SAHA

NZ Transport Agency

Roads of National Significance

Economic Assessments Review

July 2010

Melbourne Sydney Brisbane Wellington Johannesburg Cape Town Windhoek

SAHA

Contact Person
Andrew Cooper
Director
04 499 7007
acooper@sahainternational.com

Melbourne
Level 26, 385 Bourke Street
Melbourne
VIC 3000
Australia
T +61 3 9934 0600
F +61 3 9602 4825

Sydney
Suite 1, Level 12, Tower 3
Darling Park
201 Sussex Street
Sydney
NSW 2000
Australia
T +61 2 8299 4200
F +61 2 9279 2066

Brisbane
Level 5, 500 Queen Street
Brisbane
QLD 4000
Australia
T +61 7 3230 3333
F +61 7 3230 3399

Wellington
Level 4, 128 – 132 The Terrace
PO Box 5350
Wellington
New Zealand
T +64 4 499 7007
F +64 4 499 7009

Johannesburg
Level 7, The Mall Office Tower
11 Cradock Avenue
Rosebank 2196
South Africa
T +27 11 268 8800
F +27 11 327 7344

Cape Town
Canal Walk West Office Tower
1st Floor Premises
Century Boulevard
Century City
Cape Town
South Africa
T +27 21 526 2700
F +27 21 552 0440

Windhoek
Level 7, Metje Behnsen Building
Independence Avenue
Windhoek
Namibia
T +26 4 61 224 620
F +26 4 61 205 2449

SAHA

Disclaimer

Saha International Limited (SAHA) has prepared this report based on a broad economic assessment methodology developed in consultation with the NZ Transport Agency (NZTA). This report is an update to SAHA's report Roads of National Significance – Economic Assessments Review, December 2009. This report concluded a study initiated in August 2009 of the RoNS portfolio of projects, which was based on data current at the time. Consequently, since this study was concluded a number of updates have been undertaken by NZTA in relation to project specific data and changes to the implementation profile of the RoNS program of works.

The underlying data to SAHA's assessment, specifically the conventional transport economic assessments, regional wider economic benefits and the CGE modelling, has been collected and developed by other external advisers engaged by NZTA. SAHA has relied on those assessments, and updates to those assessments, in the preparation of this report. Therefore, this report provides high level analysis only and does not purport to be advice on particular investment options or strategies.

SAHA has used all reasonable endeavours to ensure the information in this report is as accurate as practicable. SAHA, its employees, and Directors shall not be liable (whether in contract, tort (including negligence), equity or on any other basis) for any loss or damage sustained by any person relying on this document whatever the cause of such loss or damage.

This report is intended for the sole use of NZTA, and should not be circulated to third parties without the express permission of SAHA.

SAHA

Table of Contents

SAHA

Appendices

1 Executive Summary

1.1 Introduction

This report constitutes the findings of an economic assessment undertaken at the portfolio level for the Roads of National Significance (RoNS). This report is an update to SAHA's report Roads of National Significance – Economic Assessments Review, December 2009. This report concluded a study initiated in August 2009 of the RoNS portfolio of projects, which was based on data current at the time. Consequently, since this study was concluded a number of updates have been undertaken by NZTA in relation to project specific data and changes to the implementation profile of the RoNS program of works.

The assessment includes consideration of the total economic benefits and costs for the seven RoNS projects taking into account traditional road user benefits, externalities, and potentially broader productivity and economic growth associated with the implementation of the RoNS.

The purpose of undertaking the assessment is for NZTA to be able to answer two fundamental questions, namely:

1. Are there quantifiable wider economic benefits associated with the portfolio of RoNS projects?
2. If such benefits exist and are quantifiable, are they of sufficient scale to demonstrate the economic worth of an aspirational RoNS implementation program?

1.2 Methodology

An economic assessment of the seven RoNS projects as a portfolio that takes into account both conventional and wider economic benefits requires a methodology that ensures the approach used is readily understood, and ensures it can be applied to necessary sensitive testing and scenario analyses.

The series of steps undertaken in this assessment is summarised as follows:

1. Research approaches used in other jurisdictions in relation to program level economic assessment and/or the application of Wider Economic Benefits (WEBs) identification and quantification.

2. Assess WEBs associated with the implementation of the RoNS. Two approaches were used (one essentially used as a comparison for the other):
    - Computable General Equilibrium model (CGE) to estimate the size of the economy-wide effects – this assessment was undertaken by Infometrics Ltd; and
    - A regionally-specific WEBs assessment of the regional impacts of each of the RoNS in relation to agglomeration effects and land use changes – this assessment was undertaken by Richard Paling Consulting Ltd.
3. Development of an economic assessment framework, incorporating existing conventional CBA results and profiles together with WEB results for each of the RoNS projects into a portfolio economic evaluation framework.

4. Preparation of the results in a 'building block' approach (conventional + WEBs, sensitivity testing) so that the specific impacts of both broader economic impacts and acceleration of funding for earlier implementation can be quantified and reported.

1.3 Approaches taken in other jurisdictions

The following conclusions were drawn from four Australian case studies and a body of UK research:

- Robust, transparent and justifiable conventional cost benefit analysis (CBA) is essential, and is the 'bedrock' of project evaluation;
- Where multiple projects comprise a program, it is necessary to ensure that CBA is applied consistently. This includes consistent transport modelling, assumptions, unit parameter values, discount rates, and sensitivity testing;
- Determining project linkages is essentially an empirical test – interdependencies between projects, if identified, may drive sequencing decisions;
- There is no simple or widely used method to quantify interdependencies between projects;
- Application of standard evaluation methods, transport modelling, along with subjective analysis remains the key approach;
- Infrastructure Australia has introduced WEBs as a potential benefit stream, with its prioritisation guidelines specifying the inclusion of agglomeration impacts as a monetised benefit in economic evaluations submitted to it. Anecdotally, through the IA process, WEBs have been incorporated into economic benefit streams in the order of 20-30% over and above conventional CBA benefits – however, it appears there has been a lack of detailed data collection, and there has been heavy reliance on one or two reference projects where such benefits have been identified;
- In terms of CGE, Infrastructure Australia acknowledge the usefulness of CGE as a tool for measuring macroeconomic effects, but have taken a clear stance to the treatment of the outcomes of CGE modelling in relation to conventional CBA:

  "Infrastructure Australia will primarily use CBA data for measuring the benefits of an initiative and will not consider CGE (Computable General Equilibrium) benefits as additive to CBA benefits"[1]
- There is still considerable work to be undertaken in developing the approach in Australia further.
- Work undertaken in the UK by Sir Rod Eddington on behalf of the UK Treasury in 2006 made a number of conclusions regarding the long-term links between transport and the UK's economic productivity, growth and stability. In relation to wider macro and regional economic benefits the report concluded, amongst other things:
  - A comprehensive and high-performing transport system is an important enabler of sustained economic prosperity: a 5 per cent reduction in travel time for all business and freight travel on the roads could generate approximately £2.5 billion of cost savings – some 0.2 per cent of GDP.
  - Transport's contribution to the agglomeration effects of economic activity is most significant within large, high-productivity urban areas of the UK. London is the most significant example, adding 30 per cent to the time saving benefits of some transport schemes.[2]
- It should however be noted when evaluating effects borne by other jurisdictions, such as the UK, of the differences in scale and population densities between these other economies and the New Zealand economy, particularly with regard to the urban environments.

[1] Infrastructure Australia, Prioritisation Guidelines 2008

[2] HM Treasury, The Eddington Transport Study, 2006

1.4 Wider Economic Benefits

The national significance assigned to the RoNS program presents an opportunity to test an approach where a national road building program may indeed have a materially quantifiable impact on the performance of the national economy, and therefore the benefits in terms of justifying the program, should be identified and quantified as part of the economic assessment.

Wider economic costs and benefits have not traditionally been included in conventional CBA. However, recent developments in Europe and Australia have indicated that conventional approaches potentially overlook benefits such as agglomeration and employment effects, and there are increasing moves to include these impacts in some way, at least for large schemes. Standard approaches to the assessment of agglomeration impacts are evolving and are being included in the formal guidance for economic evaluation, although there is still a range of opinion with regard to the inclusion of employment impacts, in part related to the difficulties associated with their estimation. Also some concerns remain more generally as to the level of accuracy of the measures provided.

Therefore, while a cautious approach is appropriate, WEBs should not be overlooked and excluded for projects with high impact and significant scope such as the RoNS.

In this regard, the definition of WEBs for this purpose was agreed by NZTA to be:

> "*Second order effects on wider economic activity, with examples of WEBs covering agglomeration benefits, labour productivity and supply, and the impacts of imperfect competition. In addition effects at a macro-economic level resulting in GDP changes or more specifically changes in Real Gross National Disposable Income (RGNDI) have been considered."*

Conventional assessments and WEBs are based upon two different fields in economics. The former is based on a project-specific standpoint, with an emphasis on changes in traffic movements and time savings. The latter takes a broader perspective, looking at regional and, in the case of CGE, national benefits.

