The Allen Consulting Group

Benefits of Investing in New Zealand's Road Infrastructure

INFOMETRICS

August 2004

A report for the New Zealand Automobile Association

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Suggested citation for this report:

The Allen Consulting Group 2004, *Benefits of Investing in New Zealand's Road Infrastructure,* Sydney

Acknowledgments

The authors wish to acknowledge the following organisations for helping fund the research for this report and for assisting with the data analysis:

- New Zealand Automobile Association;
- Greater Wellington Regional Council;
- Priority One;
- Infrastructure Auckland;
- Road Transport Forum New Zealand;
- Auckland Chamber of Commerce;
- Employers and Manufacturer's Association (Northern); and
- Business New Zealand.

Contents

Executive summary

This study evaluates the adequacy of the current stock of road infrastructure in New Zealand and investigates the economic contribution that transport infrastructure makes to the New Zealand economy at large. It also assesses the potential economic benefits that would flow from selected new investments in New Zealand's road system.

Adequacy of the current road system

In relation to the adequacy of New Zealand's current stock of road infrastructure, a range of evidence indicates that there has been under-investment in New Zealand's road network over the past decade or so (specifically, 1993-2001). There has been a significant decline in the value of New Zealand's road capital stock as a proportion of GDP and a significant increase in the utilisation of this important infrastructure. This is reflected in increased traffic congestion and higher fatality rates than in other OECD countries.

Increased road utilisation is most pronounced in the major urban areas, such as Auckland and Wellington, particularly the former. Empirical evidence suggests that congestion levels in Auckland are higher than those experienced in both Sydney and Melbourne. In Wellington, congestion is also a growing concern, with average travel speeds on major urban arterial roads declining over time.

The degree of 'connectedness' of New Zealand's major urban road networks is lower than in major urban centres in comparable countries – i.e. there are significant gaps in New Zealand's urban arterial road networks. By contrast with Australian cities (in particular, Sydney and Melbourne), where there has been significant progress, there has been little improvement in the degree of network connectedness of New Zealand major urban road networks (i.e. Auckland and Wellington) over the last decade.

Despite recent increases in New Zealand's road funding levels, New Zealand's level of annual spending on road infrastructure is still below the OECD average of 1.3 per cent of GDP.

Potential benefits of new road investments

This study also investigates the potential net benefits that may accrue to New Zealand by undertaking further investment in road transport infrastructure. To do this, the direct and indirect impacts of four proposed land transport infrastructure packages were quantified using both standard cost benefit analysis and computable general equilibrium (CGE) modelling techniques. The four proposed land transport infrastructure packages modelled include:

- the *passing lanes package*, which consists of 402 separate projects designed to improve safety on a number of New Zealand's rural roads;
- the *Auckland western ring route package*, intended to reduce inner city traffic and increase the connectedness of Auckland's urban arterial road network;
- the *Tauranga strategic roading network package*, which will meet the future road infrastructure needs of the Tauranga and the Western Bay of Plenty regions; and

- the *Wellington regional land transport package*, intended to achieve a balanced and sustainable land transport network meeting community needs.

Each of these four packages of projects have been proposed by either Transit New Zealand or relevant local government authorities in New Zealand.

Further investment in New Zealand's land transport infrastructure would involve four broad direct impacts which need to be weighed up for each package:

- *Accident costs savings*. These impacts include:
  - a reduction of loss of life and permanent disability;
  - a reduction in health care costs; and
  - a reduction in vehicle repair costs.
- *Travel time savings*. Savings in travel time are both economic and non-economic in nature. For example, travel time savings in relation to work related travel may decrease the cost associated with distribution networks thereby increasing productivity. On other hand, travel time savings for non-work related travel may not increase measured economic productivity but nonetheless are beneficial to commuters in general.
- *Project capital costs and financing impacts*. Given a predominately fixed pool of domestic savings in New Zealand an increase in investment will necessarily result in increased foreign borrowing. The cost of this is not the capital itself, but the cost of paying for the use of the capital. For this study an annual capital charge of 6 per cent has been assumed.
- *Vehicle operating cost impacts*. Changes in fuel usage and vehicle repair costs are likely to change road user behaviour. For example travel time savings may result in less fuel consumption and provide commuters with less incentive to use public transport such as the bus or the train.

Findings from project modelling

In modelling the economy-wide impacts associated with investing in New Zealand's land transport infrastructure this study quantified these direct impacts and assessed their value as they worked their way through the complex and interconnected industries and activities which make up the New Zealand economy.

The findings of the study suggest that if all four of the proposed land transport infrastructure projects were undertaken, there would be a total benefit, net of costs, to the New Zealand economy in excess of $1.5 billion dollars annually in 2012. This total net benefit is made up of the following individual benefits:

- a net increase in GDP of $1.0 billion in 2012. This is equivalent to a net increase in per capita GDP of around $243. In other words, if the proposed set of land transport projects were to be undertaken as modelled, each person in New Zealand would, on average, be better off by $243;
- a benefit of $65.9 million attributable to the value of lives saved and permanent disability avoided; and
- a benefit of $511 million from travel time savings related to non-work activities.

In addition to increased output, the proposed land transport infrastructure projects are expected to have the following macro-economic, industry and regional impacts:

- an increase in private consumption of around $670 million in 2012. This is equivalent to an annual increase of $153 per person;
- a net increase in aggregate investment of $203 million (0.5 per cent) in 2012;
- an increase in net exports of $158 million in 2012. This arises because there is an increase in labour productivity which allows New Zealand's industries to be more internationally competitive;
- an aggregate reduction in annual taxation of $538 million. That is the extra tax revenue that the government secures from a larger economy will be around $538 million per year more than what is required to pay for the annualised cost of the proposed packages;
- a net benefit to the majority of New Zealand's industries particularly those that are likely to expand as a result of increased labour productivity arising from shorter work related travel time; and
- substantial regional benefits, particularly to the Auckland, Wellington and Western Bay of Plenty regions.

(All of the above figures are ongoing annual impacts measured at 2012.)

The findings of this study indicate that net benefits will accrue by undertaking any one, or combination, of the four proposed road infrastructure packages. That is benefits are not dependent on undertaking all four packages simultaneously. That said, however, it is possible to rank each project in terms of the aggregate net benefit accruing over the life of the infrastructure. Doing this indicates that the Tauranga strategic roading network package will result in the greatest net benefit, followed by the passing lanes package and then the Auckland package.

Broad conclusions

Broadly speaking the overall conclusion from the analysis is that:

- the current level and pattern of investment in New Zealand's land transport infrastructure is sub-optimal; and
- there are substantial economic gains available to New Zealand from lifting investment in land transport infrastructure. The gross gains very substantially exceed the investment and financing costs required to undertake the four packages of projects selected for analysis.

Chapter 1

Introduction

This study was commissioned by the New Zealand Automobile Association as a contribution to the public policy debate surrounding the directions for the development of transport infrastructure policy and to increase understanding of the economic role of investment in land transport infrastructure. Other participating organisations include: the Greater Wellington Regional Council, Priority One (Tauranga), Auckland Chamber of Commerce, Infrastructure Auckland, Road Transport Forum New Zealand, Employers and Manufacturers' Association (Northern) and Business New Zealand. The study was undertaken by The Allen Consulting Group in collaboration with Infometrics Ltd.

Key objectives of the study are to:

- identify policy issues associated with development of national transport infrastructure;
- to assess the adequacy of the current stock of road infrastructure; and
- investigate the economic contribution of transport infrastructure.

The focus of this study is on New Zealand's road infrastructure. To a large degree, this reflects the lack of available information regarding other forms of land transport necessary to undertake this study. That said, it is recognised that road infrastructure is only one, but vitally important, element necessary for an integrated, sustainable land transport network.

1.1 Key issues to be investigated

With reference to a number of specific projects that have been proposed but are not currently funded this report will investigate a number of important issues, including:

- the benefits of investing in road transport infrastructure and its likely impacts on regional and national economic indicators such as output and employment;
- the adequacy of New Zealand's current road network with reference to a number of commonly used indicators, such as traffic congestion and road fatalities;
- the current adequacy of spending on New Zealand's road infrastructure and how this compares to a number of other developed nations;
- how investment in road infrastructure impacts other sectors of the economy including the government sector; and
- other likely impacts including changes in congestion levels and accident rates.

1.2 Approach to the study

The study combines the application of an economic model, with qualitative and quantitative inputs sourced from a range of relevant sources.

Inputs were sourced from:

- Statistics New Zealand;
- relevant government agencies – including New Zealand's Ministry of Transport, Transit New Zealand and Transfund New Zealand;
- the New Zealand Automobile Association;
- various regional councils including the Auckland Regional Council and the Wellington Regional Council; and
- previous studies and documentations relating to road transport infrastructure in New Zealand and overseas.

The Energy Substitution, Social Accounting Matrix (ESSAM) model and a regional input output analysis were used as a framework for the main quantitative part of the analysis. The ESSAM model is a well-documented and transparent model of the New Zealand economy taking into account inter-dependencies between the many sub-components that make up the economy. Similarly, input output analysis is a widely used approach to identify regional impacts of public policy decisions.

Appendix C contains further details about the ESSAM model and the assumptions that underpin it.

1.3 Structure of the report

As a background to the rest of the report, Chapter 2 provides a current state of play discussion of road infrastructure issues in New Zealand. In particular, it discusses the importance of the road network to the New Zealand economy as well as the adequacy of the current road system.

Chapter 3 provides an overview of current funding levels for road infrastructure in New Zealand and compares these to historic levels as well as to those levels witnessed in other developed nations.

Chapter 4 details the outcomes of the analysis undertaken using the ESSAM model. It details the likely impacts of increased road funding on a number of macro-economic indicators such as output, employment and import/export levels. This chapter also examines the likely regional and industry impacts of increased road funding.

Chapter 5 draws together the findings of the preceding chapters in order to identify key issues that merit attention by policy makers.

Appendix A gives details of the road projects.

Appendix B provides details of direct impacts.

Appendix C describes the ESSAM model.

Appendix D provides details of the regional analysis using regional economic multipliers derived from input-output tables.

Appendix E provides details of the expected industry impacts arising from the proposed road infrastructure packages.

Chapter 2

Background

This chapter provides a brief overview of New Zealand's road network infrastructure and its importance to the New Zealand economy. It also assesses the adequacy of the current road system with reference to a number of commonly used indicators.

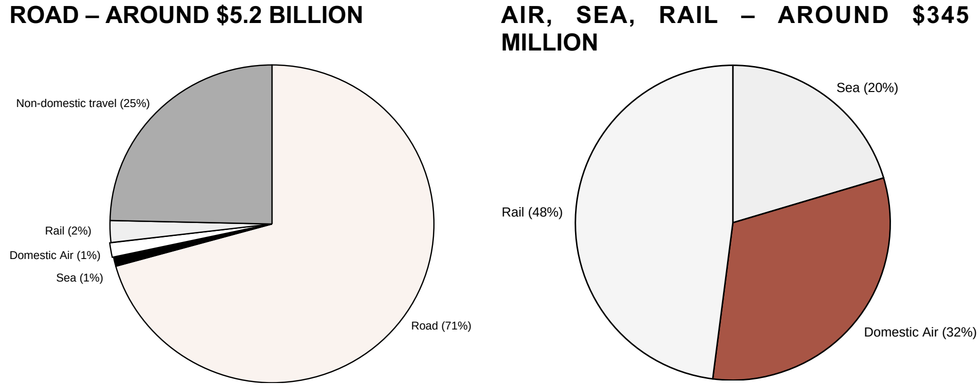
2.1 The importance of New Zealand's road network

It is difficult to overstate the economic and social importance of New Zealand's road network. It plays a significantly bigger role than other transport modes, and connects them all. It permeates all aspects of economic and social activity. The road network (notwithstanding the emergence and importance of e-commerce) continues to represent the arteries of modern daily life, playing a crucial role in economic activity at the local, regional and national levels. Public and private use of the road network underpins our ability to participate in employment, recreation and social activities, making access to it not just a matter of economic and social importance, but also one of equity.

As in many other OECD nations road transport is clearly the dominant transport mode in New Zealand. As Figure 2.1 indicates, household expenditure on road related transport is in the order of $5.2 billion per year[1] or roughly 12.7 per cent of household expenditure.[2] By contrast, use of sea, air and rail transport combined account for a little over forty per cent of that level of resource consumption (considerably less again if international air and sea transport are excluded).

Figure 2.1

BROAD INDICATORS OF HOUSEHOLD EXPENDITURE BY TRANSPORT MODE



Source: Statistics New Zealand 1998, Consumer Expenditure statistics 1998, Wellington. www.stats.govt.nz/domino/external/pasfull/pasfull.nsf/0/4c2567ef00247c6acc256b6700107093/%24FILE/conex98.pdf accessed on 15 March 2004.

1 Unless otherwise specified, all dollar figures given in this report are in New Zealand dollars.

2 Statistics New Zealand 1998, *Consumer Expenditure statistics 1998*, Wellington. **www.stats.govt.nz/domino/external/pasfull/pasfull.nsf/0/4c2567ef00247c6acc256b6700107093/%24FILE/conex98.pdf** accessed on 15 March 2004.

The importance of the road network to economic and business activity is not difficult to understand. Roads are ubiquitous; they provide virtually total connectivity of countless origins and destinations. Unlike other modes of transport such as rail, the road system offers an almost infinite range of choices for many users. Further, roads act as a feeder and distributor for other forms of transport.

Roads are open access and multipurpose. Business and commercial travel, social activity, freight transport and passenger travel and private transport or common carrier transport services all use the same network.

In most developed nations, there has historically been a strong relationship between economic growth and transport activity. The provision of physical infrastructure (such as roads, railways, ports and airports) is generally recognised as being of vital importance to economic development. A UK study that examined the effects on the performance of the economy which might be caused by transport projects and policies made the following conclusions:[3]

- Theoretical considerations suggest that the main mechanism by which changes in transport arrangements have an effect on the economy is by change in the *costs* of movement of goods and people.
- Transport infrastructure investments can potentially produce sustained reductions in transport costs, or equivalent improvements in services.
- These costs reductions could, in principle, improve economic performance in various ways. Businesses can pass on the benefit of lower production costs to consumers in the form of lower prices, or they can implement further efficiency improvements by reorganising production and distribution. The economy can also benefit if lower transport costs can help stimulate easier transfer between jobs or greater competition between firms. All of these imply improvement in real incomes and economic growth.

In addition to the theoretical links between transport costs and economic improvements, evidence from empirical studies points to outcomes consistent with what economic theory predicts. An Australian study using a general equilibrium analysis identified the main measurable benefits from new road construction, or the improvement of existing road facilities, as including: vehicle operating cost benefits, travel time benefits, accident benefits, environmental benefits and other productivity and indirect benefits. Accounting for the flow-on of these direct benefits throughout the economy reveals that investment in improved road infrastructure has two broad effects. The consequent productivity improvements in freight and passenger transport increase income and lower costs to transport-using industries. They thus expand national economic output, with the size of the gain depending on the initial productivity improvement and the market characteristics faced by the industries which benefit from the productivity improvements.[4]

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3 Standing Advisory Committee on Trunk Road Appraisal 1998, Transport and the economy: full report, London, http://www.dft.gov.uk/stellent/groups/dft_transstrat/documents/page/dft_transstrat_022512-21.hcs, Accessed 26 February 2004.

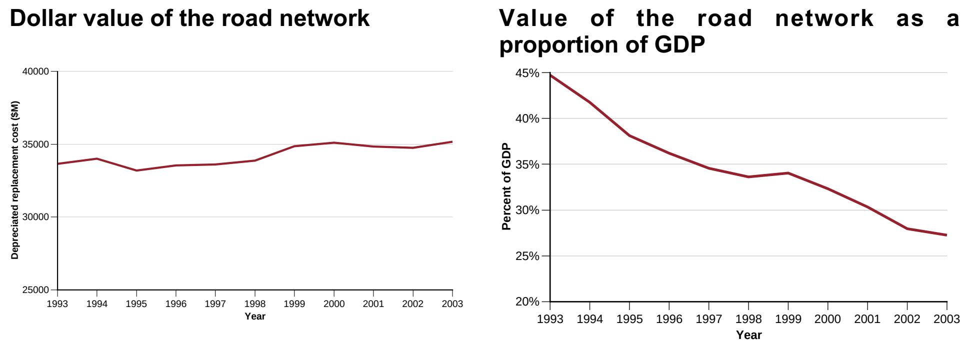
4 The Allen Consulting Group 1993, *Land Transport Infrastructure: Maximising the Contribution to Economic Growth*, Report to the Australian Automobile Association, Melbourne (ISBN 0 909 309 167).

2.2 The value of road infrastructure

Notwithstanding that there has been ongoing road investment over the last decade or so, evidence suggests that investment is not keeping up fully with need. As Figure 2.2 sets out, while the nation's net road stock has increased since 1992/93 in absolute terms, it has declined as a proportion of GDP from about 44 per cent then to a little over 28 per cent in 2003.

Figure 2.2

NET ROAD STOCK IN NEW ZEALAND



Source: ABS 5206.0, Allen Consulting Group 2001, Statistics NZ, National Accounts (revised) year ended March 2003, http://www.stats.govt.nz/domino/external/pasfull/pasfull.nsf/7cf46ae26dcb6800cc256a62000a2248/4c2567ef00247c6acc256eb2007c6597?OpenDocument.

A slowing in the growth of the net value of the road network is not necessarily an indicator for greater investment. As pointed out by The Allen Consulting Group in its study for the Automobile Association of Australia, investment should be determined on a case-by-case basis based on prospective net economic benefit. That said however, it is reasonable to expect the economically warranted level of infrastructure investment to increase with traffic and economic activity.

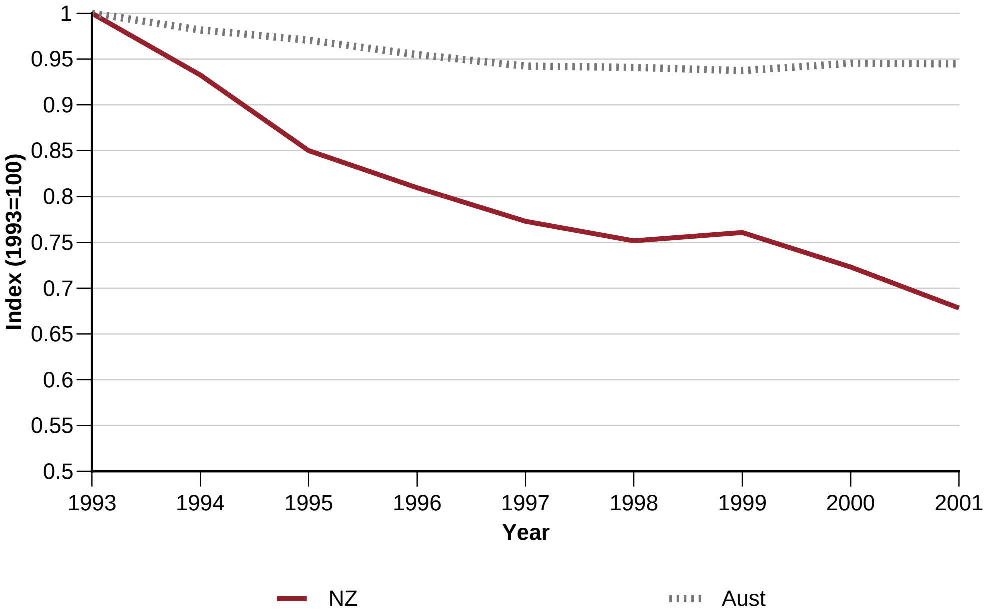
International comparison

Information about the value of the road network in overseas jurisdictions is difficult to obtain. The best available information is from Australia, sourced from the Australian Bureau of Statistics, National Accounts. While the Australian measures are not directly comparable with those estimates available for New Zealand there is merit in assessing how the respective measures of road network value have changed over time.

