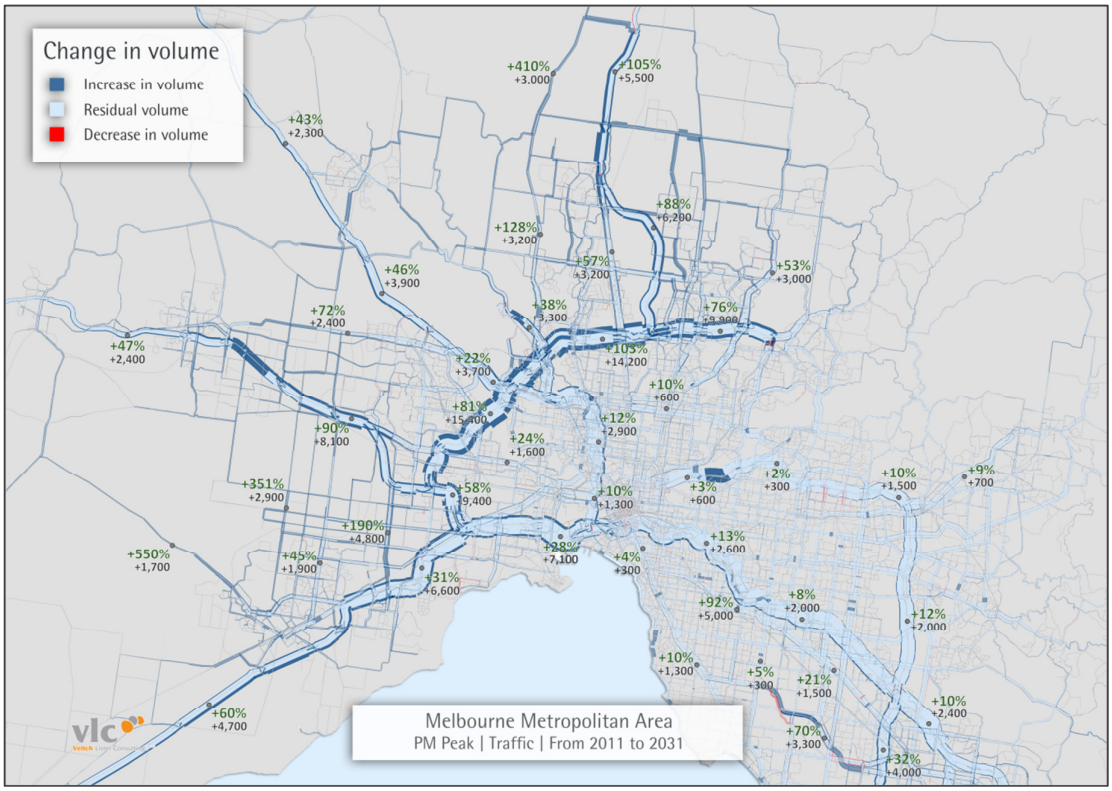

Figure 7-7: Predicted increase in central Melbourne weekday PM peak traffic (2011-2031)

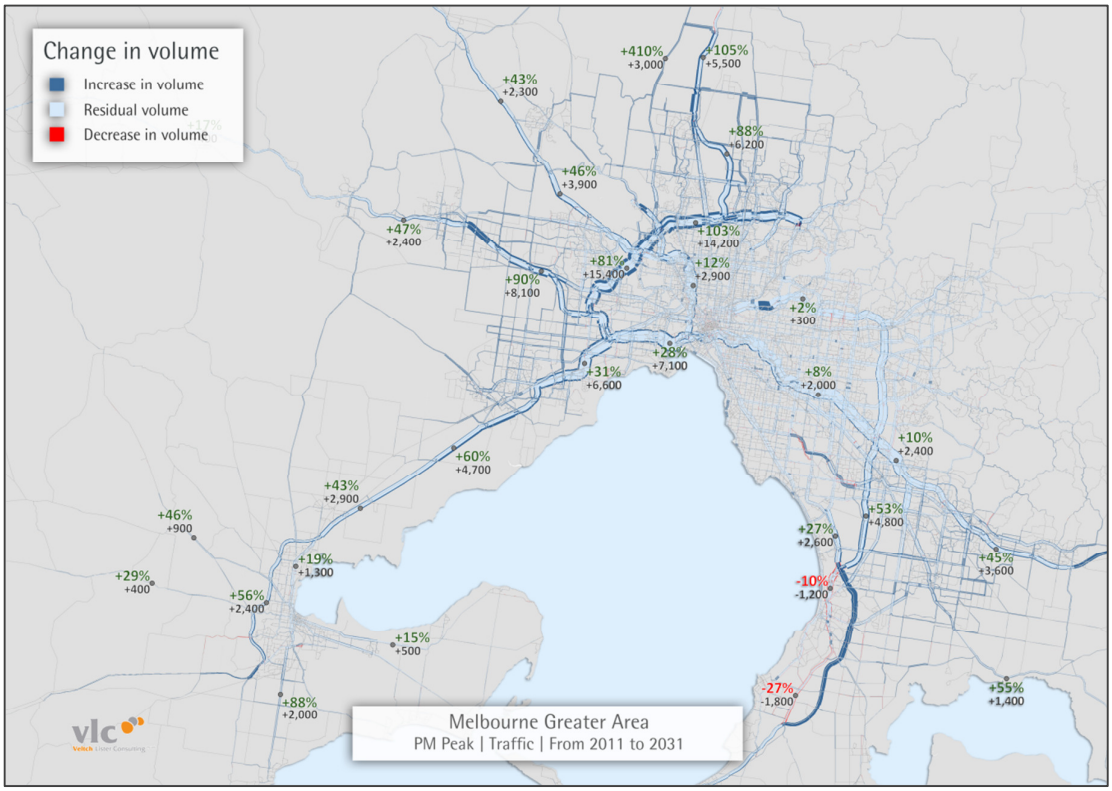

Figure 7-8: Predicted increase in metropolitan Melbourne and Geelong PM peak traffic (2011-2031)

7.4 Volume/capacity ratios (V/C)

The Zenith model's assessment of the performance of the road network in 2011 and 2031 can be gauged from volume/capacity ratio plots (V/C).

Figure 7-9 to Figure 7-14 show the Zenith model's estimates of V/C for the road network in 2011 for the maximum AM peak hour, typical interpeak[2] hour and maximum PM peak hour respectively.

While most of the EastLink operates well within its practical capacity (V/C typically in the range 0.5-0.8 in the peak hours), key major roads in Melbourne's network are operating over, at, or extremely close to capacity in 2011, including:

- M1 Monash Freeway, westwards from Beaconsfield in the southeast and including sections of the South Gippsland Hwy;
- M1 West Gate Freeway and Princess Freeway eastwards from Laverton and Hoppers Crossing, with the West Gate Bridge well over capacity;
- M80 Western Ring Road, numerous sections along the total route;
- M3 Eastern Freeway westwards from Ringwood;
- CityLink, southwards to the city;
- Tullamarine Freeway in both directions, with saturation levels reached at Terminal Drive;
- M79 Calder Freeway southwards towards the city from Diggers Rest;
- M8 Western Freeway westwards towards the city from Melton.[3]

Of note is the level of congestion on the supporting network, notably inner city roads such as Hoddle Street and Alexandra Parade, the Princess and Nepean Highways, Footscray, Dynon and Geelong Roads, as well as other distributor roads throughout the study area.

Figures 7-11 and 7-12 show the 2011 results of a typical hour in the interpeak. Accordingly a number of sections of freeway are close to or reach capacity, notable the West Gate Bridge, and sections of the M80 Western Ring Road, as well as the Eastern Freeway and Tullamarine Freeway.

V/C ratios are used to gauge the level of congestion in the road network. Significant congestion and delays occur as the V/C ratio approaches unity. Should the V/C ratio exceed unity then the excess demand can only be accommodated by drivers choosing to switch to the shoulders of the peak thereby extending the duration of the peak, changing their destination, changing mode, or not making the journey at all.

Referring to Figure 7-9 and Figure 7-13 it is evident that a significant part of Melbourne's major roads are already operating at or close to capacity in the peak direction in both peak periods.

[2] Interpeak refers to the hours between the AM and PM peak periods only, i.e. from 09:00 to 16:00

[3] Directions indicated are for the AM peak. The PM peak is exhibits similar results in the opposite (peak) direction from the CBD