The results of the two methods of economic appraisal are not simply additive, and careful consideration must be taken when putting the two sets of results together to avoid any potential double counting.

After discussions with NZTA, it was determined that conventional CBA be used as the primary measure of assessment, and the two approaches to WEBs evaluation results be added to the CBA separately in the form of sensitivity tests, using high and low estimates.

The regionalised WEBs assessment was undertaken by Richard Paling Consulting. The methodology primarily focused on looking at quantifying benefits arising from agglomeration and employment impacts. SAHA has not undertaken any independent review of this work and the results have been directly applied in the current analysis.

Infometrics Ltd evaluated national economic and productivity benefits using the ESSAM CGE model. CGE is based on an economy benchmark based on databases of input-output tables comprised of interactions between economic agents including firms, workers, households, the government and overseas markets. By "shocking" the model, the changes in terms of GDP, employment and wages can be observed.

1.5 Conclusions of RoNS portfolio assessment

Key conclusions from the economic assessment are:

i. Each RoNS has been subject to a conventional economic assessment considering traffic benefits, travel time savings, accident reductions, vehicle operating cost savings, and associated benefits and costs;

ii. WEBs have also been identified and quantified at both a regional level and a national level, consistent with the use of WEBs in program evaluation in other countries;

iii. These WEBs are generated by the RoNS program beyond those estimated through conventional economic assessment, and are of relatively considerable scale;

iv. Conventional assessments undertaken for each RoNS assessed at a portfolio level, indicate that **the RoNS portfolio generates substantial economic benefits** with an NPV of the portfolio of over $4.5bn and a BCR of approximately 1.8 (in other words, for every $1 of capital invested, the portfolio generates approximately $1.80 in return);

v. Estimates of regional WEBs and of national economic and productivity benefits indicate that the **potential exists for further additional benefits to the economy generated by the RoNS** over and above conventional transport economic benefits;

vi. There is not a materially significant difference between the outcomes of implementing the RoNS under an aspirational versus compliant timetable – the inclusion of WEBs does not change this outcome;

vii. Notwithstanding this, the results indicate that the total benefits remain larger than total costs for the RoNS portfolio as a whole, whether delivered as an aspirational program, or a compliant program;

viii. The results indicate that there is no major difference in economic outcome in substantially delivering the RoNS within a ten year timeframe (an aspirational scenario) compared to a longer delivery timeframe. **Indeed if funds are available to invest sooner, economic benefits generated by the RoNS, both conventional and wider, can be realised sooner**.

2 Introduction

This report constitutes the findings of an economic assessment undertaken at the portfolio level for the Roads of National Significance (RoNS).

The assessment includes consideration of the total economic benefits and costs for the seven RoNS projects taking into account traditional road user benefits, externalities, and potentially broader productivity and economic growth associated with the implementation of the RoNS.

The purpose of undertaking the assessment is for NZTA to be able to answer two fundamental questions, namely:

1. Are there quantifiable wider economic benefits associated with the portfolio of RoNS projects?
2. If such benefits exist and are quantifiable, are they of sufficient scale to demonstrate the economic worth of an aspirational RoNS implementation program?

2.1 Background

The New Zealand Government has announced seven Roads of National Significance projects, which have been identified as essential routes that require priority treatment to achieve economic growth and productivity.

The RoNS, from north to south, are:

- Puhoi to Wellsford – SH1
- Completion of the Auckland Western Ring Route – SH20/16/18 (including Waterview)
- Victoria Park Tunnel – SH1
- Waikato Expressway – SH1
- Tauranga Eastern Link – SH2
- Wellington Northern Corridor (Levin to Wellington) – SH1
- Christchurch motorway projects

The RoNS have been identified as the most essential routes from a nation-wide perspective that require significant development to reduce congestion, improve safety and support economic growth.

The purpose of the Government nominating these roads as “nationally significant” is to ensure they are given priority by NZ Transport Agency (NZTA) in developing the National Land Transport Program (NLTP).

NZTA is required to develop plans to substantially advance these roads over the next ten years alongside other State highway projects in the NLTP, which must be developed in accordance with the Government Policy Statement 08/09-18/19 (GPS).

Amongst other things, in developing the NLTP the NZTA must:

- Ensure funding allocations are consistent with the impacts the government wishes to achieve as set out in the GPS;
- Ensure funds allocated and spent within each activity class are within the range specified for that activity class as given in the GPS;

- Take account of the Government's priority to increase national economic growth and productivity, which includes the national roading priorities set out in the RoNS;
- Consider networks from a national perspective; and
- Achieve value for money.

2.2 Project objectives

The RoNS are each significant projects in their own right. Each has been progressed to a certain extent on an individual basis. The funding for each in a traditional approvals and procurement approach would be assessed and sought in isolation from other major roading projects within NZTA's portfolio.

Due to the priority required for the RoNS, NZTA has considered an approach which seeks to justify, on economic assessment grounds, the seven projects on a portfolio basis taking into account their expected benefits.

The objective from the process is a 'proof of concept' that quantifies:

1. The total benefits of the combined seven RoNS as a portfolio; and
2. The benefits of delivering the RoNS under an aspirational timetable (i.e. within a ten year time horizon).

NZTA is then seeking to undertake certain scenario analyses which:

- Seek to accelerate the implementation of the projects through increased funding in the short term (the 'aspirational' program);
- Seek alternative sources of funding (compared to Government funding) for certain RoNS projects, that will enable program acceleration.

This report represents the findings from the economic assessment. It does not address the funding scenarios.

It is important to note from the outset that the assessment approach adopted extends beyond conventional project level benefit-cost analyses alone, and incorporates broader second order macroeconomic effects. Similar approaches to evaluation have been made to varying degrees primarily overseas, and while there is growing agreement that the concept of including wider economic benefits in the appraisal of projects is appropriate (as evidenced by the inclusion of one component of these, agglomeration benefits, in the most recent versions of the NZTA Economic Evaluation Manual), the details of the approach in general are still embryonic and evolving, and some of the components are still the subject of ongoing debate.

It is therefore important that the results be considered within this context and, to respond in a robust manner to the likely challenge of the purported benefit streams, that a range of sensitivity tests be incorporated which seeks to respond to some of those challenges.

Notwithstanding this, it is generally acknowledged that broad benefits may accrue to a project beyond those undertaken in a conventional assessment, and this report seeks to outline a framework for identifying those benefits and then reporting on the results of quantifying those benefits in a coherent and transparent manner.

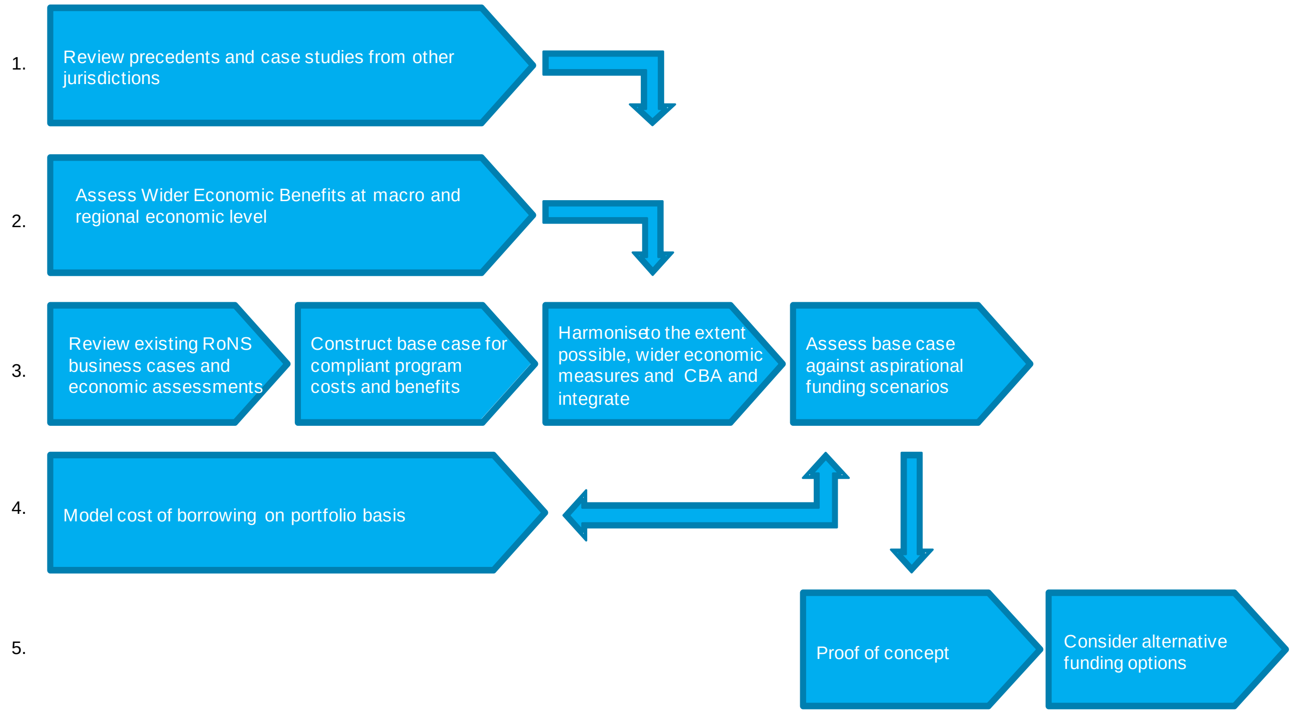
3 Methodology

3.1 Introduction

An economic assessment on a portfolio basis which takes into account both conventional and wider economic benefits requires a simple methodology which is readily understood, and enables necessary sensitive testing and scenario analyses to be undertaken.