As shown in Figure 2.3 Australia's value of road stock as a proportion of GDP declined by around 5.5 per cent over the period 1993 to 2001, gradually increasing at the end of that period. By contrast, over the same period, New Zealand's value of net road stock as a proportion of GDP decreased by over 30 per cent. This is no doubt attributable to the fact that while New Zealand has experienced consistent GDP growth over the period, the absolute value of its road stock has remained relatively unchanged.

Figure 2.3

CHANGES IN NET ROAD CAPITAL STOCK IN NEW ZEALAND AND AUSTRALIA (PERCENT OF GDP)



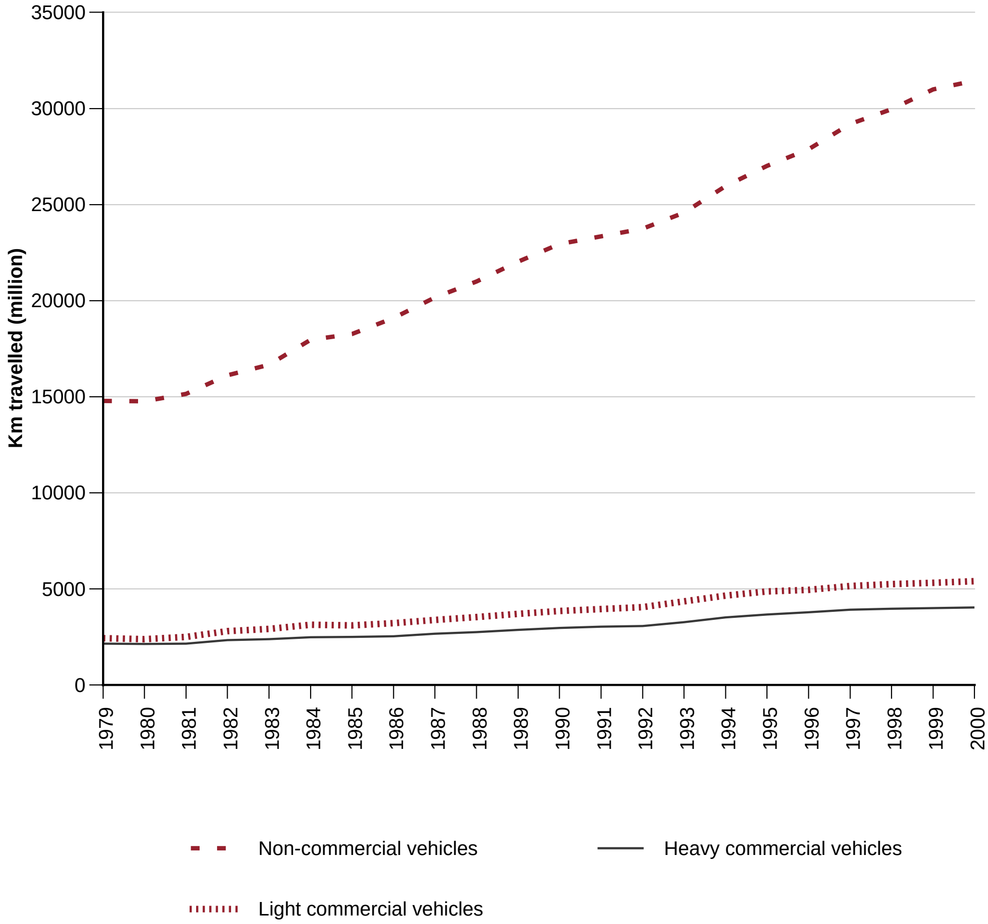
Source: ABS 5206.0, Allen Consulting Group 2001, Statistics NZ, *National Accounts (revised) year ended March 2003*, http://www.stats.govt.nz/domino/external/pasfull/pasfull.nsf/7cf46ae26dcb6800cc256a62000a2248/4c2567ef00247c6acc256eb2007c6597?OpenDocument.

2.3 Utilisation of the road network

Over the period of low growth in investment in the road network, the utilisation of the road system has increased considerably. Over the last 10 years the total kilometres travelled by both passenger and commercial vehicles have increased by 37 per cent and 40 per cent respectively (see Figure 2.4).

Figure 2.4

UTILISATION OF THE ROAD NETWORK



Source: Statistics New Zealand, Transport, www.stats.govt.nz/domino/external/web/nzstories.nsf/Response/Transport accessed on 4 April 2004

A recent report by PriceWaterhouseCoopers (see Table 2.1) noted that urban regions dominate road use. While urban roads including motorways make up only 12 per cent of the total road network[5] they are subjected to 57 per cent of total road use, as measured by vehicle kilometres travelled (VKT).

[5] Transfund New Zealand 2003, *Roading Statistics 2002/03*, http://www.transfund.govt.nz/pubs/TransfundRoadStats2003.pdf access 12 March 2004.

Table 2.1

ROAD USE INTENSITY BY REGION

Region	VKT (Millions)	VKT/KM (Thousands)	Heavy Vehicle VKT (Millions)	Heavy Vehicle VKT/KM (Thousands)
Auckland	10,356	1,316	147	18.6
Waikato	4,450	436	125	12.3
Wellington	3,469	851	52	12.8
Bay of Plenty	2,165	485	65	14.5
Hawke's Bay	1,381	299	32	6.9
Canterbury	4,555	298	94	6.2
Manawatu/Wanganui	2,409	276	72	8.2
Taranaki	944	245	31	8.1
Nelson/Marlborough/ Tasman	935	230	23	5.6
Northland	1,442	222	43	6.6
Otago	1,823	176	53	5.1
West Coast	427	153	17	6.2
Southland	947	132	28	3.9
Gisborne	289	132	9	4.1
New Zealand	**35,592**	**386**	**790**	**8.6**

Source: PriceWaterhouseCoopers 2004, pp 153-155.

As shown in Table 2.1, the Auckland region has the highest road use intensity. The Auckland region accounts for 29 per cent of the total New Zealand VKT as well as 19 percent of the heavy user vehicle VKT.[6] The Auckland region only accounts for 8.5 per cent of New Zealand's total road network.[7]

Wellington which accounts for 4.4 per cent of New Zealand's road network[8] has the third highest road use intensity, accounting for 9.7 per cent of total VKT. In regards to heavy vehicle road use, Wellington accounts for around 6.6 per cent of New Zealand's total heavy vehicle VKT.[9]

2.4 Adequacy of New Zealand's road infrastructure

The adequacy of the present stock of road transport infrastructure can be measured with reference to a number of commonly used indicators including:

- urban congestion;
- network development; and

[6] PriceWaterhouseCoopers 2004, *Infrastructure Audit a report for the Ministry of Economic Development*, p164.

[7] Transfund New Zealand 2003, *Roading statistics 2002/03*, http://www.transfund.govt.nz/pubs/TransfundRoadStats2003.pdf access 12 March 2004.

[8] Transfund New Zealand 2003, *Roading statistics 2002/03*, http://www.transfund.govt.nz/pubs/TransfundRoadStats2003.pdf access 12 March 2004.

[9] PriceWaterhouseCoopers 2004, *Infrastructure Audit a report for the Ministry of Economic Development*, p164.

- accident rates.

The above indicators shed light on the adequacy of the existing stock of road infrastructure. They should not, however, be used to draw definitive conclusions on the adequacy of current or future road funding. These indicators merely reflect the extent to which the current stock of road infrastructure causes negative externalities. By contrast, a significant proportion of current and future road infrastructure funding is undertaken to minimise negative externalities such as traffic congestion and accident rates. Moreover, these indicators do not reveal the efficiency of current funding arrangements or the appropriateness of current funding projects.

Urban congestion

Road congestion occurs because road infrastructure has a finite capacity at any given point in time. While congestion clearly imposes costs, its presence is not of itself evidence that the level or pattern of investment in roads is inefficient. In fact, attempting to eliminate all traffic congestion would be inefficient – simply because the benefits of eliminating *all* congestion would undoubtedly be outweighed by the costs. Given this caveat, it must however be recognised that congestion is clearly a negative externality and has the potential to impose a significant, and quantifiable, cost on both business and private users of the road network.

A 1997 study by Ernst and Young estimated the economic cost of congestion in the Auckland region alone to be approximately $755 million per year (1997 dollars),[10] of which around 25 per cent is borne by the manufacturing and distribution sectors. Annual traffic growth in Auckland averaging 5 per cent[11] takes this cost to over $1.0 billion per year.[12] However, a more recent study for the Auckland Regional Council showed that traffic congestion in the Auckland region is estimated to cost nearly $4 billion each year.[13]

Findings of a study undertaken by Transit New Zealand, provides further evidence that traffic congestion is a significant problem for New Zealand, particularly in Auckland and Wellington.[14] The study calculated congestion levels based on the difference between actual travel speeds and allowable speed limits. The results of this study are presented in Figure 2.5.

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10 Ernst and Young 1997, Alternative Transport Infrastructure Investments and Economic Developments for the Auckland Region, Prepared for the Keep Auckland Moving Campaign, Auckland p 19.

11 Auckland Regional Council www.arc.govt.nz/arc/index.cfm?F94A9489-E018-8BD1-32DB-B76D288C55D9 accessed 28 July 2004

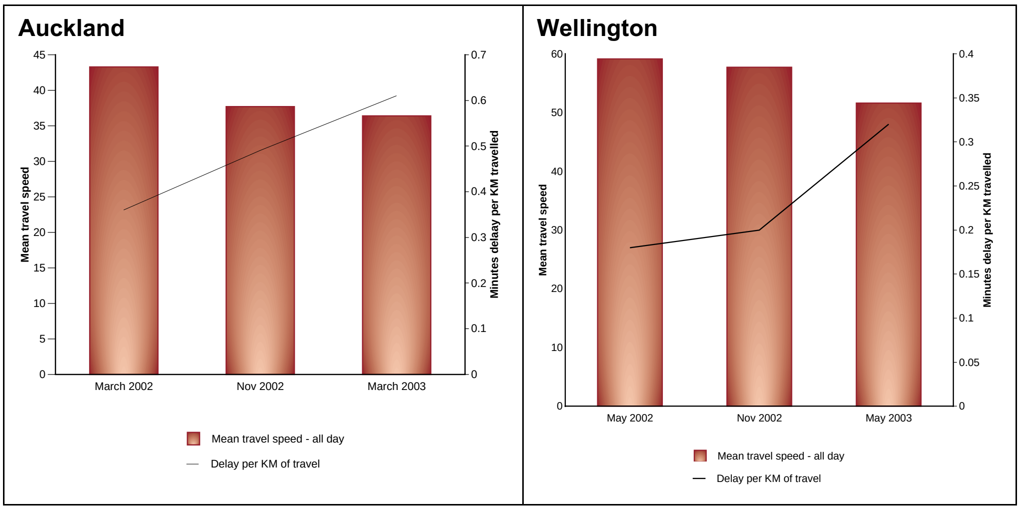
12 New Zealand Automobile Association 2001, *The Auckland Transport Crisis:Choosing the Optimum Public Transport Strategy,* Wellington, p.14

13 Deloitte 2004, Road User Pricing – A Research Report, http://www.deloitte.com/dtt/research/0,2310,sid%253D24996%2526cid%253D34868,00.html.

14 Transit New Zealand 2003, *Painting a picture of congestion – Media release*, 15 September 2003.

Figure 2.5

CONGESTION INDICATORS FOR AUCKLAND AND WELLINGTON



Source: Transit New Zealand 2003, *Painting a picture of congestion – Media release*, 15 September 2003

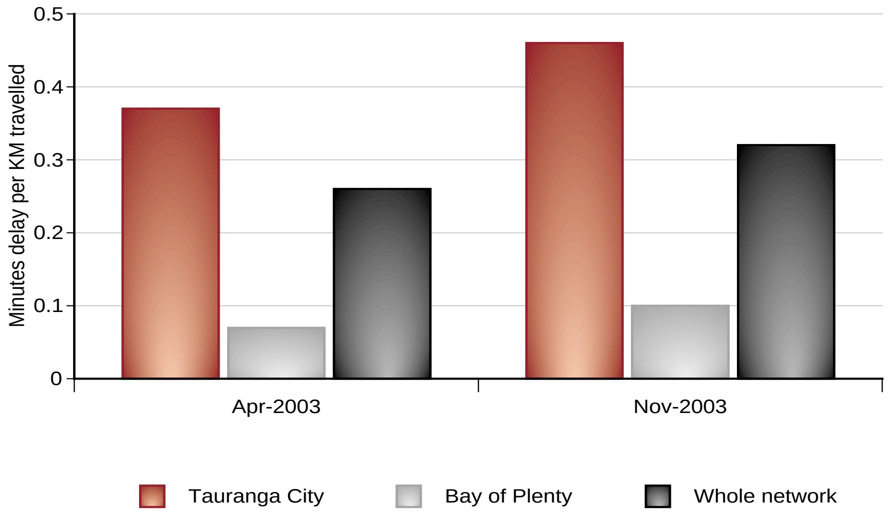
The study reveals that the median all day travel speed on a number of Auckland's major motorways, state highways and cross town regional arterial roads has decreased from around 43.3 km/hour in March 2002 to 36.3 km/hour in March 2003. Furthermore, the measure used by Transit New Zealand as the principle indicator of traffic congestion – average delay per kilometre travelled – has increased from 0.36 minutes/km in March 2002 to 0.61minutes/per kilometre in March 2003. This means that on the routes surveyed by Transit New Zealand average travel speeds are 7 km/hour slower and that a 20 km journey would on average take an additional 5 minutes of travel time.

In Wellington median travel speeds have decreased from around 59.1 km/hour in May 2002 to around 51.6 km/hour in May 2003. The average delay per kilometre travelled has also increased over this time from 0.21minutes/km travelled to 0.32 km/travelled. Hence a 20 km journey would on average take an additional 2 minutes and 20 seconds to complete.

A similar study for Tauranga City and the Bay of Plenty region reveals that average delay per kilometre travelled in these regions, particularly in Tauranga City, is comparable to those experienced in Wellington — see Figure 2.6. Unfortunately, the available studies for the Tauranga and Bay of Plenty Region are not directly comparable over time given significant increases in the level of road works.

Figure 2.6

CONGESTION INDICATORS FOR TAURANGA AND BAY OF PLENTY REGION



Source: Tauranga City Council

While these results may be due to several factors, such as changes in driving conditions and the level of road works, they do suggest that congestion is becoming an increasing problem for both Auckland and Wellington. As noted by a recent report by PriceWaterhouseCoopers:[15]

> In Auckland … heavy congestion is experienced on the Northern and Southern Motorways during peak periods, largely because there are no viable alternative routes.
>
> There are also several sections of the key strategic network which are severely under capacity during times of peak demands.

PriceWaterhouseCoopers also note that the level of congestion is a result of an inadequate road network:[16]

> Congestion surveys for Auckland and Wellington, and crash statistics infer a lack of capacity, however these measures are consequence of pressure on infrastructure rather than a direct capacity indicator itself.
>
> Congestion is a highly visible consequence of high travel demand placing pressure on the road network.

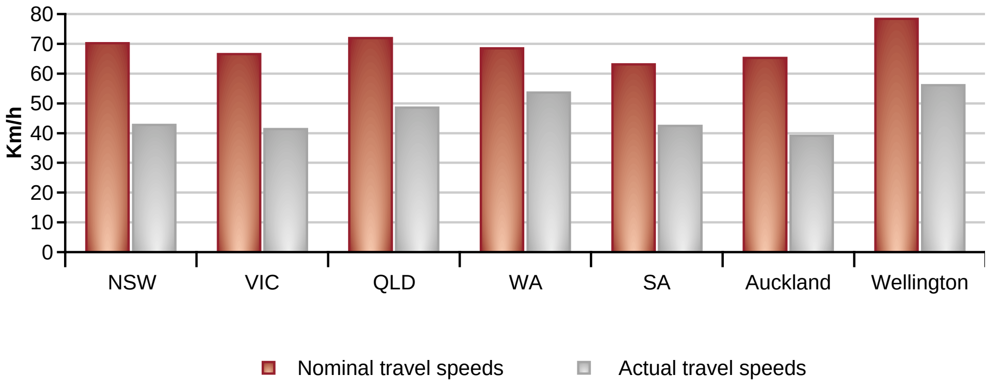
[15] PriceWaterhouseCoopers 2004, *Infrastructure Audit a report for the Ministry of Economic Development*, p 164.

[16] PriceWaterhouseCoopers 2004, *Infrastructure Audit a report for the Ministry of Economic Development*, p 163.

Uncongested travel speeds on Australian city road networks are between 63 and 72 km/h based on a weighting of freeway and arterial road travel. Similar calculations for New Zealand give maximum network speed of about 65 to 78 km/h. However, while New Zealand's average uncongested network travel speed may be broadly in line with those in Australia it is interesting to note that *actual* speeds (which are impacted by the level of network congestion) are on average lower than those in Australia, at least in Auckland. As illustrated in Figure 2.7, for Australia all day actual travel speeds in urban areas range from 41.4 km/h in Victoria to about 53.7 km/h in Western Australia. By comparison Auckland's all day actual speeds range from 36.4 km/h to 43.3 km/h. For Wellington actual travel speeds are somewhat higher, ranging between 56.6 km/h to 59.1 km/h. Traffic congestion presents as a significant issue for Auckland.

Figure 2.7

NOMINAL AND ACTUAL NETWORK SPEEDS



Source: Australian and New Zealand Road System and Road Authorities National Performance Indicators www.algin.net/austroads/ and Transit New Zealand 2003, Painting a Picture of Congestion; Media release 15 September 2003.

While congestion is less of an immediate problem for Wellington initial research indicates that traffic congestion is a growing issue, particularly on urban arterials throughout the day.[17]

Network development

The limited development of New Zealand's principal road network, and particularly of a network of controlled access roads or freeways in urban areas, may be taken as an indicator of inadequate road infrastructure. The absence of an integrated high-speed road network for high traffic levels raises business transport costs significantly. International comparisons are useful to illustrate the difference between New Zealand and overseas conditions.

[17] Transit New Zealand 2003, Painting a Picture of Congestion; Media release 15 September 2003.

Box 2.1

AN OVERVIEW OF NEW ZEALAND'S KEY URBAN ROAD NETWORKS

Auckland

Auckland is New Zealand's largest and fastest growing metropolitan area. It is built on a narrow isthmus between two natural harbours, the Waitemata and Manukau. Auckland's natural geography limits infrastructure access from North to South through the narrow isthmus.

Wider Auckland comprises seven independent local authorities, Auckland, North Shore, Waitakere, Manukau Cities, and Franklin, Papakura and Rodney Districts. Relative to many other cities Auckland is very decentralised with less than 11% of employment now in the CBD. Auckland is characterised by a number of major satellite nodes of employment, education and shopping centres. It is argued that this decentralised structure is a hindrance to the development of an integrated transport system for the region.

Auckland's population is forecast to double in 50 years, with 65% of that natural increase, the rest a combination of immigration and urban drift.

Key characteristics of Auckland's land transport system include:

- Water tranport — The Port of Auckland, located in the very heart of the CBD and carries the highest value of imports of any New Zealand port (although the Port of Tauranga carries higher volumes).
- Rail transport — The main trunk rail line from Northland crosses the isthmus and passes through West Auckland, touching the outer edge of the CBD before continuing south, bypassing Manukau City centre and the airport. Heavy freight shares this line with a very limited passenger transport service. An eastern loop has recently been extended to bring passenger rail into the heart of the CBD to the new Britomart transport centre. The rail service does not extend to the North Shore City.
- Air transport — Auckland domestic and international airports are on the southwest edge of Manukau City.
- Passenger transport — With no rail link, the North Shore City is building a rapid bus network, with dedicated two-way bus lanes between the North Shore and the CBD. There is increasing conversion of existing road capacity to bus lanes, and improvements in ticketing and information, but no long term strategic plan for growing the bus mode share through an integrated bus network in wider Auckland
- Road transport — Auckland's road network is currently at full capacity. As a consequence there is significant traffic congestion. This is most pronounced in the CBD.