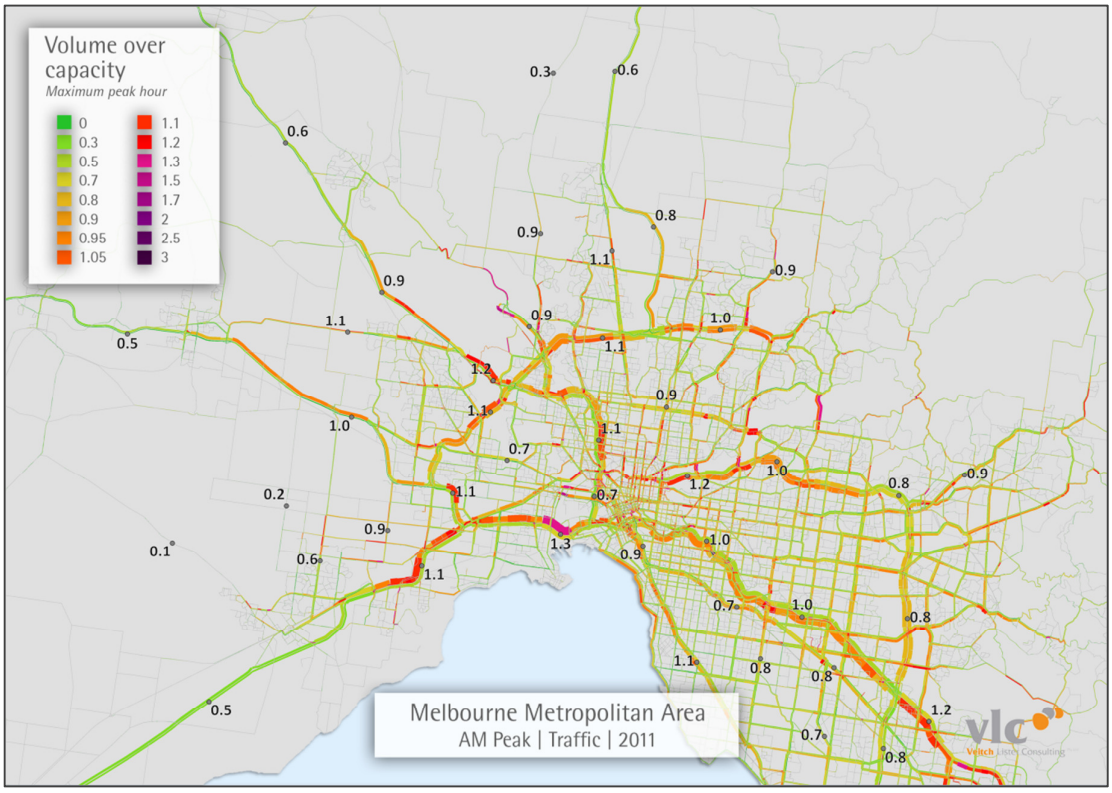

Figure 7-9: Road network V/C ratios for Melbourne Metropolitan Area in 2011 - AM maximum peak hour

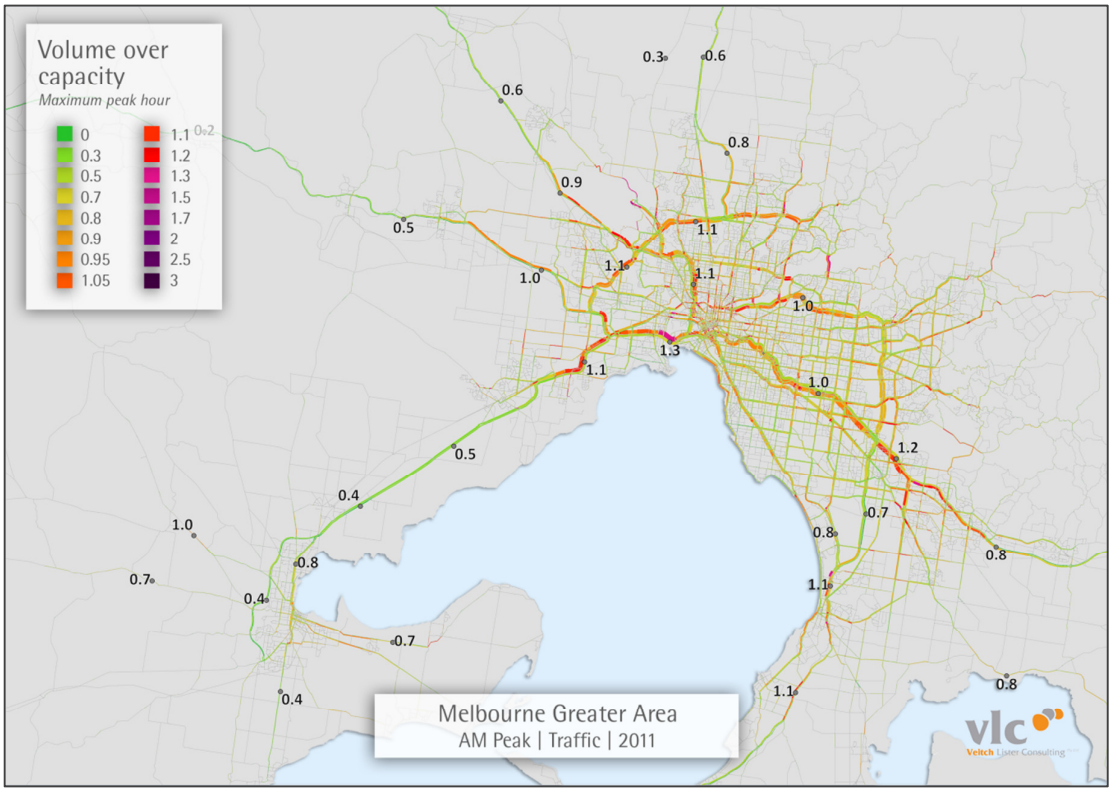

Figure 7-10: Road network V/C ratios for Melbourne Greater Region in 2011 - AM maximum peak hour

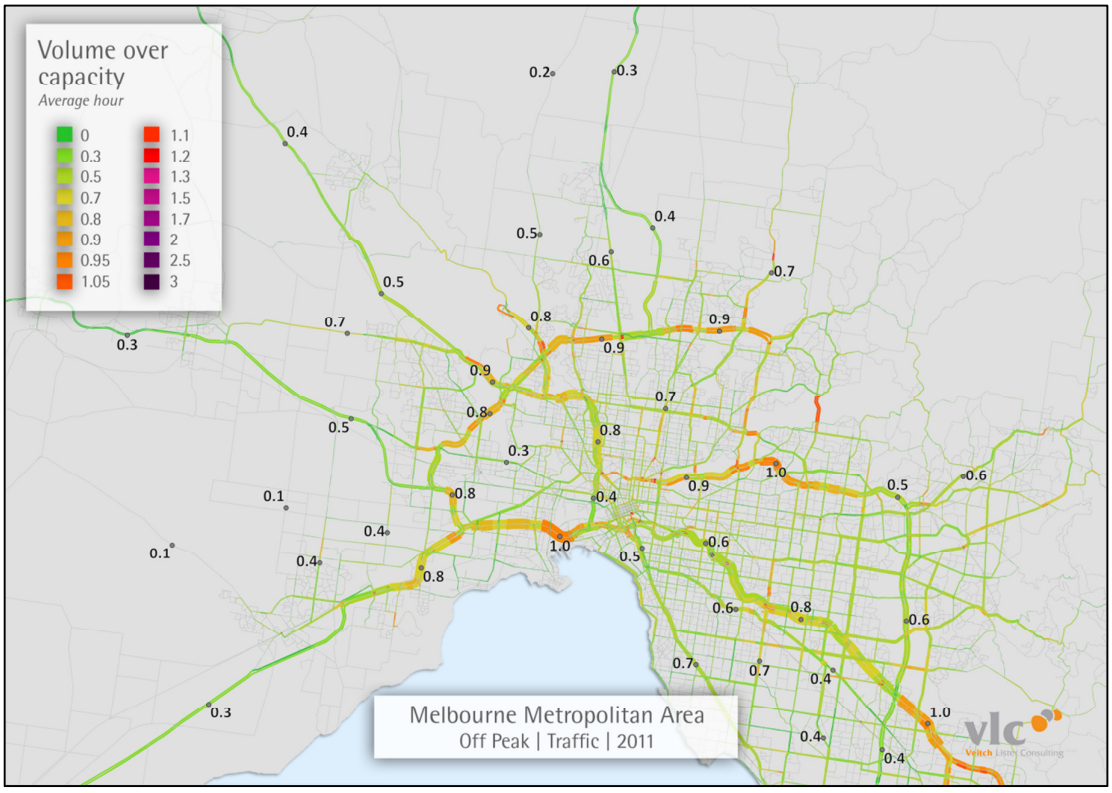

Figure 7-11: Road network V/C ratios for Melbourne Metropolitan Area in 2011 - interpeak hour

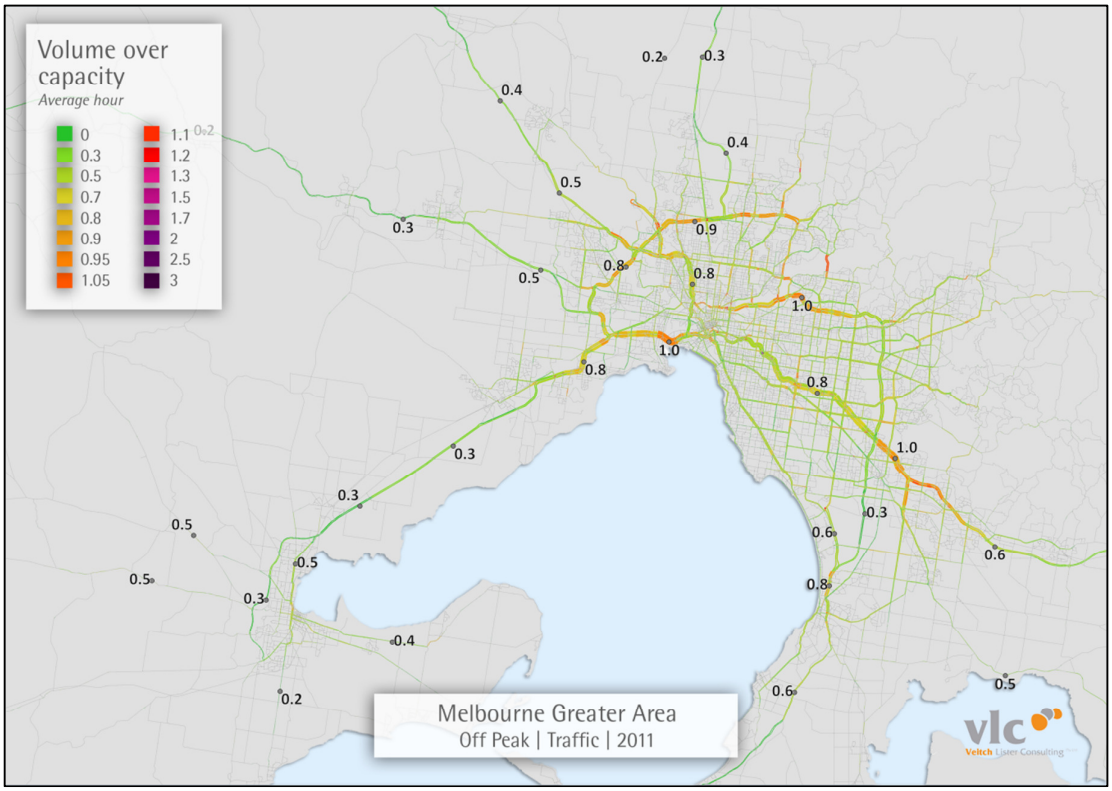

Figure 7-12: Road network V/C ratios for Melbourne Greater Region in 2011 - interpeak hour