The approach used is summarised in Figure 3.1 below.

Figure 3.1: RoNS portfolio economic assessment methodology



The workstreams outlined in the figure are further described in the following pages. The actual assessments undertaken in certain workstreams has been undertaken by various external advisers on behalf of NZTA. Those responsible for certain workstreams are also outlined in the following pages.

3.2 Workstream 1: Approaches used in other jurisdictions

This step was undertaken as a broad level review of economic assessment methodologies used in Australia to determine whether there were any learnings which could be applied in relation to program level economic assessment and/or the application of WEBs identification and quantification.

Reviews undertaken include:

- National infrastructure priorities - Infrastructure Australia, nation-wide
- Metro Rail Economic Assessment (MREP) – NSW Government, Sydney
- City Loop and Inner Core – Victorian Government, Melbourne
- Other infrastructure assessment processes and funding schemes

The specific aim was to consider the approach taken to assessing (and justifying) the individual projects as a holistic program in the context of costs and benefits at the level of the national economy

3.3 Workstream 2: Assess wider economic benefits

This workstream was undertaken to assess the WEBs impacts associated with the implementation of the RoNS. In this regard, two approaches were used (one essentially used as a comparison for the other):

Assess the potential for wider economic benefits (WEBS) using two different measures:

- The first approach used a regionally-specific WEBs model which individually assessed the regional impacts of each of the RoNS in relation to agglomeration effects and employment changes – this assessment was undertaken by Richard Paling Consulting Ltd; and
- The second approach used a Computable General Equilibrium model (CGE) to estimate the size of the economy-wide effects, on the basis that the RoNS are of a scale to have nation-wide impacts including the potential to impact gross domestic product (GDP) – this assessment was undertaken by Infometrics Ltd (Infometrics).

3.4 Workstream 3: Economic assessment framework

This workstream involved the review of available project-specific economic analyses undertaken by NZTA or other external advisers. The specific steps proposed included:

- A review of each of the seven RoNS in terms of business case and conventional economic evaluations;
- Construction of an economic assessment framework for the RoNS portfolio of projects;
- Undertake a broad assessment within the economic assessment framework of total program benefits and costs – comparing a compliant scenario (i.e. a program of works scheduled to fit within the NLTP funding envelope) against an indicative aspirational scenario (i.e. a program that would deliver the RoNS within a ten year time horizon); and
- Undertake a range of sensitivity tests to determine key variables and influencers and the veracity of results.

It should be noted that the initial approach was intended to undertake a peer review of existing economic evaluations at a detailed level to ensure the results for each RoNS were 'normalised (i.e. assessment was on the same basis for each project – travel time savings, traffic modelling assumptions, vehicle operating cost parameters, amongst other checks). However, due to time constraints and the unavailability of certain data and reporting, it has not been possible to undertake this level of review and the results as provided by NZTA have been adopted on the basis of this caveat.

As a consequence the accuracy of the integrated Cost Benefit Analysis modelling remains a function of the accuracy of the raw data provided. Notwithstanding, NZTA has advised that the conventional economic evaluations provided have been the subject of NZTA's internal peer review process.

In accordance with the NZTA Economic Evaluation Manual (EEM) guidelines the following parameters have been used in this assessment:

- A discount rate of 8% real; and
- An economic assessment period of 30 years from construction completion.

All dollars are represented in 2009 dollars unless otherwise stipulated.

3.5 Workstream 4: Model cost of borrowing

This step considers the consequential ‘financing/funding investment assessment’ as opposed to the broader public interest assessment associated with the Benefit Cost Analysis.

The workstream completes the full scope of NZTA’s assessment in reaching a conclusion regarding whether the broader economic benefits associated with accelerating implementation of the RoNS offsets the cost of borrowing funds to enact that acceleration. This workstream is documented separately and is not included in this report.

3.6 Workstream 5: Economic assessment reporting

This workstream involved preparation of the results in a ‘building block’ approach (conventional + WEBs, sensitivity testing) so that the specific impacts of both broader economic impacts and acceleration of funding for earlier implementation could be quantified and reported.

3.7 Workstream responsibilities

NZTA engaged a mix of internal resources and external advice to undertake the various workstreams which have been combined to form the evaluation results outlined in this report. External advisers have undertaken specific workstreams as follows:

1. International case studies:	Saha International
2. Wider Economic Benefits:	Richard Paling Consulting Ltd– Regional WEBs assessment for each RoNS
	Infometrics Ltd –General Equilibrium model assessments for each RoNS and for the sets of RoNS combined
	Booz & Co – Peer review and graphical representation of GE outputs
3. Assessment framework:	Saha International
4. Cost of borrowing:	Deloitte (reported separately)
5. Proof of concept:	Saha International (this report)

4 Approaches taken in other jurisdictions

4.1 Introduction

To assist in the validation of approach taken to evaluating the RoNS as a portfolio, a small body of research was undertaken to review portfolio project approaches and evaluation undertaken by various agencies in Australia and internationally. The focus of this research sought to understand the treatment of two key premises:

1. Multiple projects evaluated as portfolios and the treatment of project interdependencies; and
2. The role of alternative measures of economic benefits beyond the conventional economic analyses.

The research profiled the following Australian projects/ programs:

- Infrastructure Australia's Assessment Framework (2008);
- City Loop and Inner Core, Melbourne (2007);
- Metropolitan Rail Expansion Program, Sydney (2007); and
- AusLink, National (2007).

These examples were selected to highlight where wider economic benefits have been considered, interdependencies between projects have been identified and quantified, and the need for assessments to be based on rigorous transport demand modelling and economic concepts.

In addition reference is made to work undertaken in the UK.

4.2 Key findings

The following conclusions were drawn from the case studies researched:

- Robust, transparent and justifiable conventional cost benefit analysis (CBA) is essential, and is the 'bedrock' of project evaluation;
- Where multiple projects comprise a program, it is necessary to ensure that CBA is applied consistently. This includes consistent transport modelling, assumptions, unit parameter values, and discount rates, and sensitivity testing;
- Determining project linkages is essentially an empirical test – interdependencies, if identified, may drive sequencing decisions;
- There is no simple or widely used method to quantify interdependencies between projects;
- Application of standard evaluation methods, transport modelling, along with subjective analysis remains the key approach;
- Infrastructure Australia has introduced WEBs as a potential benefit stream, with its prioritisation guidelines specifying the inclusion of agglomeration impacts as a monetised benefit in economic evaluations submitted to it (though not CGE). Anecdotally, through the IA process WEBs have been incorporated into economic benefit streams in the order of 20-30% over and above conventional CBA

benefits – however, it appears there has been a lack of detailed data collection, and there has been heavy reliance on one or two reference projects where such benefits have been identified;

- In terms of CGE, Infrastructure Australia acknowledge the usefulness of CGE as a tool for measuring macroeconomic effects, but have taken a clear stance to the treatment of the outcomes of CGE modelling in relation to conventional CBA:

  "Infrastructure Australia will primarily use CBA data for measuring the benefits of an initiative and will not consider CGE (Computable General Equilibrium) benefits as additive to CBA benefits."[3]

- There is still considerable work to be undertaken in developing the approach in Australia further.
- Work undertaken in the UK by Sir Rod Eddington on behalf of the UK Treasury in 2006 made a number of conclusions regarding the long-term links between transport and the UK's economic productivity, growth and stability. In relation to wider macro and regional economic benefits the report concluded, amongst other things:
  - A comprehensive and high-performing transport system is an important enabler of sustained economic prosperity: a 5 per cent reduction in travel time for all business and freight travel on the roads could generate around £2.5 billion of cost savings – some 0.2 per cent of GDP.
  - Transport's contribution to the agglomeration effects of economic activity is most significant within large, high-productivity urban areas of the UK. London is the most significant example, adding 30 per cent to the time saving benefits of some transport schemes.[4]
- It should however be noted, when evaluating effects borne by other economies, such as the UK, of the differences in scale and population densities between these other economies and the New Zealand economy, particularly with regard to the urban environments.