Significant transport related issues currently facing Auckland include:

Capacity limits on urban routes:

The Auckland harbour bridge carries 160,000 vehicles per day on average (half of this volume is carried by 'temporary' bridge clip-on lanes). Hence the Harbour Bridge is at full capacity.

Inner city congestion

Auckland has essentially a single connected motorway link, a North-South spine that goes through the CBD and across the bridge. On that link, the Auckland Harbour bridge, the Victoria Park viaduct and the Newmarket viaduct are the greatest bottlenecks.

Traffic congestion in the CBD is also made worse by the fact that all traffic passing between Northland and the rest of the country must pass through the centre of Auckland. Similarly, traffic volumes in the inner city are also heightened by the fact that the Port of Auckland, the University and Auckland's major hospital are all located either within or close to the City centre.

Lack of network connectedness

There is no connected motorway standard link from the airport into the city and none is planned. Traffic travels through two lane suburban streets, and delays can be significant and variable.

In the 1960's land was reserved for a motorway network envisioned to have western and eastern alternatives to take traffic off the central 'spine'. Only a small fraction of these links have been completed.

Wellington

Key characteristics of Wellington's transport infrastructure are detailed below.

- Sea – Wellington is home to the only deep-water port accessible directly from countries west of New Zealand (New Zealand's main sea freight route). It is also the gateway between New Zealand's two main islands and it therefore serves as a hub for inter-island freight and passenger transport services including water, rail and road.
- Air transport – While Wellington has an international airport, its runway is relatively short and access can be difficult at times. As a result, in recent years Wellington Airport has been losing significant volumes of freight custom to both Auckland and Christchurch airports.
- Rail transport – Wellington has inherited a good passenger rail network, but the carriages have been run down.
- Road transport – Wellington is served by two motorways - State highway 1 (SH1) and State Highway 2 (SH2). Wellington's steep topography has meant that both these motorways, along with the rail network, are channelled into a restricted Y-shaped corridor. State highway 1 runs through Kapiti Coast (serving the areas West of Wellington), while SH2 serves the region East of Wellington including the Hutt valley. The two urban motorways (part of SH1 and SH2) join at Ngauranga Gorge and end west of the CBD at the Terrace Tunnel.
- The ferry terminal, (technically part of SH1), freight ports and railway station are located on the north side of the CBD. As such they are served by both the major arterial and the rail network. The airport, however, is located on the far side of the CBD meaning that there is no direct access through the CBD.
- Passenger transport - unlike other New Zealand cities, Wellington retains a high proportion of employment in the CBD. Accordingly a relatively high proportion of commute trips are by public transport (bus and rail).

Despite the fact, that relative to other New Zealand cities, Wellington has a strong public transport system and an extensive rail network it nonetheless faces a number of important challenges in relation to land transport infrastructure. Many of these challenges relate to the road network, including:

Capacity limits on northern arterials.

SH1up to the Terrace Tunnel, is a four-lane motorway providing access in and out of the city. At several sections (i.e. Paremata roundabout and Pukerua Bay) SH1 reduces from four lane to only two. This represents a significant reduction in the road capacity causing significant traffic congestion and lengthy delays. Moreover, given that these sections of the highway have no road shoulder they have a high severity of accidents, particularly head on collisions. An uncontrolled intersection at Paekakariki also has a high incidence of road crashes and fatality rates.

Inner city congestion

Wellington's road network does not include a city bypass or an orbital network. Instead, traffic on all major routes is directed into the city and back out again. This has consequences for both traffic volumes and road safety.

For example, the 100km/h SH1 terminates at the Terrace Tunnel and connects with a 50km/h route through the CBD. This route comprises two separate one-way roads (with car parking on both sides), seven sets of partially synchronised traffic lights, and passes through a main shopping area (including a pedestrian mall). Not surprisingly, this section of Wellington's inner city road network has one of the worst records in the country for accidents.

Lack of network connectedness

Wellington and its main industrial area, the Hutt valley, are linked by the SH 2. There is a direct link (SH 58) between the Hutt valley and SH 1 for Hutt valley traffic heading north of Wellington (and vice versa), but SH 58 is not a motorway. Consequently, north-bound heavy traffic from the Hutt valley uses SH 2 to access SH 1. This puts additional traffic on the busiest commuting parts of SH1 and SH 2.

Furthermore there is no arterial road network connecting the central Hutt Valley to SH 2. This results in significant congestion at various points in the Hutt valley, such as along the Petone Foreshore.

Currently there is no arterial road network connecting Wellington's main industrial area, the Hutt Valley, to the SH1 which provides a route to the major population centres north of Wellington. Heavy vehicle traffic has no alternative, but to travel down SH 58 in order to travel up SH1. This brings heavy vehicle traffic into the city area adding to local traffic volumes and congestion.

Limited capacity on SH2

SH2 is the main route east of Wellington. Significant sections of this road cross steep mountain divide and are very narrow and windy. Also there are limited overtaking opportunities and few roadside barriers. The condition of this road means that:

- there is a high incidence of road crashes; and
- it is unsuitable for heavy vehicles forcing additional traffic onto SH1. Furthermore, it is claimed that two trucks can't pass safely on some corners.

Traffic congestion

In addition to traffic congestion on SH 1 and on local roads within the city area the major route between Petone and Ngauranga suffers from capacity restrictions resulting in significant delays and congestion. This is despite the fact that this road is a motorway standard road.

Tauranga

Tauranga lies in the Bay of Plenty on a natural harbour. It is home to New Zealand's second largest export port by value and first by volume. Tauranga is also centrally located, within three hours' drive of Auckland, Hamilton, Rotorua and Taupo. These factors together mean that Tauranga is an important hub for transport activity in New Zealand.

Over recent years Tauranga has experienced strong population growth (17% over 5 years). The current population of the Western Bay of Plenty stands at 130,00 residents.

Key characteristics of Tauranga's transport infrastructure include:

- Road transport – Traffic volumes on SH2 through Tauranga averages about 16,000 vehicles per day between Te Puna and Paengaroa.
- Water transport and port services – The Port of Tauranga receives 50,000 containers per year from Metroport, its 'inland port' – a direct railhead link from South Auckland. The port is also well sited for dairy and horticulture, and for forestry from the central North Island and East Cape.
- Air transport – Tauranga Airport is on the Mt Maunganui side of the harbour, which means that most users of the airport have to cross the Harbour Bridge to reach it.
- Rail transport – There are heavy rail freight links into the port from both the North and South. The northern link connects to Metroport while the southern link services log processing plants. There is no rail-based passenger transport service, either within or into Tauranga.
- Passenger transport – Tauranga has low levels of public transport service for a city of its size. Passenger services are predominately bus-based services that are targeted at the "transport disadvantaged" rather than commuters.

Current transport related issues facing Tauranga include:

Road safety

SH2 both North and South of Tauranga have among the highest crash records in the country.

Urban road capacity limits

Heavy vehicles including many logging trucks and high traffic volumes are forced to go through suburban and city streets and the main streets of small towns like Te Puke and Katikati. This creates both safety concerns and congestion.

Lack of integrated transport modes

The port is on both sides of the harbour. The rail link between the two port sites deviates 12.5km via Te Maunga and through the Tauranga CBD. A new combined road and rail bridge across the Tauranga harbour would provide both direct rail access as well as solve road infrastructure capacity issues.

Traffic congestion

Despite the fact that SH2 between Te Puna and Paengaroa experiences high volumes of traffic it is not a limited access road nor is it a four lane road. Accordingly this stretch of SH2 has a very poor safety record.

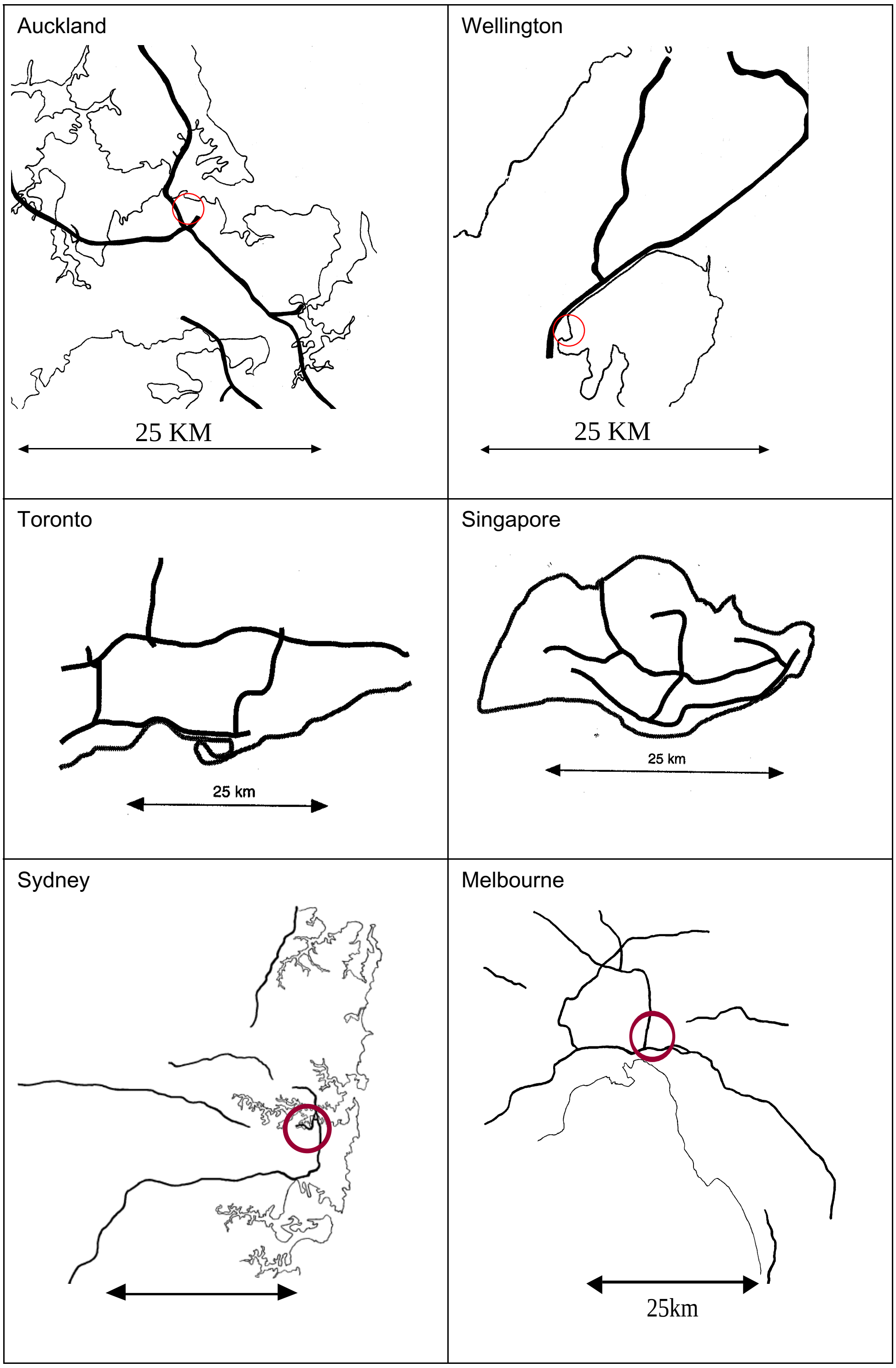
Given current road network capacity in Tauranga excessive levels of traffic are experienced in and around the CBD, the port and across the harbour bridge. This is a major cause of traffic congestion particularly at peak travel times. The planned strategic roading network will alleviate this problem.

Source: New Zealand Automobile Association.

As Figure 2.8 indicates, New Zealand's city networks of principally controlled access roads are somewhat disconnected by international standards. Toronto, which is often regarded as a model for public transport systems development, has a well-developed road network compared to New Zealand's major cities (i.e. Auckland and Wellington). Its network provides a connected system of controlled access roads to direct traffic around the city. By contrast, the principal road networks in both Auckland and Wellington tend to direct traffic to the centre of the city and do not provide circumferential routes.

Figure 2.8

ROAD NETWORK CONNECTEDNESS — SELECTED INTERNATIONAL CITIES



Source: New Zealand Automobile Association and The Allen Consulting Group.

Accident rates

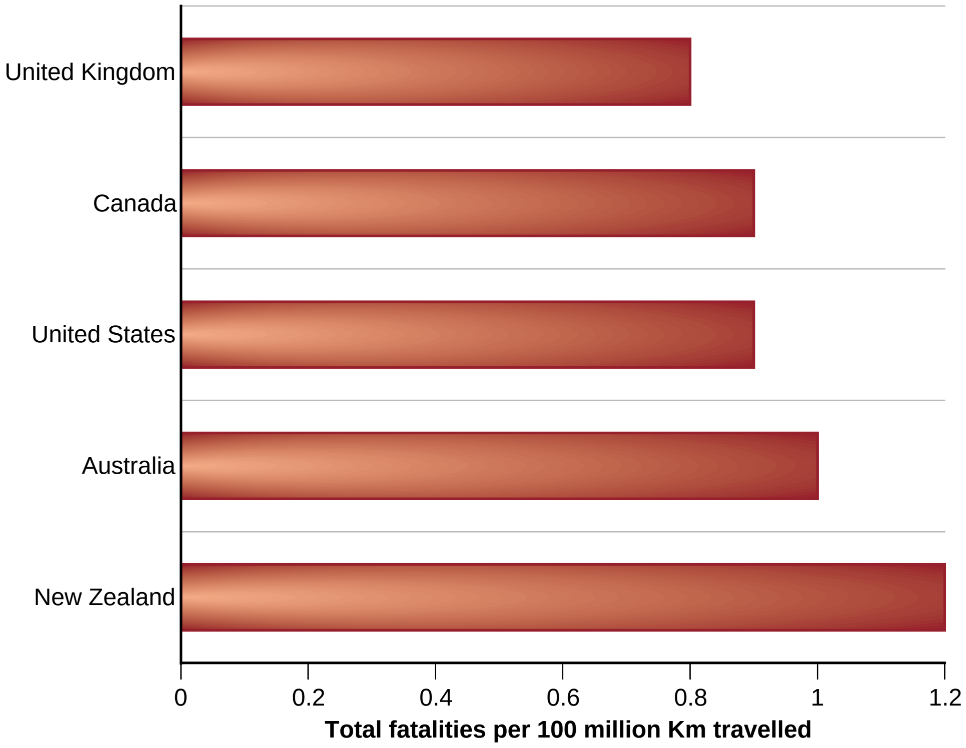
The limited development of a principal road network is also believed to contribute to higher rates of accidents than might otherwise be the case.

Evidence from both New Zealand and overseas suggests that primary controlled access roads and freeways have significantly fewer accidents than other roads. This is because relative to other roads, primary controlled access roads and freeways have fewer intersections and other interruptions to stable traffic flow (over 60 per cent of all accidents occur at intersections). In 2002, UK fatality rates on motorways represented only 6.5 per cent of total annual fatalities as opposed to those on roads outside urban areas, which accounted for approximately 61 per cent of all fatalities.[18] In Western Australia, a 1993 study revealed that accidents on freeways and multi-lane divided roads in urban areas were only 30 per cent of those on a multi-lane undivided road.[19]

The significance of these figures can be understood by comparing US and New Zealand accident rates. The US has a lower overall fatality rate than New Zealand (see Figure 2.9), despite very little effort in driver education or in the enforcement of seat belt, speed limit and alcohol regulations.[20] Road experts believe that the reason for the better safety record in the US (as well as in the UK and Sweden) is that the quality of road infrastructure is better, leading to lower accident rates. Similarly, New Zealand has a higher accident rate than Australia despite having very similar speed limits and other traffic enforcement regulations.

Figure 2.9

FATALITY ACCIDENT RATES FOR VARIOUS OECD COUNTRIES



Source: Australian Transport Safety Bureau 2000, International Road Safety Comparisons: The 2000 Report, p 13.

18 Organisation for Economic Cooperation and Development 2004, International Road Traffic and Accident Database March 2004, www.bast.de/htdocs/fachthemen/irtad/english/we32.html.

19 ATN 1993, *Study Proves Divided Roads Are Safer, Australian Transport News*, p 20.

20 In the US these regulations are considered to be infringements on a citizen's personal liberties.

The indicators discussed in this chapter suggest that the current level and pattern of investment in land transport infrastructure is not optimal. The utilisation of the road capital stock has increased substantially over the last 10 years. Over the same period the value of road infrastructure as a proportion of gross domestic product has declined. The pattern of road development and accident rates also suggests inadequacies in road infrastructure.

Chapter 3

Investment in the road network

This chapter details current funding levels for road infrastructure in New Zealand and compares them to historic levels. It also compares New Zealand's current funding levels to those in other developed nations.

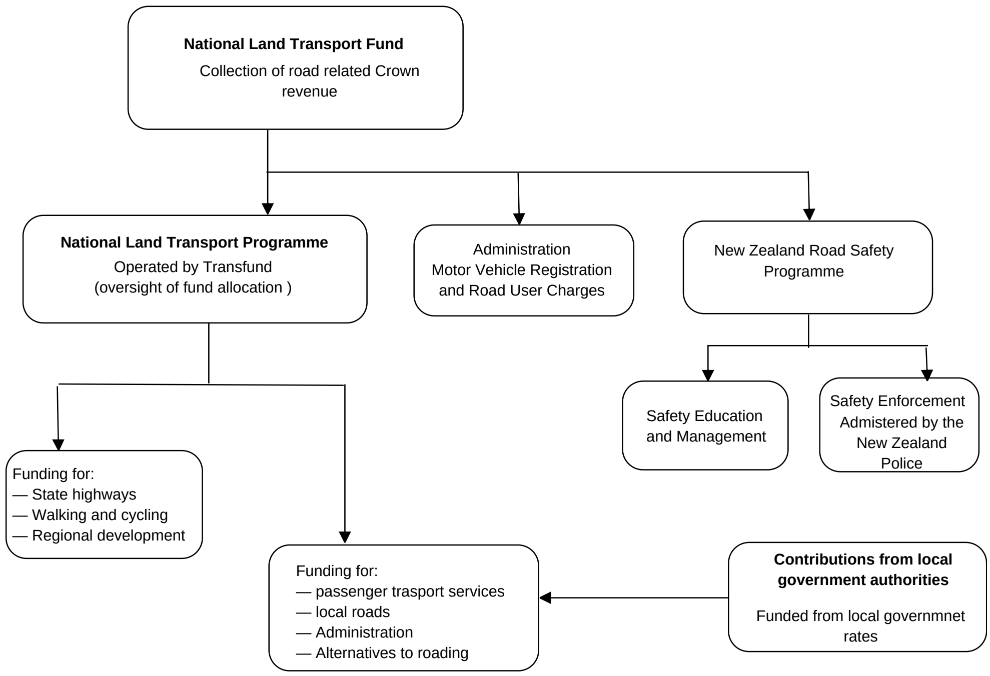
3.1 Institutional factors

New Zealand's road funding arrangements are based on a Funder/Purchaser model whereby Transfund New Zealand (Transfund), a central government agency, allocates road user funds under the National Land Transport Programme. A number of separate central and local government agencies negotiate for road funding using a structured method involving established bidding criteria. On average fifty per cent of funding for local roads is provided by Transfund, with the actual percentage varying according to the local council's ability to pay.[21] State highways in New Zealand are fully funded by the by National Land Transport Programme.[22]

Relevant government agencies and their respective responsibilities are detailed in Figure 3.1.

Figure 3.1

TRANSPORT FUNDING IN NEW ZEALAND



Source: Transfund New Zealand 2004, www.transfund.govt.nz/pubs/fundDiagram.pdf accessed on 15 March 2004.