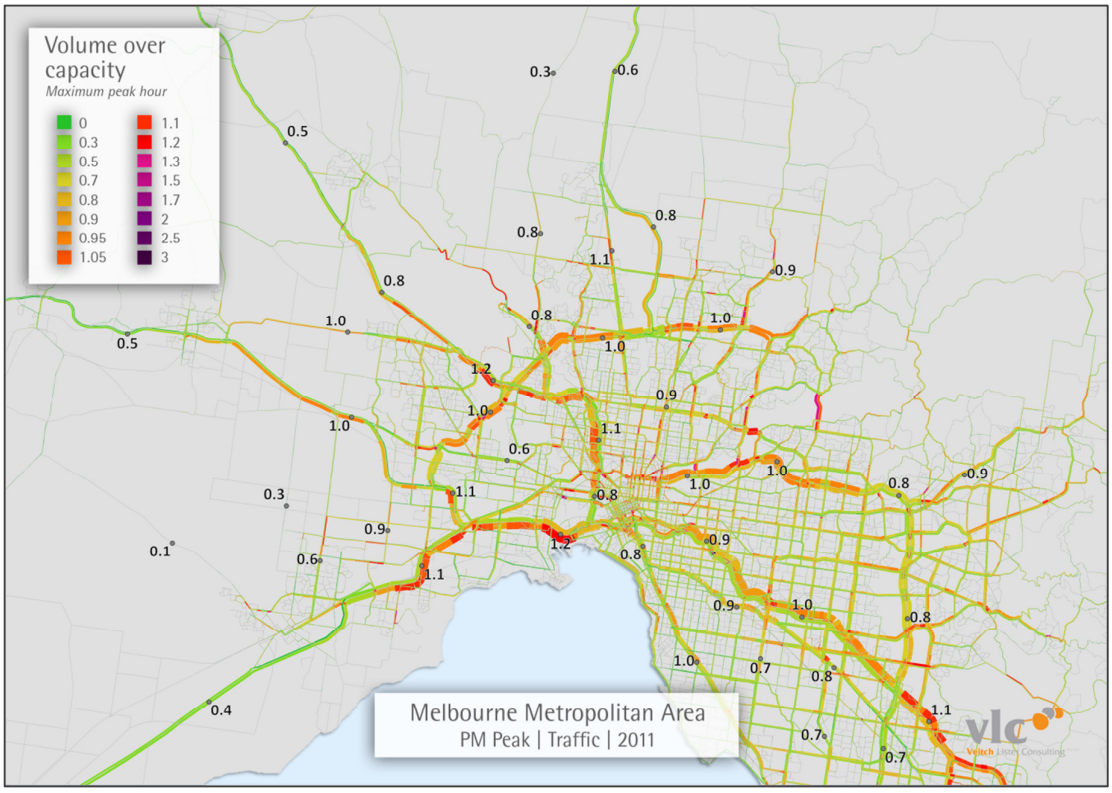

Figure 7-13: Road network V/C ratios for Melbourne Metropolitan Area in 2011 - PM maximum peak hour

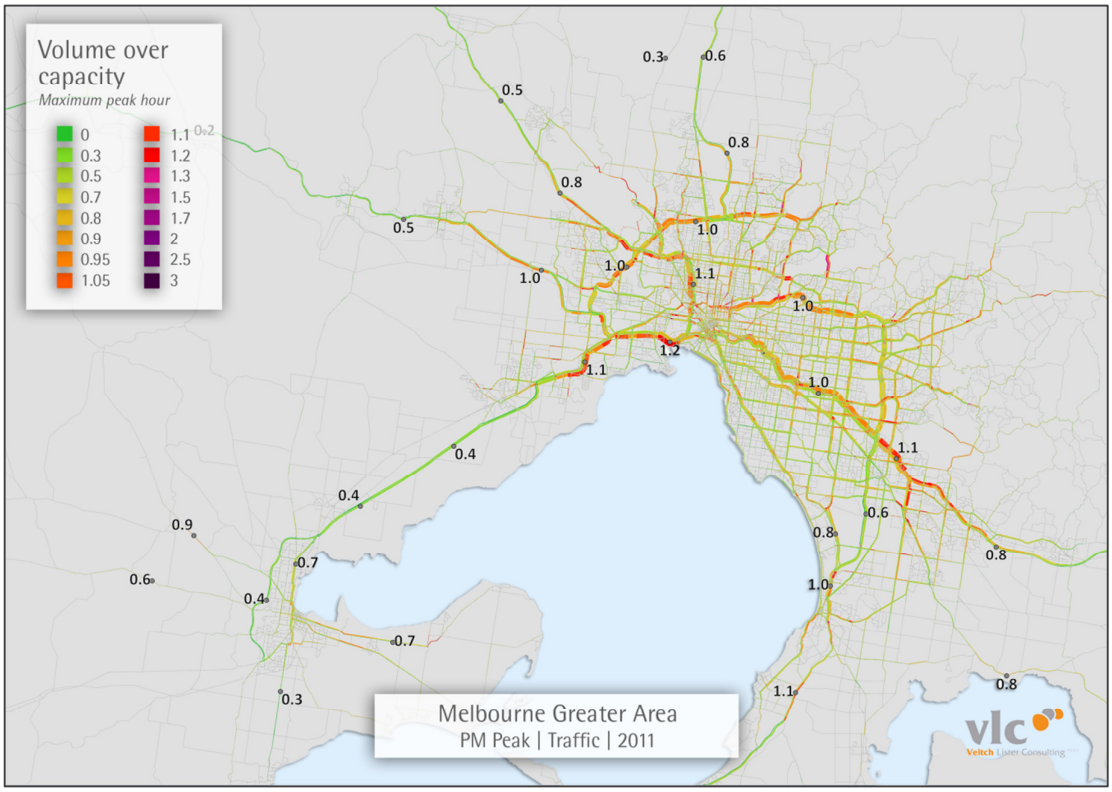

Figure 7-14: Road network V/C ratios for Melbourne Greater Region in 2011 - PM maximum peak hour

Figure 7-15 presents V/C ratios across the Melbourne road network using the Zenith model's 2031 AM peak traffic forecasts for a *low road network investment* scenario.

It is clearly evident from the figure that, if the Zenith model's forecasts are correct, a significant proportion of Melbourne's motorway network will be unable to accommodate the predicted demand. Even widened sections of the Western Ring Road (M80) will be under pressure.

In comparison to the 2011 AM Peak (Figure 7-9) there is a notable increase in congestion on the major and supporting road network to the west and north of the M80 Western Ring road. Roads to the east of the CBD, i.e. the Eastern Freeway and the Monash Freeway also have increased congestion levels, however little change is predicted for the supporting network.

Of note is that congestion levels in the CBD generally do not increase significantly. This could be due to the increased parking charges that have been assumed for future scenarios which would increase the cost of car travel and thus curb the increase.

Figure 7-19 suggests that a similar scale of problem will emerge in the PM peak.

In the interpeak in 2031 (refer Figure 7-17) the Zenith predicts that some sections of the major road network will be operating close to capacity while the supporting network generally has residual capacity.

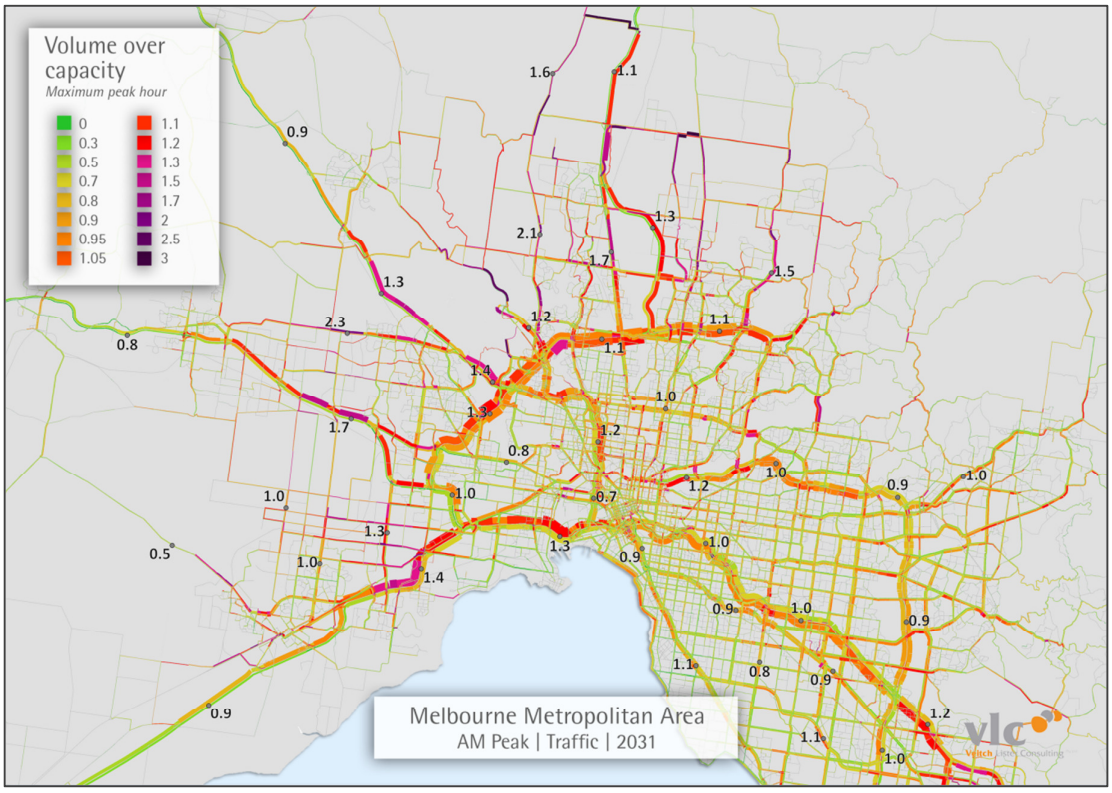

Figure 7-15: Road network V/C ratios for Melbourne Metropolitan Area in 2031 – maximum AM peak hour