[3] Infrastructure Australia, Prioritisation Guidelines 2008

[4] HM Treasury, The Eddington Transport Study, 2006

5 Wider Economic Benefits

5.1 Introduction

Conventional CBA focuses mainly on project specific costs and benefits, and are derived from changes in travel conditions including travel time, safety and vehicle associated costs. However, research in recent years has shown that these savings do not always fully capture wider economic impacts, and thus the exclusion of such impacts might increase the risk of poor investment decisions.

The fundamental issues associated with the conventional approach has been the focus on transport model outputs which transfer existing traffic flows and forecasts between routes and modes. These do not always fully take into account induced or generated traffic which may occur due to the particular impacts of the project or the second order economic effects which might arise in particular in response to changes in transport accessibility.

The extent that the underpinning transport data which 'drives' a conventional approach does not fully capture estimates of changed socio-economic activity in terms of new trips or changes in patterns of economic activity, could be considered to be a deficiency with the conventional approach.

Research in recent years has shown that conventional analysis based on savings in travel time do not necessarily capture all wider economic impacts, and thus the exclusion of such impacts increases the risk of sub-optimal investment decisions.

This is where the explicit consideration of WEBs seeks to respond to this deficiency in the conventional approach.

The national significance assigned to the RoNS program presents an opportunity to test an approach where a national road building program may indeed have a materially quantifiable impact on the national economy over and above those captured in individual (and conventional) economic appraisals. In terms of evaluating the value of the portfolio, these broader benefits should be identified and quantified as part of the economic assessment.

In this regard, the agreed definition of WEBs for this purpose is:

> "*Second order effects on wider economic activity", with examples of WEBs covering agglomeration benefits, labour productivity and supply, and the impacts of imperfect competition. In addition effects at a macro-economic level resulting in GDP changes or more specifically changes in Real Gross National Disposable Income (RGNDI) have been considered."*

Two approaches to the evaluation of WEBs have been undertaken for the purposes of answering the above two questions. These are:

- WEBs at a regional level using agglomeration and labour market effects; and
- Changes in Real Gross National Disposable Income (RGNDI) using a Computable General Equilibrium (CGE) model.

It should be noted that the outputs from these two methodologies are not considered to be additive to each other but rather demonstrate, through different means, the potential for additional economic benefits/impacts to be accrued to the RoNS program.

The value of alternative measures of wider economic impacts, beyond those provided through conventional means, as noted above are acknowledged. However SAHA has not undertaken a full peer review of the WEBs and CGE reports, and the inclusion of the WEB and CGE results in this evaluation are therefore premised on the basis that SAHA retains a number of concerns with some of the components of the outputs from these reports, reflecting the difficulties in identifying impacts which arise over considerable periods of time.[5] These concerns include for example:

- The WEBs results lack substantiation of the difference between new jobs created versus those relocated as a consequence of a project; noting however the potential for displaced jobs to migrate to more productive jobs;
- The absence of substantive induced/generated commercial and freight traffic as a result of these projects;
- The potential for double counting of benefits in both analyses with conventional economic evaluations of saved travel times, although research from overseas has largely discounted this issue;
- The distinction between average and marginal values as applied to agglomeration. The incremental effects of agglomeration could be expected to vary depending on the pre-existing conditions to which they are applied and care must be taken to ensure that there is no implication that continuing benefits accrue with ever-increasing concentration. In other words, the effect of diminishing returns may result in the overstating of agglomeration benefits;
- Not all second order effects should be taken as benefits. There are likely to be second order costs, e.g. as more projects come on stream and if there are diminishing returns to agglomeration, this might lead to more congestion, increased pollution, potentially higher levels of crime and other social dislocation with higher concentration, and therefore higher costs.

5.2 Regional WEBs

The regional WEBs assessment was undertaken by Richard Paling Consulting. The methodology primarily focused on looking at quantifying benefits arising from agglomeration and employment impacts.

Box 1: Excerpted Executive Summary from the Richard Paling Consulting report

The conventional economic analysis of the impacts of transport schemes primarily focuses on changes in travel conditions for journeys that would be made whether or not the new scheme was in place. It does not therefore include the impacts that road building might have on the level and patterns of economic activity and employment. However, a wide range of evidence suggests that road building may indeed have these wider economic impacts but to date there have only been limited attempts to quantify these. While the desirability of including the full range of impacts is recognised, in practice their assessment has been constrained by the lack of quantified data on these, particularly on the employment effects. In part, this reflects the length of time over which these impacts might emerge

[5] A peer review of the Richard Paling Consulting and Infometrics Reports was undertaken for NZTA by Booz & Co Ltd.

SAHA

.

and the difficulty of distinguishing the effects of road building from other possible influences over that period.

One approach to assessing the wider impacts is the use of a CGE model (described separately in this report). An alternative bottom up approach has also been developed, which considers the wider economic benefits for each component of the RoNS separately. While as acknowledged above, there are limitations with the data used to support this, it does provide a broad estimate of the wider economic benefits which might result.

This bottom up approach takes into account both the agglomeration impacts, the productive advantages that arise from close spatial concentration of economic activity, which are likely to arise within major urban areas, and the impacts on employment levels experienced both within the urban areas and more widely throughout the area of influence of the road. These are effects which are not included in the conventional economic analysis and which can therefore be added into the scheme appraisal.

For the agglomeration impacts, in general the broad approach set out in the Economic Evaluation Manual (EEM) has been followed, with some simplification. This uses the most recent numbers on agglomeration elasticities recently developed by NZTA.

For the employment effects, for interurban schemes use has been made of the results of studies from overseas which have suggested that new roads can increase the numbers employed in the broad area of influence of the road by between 0.4 per cent and 4 per cent. A conservative approach has been used for the analysis, based on the figures at the lower end of this range. For urban schemes, use has been made of the relationships between employment impacts and agglomeration derived from earlier work in Auckland on the Waterview Connection.

On the basis of this approach, the wider economic benefits generated by the RoNS amount to about 65 per cent of the benefits derived from the conventional economic analysis. For the schemes where they have been estimated, the agglomeration benefits typically amount to 20 per cent or less of the conventional economic benefits, a figure that is within the range typically found overseas. The employment impacts are larger but for these there is no typical range. The results from the bottom-up approach give slightly lower benefits from those derived from the GE modelling, in part reflecting the more comprehensive spatial assessment in the GE modelling. However taking both the conventional economic benefits and the wider economic benefits together, both approaches give results of a similar order of magnitude.

While there are issues with the limited data available and with the use of results from different schemes and countries, the findings suggest that the wider economic benefits from the RoNS are likely to be substantial in relation to the benefits traditionally calculated. This indicates the importance of these schemes in improving productivity and raising economic output in New Zealand.

Source: The Wider Economic Case for the Roads of National Significance (RoNS), Richard Paling Consulting, April 2010

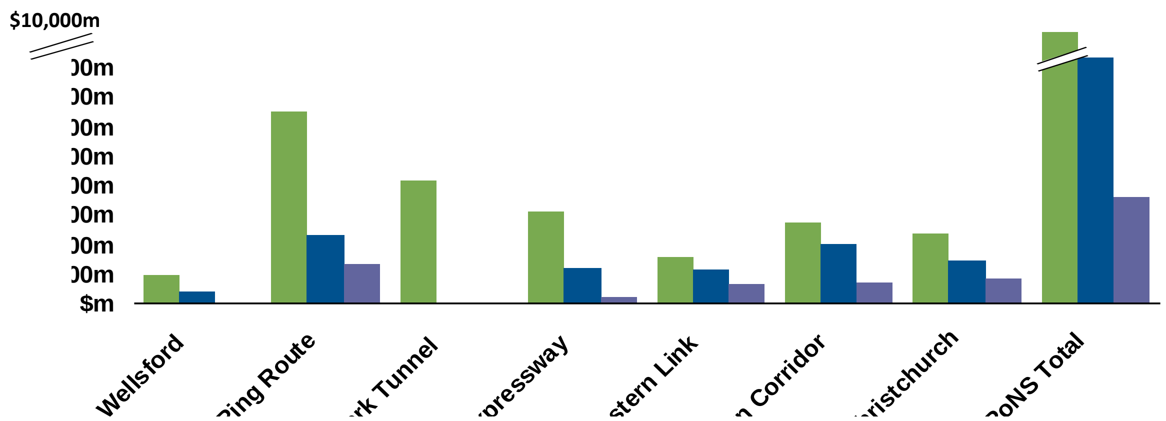
5.2.1 Summary of Regional WEBs results

The ratio of WEBs to conventional benefits of 65%, as noted above, was derived by Richard Paling Consulting based on a position as might occur in 2016, under the assumption that all roads are completed at that point in time and all ramp-ups to the full forecasted benefits have been achieved.