21 For example for a large urban council actual road funding from Transfund may average 43 per cent of total funding. By comparison for a small rural council actual funding for local roads may average 60 per cent.

22 Austroads 2000, *Road Facts 2000: An overview of the Australian and New Zealand road systems,* Sydney, p 66.

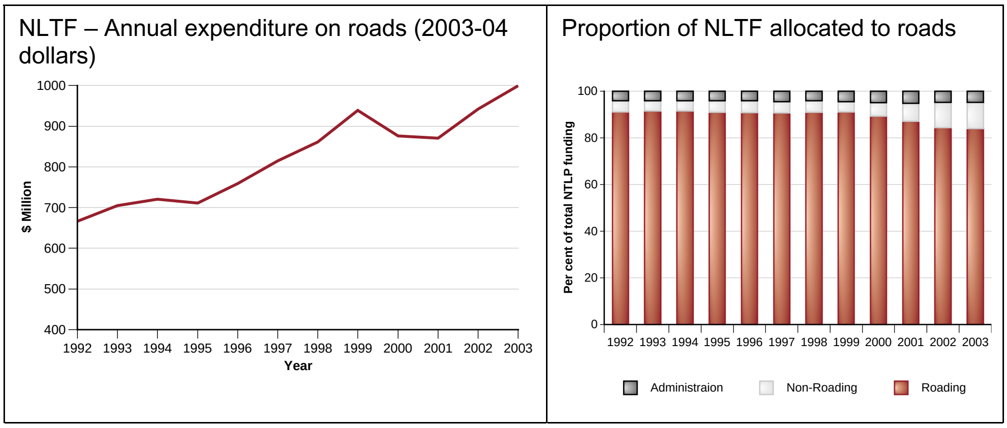
National Land Transport Programme

Transfund is the government agency responsible for the administration and receipt of revenues from a number of sources including: road user charges, fuel excise tax, motor vehicle registration and licensing fees. Transfund is also responsible for allocating funds generated from these sources among the competing demands for maintenance and expansion of the state highways, local authority roads and urban transport and non-road transport alternatives. The mechanism by which Transfund allocates the available funds is known as the National Land Transport Programme (NLTP).

Total road funding under the National Land Transport Programme has increased in real terms over the last 10 years. As Figure 3.2 indicates, that road funding under this programme, in real terms, has increased by around 50 per cent, from $666.5 million in 1992/93 to around $1 billion in 2002/03.[23] However, as a percentage of total transport funding road has declined. By contrast, the proportion allocated to the development and maintenance of non-road transport alternatives has increased by approximately 138 per cent.

Figure 3.2

NATIONAL LAND TRANSPORT FUND



Source: Statistics New Zealand, National Accounts, at www.stats.govt.nz/domino/external/web/nzstories.nsf/Response/National+Accounts.

New Zealand Automobile Association

Local Government Authorities

In addition to spending by the NLTF, local authorities also contribute to the cost of ongoing maintenance and construction of local roads. This is funded via local government taxes such as council rates.

For the 2003/04 financial year a total of $431 million was allocated to land transport outputs by New Zealand's local government authorities. This total comprised:

- $344 million for the upgrade and development of local roads;
- $63 million to the cost of providing passenger transport services; and
- $24 million to the administration of road and transport related agencies.

[23] Does not include amounts allocated to non-roading and administration purposes.

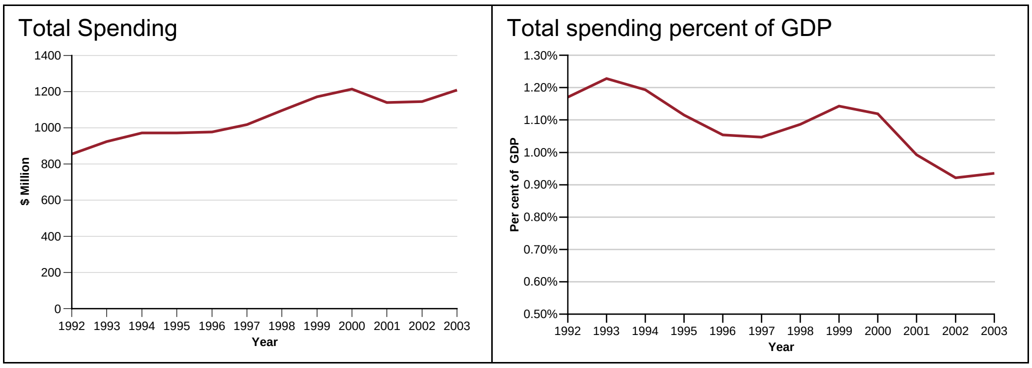
For the financial year 2003/04 spending by local government authorities on road maintenance and construction accounted for approximately 26 per cent of the total expenditure on roads in New Zealand.

3.2 Spending on roads

As shown in Figure 3.3 total spending on roads (including actual spending under the NTLF and by local councils) has increased in real terms over the period 1992/03 to 2003/04. By contrast, as a proportion of GDP, total spending on roads has declined somewhat. Over the period 1992/93 to 2002/03 total spending as a proportion of GDP has declined from 1.17 per cent to around 0.94 per cent.

Figure 3.3

TOTAL ROAD RELATED EXPENDITURE (CURRENT DOLLARS)

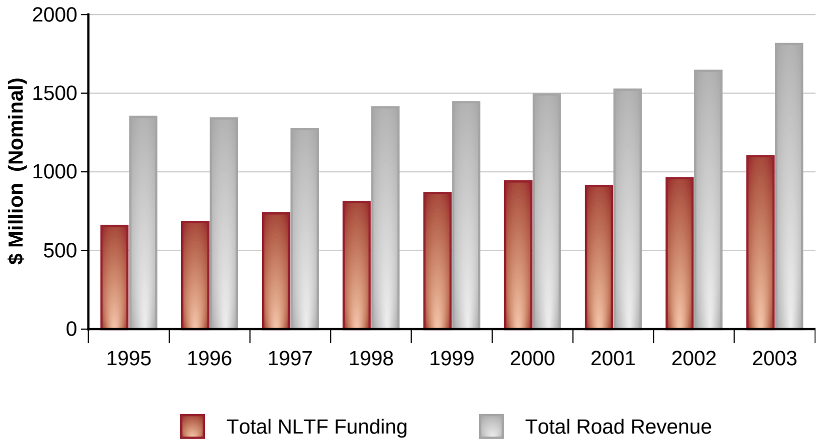


Source: Business New Zealand, Reserve Bank of New Zealand *CPI Inflation Calculator* **http://www.rbnz.govt.nz/statistics/0135595.html** and Statistics New Zealand National Accounts **www.stats.govt.nz/domino/external/web/nzstories.nsf/Response/National+Accounts**

For the 2003-04 financial year total funds allocated to road infrastructure are projected to be around $1.5 billion. By comparison, for the same period it is expected that users of New Zealand's road network will contribute a total of $2.4 billion to the National Land Transport Fund. The difference, $917 million, will be allocated to the Crown Account and will not be spent on improving or maintaining New Zealand's road network. As shown in Figure 3.4 for each of the years between 1992 and 2003 total revenue from road related taxes and user charges have exceeded spending on roads under the NLTF by an average of 42 per cent.

Figure 3.4

TRANSPORT EXPENDITURE VS ROAD RELATED REVENUES



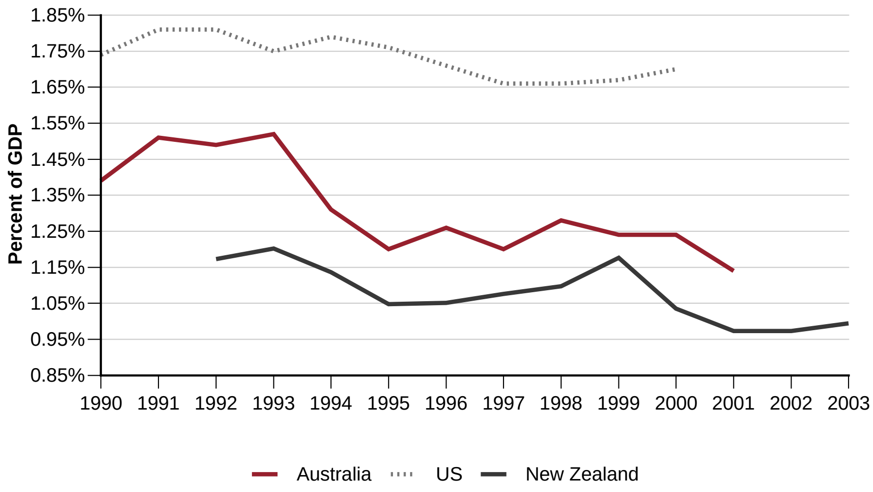
Source: The Treasury, Crown Financial statements various years **http://www.treasury.govt.nz/financialstatements/** accessed on 30 April 2004.

3.3 International comparisons

Comparative international information about the level of investment in road infrastructure is difficult to obtain. The most reliable data are from the United States and Australia. Comparing New Zealand's annual government expenditure on road infrastructure as a percentage of gross domestic product with those levels in the US and Australia shows that over the period New Zealand has been below those countries. See Figure 3.5.

Figure 3.5

GOVERNMENT EXPENDITURE ON ROADS (PER CENT OF GDP)



Sources: Statistics New Zealand, National Accounts, at www.stats.govt.nz/domino/external/web/nzstories.nsf/Response/National+Accounts
Business NZ, 2003.

Australian Automobile Association 2004, Government Funding of Road Related Expenditure, Canberra, at www.aaa.asn.au/f_search.htm.

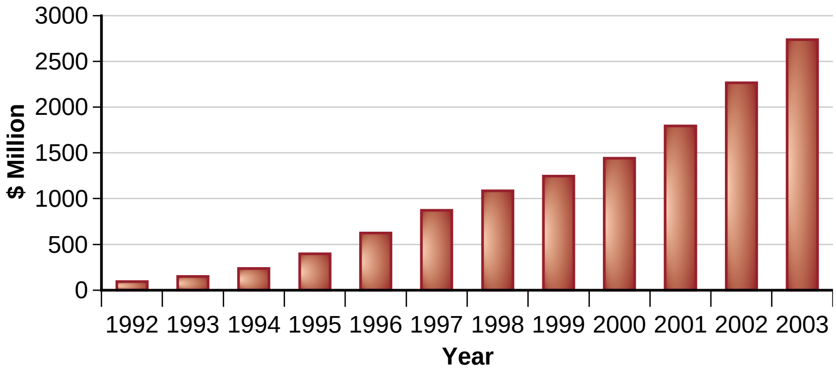
Bureau of Transportation Statistics 2002, Federal, State, and Local Government Transportation-Related Revenues and Expenditures, Washington at www.bts.gov/publications/transportation_indicators.

Furthermore it is interesting to note that over the last decade Australia has experienced a significant increase in the level of private road construction expenditure. According to Tsolakis, over the decade of the 1990s expenditure on build, own, operate, transfer (BOOT) projects represented around six per cent of total road related expenditure. This private expenditure has been in addition to government expenditure.[24]

Not only is New Zealand behind both Australia and the United States in relation to investing in its road infrastructure it is also below the OECD average of around 1.3 per cent per annum.[25] As depicted in Figure 3.6 New Zealand's investment in road infrastructure relative to the average of its OECD counterparts (i.e. 1.3 per cent of GDP) suggests a growing funding gap. Of course such comparisons are indicative only, given that New Zealand and other OECD countries have different geography and different densities and distribution of population and economic activity. However, various other OECD countries including Australia have exhibited significantly more progress in developing their road networks in recent times than has New Zealand.

Figure 3.6

ACCUMULATED FUNDING GAP RELATIVE TO OECD LEVELS



Source: Source: Statistics New Zealand, National Accounts, at www.stats.govt.nz/domino/external/web/nzstories.nsf/Response/National+Accounts.

New Zealand Automobile Association

Business NZ, 2003.

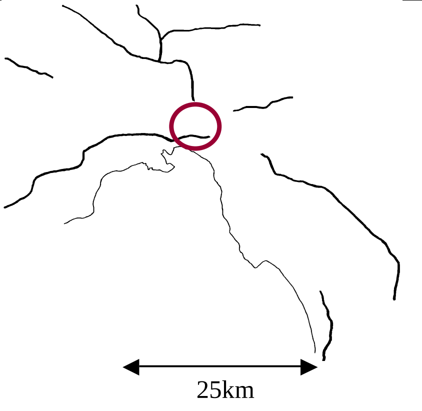
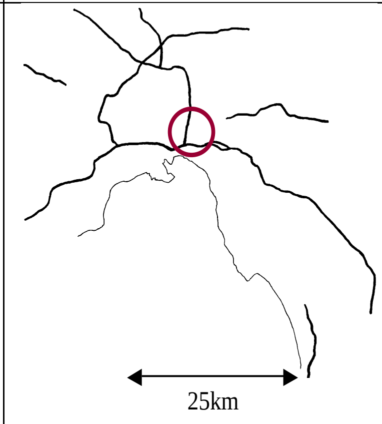
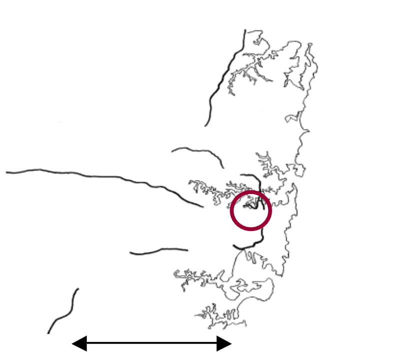
Ongoing investment in road infrastructure has a direct and visible impact on the connectedness of the road network. Both Sydney and Melbourne provide evidence of this. Over the last decade there has been significant increases to the total quantum of funding for road infrastructure in Sydney and Melbourne. As a result, there has been a significant improvement in the connectedness of the urban arterial road system in, and around, both Sydney and Melbourne, particularly the latter. Figure 3.7 illustrates these improvements between 1992 and 2002.

24 Austroads 2003, *The Outlook for Road Related Revenues and Road Transport Demand,* Sydney, p.14

25 Business NZ, 2003.

Figure 3.7

IMPROVEMENTS IN ROAD NETWORK CONNECTEDNESS – SYDNEY AND MELBOURNE

	1992	Current
Melbourne		
Sydney		

Source: The Allen Consulting Group 2003, *Benefits of Public Investment in the Nation's Road Infrastructure*, report to the Australian Automobile Association, Melbourne, p 9.

For Melbourne, the Citylink tollway has provided a significant lift in connectedness for the Melbourne arterial road system; previously, the major arterials terminated around the edges of a highly congested CBD. A recent report by The Allen Consulting Group, estimated that the direct benefits (direct benefits include, time saving benefits, accident benefits, fleet mix benefits and off road benefits) of this additional road infrastructure was in excess of $402 million.[26] [27] The benefit cost ratio of this project (assuming a discount rate of eight per cent) is estimated to be 2. This implies that the $2.1 billion invested to construct Melbourne's Citylink will provide direct benefits to commuters worth around $4.2 billion. (Here dollar figures are in Australian dollars.)

26 New Zealand Dollars converted using purchasing power parity exchange rates for 2003. See OECD Purchasing Power Parities www.oecd.org/std/ppp.

27 The Allen Consulting Group 2004, p 6.

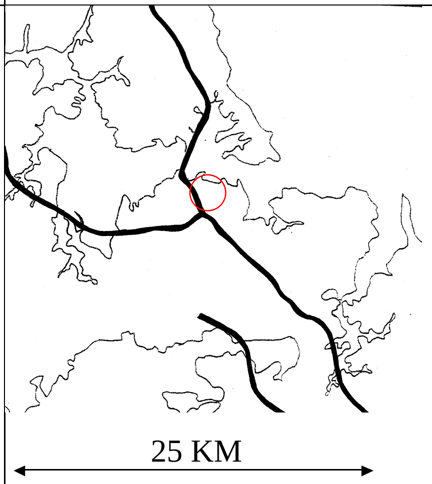
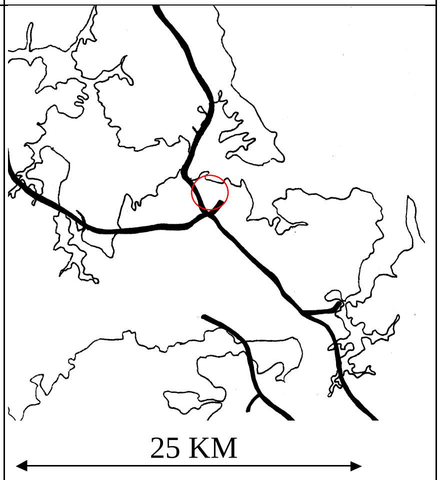
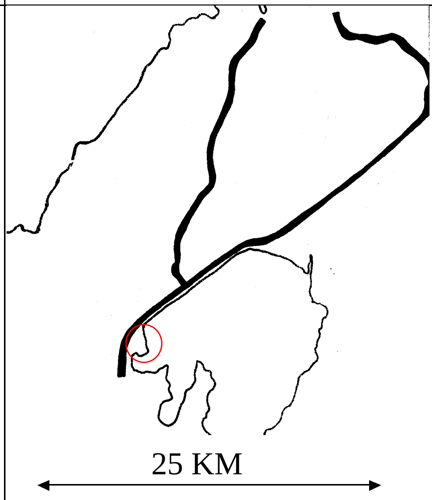
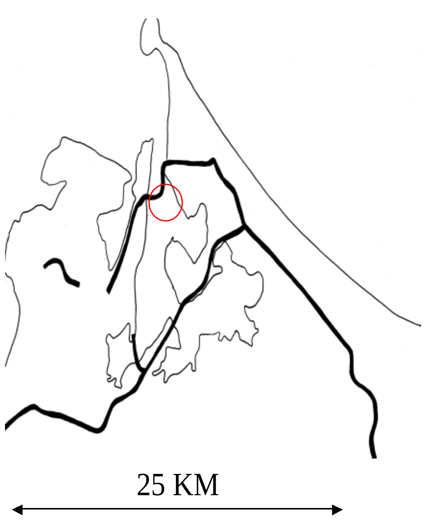
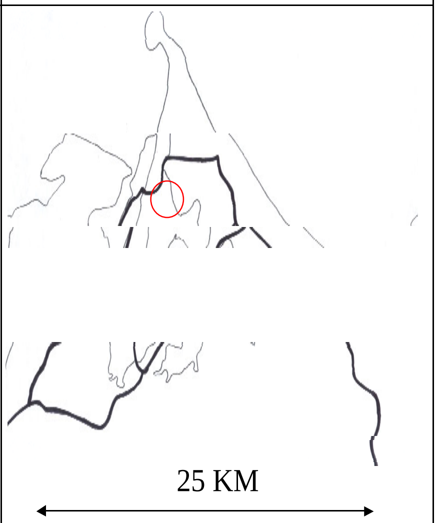
In Sydney, work is currently being undertaken on the Western Sydney Orbital network that will connect the city's growing industrial areas in the west with Port Botany and Sydney Airport, in the east. It is anticipated that this network will take heavy traffic off Sydney's congested local roads and in turn reduce road congestion and travel times. The Commonwealth Government is partly funding this $1.6 billion project, with the remainder of the project being financed under a build own operate transfer (BOOT) scheme. The ex ante benefit cost ratio for the Western Sydney Orbital network is calculated to be 2.2.[28]

In contrast to both Sydney and Melbourne there have been very few significant road infrastructure projects over the period 1992-2002 in both Auckland and Tauranga. In Wellington there have been no significant road infrastructure projects over the period. Consequently, despite increased utilisation of New Zealand's urban road networks, the gaps in its urban arterial road systems have remained relatively unchanged for the past decade. Moreover, as illustrated in Figure 3.8 the road networks in both Auckland and Wellington are characterised by a low level of connectedness relative to the road networks of Sydney and Melbourne.

[28] The Allen Consulting Group 2004, p 6.