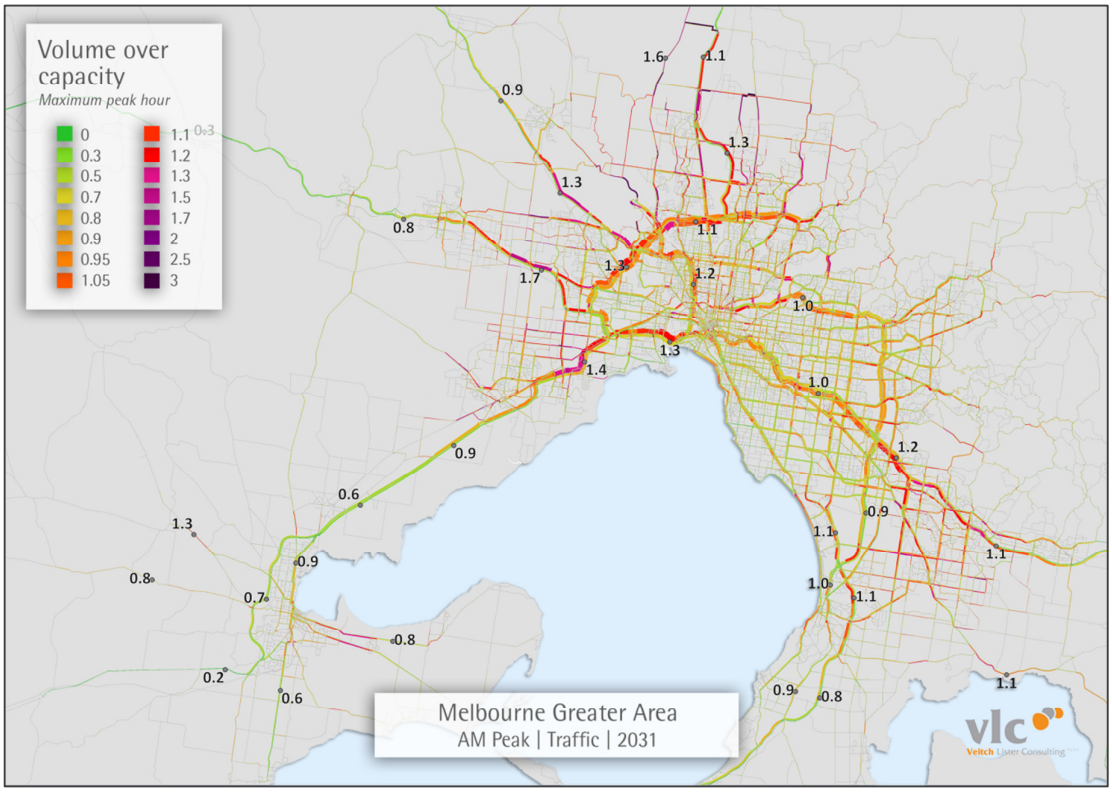

Figure 7-16: Road network V/C ratios for Melbourne Greater Region in 2031 - maximum AM peak hour

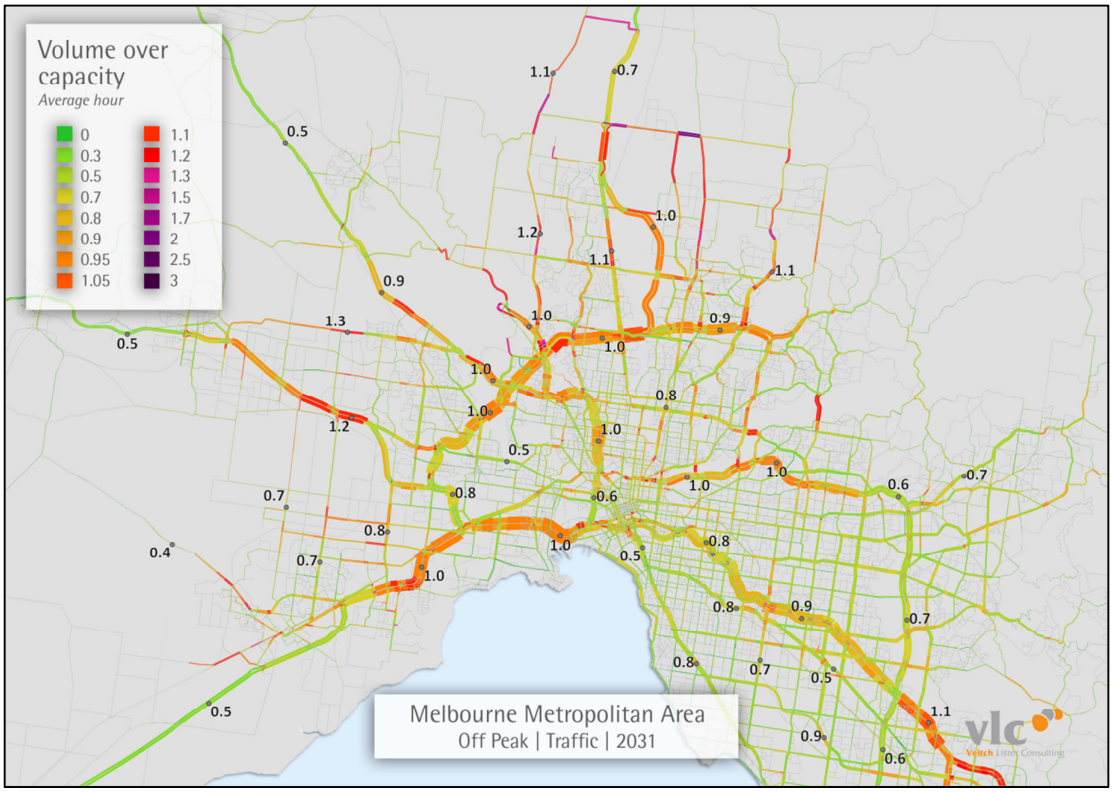

Figure 7-17: Road network V/C ratios for Melbourne Metropolitan Area in 2031 - interpeak hour

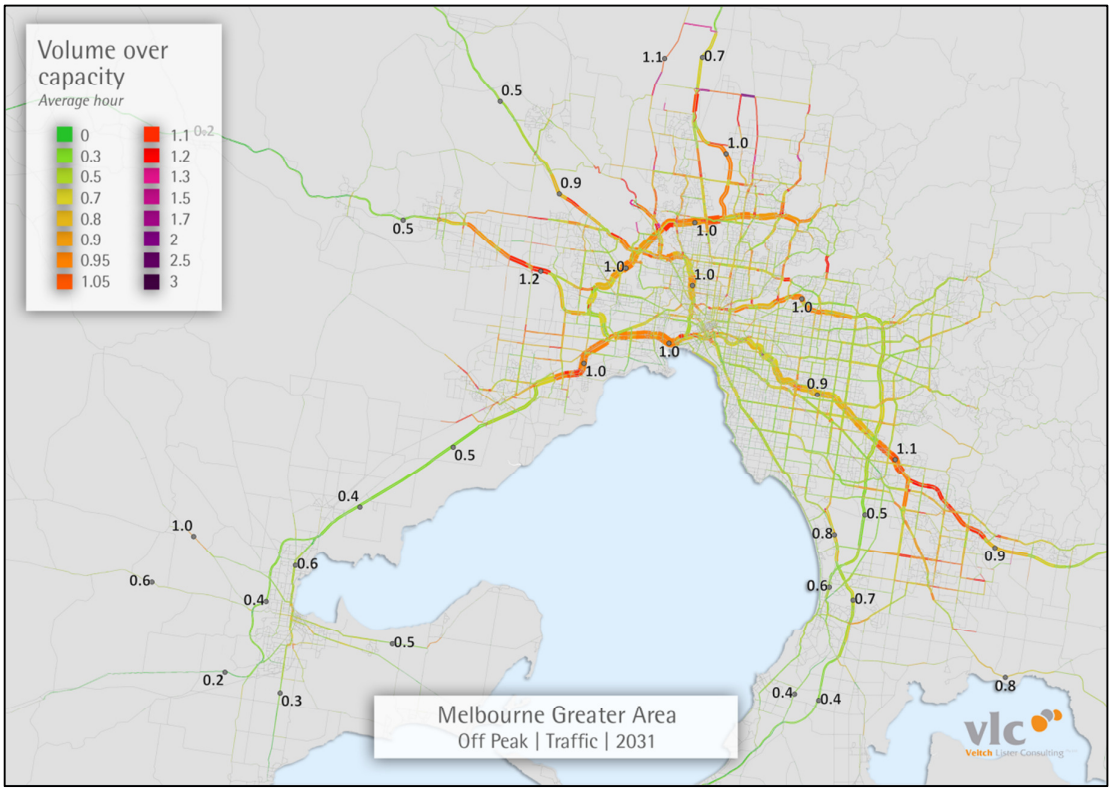

Figure 7-18: Road network V/C ratios for Melbourne Greater Region in 2031 - interpeak hour