On a present value basis across the full evaluation period, and with benefits ramping up over time as roads are completed, regional WEBs amount to about 40% of conventional benefit levels.

A comparison of WEBs, with and without employment effects, against conventional benefits for each of the RoNS projects, and the RoNS total on a present value basis, is illustrated in Figure 5.1 below.

Figure 5.1 Present Value of Benefits – Conventional Benefits and Regional WEBs[6]



Note that WEBs for Victoria Park Tunnel (VPT) were not assessed given that the purpose of this assessment is to look at the effects of accelerating the RoNS, and as VPT is actually under construction at the time of writing there would be no incremental effect.

For a more detailed description of the methodology and results for regional WEBs, please refer to the full Richard Paling Consulting report in the appendices.

5.2.2 Peer review of WEBs

Booz and Co conducted a peer review of the Richard Paling Consulting WEBs report. A copy of this report is provided in the appendices.

[6] In accordance with the NZTA Economic Evaluation Manual, these benefits were evaluated using a discount rate of 8% over a thirty year time horizon following construction completion of the project (in this case the construction completion of the RoNS portfolio).

5.3 General Equilibrium

Infometrics Ltd was commissioned by NZTA to evaluate national economic and productivity benefits. The ESSAM computable general equilibrium (CGE) model was used to estimate these benefits. CGE is based on an economy benchmark based on databases of input-output tables comprised of interactions between economic agents including firms, workers, households, the government and overseas markets. By "shocking" the model, the changes in terms of GDP, employment and wages can be observed.

The main measure of economic welfare used in the CGE modelling is Real Gross National Disposable Income (RGNDI). RGNDI measures the total incomes New Zealand residents receive from both domestic production and net income flows from the rest of the world and adjusts for changes in the terms of trade. The inputs for the CGE model for RoNS includes change in work related travel time, vehicle operating costs and repairs and accident related costs.

A CGE to net market benefits ratio was calculated using these inputs to measure the magnitude of macro-economic benefits (as measured by RGNDI) to conventional market benefits as a result of the RoNS program. As the results generated by Infometrics are based on a static output as at 2022 (assuming all roads are completed at that point in time), the ratio of CGE to market benefits has been applied to the market benefits of conventional cost-benefit analysis to estimate a temporal view of change in RGNDI.

Box 2: Excerpted Executive Summary from the Infometrics report

The Infometrics workstream used a computable general equilibrium model to estimate the wider economic benefits of the Roads of National Significance.

Standard benefit-cost analysis is a partial equilibrium technique; well-suited to the analysis of investment projects that will not have significant national effects. The RONS projects, however, have the potential to change New Zealand's gross domestic product. A general equilibrium model is one tool that can be used to estimate the size of the economy-wide effects. As well as incorporating the changes in productive efficiency that are addressed in partial equilibrium analysis, a general equilibrium model also captures flow-on effects and the effects of changes in allocative efficiency – the gains in economic welfare that emanate from improvements in the allocation of resources between industries in accordance with consumer preferences.

For the RONS projects our analysis suggests that the generation of wider economic benefits can be substantial, amounting to about $1370m per annum (estimate as at 2020, based on Infometrics May 2010 update), compared to around $450m pa of conventional market benefits using standard benefit-cost analysis. Non-market benefits (such as lives saved) which are not included in the general equilibrium modelling, add another $690m pa. Thus overall benefits [CGE + market + non-market] increase by approximately 80%.

The main driver of the expansion in economic activity is the enhanced resource productivity of transport-dependent commercial and industrial activities. As less time and money is spent transporting goods between suppliers and consumers, between cities, and between ports and factories etc, more investment can be directed to increasing other productive assets such as hotels, telecommunications infrastructure energy efficient appliances.

Industries that are critical to the economy such as dairy processing, forestry and tourism are key direct beneficiaries of better roads. The second round effects of more investment activity impact favourably on industries such as construction, base metals and metal fabrication.

Higher wage payments by these industries raise consumer demand, adding further fuel to the economic expansion. Ultimately better roads provide benefits to virtually all industries. The flow-on effect of the success or failure of road transport in supporting economic development is further underscored by the Input-Output tables, which show that Trade (wholesale and retail) is the largest user of road freight transport services

However, the existence of flow-on economic benefits depends crucially on whether there is an investment response to the potentially higher rates of return that would result from the productivity improvements generated by the RONS. Without such investment the model produces no increase in the value of benefits over that estimated in traditional benefit-cost analysis. Indeed the value of market benefits at $430m is 4% less than those estimated in the conventional benefit-cost analysis (i.e 96% of conventional benefits).

International practice in general equilibrium modelling leans towards allowing investment to respond to rates of return. Ultimately, though, this is a judgement call that we as modellers do not claim to be any better at making than anyone else. Still, if investment does not respond to profitable opportunities then much analysis of economic growth policy is flawed.

Some limitations of the modelling approach should be noted.

- The estimates of the wider economic benefits still contain whatever error margins exist in the standard benefit-cost analysis.
- The consumption of petrol and diesel may be a poor proxy for the allocation of benefits if the RONS users are not representative of all road users.
- Agglomeration benefits are sometimes cited as a type of wider economic benefit from investment in transport infrastructure. The relationship between such benefits and those encompassed by GE model is unclear. They are not necessarily additive.

Source: General Equilibrium Analysis of Roads of National Significance, Infometrics Ltd, December 2009 and May 2010

5.3.1 Update to Infometrics CGE report

Infometrics' original RoNS analysis and report was concluded in December 2009. Since this time, NZTA published an updated conventional evaluation of the Waikato Expressway. The materiality of the change to the Waikato Expressway assessment warranted an update and re-run of the CGE model. The data outputs from the updated CGE model have been used as the basis of CGE inputs to this report.

Infometrics original and updated reports are provided in the appendices.

5.3.2 Peer review of CGE

Booz and Co conducted a peer review of the original Infometrics CGE report. A copy of this report and Infometrics response is provided in the appendix.

5.3.3 Graphical representation of CGE

Booz and Co have developed a series of graphical representations of the CGE outputs to assist in the demonstration of industry and regional distribution of outcomes. A copy of this report is provided in the appendix.

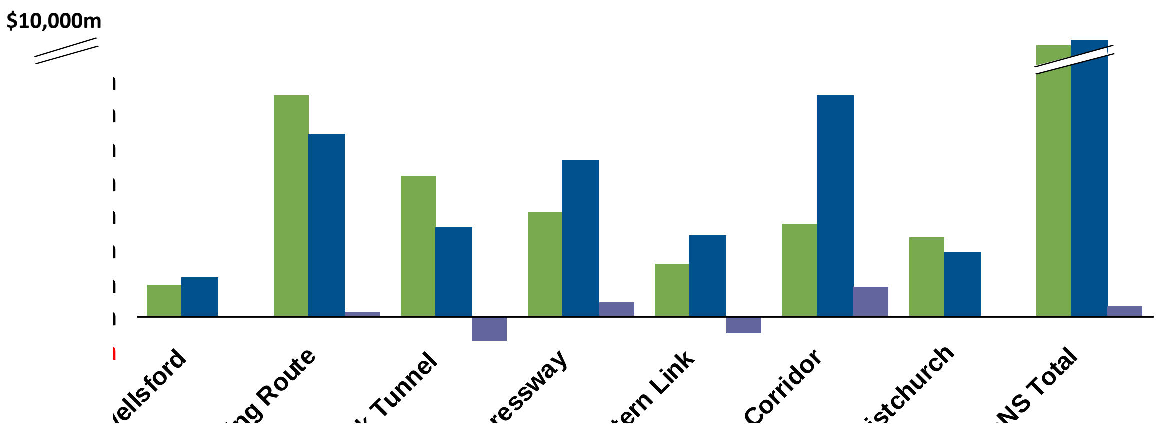
5.3.4 Summary of results

Infometrics determined the ratio of total CGE benefits [CGE benefits + non-market benefits] to conventional benefits under their high scenario to be 180% (i.e. a factor of 80% greater than total conventional benefits). This assessment is based on a position as might occur in 2020, under the assumption that all roads are completed at that point in time and all ramp-ups to the full forecasted benefits have been achieved. Under the high scenario, on a present value basis across the full evaluation period, and with benefits ramping up as roads are completed, total CGE benefits amount to about 117% of conventional benefit levels.