Figure 3.8

ROAD NETWORK CONNECTEDNESS – 1992 VS CURRENT

	1992	Current
Auckland		
Wellington		No significant change
Tauranga		

Source: New Zealand Automobile Association.

It is interesting to note that, given the Western Sydney Orbital project and the Melbourne Citylink project have benefit cost ratios less than 4 neither would have qualified for funding under the strict approach used by Transfund up until 2002. This approach required the ranking of projects according to their benefit cost ratio (not including the flow on economy-wide impacts) using standard cost benefit assessment techniques. This has been subsequently replaced by an approach which takes into account several strategic factors, of which one important factor is the project's benefit cost ratio.

Despite this new approach Transfund has still deferred the funding of projects that have benefit cost ratios of 4 or more, calculated using a discount rate of ten per cent. This is despite the fact that there are ongoing costs (both direct and indirect) associated with putting-off certain projects. Such costs include, loss of economic output due to traffic congestion, road fatalities and increased health care and vehicle repair costs due to road crashes.

Deferring funding for projects with benefit cost ratios of 4 or more, calculated using a ten percent discount rate, indicates a very high hurdle rate for funding road infrastructure projects and suggests that current funding levels may be inadequate. Theoretically, all projects above a benefit cost ratio of 1 would benefit the country, and should proceed. (Certainly, projects with a benefit cost ratio less than 1 should not proceed, as they would impose a net cost on society.) In reality, decisions on whether or not to undertake projects are necessarily subject to budget and funding constraints, and competing demand for investment resources elsewhere in the public and private sectors, which necessitates strict prioritising. However in practice, it is not unreasonable, given financial constraints, to fund projects with benefit cost ratios around 1.5-2 (all other things being considered, such as strategic fit).

This chapter has shown that although total spending on roads has increased in real terms over the period 1993 – 2003, as a proportion of total expenditure on land transport it has declined. Furthermore, spending on roads as a proportion of GDP has also fallen over the period by around 11 percentage points.

As a proportion of GDP, New Zealand allocates fewer resources to road infrastructure than do several other OECD countries, including Australia and the United States. Consequently, over the last decade New Zealand's cities (i.e. Auckland and Wellington and Tauranga) have experienced few improvements in the road network. By comparison, both Sydney and Melbourne have experienced improved levels of network connectedness from undertaking road infrastructure projects that have benefit cost ratios of well below 4.[29]

[29] Calculation assumes a ten per cent discount rate.

Chapter 4

Evaluating gains from alternative road investments

This chapter uses a multisector, multiregion framework to model the economic impact associated with undertaking a number of proposed road transport infrastructure projects which to date are currently unfunded. Specifically, this chapter describes each of the proposed infrastructure projects modelled and their associated economic benefits.

4.1 Modelling approach

To evaluate the economy wide implications of undertaking a number of proposed road infrastructure projects in Auckland, Wellington, Tauranga and in rural parts of New Zealand, the Energy Substitution, Social Accounting Matrix (ESSAM) model has been used. The ESSAM model is a multi-sectoral general equilibrium model that takes into account all of the interdependencies in the New Zealand economy.

Box 4.1

THE ESSAM MODEL

The Energy Substitution, Social Accounting Matrix (ESSAM) model is a computable general equilibrium model of the New Zealand economy. It takes into account all of the inter-dependencies in the economy, such as flows of goods from one industry to another, plus the passing on of higher wage costs in one industry into prices and hence the costs of other industries.

- It is useful to think of the model as simply a larger and more sophisticated form of cost-benefit analysis. However, traditional cost-benefit analysis is a partial equilibrium technique whereby variables and events which are defined as being outside the issue of interest are held constant or assumed unchanged. By contrast, in a general equilibrium model, all variables are allowed to change if they are impacted by a particular event or change in the economy. A general equilibrium approach is especially useful where one is concerned with issues that that have significant economy-wide effects

Some of the model's features are:

- 25-50 industry groups,
- Substitution between inputs into production - labour, capital, materials, energy; with energy split into coal, oil, gas and electricity, between which substitution is also allowed.
- Substitution between goods and services used by households.
- Social accounting matrix (SAM) for complete tracking of financial flows between households, government, business and the rest of the world.
- Taxes levied at the appropriate stage in the production process. For example GST is levied entirely on final demand, petrol taxes at the point of sale and so on.

The model's output covers the standard collection of macroeconomic and industry variables, including:

- GDP, private consumption, exports and imports, employment, etc.
- Demand for goods and services by industry, government, households and the rest of the world.
- Industry data on output, employment, exports etc.
- Import-domestic shares.
- Fiscal effects.

An additional advantage of using the ESSAM model is that its assumptions and input parameters are clearly transparent. All are open to amendment and revision where appropriate.

Source: Infometrics Ltd.

Further details about the ESSAM model and the assumptions that underpin it are provided in Appendix C.

In addition to using a general equilibrium analysis to identify the economy wide impacts of the proposed road infrastructure this study has also undertaken a regional input output multiplier analysis of the impacts on economic activity, jobs etc, *in the three metropolitan regions* of Auckland, Wellington and Tauranga. The benefits of an input-output framework include:

- it allows for a regional disaggregation of the economy wide impacts;
- it is consistent with, and complementary to, a general equilibrium analysis framework;
- it allows for a high degree of data confrontation, by analysing flows of products through the economy in a systematic way at the same time as analysing the incomes generated by economic activity; and

- it is recognised and used by Statistics New Zealand which compiles and publishes a snapshot of the size and industrial structure of the New Zealand economy by measuring the direct and indirect relationships between industries and commodities using an input output framework (see for example, Statistics New Zealand *Inter-Industry Study 1996)*.

Combined, these two analytical approaches provide a comprehensive assessment of the economic impacts associated with undertaking the proposed road infrastructure projects at both the national and regional levels.

4.2 Discount rate

In order to compare the costs and benefits flowing from a project over time, it is necessary to bring them back to a common time dimension. This is achieved by discounting the value of future costs and benefits in order to determine their present value.[30] In New Zealand, a ten per cent real discount rate is used when assessing land transport infrastructure projects. For example, Transfund requires that a ten per cent real discount rate is used when evaluating projects seeking NLTF funding.

There appears to be little economic justification for the use of a ten per cent discount rate by New Zealand policy makers in the current economic environment. For most public sector proposals a real discount rate of 10 per cent poses an almost punitively high rate of return, given that for several years nominal interest rates have averaged about six to seven per cent. In fact, a ten per cent real discount rate implies that the nominal cost of borrowed funds for government is around 12.5 per cent.[32] This is around double the current yield on ten-year government bond rates of 6.26 per cent.[33]

According to Wilkinson (1982) the New Zealand Cabinet adopted a ten per cent discount rate in 1971. The rate was consistent with the opportunity cost of capital based on the expected return of a low risk private sector investment at the time. In the 1982 Budget the Minister of Finance subsequently reaffirmed the use of this rate by policy makers. Since then the government has provided little guidance in relation to the appropriate discount rate to use when undertaking economic appraisals of public sector projects. That said, however, the Cabinet Office Circular (CO (00) 12 Annex One) does require that business cases identify and detail ‘the discount rate used, and its derivation’.

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[30] NSW Treasury 2004, *Guidelines for Economic Appraisal*, www.treasury.nsw.gov.au/pubs/tpp97_2/ea-10.htm.

[31] Transit New Zealand 2001, Improving Heavy Vehicle Efficiency on New Zealand’s Roads, p 3.

[32] Assumes an inflation rate of 2.5 per cent based on the Reserve Bank’s current inflation target of between 0 and 3 per cent. See Donald T Brash 1997, *The new inflation target, and New Zealanders' expectations about inflation and growth, An* address to the Canterbury Employers' Chamber of Commerce, Christchurch, 23 January 1997.

[33] RBNZ, see ww.rbnz.govt.nz/statistics/exandint/b1/download.html.

In Australia, most Government agencies at both the State and Commonwealth levels are required to use discount rates of either seven or eight per cent for assessing public sector projects generally. In particular, the benchmark discount rate recommended by the Australian Commonwealth Department of Finance is 8 per cent, with calculations also made for 6 per cent and 10 per cent, to test the sensitivity of the proposal to changes in the discount rate.[34] Similarly, the New South Wales Treasury stipulates the application of a seven per cent real discount rate, with sensitivity tests performed using rates of four per cent and ten per cent.[35]

Theoretical considerations suggest that the discount rate for government sector projects should reflect the *social rate of time preference*. This is the rate at which the marginal rate of substitution between consumption in one period and the next period is equal.[36] There are, however, significant estimation difficulties with this approach, and therefore the discount rate for many government sector projects is estimated using a *social opportunity cost* approach.

The social opportunity cost rate of discount is the rate that reduces the net present value of the best alternative private use of the funds to zero.[37] This means that the social opportunity cost largely reflects the cost in financial market terms. This leads to an approach where the government takes into account what similar projects would provide in returns if undertaken by the private sector. According to the Australian Commonwealth Department of Finance:[38]

> …the social opportunity cost (SOC) rate represents the return on investment (rather than consumption) elsewhere in the economy which is displaced by the marginal public sector project. While, with fully competitive markets, the two rates should converge, in the presence of tax and other distortion, the SOC is generally considered to represent a higher value than the SRTP [social rate of time preference].

While there are several approaches to estimating the social opportunity cost discount rate, the most common method is to use the Capital Asset Pricing Model (CAPM) to determine the expected return from a given project assuming that all diversifiable risks are removed. As noted by Young:

> In practice the use of the capital asset pricing model (CAPM) dominates in determining a cost of capital, and other models are not considered superior. The use of CAPM reflects an opportunity cost of capital approach. The CAPM formula is used to calculate the expected return on equity for government departments. This is then used in a weighted average cost of capital (WACC) formula to take account of the assumed debt equity structure in government departments.

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34 Department of Finance (Commonwealth) 1997, *Handbook of Cost Benefit Analysis*, AGPS, Canberra.

35 NSW Treasury 2004, *Guidelines for Economic Appraisal*, www.treasury.nsw.gov.au/pubs/tpp97_2/ea-10.htm.

36 Young L 2002, Determining the Discount Rates for Government Projects, New Zealand Treasury working paper 02/21.

37 Young L 2002, Determining the Discount Rates for Government Projects, New Zealand Treasury working paper 02/21 New Zealand Treasury, p 13.

38 Department of Finance 1991, Handbook of Cost-benefit Analysis, Australian Government Press, Canberra, p 55.

According to Young, for the 2001/02 period the WACC across all of New Zealand's central government departments was estimated to be 9.0%. This estimate assumes an equity beta for the whole of government of 0.6 and a corresponding asset beta of 0.3. These estimates reflect the risks (i.e. the variability of returns) associated with all activities undertaken by government including but not limited to electricity generation, operation of ports and rail networks and education services. Accordingly, these assumed beta estimates and the corresponding WACC estimate do not properly reflect the specific risks associated with the operation of road infrastructure.

Market evidence from Australia and elsewhere suggests that companies with a core business in the operation of road infrastructure assets, such as toll roads, have relatively low betas compared to those assumed for the whole of government – see Table 4.1. Taking a five-year average of the observed equity betas for the relevant companies implies an asset beta of 0.21. Assuming a gearing level of 60 per cent (debt to equity) implies an equity beta of 0.53.

Table 4.1

OBSERVED BETAS — ROAD INFRASTRUCTURE ASSETS

Company	Asset Beta	Equity Beta
Macquarie Infrastructure Group	0.19	0.48
Hills Motorway Group	0.19	0.48
Transurban Group	0.25	0.62
Average	0.21	0.53

Note: Equity Beta's have been delevered assuming a zero debt beta and relevered using a 60 per cent gearing level (debt to assets). The Asset betas are calculated assuming a zero debt beta. Source: Bloomberg and The Allen Consulting Group. Note that Macquarie Infrastructure Group has toll road investments in several countries.

Using current market information that reflects investors expectations of the future, reveals that those Australian businesses that operate and maintain road infrastructure assets as their core business have a real pre-tax cost of capital of around 6 per cent. Table 4.2 details the relevant parameters used to calculate this estimate.

Table 4.2

WACC — ROAD INFRASTRUCTURE ASSETS

Parameter		Assumed value	Source
Risk free rate (nominal)	A	5.75%	Nominal yield on 10 year Commonwealth bonds
Implied Inflation factor	B	2.38%	The difference between the nominal bond rate and the CPI-indexed bond rate of the same term.
Market risk premium	C	6.0%	Estimate commonly used by Australian economic regulators for purposes of estimating the WACC.
Equity beta	D	0.53	Average equity beta for comparable firms — see table 4.1
Debt Margin	E	1.45%	Mid point of the range typically used by Australian regulators (i.e. between 1.2% and 1.7%).
Gearing level (debt/ value)	F	60%	Assumed gearing level of firms as per the calculated equity beta.
Cost of Equity (real)	G	6.37%	The real return expected by equity holders in the firm [1+(A+(D*C))]/[(1+C)]-1
Cost of debt (real)	H	4.71%	The real return expected by debt holders in the firm [1+(E+A)]/[(1+C)]-1
WACC (real, pre tax)	I	5.99%	Calculated as the weighted average of the cost of debt and the cost of equity [1+((A+(D*C))*(1-F))+((E+A)*F)]/[(1+C)]-1]

Source: The Allen Consulting Group.

A WACC of 6 per cent implies that if private sector firms were to undertake the road infrastructure projects normally undertaken by government, investors would expect an average real total asset return of around 6 per cent. By comparison, a real discount rate of 8 per cent, as used by the Australian Commonwealth Government (albeit as a general purpose rate), seems somewhat conservative for road investments while a 10 per cent rate seems somewhat punitive.

For the purposes of this study a central discount rate of 8 per cent real has been used. The sensitivity of the results to changes in the discount rate has also been undertaken using real discount rates of 6 per cent and 10 per cent. We believe that this approach is conservative for the range of reasons discussed above, and given the current government bond rate of around 6 per cent.

4.3 The base case

Like other computable general equilibrium models, the ESSAM model starts with a base case forecast of the economy at large.[39] The base case reflects expected outcomes in terms of value added, employment, sales, prices imports and exports across the economy as a whole. It also reflects expected outcomes regarding the use of transport infrastructure by households and businesses. The taxing and spending activity of governments (including regional councils) is also included. Hence, the base case reflects expected outcomes regarding transport infrastructure spending by government.[40]

Analysis is conducted by evaluating the changes in economic outcomes brought about by the construction of the identified road infrastructure projects in comparison to the base case. Results are reported as the net economic impact arising (i.e. an economic gain) from an assumed scenario relative to the base case (i.e. where the assumed scenario does not occur). For example, if a particular project were to result in GDP growing to $100.1 billion annually in 2012 relative to the base case forecast of only $100 billion, the results would be reported as a $100 million (or 0.1%) gain.

4.4 Passing lanes package

The passing lanes package comprises 402 separate projects that are assumed to be delivering full benefits by 2012. The overarching purpose of the passing lanes project is to improve safety on a number of rural roads which are currently restricted and do not allow for safe overtaking of vehicles. This is to be achieved by constructing passing lanes every five kilometres on those roads (or sections of roads), which experience traffic volumes of between 4000 and 12000 vehicles per day.[41]

Direct impacts

Table 4.3 details the key characteristics of the passing lanes package identified using standard benefit-cost analysis techniques. The total capital costs are estimated to be $213.5 million. Assuming a discount rate of 8 per cent, the annual benefits in 2012 are estimated to be $121.7m. This corresponds to a benefit-cost ratio of 4.1.

39 While the base case is intended to represent a plausible picture of the economy in 2012, it is not a forecast. Its role is to provide a basis for comparison so that we may ascertain the pure effects of the passing lanes package.

40 The base case does not reflect the construction of the proposed road infrastructure projects detailed in Section 3.3.

41 This package is based on the projects identified by Transit New Zealand to complete its Passing Lane Strategy.

Table 4.3

PASSING LANES PROJECT - KEY CHARCTERISTICS AND DIRECT IMPACTS

CHARACTERISTIC	Economic value ($ Million)
Project costs	
Capital cost	213.5
Annual financing charge at 6%	12.8
Expected direct impacts in 2012	
Reduction in loss of life and permanent disability	41.2
Reduction in health care costs	2.0
Reduction in travel time and congestion	80.8
Increase in vehicle operating costs	(2.4)
Net benefit in 2012	121.7
Benefit-cost ratio	4.1

Source: Infometrics Ltd.

Appendix B provides a detailed overview of the direct impacts and the assumptions underlying their calculation.

Economy wide impacts

The direct impacts likely to result from undertaking the passing lanes package are substantial. In particular, a benefit cost ratio of 4.1 implies that, over the life of the project, for every dollar invested road users will receive $4.10 in benefits. On this basis alone the project should proceed.

That said, however, the above analysis does not take into account the flow-on effects from one industry to another. Accordingly, a benefit cost ratio of 4.1 understates the expected economic gains from undertaking the passing lanes project.

Accounting for the flow-on impacts from undertaking the passing lanes package suggests that the benefit cost ratio of the project rises from 4.1 to 5.7. Key economy-wide impacts of the proposed package are detailed in Table 4.4.

Table 4.4

ECONOMY WIDE IMPACTS OF PASSING LANES PROJECT

MACRO ECONOMIC VARIABLE	Net impact ($ M)	Per cent change (%)
Consumption		
Private Consumption	70	0.07
Government Consumption	-13	-0.04
Total consumption/ capita ($)	13	0.04
Investment	18	0.05
Trade		
Exports	51	0.08
Imports	36	0.06
Output		
GDP	94	0.06
GDP/capita ($)	22	0.06
Real wage rate (index)	1.512	-0.13
Household income tax	73.7	-0.17

Source: Infometrics Ltd.

The total change in GDP arising from the passing lanes package is 0.06% or $94 million. In addition to increased economic output the passing lanes project is expected to have the following economy wide per annum impacts in 2012:

- a 0.05 per cent increase in investment worth around $18 million;
- an increase in net exports of around $15 million dollars;
- increased private consumption of $70 million and a decrease in government consumption of around $13 million; and
- a decrease in household income tax rate of 0.17 per cent implying that the extra tax revenue that the government secures from a larger economy will be greater than the annualised cost incurred from undertaking the passing lanes package.[42] A 0.17 per cent decrease in the household tax rate means that on average households will pay $49 less tax per year.

In addition to the traditional macroeconomic impacts detailed above, there will also be an increase in total CO_2 emissions. This increase is due to the fact that the passing lanes package enables faster average travel speeds and therefore increases vehicle operating costs (see Table 4.3). The magnitude of the expected increase in CO_2 emissions is 71 kilotonnes in 2012. Assuming that under the government's Kyoto package the dollar value of carbon credits will not be higher than $25 per tonne, implies that the maximum cost to the New Zealand economy from increased CO_2 emissions will be no more than $1.8 million in 2012. This is easily offset by the savings in travel time that results from the passing lanes package.

[42] The ESSAM model assumes that there is no change in the net fiscal balance. Accordingly it allows the household tax rate to adjust to reflect what otherwise would be a rise in budget surpluses or a decline in budget deficits.

One way of expressing the total benefit to the economy is to add the change in GDP to the direct benefits that were excluded from the economy wide model (i.e. the value of lives saved and permanent disability avoided net of the lost output and the value of travel time saved in relation to non-work travel). Doing this implies a net economy wide benefit of $169.5 million annually in 2012. Using an 8 per cent discount rates reveals that the benefits of the passing lanes package exceeds its costs by a ratio of 5.7:1. Hence, for every $1 dollar invested in the passing lanes package, there will be additional benefits (both direct and indirect) worth $4.70.

Regional impacts

Given that the passing lanes package is not concentrated in one region of the country it is difficult to estimate the distribution of benefits that would result from undertaking each of the 402 individual projects. While the economic benefits of each of the separate projects may accrue largely to the regions concerned, the distribution of benefits could be quite diverse and very project specific, depending on the location and class of road. A reasonable inference is that if the 402 separate projects are distributed throughout the country approximately in proportion to the distribution of economic activity, then the benefits are likely to be similarly distributed. A more precise estimation would require more knowledge on each individual project.