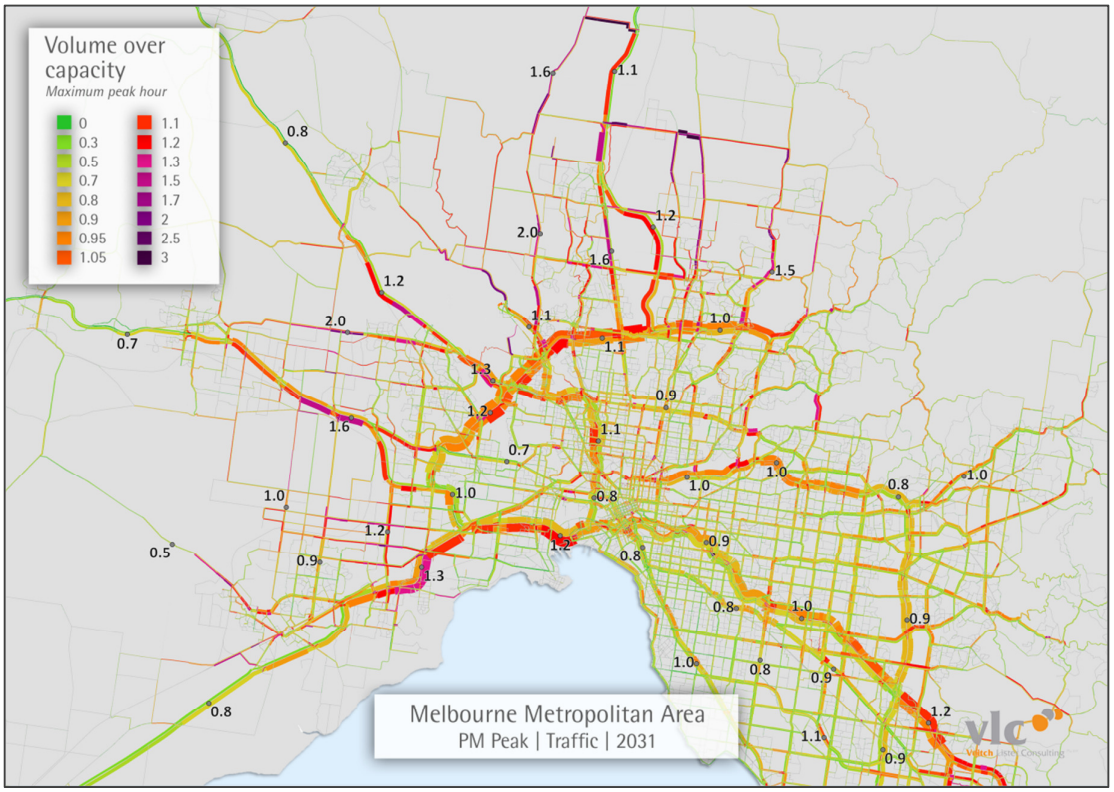

Figure 7-19: Road network V/C ratios for Melbourne Metropolitan Area in 2031 – maximum PM peak hour

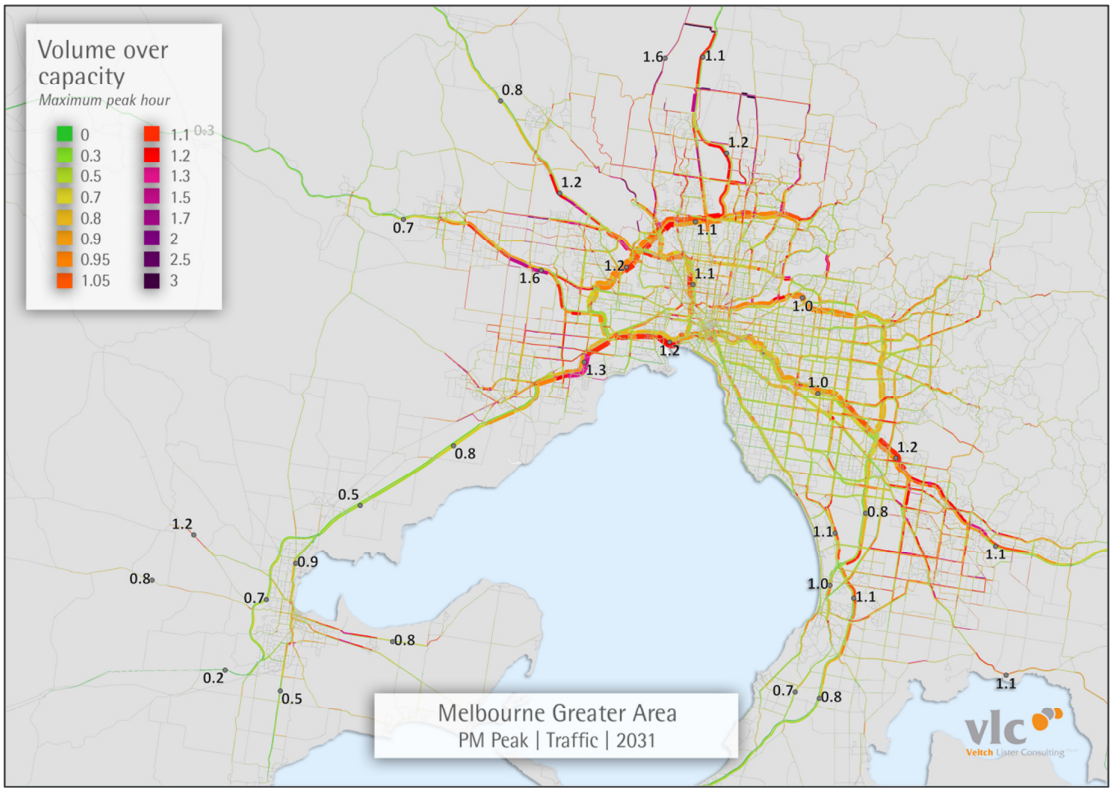

Figure 7-20: Road network V/C ratios for Melbourne Greater Region in 2031 - maximum PM peak hour

7.5 Change in travel times (2011-2031)

This section of the report translates the forecast increase in levels of congestion in Melbourne in 2031 (as described in Section 7.3), into the likely implications for AM peak car travel times to key destinations. Three key destinations are considered:

- The Melbourne CBD
- Melbourne Airport; and
- The Geelong regional centre.

Figure 7-21 to Figure 7-26 provide 2011 and 2031 travel time contours for car travel to these three destinations in the AM peak, under a *low investment road network* scenario.

Referring to Figure 7-21 and Figure 7-22, it is evident that the Zenith model does not predict significant contraction of the travel time contours for car around the Melbourne CBD by 2031. This is due to the level of parking charges assumed for 2031 which have a direct impact on the level of car travel demand into the CBD.

In contrast Figure 7-23 and Figure 7-24 show a very significant contraction of the AM peak travel time contours for car around Melbourne Airport by 2031. Travel times to the airport increase substantially between 2011 and 2031. For example the travel time by car in the AM peak from the CBD to the airport increases from 33 minutes to 42 minutes, a 27 percent increase; while travel times by car from Werribee and Doncaster increase from an average 61 minutes to 90 and 74 minutes respectively (a 48 percent and 21 percent increase).

Figure 7-25 and Figure 7-26 show the travel time contours for car for greater Geelong for 2011 and 2031; which seem to be broadly similar, reflecting` the level of residual capacity in the network, both in 2011 and 2031.