However without an investment response (low scenario), the Infometrics model produces no increase in benefit value. Indeed the total benefit value is estimated to be 4% less than the benefits estimated by traditional benefit-cost analysis at the same fixed point in time (2020) (i.e. 96% of conventional benefits). However over the whole evaluation, under this low scenario, the addition of CGE benefits leads to an uplift of 1% of total benefits over and above the conventional benefits.

Figure 5.2 demonstrates the CGE output results at an individual project and the portfolio level on a present value basis across the evaluation timeframe. The high and low scenarios are based on the capital closure assumptions, i.e. whether or not there is a secondary investment response to the potentially higher rates of return that would result from the productivity improvements generated by the RoNS.

Figure 5.2 Present Value of Benefits – Conventional Benefits and CGE



Noting the negative CGE benefit results for two individual RoNS projects in Figure 5.2, the following extract from Infometrics' report serves to explain the negative results that can be produced at the low CGE estimate (i.e. fixed capital stock assumption):

"The total change in RGNDI from all of the RONS combined is estimated at $1370m per annum (estimate as at 2020), compared to $450m [of market benefits] in the B-C analyses; a roughly three-fold increase. However, these benefits are crucially dependent on the capital closure assumption. If investment is not responsive to rates of return, implying a total capital stock that is fixed at the BAU level, the increase in market benefits across all RONS combined is just $430m; a reduction of 4% compared to the B-C results. The main contributors to this result are TEL and VPT, which have high values for work travel time.

Closing off the responsiveness of investment to rates of return prevents the economy from expanding. That is, there is essentially no opportunity for the benefits that are fed into the model to generate any wider economic benefits through multiplier effects. Not surprisingly then, the output of the model is much the same as what goes in – namely the benefits from the B-C analysis. While one might expect to see some additional benefit from gains in allocative efficiency (as resources flow to where they are most valued), such gains do not seem to be strong enough to offset various negative savings in vehicle operating costs and accident costs under some of the RONS, and of course the annual maintenance costs and financing charge." [7]

It is due to this broad variability in results that the CGE modelling has been used as one of two wider economic assessment approaches (the other being regional WEBs).

For a more detailed description of the CGE methodology and results, please refer to the full Infometrics report in the appendices.

5.4 Relativity of benefits generated

Figures 5.3 and 5.4 provides a comparison of the present value of benefits for the aspirational scenario that are generated by the three evaluation methods, i.e. benefits generated by the conventional cost benefits analysis and the high and low estimates of the regional WEBs and CGE (i.e. regional WEBs with and without employment effects and CGE with and without an investment response).

[7] Infometrics, General Equilibrium Analysis of Roads of National Significance, December 2009 and May 2010 update

Figure 5.3 PV of benefits (Aspirational Program) – Conventional benefits, WEBs (agglomeration + employment), GE (high estimate)

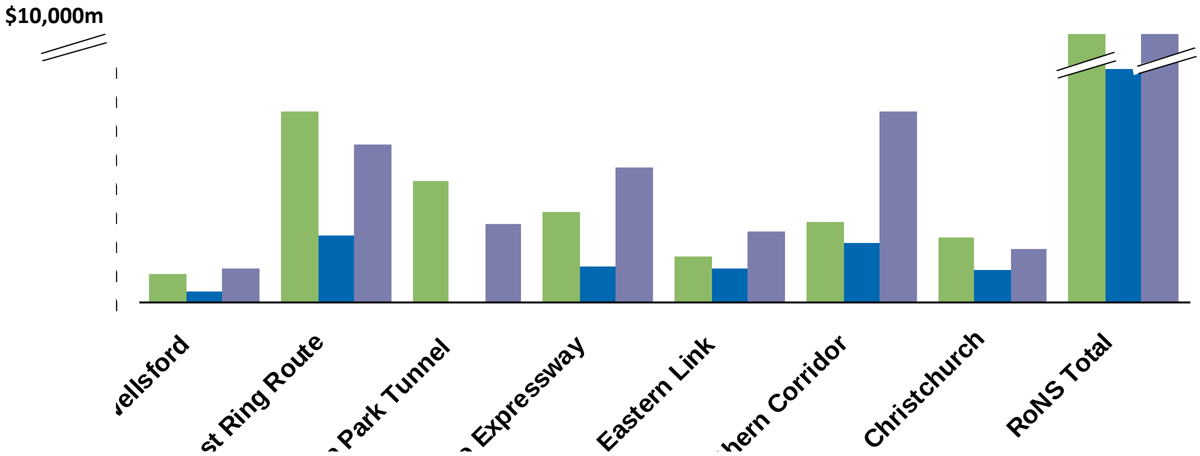
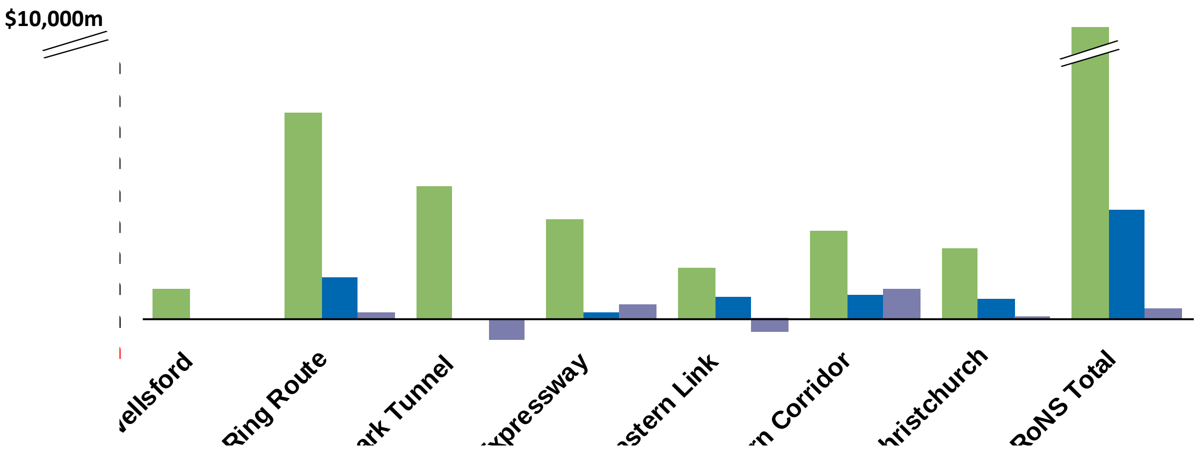


Figure 5.4 PV of benefits (Aspirational Program) – Conventional benefits, WEBs (agglomeration only), GE (low estimate)



6 Economic evaluation framework

To assess the economic impacts of an accelerated or aspirational RoNS program, the evaluation results of an indicative aspirational program have been compared against the “base case” or a compliant program. This section provides an overview of the methodologies used in undertaking the economic evaluation of the RoNS, including both conventional Cost Benefit Analysis (CBA) and integration of the WEBs evaluations undertaken for each project.

6.1 Combining CBA and WEBs

The economic evaluation of the RoNS incorporates conventional benefits and costs specific to each project, as well as WEBs which look at regional and national economic impacts.

Conventional economic appraisal assesses the cost and benefits of a project to the community, which are incurred by different stakeholders such as the project proponents, road users and the government.

Wider economic costs and benefits have not traditionally been included in conventional cost-benefit analysis (CBA). However, recent developments in Europe and Australia have indicated that conventional approaches overlook benefits such as agglomeration and employment effects, and there are increasing moves to include these impacts in some way, at least for large schemes. Standard approaches to the assessment of agglomeration impacts are evolving and are being included in the formal guidance for economic evaluation, although there is still a range of opinions with regard to the inclusion of employment impacts, in part related to the difficulties associated with their estimation and potential double counting effects. Also some concerns remain, for the reasons noted in Section 4, as to the level of accuracy of the measures provided.

The WEBs analysis undertaken by Richard Paling Consulting at a regionalised level, and the CGE modelling by Infometrics, attempt to capture these benefits for the RoNS, using two different approaches.

It should be noted that the relationship between agglomeration benefits derived from regional wider economic benefits and those encompassed by CGE models is at this stage unclear. It is probable that they are not additive to each other, but rather have been treated as two separate sensitivity tests over and above conventional results.

For the purposes of this assessment, the estimates of both regional WEBs and CGE have been added, as a sensitivity test, to the conventional cost benefit analysis of the RoNS portfolio. The intention of adopting this approach has been to produce an indicative single investment measure that can be used to inform decision making with regards the acceleration of the RoNS program. SAHA notes specific concerns and lack of precedents in adding WEBs and CGE to conventional CBA and emphasises such an approach provides an indicative outcome only and is not intended to be used as a conclusive investment validation tool.