4.5 Auckland western ring route package

The Auckland western ring route package comprises seven linked projects, from Manukau through Avondale to beyond Auckland's northern suburbs – see Figure 4.1. Broadly speaking, the primary objective of this package of projects is to reduce inner city traffic and to increase the connectedness of Auckland's existing urban arterial road network.

Figure 4.1

AUCKLAND WESTERN RING ROUTE PACKAGE

Source: Transit New Zealand.

Details of each of the seven individual projects that make up the western ring route package are provided in Appendix A.

Direct impacts

Table 4.5 details the key characteristics of the Auckland western ring route package identified using standard benefit-cost analysis techniques. The total capital costs are estimated to be $1,292.6 million. By comparison annual direct benefits in 2012 are estimated to be $406.7 million. Assuming a discount rate of 8 per cent suggests a benefit-cost ratio of 2.3, considering only *direct* benefits and costs.

Table 4.5

AUCKLAND WESTERN RING ROUTE PACKAGE — KEY CHARACTERISTICS AND DIRECT IMPACTS

CHARACTERISTIC	Economic value ($ Million)
Project costs	
Capital cost	1 292.6
Annual financing charge at 6%	77.6
Expected direct impacts in 2012	
Reduction in loss of life and permanent disability	14.2
Reduction in health care costs	2.5
Reduction in travel time and congestion	379.8
Reduction in vehicle operating costs	10.2
Net direct benefit in 2012	406.7
Benefit-cost ratio	2.3

Source: Infometrics Ltd.

Appendix B provides a detailed overview of the direct impacts and the assumptions underlying their calculation.

Economy wide impacts

Accounting for the flow-on impacts from undertaking the Auckland western ring route package suggests that the benefit cost ratio of the project rises from 2.3 to 4.6. Key economy-wide impacts of the proposed package are detailed in Table 4.6.

Table 4.6

ECONOMY WIDE IMPACTS OF AUCKLAND WESTERN RING ROUTE PACKAGE

MACRO ECONOMIC VARIABLE	Net impact ($ M)	Per cent change (%)
Consumption		
Private Consumption	363	0.37
Government Consumption	- 6	(0.02)
Total consumption/ capita ($)	84	0.28
Investment	111	0.27
Trade		
Exports	282	0.46
Imports	196	0.32
Output		
GDP	567	0.33
GDP/capita ($)	133	0.28.
Real wage rate (index)	1.507	-0.46
Household income tax	281	-0.79

Source: Infometrics Ltd.

It is expected that construction and use of the Auckland western ring road will result in the following economy wide impacts in the year 2012:

- an increase in economic output (i.e. GDP) worth $567 million or 0.37 per cent of GDP;
- increased aggregate investment worth around $111 million;
- an increase in net exports of around $96 million dollars;
- increased private consumption of around $363 million and a decrease in government consumption of around $6 million;
- a decrease in the household income tax rate of 0.79 per cent. This implies that, similar to the passing lanes package, New Zealand households will on average pay $187 less tax per year; and
- a 355 kilotonne increase in CO2 emission. The maximum cost of which is not expected to exceed $8.9 million.

In 2012 the total benefit to the economy, likely to result from the Auckland western ring road package, is $838 million annually. The corresponding benefit cost ratio of the package is 4.6. This means that for every dollar invested in constructing the western ring road project the New Zealand economy as whole will receive benefits of $4.60.

Regional impacts

The Auckland region is expected to receive the greatest share of the total benefits accruing from the Auckland western ring route package. Regional economic multiplier analysis suggests that Auckland will gain a net regional benefit of $741.1 million in 2012. This consists of:

- an annual increase in regional GDP of $425.4 million in 2012; and

- an annual benefit of $315.6 million reflecting benefits associated with avoided loss of life and permanent disability and non-work related travel time savings.

The detailed calculations for estimating the regional economic impacts are set out in Appendix D.

4.6 Tauranga strategic roading network

The Strategic Roading Network is located in Tauranga and the surrounding Western Bay of Plenty sub region. It is a series of twelve inter-related projects, which will form a fast efficient ring road linking Tauranga, Mt Maunganui and the Port of Tauranga. The network includes high capacity feeder routes to the north, west and east. The strategic purpose of this proposed road network is to relieve congestion and accommodate future traffic growth in the Western Bay of Plenty region.[43]

Details of the twelve individual projects are provided in Appendix A.

Direct impacts

Table 4.7 details the key characteristics of the Tauranga strategic roading network identified using standard benefit-cost analysis techniques. The expected capital cost of the package is estimated to be $482.0 million. Assuming a discount rate of 8 per cent, the annual benefits in 2012 are estimated to be $251.7 million. This corresponds to a benefit-cost ratio of 3.7, based on direct impacts only.

Table 4.7

TAURANGA STRATEGIC ROADING NETWORK — KEY CHARACTERISTICS AND DIRECT IMPACTS

CHARACTERISTIC	Economic value ($ Million)
Project costs	
Capital cost	482.0
Annual financing charge at 6%	28.0
Expected direct impacts in 2012	
Reduction in loss of life and permanent disability	0.0
Reduction in health care costs	0.0
Reduction in travel time and congestion	245.7
Reduction in vehicle operating costs	6.0
Net direct benefit in 2012	251.7
Benefit-cost ratio	3.7

Source: Infometrics Ltd.

43 The city of Tauranga is one of New Zealand's fastest growing cities. The surrounding Western Bay of Plenty is expected to experience population growth at approximately 3 per cent for the foreseeable future — see http://www.srnetwork.co.nz/projects/pkk.html.

Economy wide impacts

The construction and use of the strategic roading network as proposed, is expected result in substantial economy wide benefits in the year 2012 – see Table 4.8. Specific economy wide impacts include:

- an increase in economic output (i.e. GDP) worth \$278 million or 0.18 per cent of GDP;
- increased aggregate investment worth around \$54 million;
- a \$41 million dollars increase in net exports;
- an increase in private consumption of around \$175 million;
- a decrease in the household income tax rate of 0.20 per cent implying that on average each household in New Zealand will pay approximately \$95 per year less tax; and
- an increase in CO_2 emission of 172 kilotonnes. The maximum cost of this increased CO_2 pollution is not expected to exceed \$4.3 million in 2012.

Table 4.8

ECONOMY WIDE IMPACTS OF TAURANGA STRATEGIC ROADING NETWORK

MACRO ECONOMIC VARIABLE	Net impact ($ M)	Per cent change (%)
Consumption		
Private Consumption	175	0.18
Government Consumption	0	0.0
Total consumption/ capita ($)	41	0.14
Investment	54	0.13
Trade		
Exports	137	0.22
Imports	96	0.16
Output		
GDP	278	0.16
GDP/capita ($)	65	0.16
Real wage rate (index)	1.51	-0.20
Household income tax	143	-0.42

Source: Infometrics Ltd.

The total benefit to the economy expected from the construction and use of the strategic roading network is estimated to be \$439 million annually in 2012. Applying an eight per cent discount rate to expected benefits and costs of the project reveals that the strategic roading network package has a benefit cost ratio of 6.5. Thus means that for every dollar invested in the strategic roading network will result in benefits to New Zealand as whole of \$6.50. On this basis the strategic roading network should clearly proceed.

Regional impacts

Given that the Tauranga strategic roading network has a specific regional focus of Tauranga and the Western Bay of Plenty, it is no surprise that the majority of the total benefits will accrue locally. As detailed in Appendix D, it is estimated that Tauranga and the Western Bay of Plenty will gain a net regional benefit of $372.7 million in 2012. This consists of:

- an annual increase in regional GDP of $186.1 million in 2012:and
- an annual benefit of $186.6 million reflecting benefits associated with avoided loss of life and permanent disability and non-work related travel time savings.

4.7 Wellington regional land transport package

The vision or ultimate goal of the Wellington regional land transport strategy is to achieve a balanced and sustainable land transport system that meets the needs of the general community.[44] A balanced transport system is an integrated transport network with capacity balanced within and between each transport mode. A sustainable transport system is one that is environmentally and economically sustainable.[45]

To achieve a balanced and sustainable transport solution for the region the Wellington Regional Land Transport committee has developed five key objectives:[46]

- Accessibility and economic performance – to provide a transport system that optimises access to, and within, the region;
- Economic efficiency – to implement the most efficient transport options and ensure that all users of land transport are subject to pricing and non-pricing incentives which promote efficient and optimal decisions and behaviours. The strategy to achieve this is to implement those projects that have a benefit cost ration above four.
- Affordability – to plan for a land transport system that recognises funding constraints and ability to pay. A five-year cost target of $250 million has been adopted to achieve this objective.
- Safety – to provide a safer community for everyone through a transport system that achieves or improves on the targets of the National Road Safety Plan through the Regional Road Safety Strategy.
- Sustainability – to provide a land transport system that operates in a manner that recognises the needs of the community and avoids, remedies, or mitigate negative externalities. In addition, the transport system should use resources in an efficient manner and should support an optimal demand for energy.

To achieve these objectives the Wellington regional land transport strategy has been designed to:[47]

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[44] Wellington Regional Land Transport Committee, 1999, *The Wellington Regional Land Transport Strategy 19999-2004*, Wellington p 33.

[45] Wellington Regional Land Transport Committee, 1999, *The Wellington Regional Land Transport Strategy 19999-2004*, Wellington p 33.

[46] Wellington Regional Land Transport Committee, 1999, *The Wellington Regional Land Transport Strategy 19999-2004*, Wellington pp 33 - 35.

- expand and enhance Wellington's urban passenger transport system and to encourage its use by the community;
- improve the road network;
- influence travel demand through appropriate land use; and
- expand and enhance walking and cycling routes and to encourage the general community to use these travel modes.

The specific set of projects from the Wellington Regional Land Transport Strategy that were modelled in this study is detailed in Appendix A.

Direct impacts

Key characteristics of the Wellington regional land transport package, as identified using standard benefit-cost analysis techniques, are shown in Table 4.9. The total capital cost of undertaking the road parts of the package is estimated to be $415.0 million. By comparison the direct impacts expected to result in 2012 are worth around $82.1 million.

Using an 8 per cent real discount rate implies a benefit-cost ratio in excess of 1.4. On this basis alone the project should proceed given that for every dollar invested in the Wellington regional land transport package there will be benefits exceeding $1.40, again considering direct impacts only.

Table 4.9

WELLINGTON REGIONAL LAND TRANSPORT PACKAGE — KEY CHARACTERISTICS AND DIRECT IMPACTS

CHARACTERISTIC	Economic value ($ Million)
Project costs	
Capital cost	415.0
Annual financing charge at 6%	24.9
Expected direct impacts in 2012	
Reduction in loss of life and permanent disability	10.5
Reduction in health care costs	1.9
Reduction in travel time and congestion	62.7
Reduction in vehicle operating costs	7.1
Net direct benefit in 2012	82.1
Benefit-cost ratio	1.4

Source: infometrics Ltd.

[47] Wellington Regional Land Transport Committee, 1999, *The Wellington Regional Land Transport Strategy 19999-2004*, Wellington pp 31 - 62.

Economy wide impacts

In addition to the substantial direct benefits identified above, the Wellington regional land transport package is also expected to result in additional economy wide benefits for New Zealand – see Table 4.10. In particular, in 2012 the Wellington land transport package is expected to result in the following economy wide impacts:

- an increase in economic output (i.e. GDP) worth $100 million or 0.08 per cent of GDP;
- increased aggregate investment worth around $20 million;
- an increase in net exports of $15 million dollars;
- an increase in private consumption of around $68 million;
- a decrease in the household income tax rate of 0.07 per cent. This is equivalent to an average reduction of about $27 per household per year; and
- an increase in CO_2 emission of 52 kilotonnes. The maximum cost this additional pollution is not expected to exceed $1.3 million in 2012.

The total benefit to the New Zealand economy from undertaking the Wellington regional land transport package is estimated to be $148.7 million annually in 2012. Applying an eight per cent discount rate to the expected benefits and costs of the project reveals that the package has an economy-wide benefit cost ratio of 2.6. This implies that for every dollar invested in the Wellington regional land transport package, it will return benefits to the New Zealand economy as a whole of $2.60.

Table 4.10

ECONOMY WIDE IMPACTS OF WELLINGTON REGIONAL LAND TRANSPORT PACKAGE

MACRO ECONOMIC VARIABLE	Net impact ($ M)	Per cent change (%)
Consumption		
Private Consumption	68	0.07
Government Consumption	-5	-0.02
Total consumption/ capita ($)	15	0.05
Investment	20	0.05
Trade		
Exports	50	0.08
Imports	35	0.06
Output		
GDP	100	0.06
GDP/capita ($)	23	0.06
Real wage rate (index)	1.513	-0.07
Household income tax rate	40	-0.13

Source: Infometrics Ltd.

Regional impacts

It is no surprise that the Wellington region will receive the lion's share of the total benefits accruing from the Wellington regional land transport package. Regional economic multiplier analysis suggests that Wellington will gain a net regional benefit of $128.5 million per annum in 2012. This consists of:

- an annual increase in regional GDP of $69.7 million in 2012; and
- an annual benefit of $58.8 million reflecting benefits associated with avoided loss of life and permanent disability and non-work related travel time savings.

The detailed calculations for estimating the regional economic impacts are set out in Appendix D.

4.8 Industry impacts

Each of the four proposed road infrastructure projects will result in a degree of structural change to the New Zealand economy. This means that some sectors of the economy will expand and displace the activity of other sectors.

The main sectors that are likely to expand as a result of undertaking the proposed road infrastructure projects are those industries that benefit from increased labour productivity arising from shorter travel times. These industries include basic metal manufacturing, other mining and quarrying and structural, sheet and fabricated metal production. Table 4.11 ranks the highest 10 industries in terms of their 2012 output results (Appendix E contains detailed results for all industries).

Table 4.11

INDUSTRY OUTPUT: RANKING OF HIGHEST 10 (PER CENT DEVIATION FROM BASE CASE)

Industry	Passing lanes package (%)	Auckland western ring route package (%)	Tauranga strategic network (%)	Wellington regional transport package (%)	Total (%)
Basic metal manufacturing	0.38%	2.23%	1.09%	0.39%	4.08%
Other mining & quarrying	0.26%	1.56%	0.76%	0.28%	2.86%
Structural, sheet & fabricated metal products	0.20%	1.16%	0.57%	0.20%	2.13%
Paper and paper product manufacturing	0.20%	1.12%	0.55%	0.19%	2.05%
Gas supply	0.18%	1.03%	0.50%	0.17%	1.89%
Chemical and chemical products	0.17%	0.99%	0.49%	0.17%	1.82%
Road transport	0.22%	0.86%	0.47%	0.23%	1.78%
Forestry & logging	0.16%	0.92%	0.45%	0.17%	1.70%
Printing, publishing etc	0.15%	0.88%	0.43%	0.15%	1.62%
Electricity generation	0.13%	0.78%	0.38%	0.14%	1.43%

Source: Infometrics Ltd

On the flip side some industries may experience some displacement. That is, those industries that provide services that are replaced by greater utilisation of road transport may be worse-off. It should be noted, that although these industries are likely to see less activity than otherwise, they might still grow in absolute terms. Similarly, other industries such as hospitals, nursing homes and community care may be disadvantaged due to fewer road crashes arising from safer roads.

As detailed in Table 4.12 it is expected that, if all of the proposed road infrastructure projects are undertaken, only 5 of the 52 industries analysed would experience displacement in 2012.

Table 4.12

INDUSTRY OUTPUT: RANKING OF LOWEST 10 (PER CENT DEVIATION FROM BASE CASE)

Industry	Passing lanes package (%)	Auckland western ring route package (%)	Tauranga strategic roading network (%)	Wellington regional transport package (%)	Total (%)
Dairy product manufacturing	0.05%	0.24%	0.12%	0.04%	0.44%
Government administration & defence	0.05%	0.22%	0.11%	0.04%	0.41%
Water supply	0.03%	0.19%	0.09%	0.03%	0.35%
Construction	0.01%	0.10%	0.05%	0.02%	0.18%
Medical, dental & other health services	0.01%	0.04%	0.02%	0.01%	0.08%
Ownership of owner-occupied dwellings	0.00%	-0.03%	-0.02%	0.00%	-0.04%
Pre-school, primary, secondary & other education	-0.01%	-0.10%	-0.05%	-0.02%	-0.17%
Post-school education	-0.02%	-0.13%	-0.07%	-0.02%	-0.24%
Hospitals, nursing homes, community care	-0.19%	-0.12%	-0.01%	-0.07%	-0.39%
Water and rail transport	-0.17%	0.04%	-0.09%	-0.17%	-0.40%

Source: Infometrics Ltd

Chapter 5

Benefits of investment in the nation's road infrastructure

This chapter draws together the findings from the previous chapters and identifies the aggregate economy wide-benefits resulting from increased investment in road infrastructure (as identified by the modelling undertaken in Chapter 4).

This study has investigated the adequacy of New Zealand's current level of investment in road infrastructure as well as the benefits of investing in the road network. Key findings are discussed below.

5.1 Adequacy of New Zealand's land transport infrastructure

A number of commonly used indicators reveal that the current level and pattern of investment in New Zealand's road infrastructure is not optimal. Specifically, over the last 10 years:

- Investment levels in New Zealand's road capital stock have not kept pace with the increased utilisation of the road network. Over the period 1993 – 2001 the total value of road capital stock as a proportion of GDP has decreased by around 12 per cent. By comparison road utilisation by both passenger and commercial vehicles has increased substantially over the same period.
- Increased road utilisation is most pronounced in the major urban areas of Auckland and Wellington. However, it is important not to ignore other areas which are also experiencing significant increases in road utilisation such as the City of Tauranga and the surrounding Western Bay of Plenty region.
- High levels of traffic congestion are experienced in both Auckland and Wellington relative to other regions of the country. Auckland, in particular, suffers from heavy congestion during times of peak travel demand and its major motorways are experiencing falling average travel speeds. In Wellington congestion is less of an immediate problem; however research by Transit New Zealand indicates that on major arterial roads congestion is a growing concern.
- By international comparisons New Zealand's urban arterial road network is characterised by a relatively low level of network connectedness. It has been argued that this is a direct cause of New Zealand's higher road fatality rate compared with other OECD nations.
- New Zealand has a higher incidence of road fatalities relative to Australia, United States Canada and the United Kingdom. Road experts believe fatality rates are directly related to the quality of road infrastructure (i.e. better road infrastructure leads to less road fatalities). In New Zealand the limited development of a principal road network (relative to other OECD nations) is thought to be a direct contributor to higher rates of road accidents than otherwise might be the case.

As a proportion of GDP New Zealand's level of road infrastructure funding has fallen over the period 1993-2001 (although recovering partially in the latter years). Over the same period New Zealand's expenditure on roads (as a proportion of GDP) has been below the levels of both Australia and the United States. Furthermore, road funding levels in New Zealand are below the OECD average of 1.3 per cent of GDP.

Broadly speaking the above findings suggests that current level and pattern of investment in land transport infrastructure is sub-optimal. It also suggests that over the past decade, there has been under-investment in New Zealand's road network, including by comparison with Australia and other OECD countries.

5.2 The benefits of investing in the road network

In addition to assessing the current adequacy of New Zealand's road infrastructure and its levels of road infrastructure funding, this study has also analysed the direct and indirect impacts associated with undertaking a number of proposed road packages. The specific packages assessed include:

- the passing lanes package which consists of 402 separate projects. The purpose of this package is to improve road safety in a number rural areas;
- the Auckland western ring road package. It is expected that this package will reduce traffic on the central motorway and increase the connectedness of Auckland's existing urban arterial road network;
- the Tauranga strategic roading network package which will meet the current and future road infrastructure needs of Taurangaa and the Western Bay of Plenty region; and
- Wellington regional land transport package which aims to achieve a balanced and sustainable land transport network that meets the needs of the community.