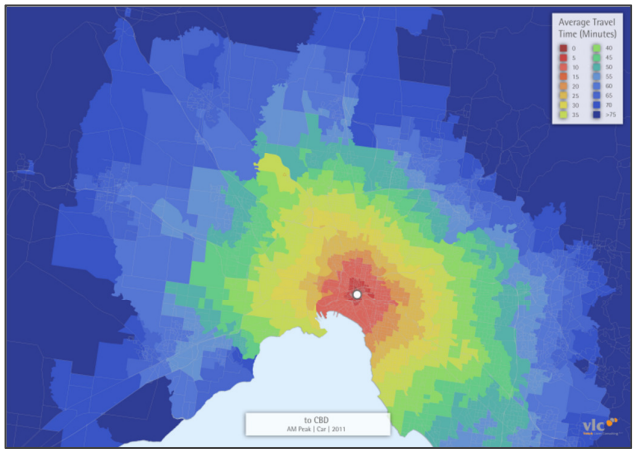

Figure 7-21: To CBD | Road | AM Peak | 2011

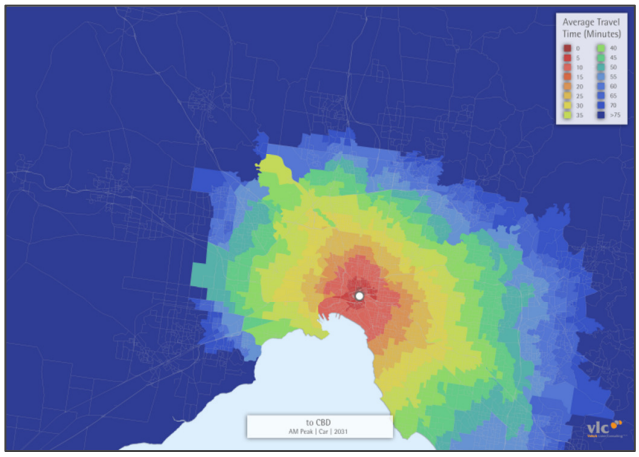

Figure 7-22: To CBD | Road | AM Peak | 2031

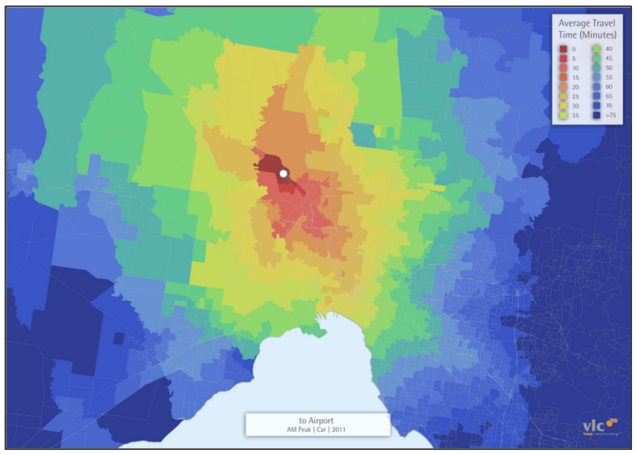

Figure 7-23: To Airport | Road | AM Peak | 2011

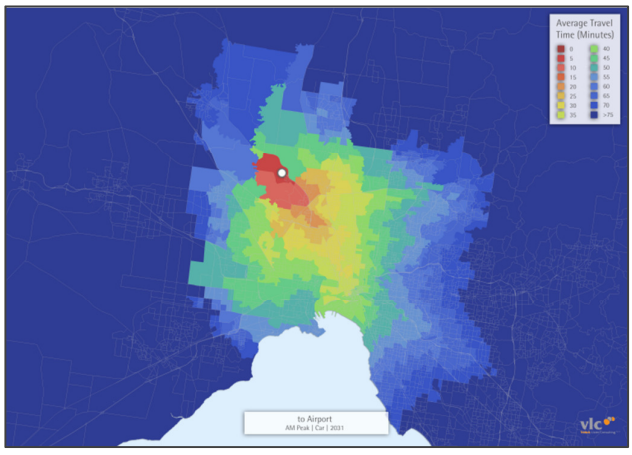

Figure 7-24: To Airport | Road | AM Peak | 2031

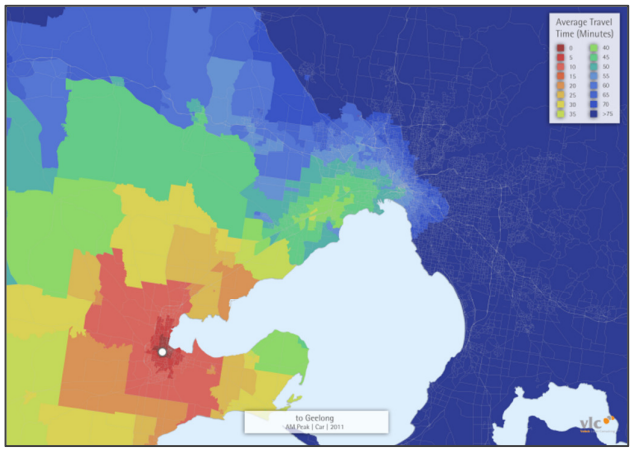

Figure 7-25: To Geelong | Road | AM Peak | 2011

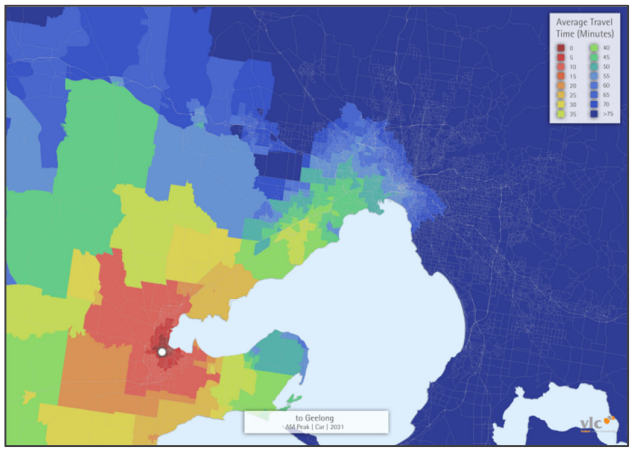

Figure 7-26: To Geelong | Road | AM Peak | 2031

8. Public transport system performance

8.1 Introduction

This section of the report presents the Zenith model's predictions, indicating how the public transport ridership will increase in the future in Melbourne, and how these predicted increases will affect the performance of the public transport system under a *low public transport investment* strategy, that only includes committed and "highly likely" public transport projects.

A conservative approach has been adopted regarding public transport service frequencies. Only short term committed changes have been implemented in the assumed public transport networks. This also includes extensions to the railway system as described in chapter 3-2. For buses, new bus routes have been added to the public transport network to service, mainly in the growth areas. Existing services have been retained and only contain short term frequency changes.

8.2 Forecast increase in demand on the public transport system (2011-2031)

Figure 8.1 shows the Zenith model's forecast increase in daily passenger loading on the regional and metropolitan rail network between 2011 and 2031.

The largest increase in daily rail line loading by 2031 is forecast for the rail services approaching the CBD

- From the west, the Werribee and Sunshine lines
- From the north, the Craigieburn line
- From the south-east: the Cranbourne and Pakenham lines

Larger increases in passenger loading are further forecast for the regional services to Ballarat, Bendigo and Seymour, however to a lesser degree to Geelong. This is in line with the higher increase in total trips on regional rail services, as discussed in Section 6.4

Figure 8-2 shows where the Zenith model forecasts changes in weekday bus passenger loading by 2031. The model forecasts a large increase in usage of services operating between the CBD and the airport, as well as on the Doncaster Area Rapid Transit (DART) services along the Eastern Freeway. General increases are also predicted for the bus services in the growth areas, such as Casey and Cardinia, Werribee and Hume.

Figure 8-3 shows the predicted increase in weekday passenger loading for the tram network by 2031. It shows a general increase on the network.

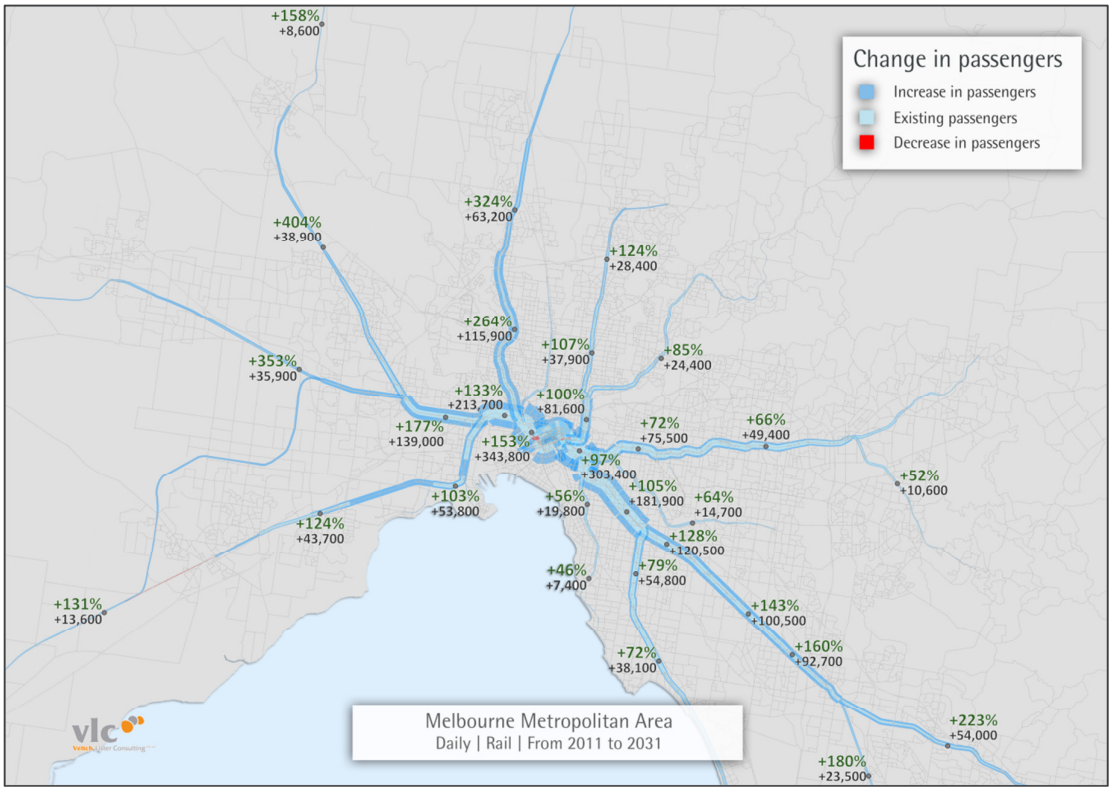

Figure 8-1: Increase in weekday rail passenger loading (2011-2031)