6.2 Conventional economic evaluation

6.2.1 NZTA methodology

The conventional economic evaluation of RoNS follows standard methodologies for assessing projects of this nature, broadly in accordance with the Economic Evaluation Manual (EEM) of NZTA.

The evaluation looks at conventional benefits including travel time savings, reduction in accidents and vehicle operating costs, as well as the capital and operation costs associated with each of the RoNS.

The only toll road in this evaluation is the Tauranga Eastern Link, and the estimated toll revenue and collection costs have also been incorporated.

An integrated RoNS assessment was undertaken by the straightforward summing of the annualised (real) benefits and costs for each individual evaluation.

A Net Present Value (NPV) of net benefits (gross benefits less capital and operational costs) was calculated for each of the RoNS and aggregated for the integrated program. A benefit cost ratio (BCR) was also derived by dividing the total benefits by the total costs. Both measures act as primary tools to evaluate the economic feasibility of projects.

In accordance with NZTA's Economic Evaluation Manual an 8% discount rate was used in the evaluation, with an evaluation period of 30 years following construction completion of the RoNS program. With Stage 2 of Puhoi-Wellsford being the last component of the RoNS portfolio scheduled to be completed in 2025 under the compliant program, the evaluation period extends from 2009 (RoNS commencement with Victoria Park Tunnel) to 2055 (30 years following Puhoi-Wellsford completion).

6.2.2 CBA data source

The primary data for each of the conventional CBA evaluations for the individual RoNS projects was provided by NZTA.

The quantum and profile of capital expenditure for each project was based on data provided by NZTA modelling indicative aspirational and compliant capex profiles.

The annual benefit profiles were provided from the conventional CBA results for each RoNS project. Where the individual CBA evaluations were based on a compliant RoNS program, it was necessary to develop an estimate of the benefit streams for an aspirational program. In general the benefit streams were brought forward to align with the construction profile of the aspirational program modelled. Conversely where individual CBA evaluations were based on an aspirational RoNS program, it was necessary to develop an estimate of the benefit streams for a compliant program. This was achieved by deferring benefit streams to align with the construction profile of the compliant scenario.

The evaluations provided to SAHA were principally cost and benefit profiles containing hard coded data. Given the nature of the data provided and without access to the underpinning transport modelled outputs and the generated/induced private, commercial and freight transport movements for each project assessment, it was not possible for SAHA to undertake its own peer review of the data inputs to this evaluation nor to better understand the real underlying drivers of benefits and costs at a detailed level.

It is noted though that the economic assessments provided by NZTA had been subject to NZTA's normal peer review process, in line with its EEM processes.

6.3 The role of WEBs

Conventional assessments and WEBs are based upon two different fields in economics. The prior is based on a project-specific standpoint, with an emphasis on changes in traffic movements and time savings. The latter takes a broader perspective, looking at regional and national benefits.

The results of the two methods of economic appraisal are not simply additive, as careful consideration must be taken when putting the two sets of results together to minimise the risk of double counting.

In this regard, Infrastructure Australia in their Prioritisation Guidelines (2008), has taken a clear stance to treating the outcomes of CGE modelling:

: *"Infrastructure Australia will primarily use CBA data for measuring the benefits of an initiative and will not consider CGE (Computable General Equilibrium) benefits as additive to CBA benefits."*[8]

Notwithstanding the above, Infometrics refutes Infrastructure Australia's position and has provided a suggested methodology in their report to convert their "one snapshot moment after the investment" into an annualised temporal view to provide an additive approach of CGE to CBA. Infometrics does, however, caveat any reliance on this approach by stating that *"the results can only ever be indicative. The interpretation of CGE results should centre on their direction (up or down) and broad magnitude (small, medium or large), rather than on the precise point estimates that the model produces."*

While Infrastructure Australia has excluded CGE as an additive to CBA, it does support the inclusion of regional WEBs in its economic evaluations and specifically, with respect to agglomeration impacts, it *"expects these to be monetised and included in a CBA of any initiative"*[9].

As a result while a cautious approach is appropriate, particularly with regards to the scale of such benefits, WEBs should not be overlooked and excluded for projects with high impact and significant scope such as the RoNS.

After discussions with NZTA, it was determined that conventional CBA be used as the primary measure of benefits, and the two approaches to WEBs evaluation results be added to the CBA separately in the form of sensitivity tests, using high and low estimates.

Another issue identified is the extent to which regional WEBs and those produced from a CGE model cover similar effects and the potential for over-estimation if they are incorporated simultaneously into a cost-benefit analysis for RoNS.

Due to the lack of detailed data, it has not been possible to determine precisely which component of the benefits from the regionalised WEBs analysis and those from CGE modelling are covered by one or the other.

Again, following discussions with NZTA, it was agreed that the two measures can be regarded as substitutes rather than complementary. Therefore, in the RoNS economic evaluation, the regionalised WEBs and those arising from CGE outcomes have been treated as two separate sensitivity tests over and above conventional results.

---

[8] Infrastructure Australia, Prioritisation Guideline v5, September 2008

[9] Infrastructure Australia, Prioritisation Guideline v5, September 2008 – Appendix D

6.4 Project interdependencies

In recent years, different jurisdictions across the world have identified economic benefits arising from interdependencies between closely related infrastructure projects. That is, there will be additional benefits generated by implementing a “package” of projects, which will be greater than the sum of the benefits of the individual projects in the package.

Agencies such as the UK Department of Transport have identified these explicitly, and have implemented a systematic approach for capturing these benefits. The case studies also provide an approach for which interdependencies between projects were identified (Victoria, NSW – rail projects – refer Appendix A).

However, following discussions with NZTA, it was determined that the RoNS do not have any tangible project interdependencies, primarily due to the significant geographical discrepancies between each of the RoNS. Therefore, any additional benefits from potential interdependencies have not been considered further in this assessment framework.

7 Scenarios assessment

7.1 Comparing the programs

The figures below outline the cost and benefit profiles for the indicative compliant and aspirational programs that were modelled for the purposes of this evaluation.

Figure 7.1 Cost and Benefit Profile – RoNS Compliant Program

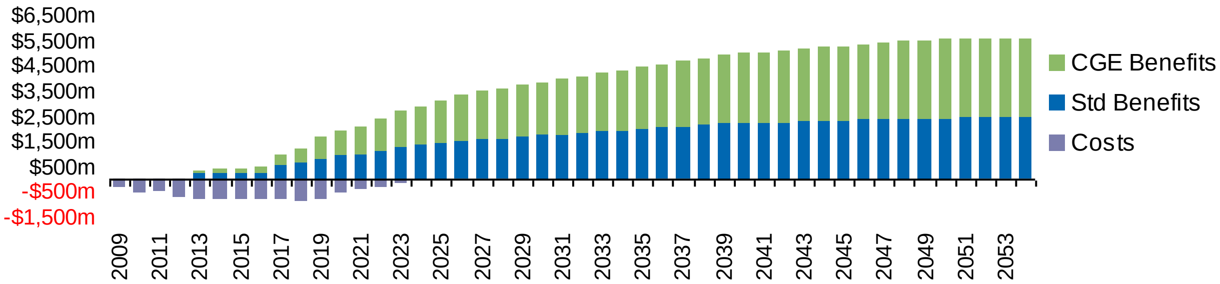
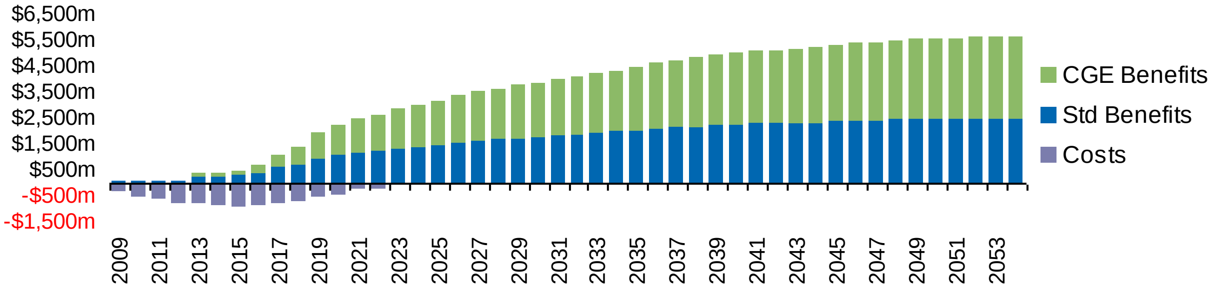


Figure 7.2 Cost and Benefit Profile – RoNS Aspirational Program



The figures show that as construction of the RoNS are accelerated, capital costs are brought forward, and benefits are realised sooner than the compliant program. The following sections discuss the economic evaluation outcomes of the compliant and aspirational RoNS programs in more detail.