The modelling undertaken suggests that completing this set of proposed land transport packages will result in substantial economy wide gains to New Zealand. This is indicated by:

- an increase in GDP of $1.0 billion in 2012. This is equivalent to a net increase in per capita GDP of around $243. In other words, if the proposed set of land transport projects were to be undertaken as modelled, each person in New Zealand would be better off by $243 in 2012;
- an increase in private consumption of around $670 million in 2012. This is equivalent to per capita increase of $153 in 2012;
- a net increase in aggregate investment of $203 million (0.5 per cent) in 2012;
- a net reduction in the household tax rate. The magnitude of this reduction implies that on average of each household in New Zealand will pay $359 per year less tax; and
- an increase in net exports of $158 million in 2012 reflecting the increased international competitiveness of New Zealand's industries.

Note that the above impacts are all *ongoing* changes (relative to the base case), at annual rates.

The economy wide gains expected from undertaking all four proposed road infrastructure projects are shown in Table 5.1.

Table 5.1

ECONOMY WIDE IMPACTS OF UNDERTAKING ALL PROPOSED ROAD INFRASTRUCTURE PACKAGES

MACRO ECONOMIC VARIABLE	Net impact ($ M)	Per cent change (%)
Consumption		
Private Consumption	676	0.69
Government Consumption	-23	-0.08
Total consumption/ capita ($)	153	0.51
Investment	203	0.50
Trade		
Exports	520	0.85
Imports	362	059
Output		
GDP	1039	0.61
GDP/capita ($)	243	0.61
Real wage rate (index)	1.501	-0.86
Household income tax rate	538	-1.50

Note: Impacts are ongoing changes relative to base case, at annual rates.

Source: Infometrics Ltd.

In addition to the economy wide impacts there are substantial direct benefits not factored into the economy wide modelling. These benefits include the value of lives saved and permanent disability avoided (net of the lost output included in the economy wide modelling) plus the value of travel timed saved for non-work purposes. Adding these direct benefits to the estimated economy wide benefits suggest that the set of proposed road transport infrastructure packages would result in total benefits to the New Zealand economy worth $1.6 billion in 2012 – see Table 5.2. This is equivalent to almost one per cent of GDP, or alternatively in 2012 each person in New Zealand would be better off by $375.

Using an eight per cent discount rate suggests that the aggregate benefit cost ratio for the set of proposed road transport infrastructure packages is 4.75. The sensitivity of each of the four projects to changes in the discount rate is shown in Table 5.2.

Table 5.2

BENEFITS OF ROAD INFRASTRUCTURE INVESTMENT

	Passing lanes package	Auckland western ring road package	Tauranga strategic roading network	Wellington regional land transport package	Total impact
Costs					
Initial capital cost	213.5	1292.6	482.0	415.0	2403.1
Annual finance cost	12.8	77.6	28.9	24.9	144.2
Benefits					
Direct	121.7	406.7	251.7	82.1	862.2
Economy wide	169.5	838.0	439.7	148.7	1599.5
BCR					
6 per cent	6.6	5.4	7.6	3.0	5.6
8 per cent	5.7	4.6	6.5	2.6	4.8
10 per cent	5.0	4.1	5.7	2.2	4.2

Source: Infometrics Ltd.

The main conclusion from the analysis is that there are substantial net economic gains available from investing in New Zealand's land transport infrastructure. These gains accrue not only to the economy as a whole but for three of the four packages modelled, significant benefits are likely to accrue to specific regions, namely Auckland, Wellington, and the Bay of Plenty.

Similarly, the majority of New Zealand's industries are likely to also benefit directly due mainly to increased productivity arising from work related travel time savings. This in turn is likely to enhance the international competitiveness of New Zealand's industries and the economy as a whole. This is reflected by a significant increase in net exports.

These gains tower over the initial investment costs required to finance the proposed infrastructure. Moreover, this is the case if the set of proposed road infrastructure packages are undertaken individually or in aggregate.

Appendix A

Individual roading projects

A.1 Auckland western ring route

A.2 Tauranga Strategic Roading Network

A.3 Wellington Regional Land Transport Strategy

Figure A.1

AUCKLAND WESTERN RING ROUTE — INDIVIDUAL PROJECT DETAILS

Project	Description	Estimated Cost
Upper Harbour Motorway (SH18)	To upgrade the existing SH 18 corridor between Waitakere City (SH16) and North Shore City (SH1). The project will provide additional road capacity and will reduce travel times. Includes Greenhithe Deviation, Upper Harbour bridge duplication, Hobsonville Deviation and Brigham Creek Extension	n/a
Kirkbride Rd Grade separation (SH20A)	Construction of a grade separated interchange at Kirkbride Road to replace the existing traffic signals on the northern access to Auckland International Airport.	n/a
Avondale extension (SH20)	To provide a high standard extension from SH20 to SH16, which will interconnect the North Western (SH16) and Southern (SH1) motorway systems and provide an alternative regional route through greater Auckland linking Waitakere, Auckland and Manukau cities The project will improve access from the western isthmus and Waitakere City to SH20 and the motorway system. It will also separate longer distance trips from local traffic in residential areas by providing a safe and efficient traffic corridor.	$600 million to $1,200 million
Mt Roskill extension (SH20)	This project is the development of a long planned traffic corridor through the Mt Roskill area in Auckland City. The project will extend the SH20 termination at Hillsborough Road to Richardson road in Mt Roskill. The project is designed to provide a stage towards a high standard strategic extension from SH20 to SH16, which will interconnect the SH16 and SH1 and provide an alternative regional route through greater Auckland and linking Waitakere, Auckland, Manukau and North Shore cities via SH18.	$167 million
Manukau Harbour Crossing (SH20)	The SH20 Manukau Harbour Crossing will consist of a new four-lane bridge over the Manakau Harbour in close proximity to the existing bridge. The bridge approaches will be widened and the Gloucester Park Road interchange will be upgraded.	$75 million to $125 million
Manukau Extension (SH20 to SH1 connection)	Construction of a 4-lane motorway link between SH20 to SH1 between Puhinui Interchange on the eastern access to Auckland International Airport and Manukau City.	$174 million

Source: Transit New Zealand

Table A.1

TAURANGA STRATEGIC ROADING NETWORK — INDIVIDUAL PROJECT DETAILS

Project	Description	Estimated Cost
Harbour Link	Includes a four-lane flyover from Takitimu Drive to the existing Harbour Bridge, a duplicate Harbour Bridge and four-laning across bridge causeway down Hewlett's Road to Jean Batten Drive. This project will provide improved pedestrian/cycle routes across the harbour as well as improve access to the Port of Tauranga and between Tauranga and Mt Maunganui.	$191 million
Tauranga Eastern Arterial	Construction of a 17km four-lane expressway bypassing Te Puke which is currently a traffic bottleneck and has a high incidence of road crashes. The new route is expected to improve road safety by eliminating a number of crash-prone curves. It also provides interchanges for future development of Papamoa East and a proposed Rangiuru Business Park.	$110 - $115 million
Tauranga Northern Arterial	Construction of a 7km four-lane bypass of Bethlehem and Te Puna on SH2. This route will provide a direct four-lane route into and out of the city for commuters and through traffic bypassing residential areas. It also provides direct connections to Route K and will enable road users direct access to the 'Southern' side of the Strategic Network's 'Ring road' around central Tauranga.	$90 - $100 million
Katikati Bypass	Current SH2 passes through the rural service town of Katikati, which is located 34m northeast of Tauranga. This project will construct a bypass of SH2 providing a more direct highway route and reduce traffic passing through the town of Katikati improving both the safety and enviroment for the community.	$10 - $15 million
Omokoroa to Te Puna four-laning	A four-lane upgrade of SH2 between Omokoroa to Te Puna. This project will provide a more appropriate level of service for the existing 16,000 VPD using a two lane 'Rural' highway which has less than desirable geometric alignment which results in a high crash rate. The upgrade will also provide for the planned growth of Omokoroa.	$45 - $50 million
Project PJK *(Jayne this has been completed)*	Construction of 8.5km two and four-lane expressways, including seven bridges and a raised road embankment. Construction was completed in 2003. This project is comprised of three separate routes: • Route J is a four lane expressway bypassing residential streets to bring SH2 traffic directly into the city from the north. • Route K is a two lane expressway linking SH29 from Hamilton directly with downtown Tauranga. This project was funded by Tauranga District Council as a toll road and built to allow future widening to four lanes. Route P is a short link connecting the two new expressways with the existing four-lane Takitimu Drive expressway link to the Port of Tauranga and Mt Maunganui.	$100 milllion
Upgrade of Pyes Pa Road	Upgrade to Pyes Pa Road to provide a feeder route to network ring road. Will provide an alternative route to Rotorua.	n/a
Hewletts Flyover	Construction of two-lane flyover to bypass two roundabouts and a rail crossing. This project will also involve the four-laning of Hewlett's Road to just east of Jean Batten Drive and construction of a link road between Jean Batten Drive and Aerodrome Road. This project is expected to reduce traffic delays and congestion experienced due to roundabouts and the rail crossing.	$27.6 million

Project	Description	Estimated Cost
Girven Road Intersection Improvements	Upgrading of the Girven Road intersection to reduce congestion.	n/a
Te Maunga to Maungatapu Median Barrier	Installation of concrete crash barrier to prevent head on collisions on this stretch of roads.	$4.4 million
Te Maunga to Domain Road four-laning	Upgrade SH2 between Te Maunga to Domain Road from two lanes to four-lanes. This is expected to increase traffic capacity and reduce traffic congestion around the Sandhurst Interchange.	$15 - $20 million
Domain Road intersection improvements	Construction of a new roundabout to provide improved access from SH2 to Papamoa. This project is expected to increase traffic capacity and road safety.	$5.1 million

Source: Tauranga City, **http://www.srnetwork.co.nz/projects/**, accessed on 11 June 2004

Table A.2
WELLINGTON REGIONAL LAND TRANSPORT PACKAGE— INDIVIDUAL PROJECT DETAILS

Transport corridor	Project	
Western corridor: Otaki to Ngauranga Merge	• Complete Plimmerton to Mana upgrade and duplication of Paremata Bridge; • Design and construct stage I and II of Kapiti Western Link Road; • Complete alignment and safety improvements at McKays Crossing Junction; • Design and build new railway stations at Raumati and Lindale; • Extend the urban electric rail service to Waikanae; • Increase frequency of the rail service from Kapiti Coast to Wellington; • Construct an improved bus/rail connection at Porirua Railway Station.	$151.0 million
Hutt corridor: Upper Hutt to Ngauranga Merge	• Design and construct an upgrade of SH2 between Dowse and Petone; • Design and construct additional tidal flow HOT lane and cycle lanes between Petone and Ngauranga; • Design and construct grade separated intersection on SH2 at Melling; • Design and construct SH2/SH58 intersection improvements involving grade separation; • Increase peak hour rail services to a 15 minute frequency from Upper Hutt.	$131.4 million
Wairarapa corridor: Masterton to Upper Hutt	• Design and build new railway stations at Timberlea and Cruickshank; • Extend the urban electric rail service to Timberlea; • Improve commuter train service on the Upper Hutt – Masterton route.	$10.4 million
Porirua to Hutt Valley	Provide safety improvements to SH58 and its junction with SH1	n/a
Ngauranga to Wellington CBD	• Construct additional north and south bound lane on SH1 between Ngauranga and Aotea; • Construct the next phase of the inner city bypass through Buckle and Arthur streets; • Upgrade Basin Reserve interchange and traffic management; • Upgrade Adelaide Road between Basin Reserve and John Street; • Improve bus priority through CBD traffic; • Enhance the bus/rail interchange at Wellington Railway Station.	$76.2 million
Johnsonville rail line tunnel	• Construct the Johnsonville rail line tunnel and passing loop. Is expected to result in an increase in peak time services.	$8.0 miilion

Source: Wellington Regional Land Transport Committee, 1999, The Wellington Regional Land Transport Strategy 1999-2004, Wellington pp.52 - 62.

Appendix B

Direct impacts

This appendix examines how and why investment in New Zealand's road infrastructure has broader relevance for the New Zealand economy. Specifically, it identifies the direct impacts associated with each of the projects discussed in chapter 3. It also identifies those impacts which were used as inputs into the modelling process.

B.1 Data and information sources

In order to model the economy-wide effects of each of the four case studies, it was necessary to identify their expected direct impacts. This was done using a number of specific data and information sources including:

- data relevant to the eleven projects in the Blenheim-Kaikoura region were used to model the expected direct impacts associated with the passing lanes package. These data were sourced from Transit New Zealand and the New Zealand Automobile Association;
- for the Auckland western ring road package the cost and benefits associated with each of the individual projects were sourced from Transit New Zealand and the New Zealand Automobile Association;
- information relevant to the Tauranga strategic roading network was obtained from Transit New Zealand, Tauranga City and the New Zealand Automobile Association; and
- information relevant to the Wellington regional land transport package was sourced from the Wellington Regional Council and the New Zealand Automobile Association.

It is assumed that each of the packages modelled will be delivering full benefits by 2012.

B.2 Impacts

The ESSAM model deals principally with the Production Account within the System of National Accounts. It also includes the major components of the Income and Outlay Account. It does not, however, include non-economic costs. Accordingly, not all aspects of identified benefits from the proposed projects are suitable for inclusion in a general equilibrium model. Such benefits include compensation for pain and suffering, the value of travel time for non-work purposes and the value of life.

To over come this, identified benefits were disaggregated into economic and non-economic components. For example accident savings were split into loss of life and permanent disability, health care, vehicle repairs and legal services. Moreover assumptions were made in relation to value of total travel time for non-work purposes such as recreation and education.

A breakdown of the identified direct impacts of each project in 2012 is provided in Table B.1.

Table B.1

AGGREGATE DIRECT IMPACTS

	Passing lanes package ($M)	Auckland western ring road package ($M)	Tauranga strategic roading network ($M)	Wellington regional lan transport package ($M)
Total capital cost	213.5	1,292.6	482.0	415.0
Total economic benefits	80.5	392.5	251.7	71.6
Total non-economic benefits	41.2	14.2	0.0	10.5
Total benefits	121.7	406.7	251.7	82.1

Source: Infometrics Ltd.

Each of the identified model inputs and their underlying assumptions are discussed below.

Accident savings

For the each of the projects modelled the number of road fatalities prevented and injury time avoided are expressed as person-year equivalents.

For the passing lanes project it is estimated that in 2012, approximately 292 extra people will be alive, and 95 cases of significant injury and 175 cases of minor injury will be avoided (spread across all age groups). This is the aggregate impact of accident savings between now and 2012.

This is equivalent to 303 person years of time of which 122 person years are attributed to economic activities (paid work in the market economy).

Travel time saved

For the purpose of the model, travel time is broken down into work related and non-work related purposes. Travel, which is not work related, is considered to be non-economic in nature and therefore the value of the benefits associated with non-work related travel time-savings do not serve as a model input. Savings in work-related travel time are treated as improvements in labour productivity and, in the absence of being provided with any better information, are distributed by industry according fuel use.

Direct economic impacts associated with each of the projects are detailed in Table B.2.

Table B.2

TRAVEL TIME SAVINGS

	Passing lanes package Total person hours	Auckland western ring road package Total person hours	Tauranga strategic roading network Total person hours	Wellington regional land transport package Total person hours
Work	2.4	10.8	4.7	1.4
Commuting				
Work related	0.3	5.1	3.2	2.4
Non work related	0.3	5.1	3.2	2.4
Other	3.3	29.4	12.1	3.5
Total	6.2	50.4	23.2	7.6
Work-related travel as a proportion of total time (%)	43.5	31.5	34.1	49.3

Source: Infometrics Ltd.

Vehicle operating costs

Net savings in vehicle operating costs include changes in the cost of fuel use and vehicle repair costs that result from changes in travel behaviour. Savings in vehicle operating costs are modelled as efficiency improvements with respect to inputs of these services into production and private consumption.

The assumed vehicle operating costs for each of the projects modelled are shown in Table B.3.

Table B.3

CHANGES IN VEHICLE OPERATING COSTS

	Passing lanes package ($M)	Auckland western ring road package ($M)	Tauranga strategic roading network ($M)	Wellington regional land transport package ($M)
Net change	(2.4)	10.2	6.0	7.1

Source: Infometrics Ltd.

Project financing costs

For the purpose of this study it has been assumed that each of the modelled projects will be financed by government debt. Government will necessarily incur an annual financing charge as a result of taking on additional debt, which will be met, via the increases to personal income tax. That is, the construction of the additional road infrastructure will be financed through income tax.

It should be noted that the expected savings in health care costs would provide some offset to the required increase in tax rates.

Table B.4 details the expected annual finance charge associated with each of the modelled projects. These have been calculated using an interest rate of 6 per cent.

Table B.4
EXPECTED ANNUAL FINANCE CHARGES

	Passing lanes package ($M)	Auckland western ring road package ($M)	Tauranga strategic roading network ($M)	Wellington regional land transport package ($M)
Annual cost	12.8	77.6	28.9	24.9

Source: Infometrics Ltd.

Other impacts

Other costs and benefits that are likely to arise directly from undertaking the proposed road infrastructure projects include health care, legal and vehicle repair costs.

Savings in health care costs are modelled as a reduction in government spending together with a change in the composition of government spending away from health care services. Changes in health care costs are a direct result from changes in the number of road accidents that result in hospitalisation and ongoing health care.

It is assumed that changes in legal costs result from changes in accident rates. Specifically, a reduction in road crashes is expected to result in fewer insurance claims involving legal processes as well as less litigation.

The expected changes in health care and legal costs for each of the four road infrastructure packages is shown in Table B.5.

Table B.5

CHANGES IN OTHER COSTS

	Passing lanes package ($M)	Auckland western ring road package ($M)	Tauranga strategic roading network ($M)	Wellington regional land transport package ($M)
Reduction in vehicle repair costs	1.0	2.0	0.0	1.5
Health care savings	0.8	0.4	0.0	0.3
Reduction in legal costs.	0.2	0.1	0.0	0.1

Source: Infometrics Ltd.

B.3 Direct impacts not modelled

Using standard quantitative techniques the avoided loss of economic value (i.e. GDP) associated with reducing loss of life and permanent disability can be estimated. While these impacts are not used as inputs into the ESSAM modelling they are accounted for when calculating both the net economy-wide total benefit and the corresponding benefit-cost ratio for each project.

For each of the projects modelled, the estimated value of avoided economic loss associated with reducing loss of life and permanent disability is shown in Table B.6.

Table B.6

EXPECTED AVOIDED LOSS OF ECONOMIC VALUE

	Passing lanes package ($M)	Auckland western ring road package ($M)	Tauranga strategic roading network ($M)	Wellington regional land transport package ($M)
Avoided loss of economic value	12.5	2.7	0.0	2.1

Source: Infometrics Ltd.

B.4 Other relevant assumptions

To ensure that the ESSAM model captures only the gains from improvements in allocative efficiency, total employment is held constant, apart from the increment that is assumed to arise directly from the roading packages. Total capital stock utilisation is also held constant. These two assumptions mean that the benefits from the proposed packages will be understated to the extent that improvements in roading infrastructure lead to more efficient investment decisions (by the private sector) that raise the long-term rate of economic growth.

Appendix C

The ESSAM General Equilibrium Model

The ESSAM (Energy Substitution, Social Accounting Matrix) model is a general equilibrium model of the New Zealand economy. It takes into account all of the inter-dependencies in the economy, such as flows of goods from one industry to another, plus the passing on of higher wage costs in one industry into prices and thence the costs of other industries.