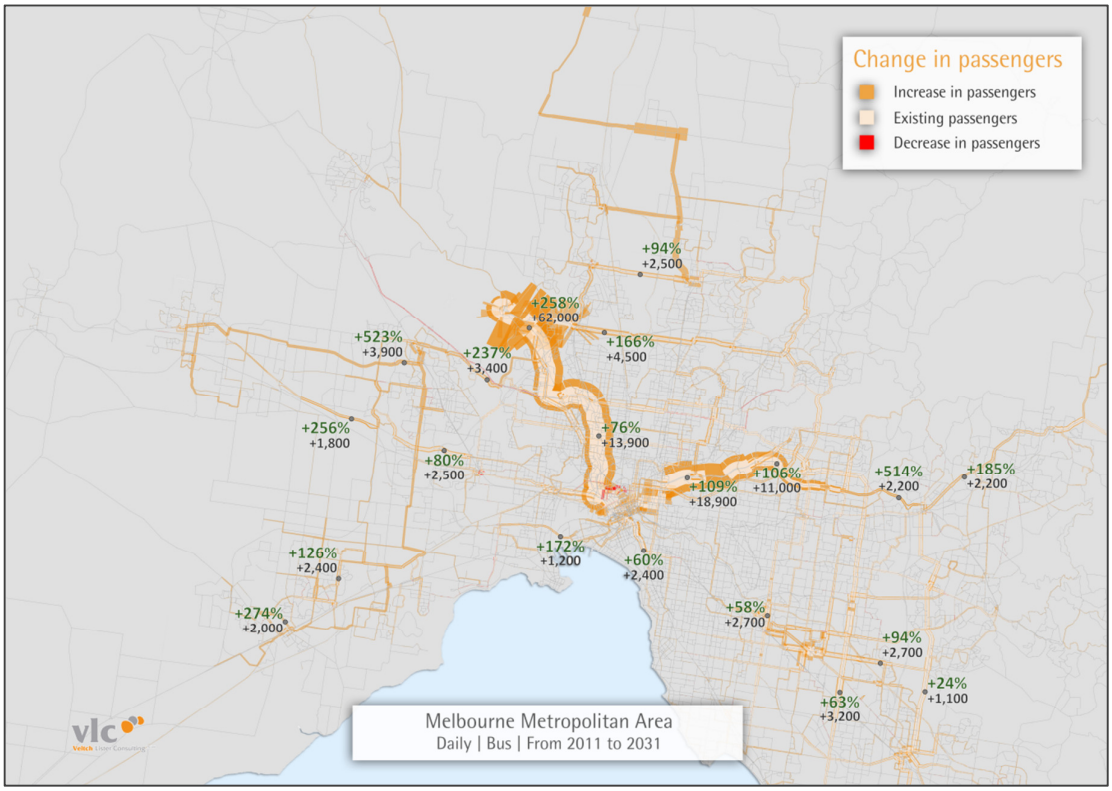

Figure 8-2: Increase in weekday bus passenger loading (2011-2031)

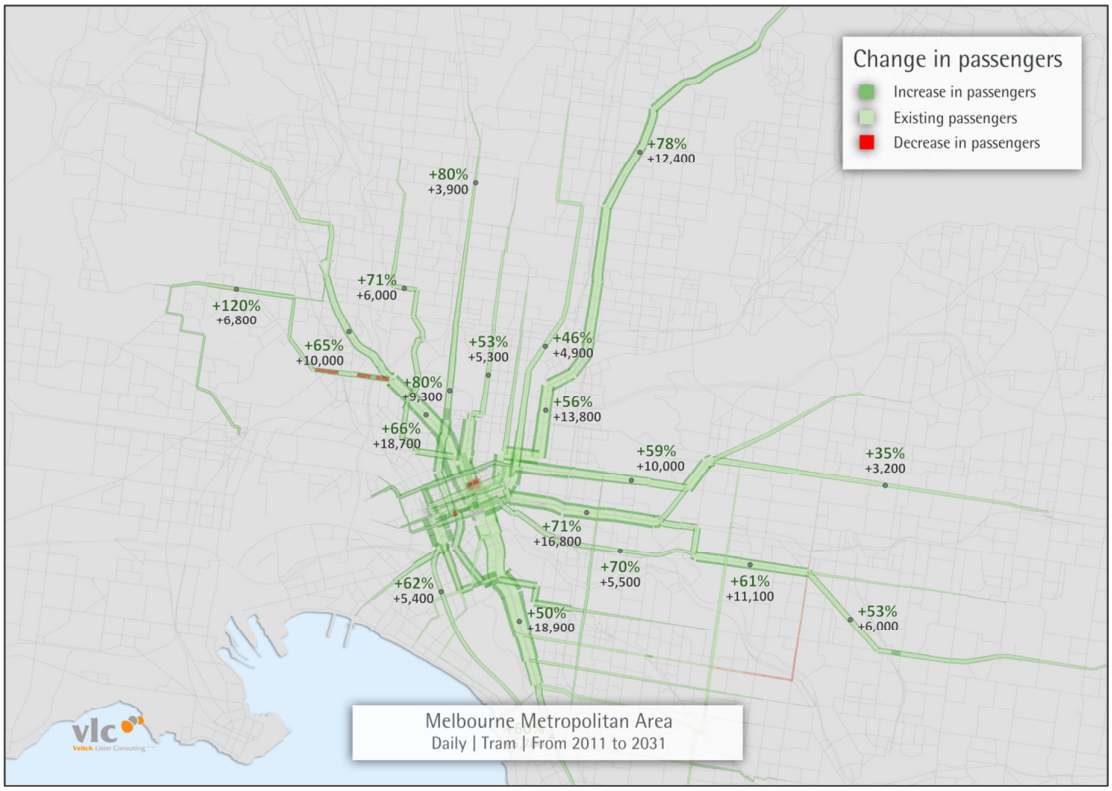

Figure 8-3: Increase in weekday tram passenger loading (2011-2031)

8.3 Rail line loadings relative to seating and crush capacity

Figure 8-4 that follows shows the Zenith model's weekday AM peak (busiest one hour) passenger load on the rail network relative to the available seating capacity in 2011 and 2031, while Figure 8-5 plots the weekday passenger load relative to the "crush" capacity. For this assessment the capacity for the rail services was modelled dependant on the rolling stock configuration on each line, as provided by Public Transport Victoria. Assumptions used for tram, regional train, and bus services are summarised in Appendix B.

Referring to Figure 8-4, it shows that the Zenith model's estimates that 2011 passenger demand on the rail network exceeds the seating capacity of the trains on all lines as they approach the Melbourne CBD. This figure suggests that in 2011 the passenger demand on inbound trains in the morning peak hour exceeds the seating capacity of the trains for a considerable distance from the Melbourne CBD, resulting in some passengers having to stand for an extensive period of time.

For example, passengers boarding trains operating from the Cranbourne and Pakenham would have to stand for virtually the whole trip. The same is the case for passengers from Frankston and most other lines.

By 2031 the Zenith model suggests that loads would increase considerably, as shown in Figure 8-4, particularly on the Cranbourne Pakenham and Craigieburn lines. Capacity on the new Regional Rail Link will also reach capacity when approaching Melbourne's west.

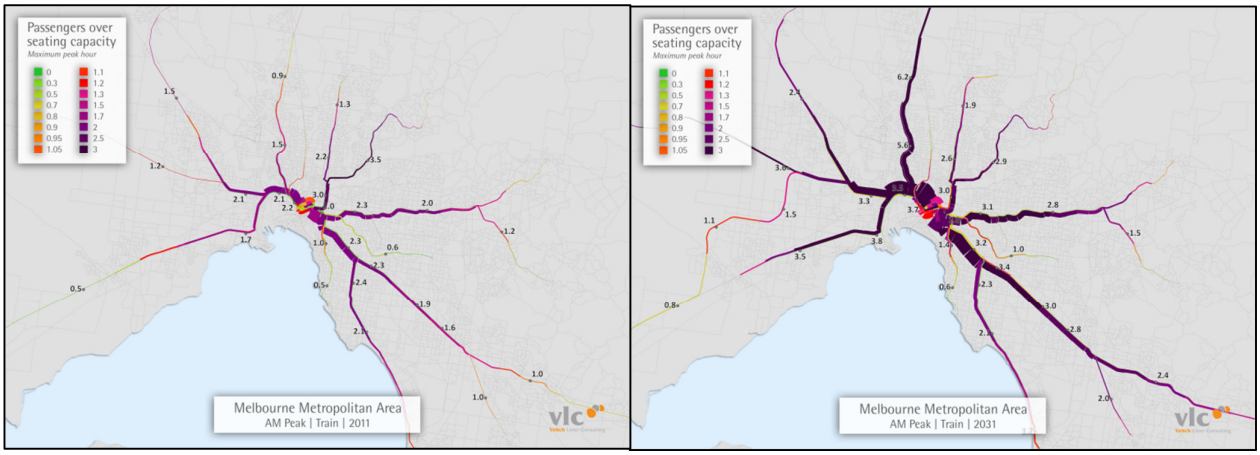

Figure 8-4: Rail weekday passenger demand relative to seating capacity (2011 and 2031)

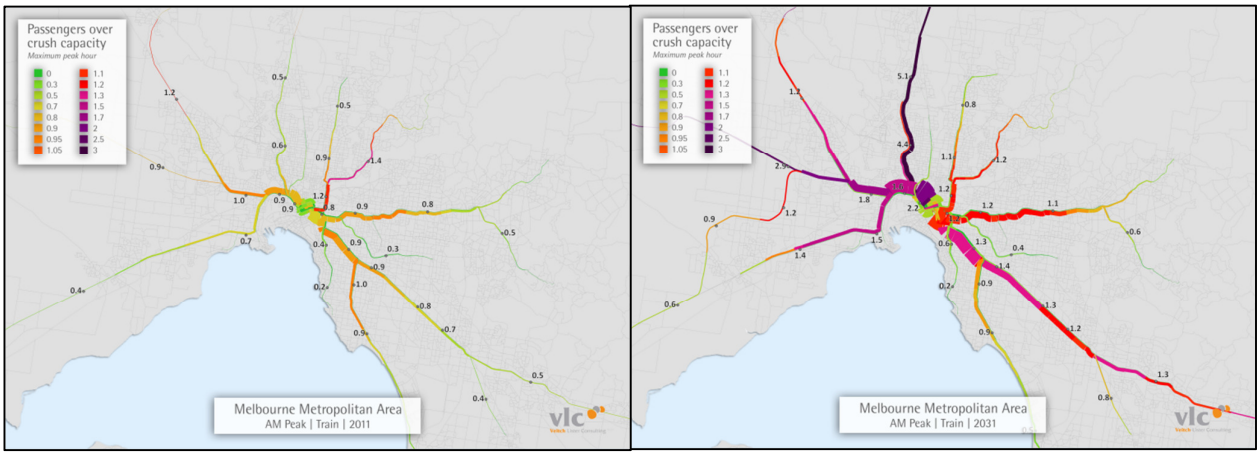

Figure 8-5: Rail weekday passenger demand relative to crush capacity (2011 and 2031)

Figure 8-5 shows that in most cases the average train passenger loads across the AM peak (busiest one hour) in 2011 are below the defined crush capacity. This does not mean that individual trains are not operating at, or above, the defined crush capacity at the peak of the peak.