The ESSAM model has previously been used to analyse the economy-wide and industry specific effects of a wide range of issues. For example:

- Energy pricing scenarios
- Changes in import tariffs
- Faster technological progress
- Policies to reduce carbon dioxide emissions
- Funding regimes for roading
- Release of genetically modified organisms

Some of the model's features are:

- 49 industry groups (currently), as detailed in the table below.
- Substitution between inputs into production – labour, capital, materials, energy.
- 4 energy types: coal, oil, gas and electricity, between which substitution is also allowed.
- Substitution between goods and services used by households.
- Social accounting matrix (SAM) for complete tracking of financial flows between households, government, business and the rest of the world.
- Taxes levied at the appropriate stage in the production process. For example GST is levied entirely on final demand, petrol taxes at the point of sale and so on.

The model's output is extremely comprehensive, covering the standard collection of macroeconomic and industry variables:

- GDP, private consumption, exports and imports, employment, etc.
- Demand for goods and services by industry, government, households and the rest of the world.
- Industry data on output, employment, exports etc.
- Import-domestic shares.
- Fiscal effects.

An additional advantage of using the ESSAM model is that its assumptions and input parameters are clearly transparent. Transparency, the judicious use of sensitivity analysis, and careful interpretation of results, ensure that the model does not appear as a total black box.

C.1 Production Functions

These equations determine how much output can be produced with given amounts inputs. A two-level standard translog specification is used which distinguishes four factors of production – capital, labour, and materials and energy, with energy split into coal, oil, natural gas and electricity.

C.2 Intermediate Demand

A composite commodity is defined which is made up of imperfectly substitutable domestic and imported components - where relevant. The share of each of these components is determined by the elasticity of substitution between them and by relative prices.

C.3 Price Determination

The price of industry output is determined by the cost of factor inputs (labour and capital), domestic and imported intermediate inputs, and tax payments (including tariffs). World prices are not affected by New Zealand purchases or sales abroad.

C.4 Consumption Expenditure

This is divided into Government Consumption and Private Consumption. For the latter eight household commodity categories are identified, and spending on these is modelled using price and income elasticities in an AIDS framework. An industry by commodity conversion matrix translates the demand for commodities into industry output requirements and also allows import-domestic substitution.

Government Consumption is usually either a fixed proportion of GDP or is set exogenously. Where the budget balance is exogenous, either tax rates or transfer payments are assumed to be endogenous.

C.5 Stocks

Owing to a lack of information on stock change, this is exogenously set as a proportion of GDP, domestic absorption or some similar macroeconomic aggregate. The industry composition of stock change is set at the base year mix, although variation is permitted in the import-domestic composition.

C.6 Investment

Industry investment is related to the rate of capital accumulation over the model's projection period as revealed by demand for capital in the horizon year. Allowance is made for depreciation. Rental rates or the service price of capital (analogous to wage rates for labour) also affect capital formation. Investment by industry of demand is converted into investment by industry of supply using a capital input-output table. Again, import-domestic substitution is possible between sources of supply.

C.7 Exports

These are determined from overseas export demand functions in relation to world prices and domestic prices inclusive of possible export subsidies, adjusted by the exchange rate. It is also possible to set export quantities exogenously.

C.8 Supply-Demand Identities

Supply-demand balances are required to clear all product markets. Domestic output must equate to the demand stemming from consumption, investment, stocks, exports and intermediate requirements.

C.9 Balance of Payments

Receipts from exports plus net capital inflows (or borrowing) must be equal to payments for imports; each item being measured in domestic currency net of subsidies or tariffs.

C.10 Factor Market Balance

In cases where total employment of a factor is exogenous, factor price relativities (for wages and rental rates) are usually fixed so that all factor prices adjust equi-proportionally to achieve the set target.

C.11 Income-Expenditure Identity

Total expenditure on domestically consumed final demand must be equal to the income generated by labour, capital, taxation, tariffs, and net capital inflows. Similarly, income and expenditure flows must balance between the five sectors identified in the model – business, household, government, foreign and capital.

C.12 Industry Classification

The 49 industries identified in the ESSAM model are defined below. Industries definitions are according to Australian and New Zealand Standard Industrial Classification (ANZSIC).

Table C.1

ESSAM – INDUSTRY CLASSIFICATION

		Industry
1	HFRG	Horticulture and fruit growing
2	MLVC	Mixed livestock and cropping
3	SHBF	Sheep and beef cattle farming
4	DAIF	Dairy cattle farming
5	OAGR	Other farming and services to agriculture, hunting & trapping
6	LOGG	Forestry & logging
7	FISH	Commercial fishing
8	COAL	Coal mining
9	OILG	Oil & gas extraction and exploration
10	OMIN	Other mining & quarrying and services to mining
11	MEAT	Meat processing
12	DAIR	Dairy product manufacturing
13	OFOD	Other food processing & manufacturing
14	TCFL	Textiles, clothing, footwear & leather mfg
15	WOOD	Log sawmilling, timber dressing & other wood product mfg
16	PAPR	Paper and paper product manufacturing
17	PPRM	Printing, publishing & recorded media
18	PETR	Petroleum
19	CHEM	Chemical and chemical product manufacturing
20	RBPL	Rubber and plastic product manufacturing
21	NMMP	Non-metallic mineral product manufacturing
22	BASM	Basic metal manufacturing
23	FABM	Structural, sheet and fabric metal production manufacturing
24	MACH	Machinery and equipment manufacturing
25	OMFG	Other manufacturing
26	EGEN	Electricity generation
27	EDIS	Electricity transmission & supply
28	GASS	Gas supply
29	WATS	Water supply
30	BLDG	Construction
31	TRDE	Wholesale & retail trade
32	ACCR	Accommodation, cafes & restaurants
33	ROAD	Road transport
34	WRAI	Water and rail transport
35	AIRS	Air transport, services to transport, storage
36	COMM	Communication services
37	FIIN	Finance and Insurance
38	OWND	Ownership of owner-occupied dwellings
39	OPRS	Other property services
40	SCIT	Scientific research & technical services

41	COMP	Computer services
42	LAOB	Legal, accounting & other business services
43	GOVD	Govt administration & defence
44	SCHL	Pre-school, primary, secondary & other education
45	OEDU	Post-school education
46	HOSP	Hospitals, nursing homes, aged accommodation & other community care
47	OHLT	Medical, dental and other health services
48	MPRT	Cultural and recreational services
49	PERS	Personal and other services, waste disposal & sewerage systems

Source: Infometrics Ltd

Appendix D

Regional impacts

Three of the four proposed road infrastructure packages have a specific regional focus, implying that most of the economy-wide effects from these packages are in fact likely to occur in the respective regions. For this reason, it is useful to estimate the proportion of the national benefits that will occur locally for the Auckland, Bay of Plenty and Wellington packages.

Ideally, this would be assessed with regional general equilibrium models, however such models do not exist and their development is beyond the resources of this research project. Instead, regional economic activity multipliers have been used. These multipliers are derived from regional inter-industry tables.

D.1 Regional economic multipliers

Economic multipliers estimate the indirect effects on output required to meet the requirements of a unit increase in demand. Broadly speaking there are two types of regional multipliers:

- *Type I multipliers* capture upstream effects; for example the energy required to meet an increase in demand for furniture; and
- *Type II multipliers* subsume Type I multipliers and also incorporate the effects of the induced demand that comes from increased expenditure by households. For example, employees in the furniture and energy industries will earn income that will be spent on other goods and services.

Given their wider ambit Type II multipliers are a better approximation of the general equilibrium effects than the Type I multipliers. That said however, it is important to note that Type II multipliers are likely to under or over-estimate the full range of general equilibrium effects.[48] For example, given that Type II multipliers exclude the following factors they are likely to under estimate the full range of general equilibrium effects:

- increased capital formation that might be required to increase industry output;
- increased exports that might be required to purchase the additional imports needed by industry to increase output – in the presence of a macroeconomic balance of payments constraint; and
- expenditure by government using revenue raised from taxation.

Similarly, for the following reasons Type II multipliers may over-estimate the full range of general equilibrium effects:

- the effects of capital formation are not considered, the implicit assumption is that output can be increased without limit;
- it is assumed that there is no labour constraint; and

[48] The extent to which Type II multipliers either under or over-estimate the full range of flow-on effects that arise from a given economic shock is an empirical question, specific to that shock and how it is simulated within a general equilibrium model.

- there is no allowance for the deadweight costs of taxation or for substitution in consumption and production in response to changes in relative prices.

D.2 Calculating the regional impacts

Calculating the regional impacts arising from each of the three relevant road infrastructure packages involves the following steps:

Step 1 — Estimating the degree of over/under estimation

In order to ascertain the degree of over-estimation or under-estimation by regional Type II multipliers, we firstly compare the results from the ESSAM model with those obtained by applying Type II multipliers for New Zealand as a whole to each of the three road infrastructure packages.

Step 2 — Estimating the regional flow on effects

As noted above, multipliers apply to a given economic shock. For the each of packages considered the shocks have two main components: the reduction in vehicle operating costs and accident costs, and the reduction in labour demand (increase in labour efficiency) arising from lower travel times. In the first instance both are negative shocks, so multiplier analysis estimates the direct and indirect effects of a lower level of expenditure. In reality though, trade diversion occurs whereby resources saved in servicing motor vehicles or operating transport fleets, can be reallocated to other uses as dictated by consumer preferences. Hence the analysis can be undertaken in two ways:

Method 1 — estimate the flow-on effects of the negative shocks, as a proxy for the value of the liberated resources that can now be used elsewhere in the economy. The inputs into this calculation are the same as the inputs used for the general equilibrium modelling, excluding the additions to the labour force from lives saved. That is, output shocks are imposed on:

- the Petroleum, Rubber, Retail Trade and Health industries to capture changes in vehicle operating costs and accident costs,
- all industries in accordance with the productivity benefits arising from lower travel times.

Method 2 — estimate the flow-on effects of the new activities into which the liberated resources may flow. Of course at the regional level it is not known which new activities would materialise, but we can approximate this by the change in the mix of domestically supplied final demand that occurs in the general equilibrium model. Thus the inputs into this calculation have the same dollar value as in method 1, but rather than distributing them in the manner of method 1 they are distributed according to the change in the industry mix of final demand in the ESSAM model runs.

Step 3 — Adjusting the regional impacts for over/estimation

The estimated level of under or over-statement produced by the multiplier methodology at the national level is applied to the regional impacts calculated in step 2. For example for the Auckland package it is estimated that the Type II multiplier analysis over estimates the economic impacts by around 6.5 per cent. Applying this to the estimated regional impacts suggests an adjustment of around $36.8 million (i.e. from $603.6 million to $566.8 million).

Step 4 — Accounting for non economic impacts

The general equilibrium analysis excludes both non-work related travel time and loss of life and permanent disability. It is reasonable to assume that virtually all of these benefit would accrue to the residents of the local region. Accordingly, these non-economic benefits are added to the regional economic impacts calculated in steps 1 to 3.

Each of the step-by-step calculations for estimating the regional impacts associated with each of the three road infrastructure packages are detailed in table D.1.

Table D.1

ECONOMIC IMPACT ON REGIONAL GDP

	Auckland	Bay of Plenty	Wellington
Change in GDP (from ESSAM model)	566.8	277.6	102.5
Type II effect for New Zealand			
Method 1	608.2	300.7	109.4
Method 2	599.0	297.2	108.3
Average	603.6	298.9	108.86
Degree of under/over estimation	6.5%	7.7%	6.2%
Type II effect for region			
Method 1	461.9	203.9	76.0
Method 2	448.1	199.3	72.6
Average	455.0	201.6	74.30
Scaled effect on regional GDP	425.4	186.1	69.7
Loss of life, permanent disability and other travel time benefits	315.6	186.6	58.8
Total regional benefit	**741.1**	**372.7**	**128.5**

Source: Infometrics Ltd

Appendix E

Industry impacts in detail

Table E.1

INDUSTRY IMPACTS

Industry	Passing lanes package ($M)	Auckland western ring route package ($M)	Tauranga strategic network ($M)	Wellington regional transport package ($M)	Total ($M)
Wholesale & retail trade	43.03	235.38	116.00	39.58	433.99
Machinery and equipment mfg	15.08	83.67	40.91	14.60	154.25
Other food processing & mfg	13.78	76.20	37.25	13.56	140.79
Chemical and chemical products	11.30	65.67	32.24	11.44	120.66
Legal, accounting, etc services	10.98	62.63	30.62	10.84	115.07
Finance and Insurance	11.25	62.07	30.17	11.21	114.70
Road transport	14.18	54.59	29.67	14.50	112.95
Basic metal manufacturing	10.08	59.45	29.13	10.28	108.94
Air transport, services & storage	10.31	58.17	28.42	10.71	107.62
Forestry & logging	9.76	56.84	27.81	10.49	104.90
Paper and paper product mfg	9.85	56.27	27.59	9.80	103.51
Structural, sheet & fab metal prods	8.96	51.71	25.29	8.95	94.91
Printing, publishing etc	8.52	48.97	24.03	8.59	90.12
Communication services	7.13	39.06	19.24	7.11	72.54
Other property services	6.78	38.20	18.52	6.93	70.44
Sawmilling & wood product mfg	6.20	36.17	17.69	6.50	66.56
Electricity transmission & supply	6.27	36.13	17.72	6.35	66.46
Govt administration & defence	6.98	33.27	16.09	6.05	62.39
Cultural and recreational services	5.14	27.11	13.13	4.88	50.26
Construction	3.16	24.58	11.87	5.47	45.08

Industry	Passing lanes package ($M)	Auckland western ring route package ($M)	Tauranga strategic network ($M)	Wellington regional transport package ($M)	Total ($M)
Dairy product manufacturing	4.62	24.21	11.80	4.19	44.82
Accommodation, cafes & restaurants	4.38	23.97	11.70	4.39	44.44
Rubber and plastic product mfg	4.10	23.21	11.36	4.01	42.68
Meat processing	3.79	19.84	9.65	3.47	36.75
Dairy cattle farming	3.70	19.50	9.49	3.41	36.10
Sheep and beef cattle farming	3.46	18.90	9.22	3.27	34.85
Other mining & quarrying	3.11	18.55	9.08	3.27	34.01
Scientific research & tech services	3.20	18.34	8.96	3.14	33.65
Personal, waste & other services	2.87	16.06	7.83	2.87	29.63
Other manufacturing	2.76	15.72	7.67	2.72	28.88
Electricity generation	2.68	15.70	7.72	2.76	28.87
Petroleum	3.63	14.23	6.72	1.31	25.88
Other farming and services to agr	2.50	13.86	6.75	2.50	25.61
Non-metallic mineral product mfg	2.32	13.78	6.75	2.51	25.35
Textiles	2.37	13.06	6.38	2.29	24.11
Computer services	2.07	12.19	5.98	2.07	22.31
Oil & gas extraction & exploration	1.47	8.77	4.31	1.51	16.06
Gas supply	1.56	8.72	4.27	1.46	16.01
Commercial fishing	1.45	8.04	3.93	1.43	14.85
Horticulture and fruit growing	1.45	7.29	3.51	1.24	13.50
Clothing	1.11	5.84	2.83	1.04	10.82
Coal mining	0.88	5.21	2.56	0.90	9.54
Mixed livestock and cropping	0.89	4.72	2.29	0.83	8.73

Industry	Passing lanes package ($M)	Auckland western ring route package ($M)	Tauranga strategic network ($M)	Wellington regional transport package ($M)	Total ($M)
Leather	0.61	3.20	1.56	0.55	5.92
Medical, dental & other health services	0.26	1.66	0.79	0.31	3.03
Water supply	0.25	1.38	0.66	0.25	2.55
Footwear	0.18	0.98	0.47	0.17	1.81
Ownership of owner-occ. dwellings	0.32	-4.11	-2.72	0.01	-6.50
Post-school education	-0.65	-4.96	-2.53	-0.89	-9.03
Water and rail transport	-4.24	0.93	-2.40	-4.38	-10.08
Pre-school, pri., sec. & other educ	-0.92	-7.28	-3.72	-1.26	-13.18
Hospitals, nursing homes, comm care	-14.56	-9.24	-1.12	-5.55	-30.47
Total	260.36	1518.41	745.15	263.68	2787.61

Source: Infometrics Ltd

Appendix F

References

ATN 1993, *Study Proves Divided Roads Are Safer*, Australian Transport News.

Australian Automobile Association 2004, Government Funding of Road Related Expenditure, Canberra, at www.aaa.asn.au/f_search.htm

Austroads 2003, *The Outlook for Road Related Revenues and Road Transport Demand,* Sydney.

Austroads 2000, *Road Facts 2000: An overview of the Australian and New Zealand road systems*, Sydney.

Brash, T Donald 1997, *The new inflation target, and New Zealanders' expectations about inflation and growth*, An address to the Canterbury Employers' Chamber of Commerce, Christchurch, 23 January 1997.

Bureau of Transportation Statistics 2002, Federal, State, and Local Government Transportation-Related Revenues and Expenditures, Washington at www.bts.gov/publications/transportation_indicators

Christchurch City Council 1998, *Fact Sheet: Ownership of Structure of New Zealand Roads*, Media Statement 26 March 1998, http://www.ccc.govt.nz/MediaaReleases/1998/ownershi.asp, Accessed on 1 March 2004.

City of Tauranga http://www.srnetwork.co.nz/projects/pkk.html

Deloitte 2004, Road User Pricing – A Research Report, http://www.deloitte.com/dtt/research/0,2310,sid%253D24996%2526cid%253D34868,00.html.

Department of Finance (Commonwealth) 1997, Handbook of Cost Benefit Analysis, AGPS, Canberra.

Ernst and Young 1997, *Alternative Transport Infrastructure Investments and Economic Developments for the Auckland Region*, Prepared for the Keep Auckland Moving Campaign, Auckland.

New South Wales Treasury 2004, *Guidelines for Economic Appraisal*, www.treasury.nsw.gov.au/pubs/tpp97_2/ea-10.htm.

Organisation for Economic Cooperation and Development 2004, International Road Traffic and Accident Database March 2004, www.bast.de/htdocs/fachthemen/irtad/english/we32.html.

Organisation for Economic Cooperation and Development, *Purchasing Power Parities*, www.oecd.org/std/ppp.

PriceWaterhouseCoopers 2004, *Infrastructure Audit*, a report for the Ministry of Economic Development.

Reserve Bank of New Zealand, www.rbnz.govt.nz/statistics/exandint/b1/download.html.

Standing Advisory Committee on Trunk Road Appraisal 1998, *Transport and the economy: full report, London*, http://www.dft.gov.uk/stellent/groups/dft_transstrat/documents/page/dft_transstrat_022512-21.hcs, Accessed 26 February 2004.

Statistics New Zealand 1998, Consumer Expenditure statistics 1998, Wellington. www.stats.govt.nz/domino/external/pasfull/pasfull.nsf/0/4c2567ef00247c6acc256b6700107093/%24FILE/conex98.pdf accessed on 15 March 2004.

Statistics New Zealand, National Accounts, at www.stats.govt.nz/domino/external/web/nzstories.nsf/Response/National+Accounts

The Allen Consulting Group 1993, Land Transport Infrastructure: Maximising the Contribution to Economic Growth, Report to the Australian Automobile Association, Melbourne. (ISBN 0 909 309 167).

Transfund New Zealand 2003, *Roading Statistics 2002/03*, http://www.transfund.govt.nz/pubs/TransfundRoadStats2003.pdf access 12 March 2004.

Transit New Zealand 2003, *Painting a Picture of Congestion*; Media release 15 September 2003.

Transit New Zealand 2001, *Improving Heavy Vehicle Efficiency on New Zealand's Roads*, Wellington.

Wellington Regional Land Transport Committee, 1999, The Wellington Regional Land Transport Strategy 19999-2004, Wellington.

Young L 2002, *Determining the Discount Rates for Government Projects*, New Zealand Treasury working paper 02/21 New Zealand Treasury, Wellington.