Figure 8-5 further shows that by 2031 extensive sections of the rail network would experience demand in the AM peak in excess of, or close to crush capacity. The Cranbourne Pakenham lines and the Sunshine and Werribee lines are predicted to be the most over-loaded.

Appendix A:
Transport Infrastructure Improvements
2031 Base Case Network

Full list of transport infrastructure improvements included in the 2031 base case network

Item	Description
1	M1 - WGB widening Managed motorway
2	Central Arterial - (Waterview Bvd to) Aitken Bvd to Windrock Av (2x1 lane divided)
3	Hallam Rd - Pound Rd to Ormond Rd => 4 lane Divided
4	Plenty Rd - Gordons Rd to Hawkstowe Pde => 4 lane Divided
5	Plummer St Extension (widening included in Project 002)
6	Windrock Av - Central Arterial to Craigieburn Rd
7	Tullamarine Airport Access Upgrades
8	Grand Bvd - Mt Ridley Rd to Winrock Ave => 4 lane Collector
9	Nagambie Bypass - Mitchellstown Road and Moss Road
10	Princes Highway Duplication - Reid Drive, Wurruk and Reeve Street, Sale
11	Mitcham Road level crossing grade separation
12	Bass Hwy Duplication - Lang Lang to Anderson
13	Western hwy duplication - Beaufort to Ballarat
14	Bush Bvd in Mill Park between Plenty Rd and McDonalds Rd - New Road
15	Breakwater Road realignment - Tucker Road to Barwon Heads Road
16	O'Herns Rd - Edgars Rd to Epping Rd => 4 Lanes Divided
17	Sayers Rd - Derrimut Rd to Tarneit Rd => 4 lane Divided
18	Shearwater Dr - Cardinia Rd to Princes Hwy
19	Dingley Arterial East - Springvale Rd to Perry Rd
20	Frankston Bypass - EastLink to Dandenong-Frankston Rd => 6 lane Freeway
21	M80 Upgrade Calder Fwy to Sydney Rd
22	M80 Upgrade Western Hwy to Sunshine Ave
23	M80 Upgrade Edgars Rd to Plenty Rd
24	M80 Upgrade Princes Hwy to Western Hwy
25	M80 Upgrade Sunshine Ave to Calder Fwy
26	M80 Upgrade Sydney Rd to Edgars Rd
27	M80 Upgrade Plenty Rd to Greensborough Hwy
28	Cardinia Rd - Princes Hwy to Pakenham Bypass => 4lanes
29	Clyde Rd - Kangan Dr to Princes Hwy => 4 Lanes Divided
30	Cooper St - Hume Fwy to Edgars Rd - 4 lanes => 6lanes Divided
31	Derrimut Rd - Sayers Rd to Leakes Rd => 4 lane Divided (see also 013)
32	Dohertys Rd - Hume Rd to Grieve Pde => 4 lanes Divided, but Undivided on Fwy Overpass
33	E14 (Aitken Bvd) - Craigieburn Rd to Mt Ridley Rd - 2 lanes undivided.
34	E14 (Aitken Bvd) - Somerton Rd to Craigieburn Rd - 2 lanes undivided
35	Grices Rd - Berwick-Cranbourne Rd to Soldiers Rd - 2 lane undivided - Sealed
36	Hallam Rd - Princes Hwy to Pound Rd => 4 lane Divided
37	Hallam Rd - Ormond Rd to South Gippsland Hwy => 4 lane Divided
38	Heaths Rd - Shaws Rd to Tarneit Rd => 4 Lanes Divided
39	Heaths Rd-Bolton Rd - Ballan Rd to Shaws Rd => 4 Lanes Divided - Incl Bridge widening.
40	High Street Rd - Stud Rd to Burwood Hwy =>
41	Koo Wee Rup Bypass - Manks Rd to South Gippsland Hwy - 2 lanes undivided

42	Linsell Bvd - Narre Warren-Cranbourne Rd to Berwick-Cranbourne Rd - 2 Lanes undivided
43	Narre Warren-Cranbourne Rd - Pound Rd to Thompsons Rd => 4 lane divided
44	Palmers Road - Dunnings Rd to Sayers Rd => 4 lane Divided
45	Palmers Road - Sayers Rd to Dohertys rd => 4 lane Divided
46	Palmers/Robinsons Road - Dohertys Rd to South of Deer Park Bypass => 4 lane Divided
47	Plenty Road - McKimmies Rd to Centenary Dr 4 Lanes => na Lanes
48	Point Cook Road - Point Cook Homestead Rd to Dunnings Rd => 4 lanes Divided
49	Princes Freeway West - Interchange at Duncans Rd => Full Diamond
50	Somerton Rd - Mickleham Rd to Roxburgh Park Dr => 4 lanes Divided
51	Thompsons Rd - Western Port Hwy to South Gippsland Hwy =>4 lane Divided
52	Thompsons Rd - Dandenong Valley Hwy to Western Port Hwy =>4 lane Divided
53	Thompsons Rd, Templestowe - Manningham Rd to Foote St =>4 lane undivided
54	Boronia Rd - Mountain Rd to Stud Rd => 6 Lanes Divided
55	Geelong Ring Road Stages 4A, 4B & 4C
56	Princes Highway Duplication - Waurn Ponds to Winchelsea
57	Princes Freeway East - Melbourne to Sale
58	Calder Park Dr-Westwood Dr - Western Hwy to Taylors Rd =>Stage 1
59	Peninsula Link - Dandenong-Frankston Rd to Frankston-Flinders Rd
60	Peninsula Link - Frankston-Flinders Rd to Mornington Peninsular Fwy
61	Calder Fwy Interchanges: , Kings Rd (Diamond), Kings Rd=>4 Lanes
62	Dingley Arterial West - Springvale Bypass (Westall Rd) to Warrigal Rd => 4lane Divided
63	Kororoit Creek Rd - Grieve Pde to Millers Rd => 4 Lanes Divided + Grade Separation.
64	Sneydes Road full Interchange
65	Cardinia Rd, Shearwater Dr to Pakenham Bypass
66	Dandenong Valley Hwy (Stud Rd) - Boronia Rd to Mountain Hwy =>4 Lanes Divided
67	Regional Rail Link (Tarniet and Manor Lakes Stn)
68	Sunbury Electrification and Extension (Calder Park Stn) - Stage 1
69	South Morang Extension
70	Maryborough Line improvements (Talbot Stn)
71	New Stations to existing lines (Cardinia Rd, Lynbrook & Williams Landing)
72	Growth Area Bus Infrastructure
73	Maryborough Line improvements (Clunes Stn)
74	Cranbourne-Pakenham Rail Corridor project
75	M80 Ring Rd upgrade (widening)
76	Western Hwy duplication – Ballarat to Stawell
77	Metro Level Crossing Blitz - Blackburn Rd | Burke Rd | North Rd
78	Metropolitan grade separations - Mitcham Rd & Rooks Rd | Springvale Rd
79	Princes Hwy duplication project – Winchelsea to Colac
80	Main Road Level Crossing Removal
81	Western Hwy realignment – Anthonys Cutting (Melton to Bacchus Marsh)
82	Goulburn Valley Nagambie Bypass
83	Princes Hwy East – Traralgon to Sale duplication
84	Princes Hwy West – stage 1 Waurn Ponds to Winchelsea

85	Dingley Bypass btn Warrigal Rd to Westall Rd
86	Geelong Ring Rd stage 4C – Geelong Ring Rd to Surf Coast Hwy
87	Calder Hwy interchange at Ravenswood
88	Koo Wee Rup Bypass
89	Breakwater Road – upgrade
90	Geelong Ring Rd Stage 4B – Anglesea Rd to Princes Hwy West
91	Peninsula Link
92	Port-Rail shuttle (metropolitan intermodal system)
93	Clyde Rd duplication – High St to Kangan Dr (4L)
94	Narre Warren Cranbourne Rd duplication btn Pound Rd and Thompson Rd (4 & 6L)
95	South Gippsland Hwy upgrade – Sale to Longford
96	Bass Hwy duplication Stage 7 – Woolmer Rd to Phillip Island Rd

Note: CityLink widening was announced after the modelling assessment

Appendix B:
Public transport capacity assumptions

	2011		2031	
	Seats	**Crush capacity**	**Seats**	**Crush capacity**
Tram	36 to 64	168 to 260	36 to 64	168 to 260
Train	500	1250	500	1250
Regional Train	222 to 750	223 to 910	222 to 750	223 to 911
Bus	50	75	50	75

Appendix C:
ABS Statistical Areas level 3

Melbourne Greater Region SA3s