7.2 Economic evaluation results

Table 7.2 summarises the results of the economic evaluation at 8% real discount rate for the compliant and aspirational programs for the RoNS taken together under **three scenarios:**

1. Conventional Cost Benefit Analysis
2. Conventional Cost Benefit Analysis plus regionalised WEBs
3. Conventional Cost Benefit Analysis plus GE benefits

As illustrated by Table 7.2, under conventional CBA the RoNS portfolio under both the aspirational and compliant scenarios delivers positive investment results with an NPV of over $4.5bn and a BCR of 1.8 (that is, for every $1 of capital invested, the portfolio generates approximately $1.80 in return). Both approaches to WEB calculations indicate substantial *additional* benefits may accrue to the economy from investment in the RoNS portfolio under both the aspirational and compliant scenarios.

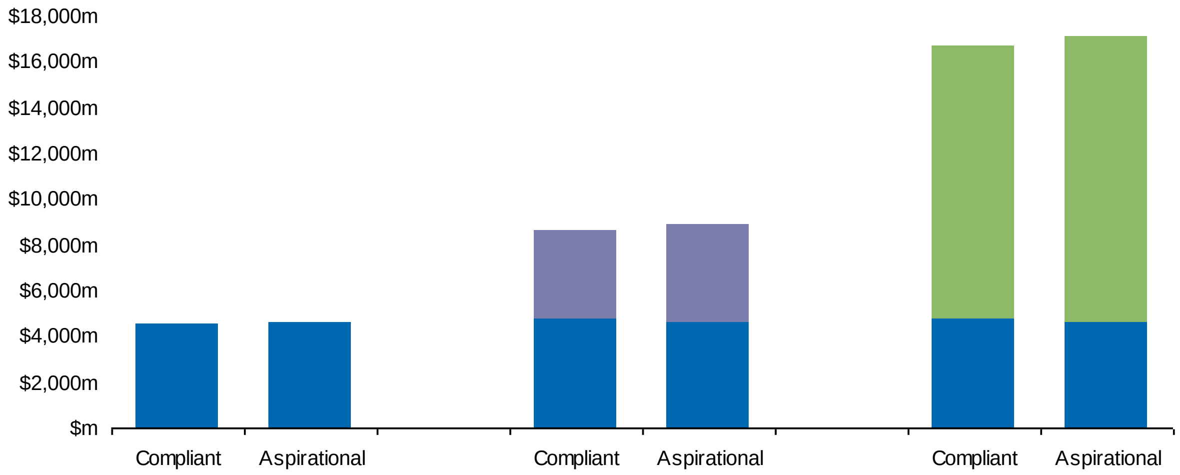
Table 7.2 Program Results for Compliant and Aspirational Programs

Criteria	Compliant Program	Aspirational Program
Total Undiscounted Capital Costs ($m)	9,127	9,129
Total Project Costs (PV, $m)	5,797	5,981
Total Project Benefits (PV, $m)	10,309	10,562
Conventional CBA Economic Evaluation Measures:		
Net Present Value ($m)	4,512	4,582
Benefit-Cost Ratio	**1.8**	**1.8**
Economic Evaluation Measures with WEBs (agglomeration + employment):		
Net Present Value ($m)	8,214	8,647
Benefit-Cost Ratio	**2.4**	**2.5**
Economic Evaluation Measures with WEBs (agglomeration only):		
Net Present Value ($m)	6,118	6,320
Benefit-Cost Ratio	2.1	2.1
Economic Evaluation Measures with CGE (high estimate):		
Net Present Value ($m)	16,434	16,984
Benefit-Cost Ratio	**3.8**	**3.8**
Economic Evaluation Measures with CGE (low estimate):		
Net Present Value ($m)	4,613	4,724
Benefit-Cost Ratio	1.8	1.8

The results in Table 7.2 indicate that net economic benefits would accrue to the economy in the form of higher NPV from delivering the RoNS under an aspirational program across all scenarios. However we would note that the specific numbers presented and their relativities should be treated with some caution given the margin of error present in the underlying data, and when considering the previously mentioned concerns regarding the addition of WEBs and CGE outcomes to the conventional analysis. Notwithstanding this, the outcomes indicate that the economy would be no worse off from implementing the RoNS under an aspirational program.

Figure 7.3 below illustrates the comparison in Net Present Value for the RoNS portfolio between each program with the effects of the WEBs and CGE sensitivity scenarios.

Figure 7.3 Net Present Value of the Compliant and Aspirational Programs



Key conclusions from the above analysis are:

1. The RoNS generate substantial positive economic benefits under a conventional CBA approach;
2. The RoNS are likely to generate substantial additional wider economic benefits; and
3. There is not a statistically significant difference between the outcomes delivered by the aspirational and compliant scenarios. While the results indicate that there would not be a major difference to the economic outcome from delivering the RoNS under an aspirational program compared to a longer timeframe, if funds are available to invest sooner, benefits generated by the RoNS, both conventional and wider, can be realised sooner.

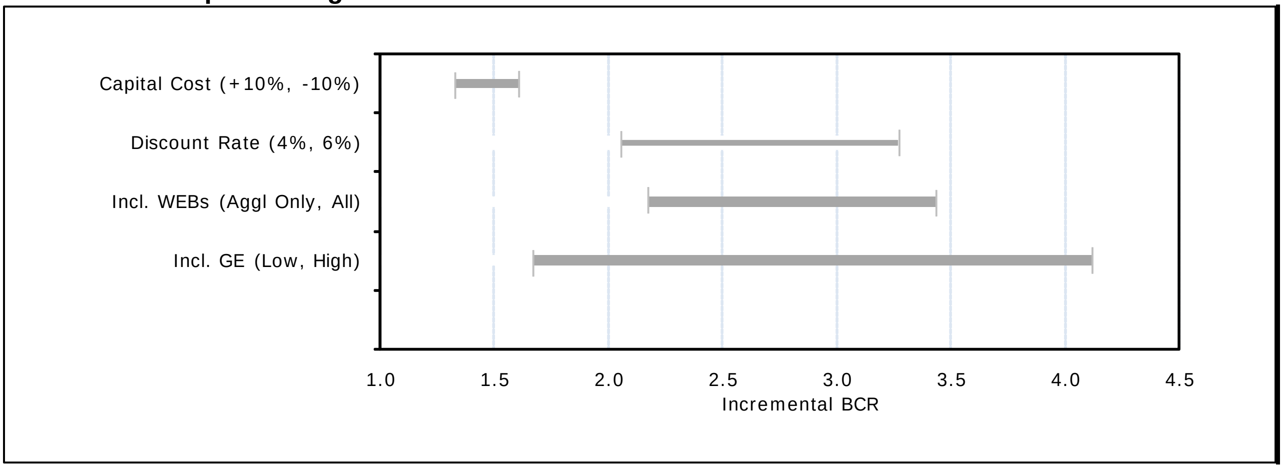
7.3 Sensitivity testing

7.3.1 Sensitivity testing of inputs

Sensitivity tests were undertaken on the incremental results of the program evaluation. These included:

1. Changes in capital costs of +/-10%;
2. Changes in discount rate of 6% and 4% (per NZTA policy);
3. Inclusion of regionalised WEBs – at a low estimate (agglomeration only) and a high estimate (agglomeration and employment effects); and
4. Inclusion of CGE results – at a low estimate (capital closure) and a high estimate (capital responsiveness).

Figure 7.4 Sensitivity Analysis of the Incremental Results of the Aspirational Program to the Compliant Program



The results indicate that the outcomes in relation to the incremental differences between the compliant and aspirational programs modelled are not materially sensitive to capital costs, however the discount rate selected and the level of WEBs applied will have a more material impact on the analysis.

Table 7.3 below summarises the results of sensitivity tests on the incremental results of the aspirational program against the compliant program

Table 7.3 Economic Evaluation Sensitivity Tests on the Incremental Results

Sensitivity		Incremental Results to Compliant Program
Discount Rate: 8% (Standard Evaluation)	NPV BCR	$70m 1.4
Discount Rate: 4%	NPV BCR	$264m 3.2
Discount Rate: 6%	NPV BCR	$153m 2.0
Higher Capital Costs (+10%)	NPV BCR	$52m 1.3
Lower Capital Costs (-10%)	NPV BCR	$88m 1.5
WEBs Scenario Comparison		
WEBs – All	NPV BCR	$434m 3.4
WEBs – Agglomeration Only	NPV BCR	$202m 2.1
CGE Scenario Comparison		
High Scenario CGE	NPV BCR	$549m 4.0
Low Scenario CGE	NPV BCR	$110m 1.6

Source: SAHA estimates, WEBs by Richard Paling Consulting, CGE benefits by Infometrics

8 Conclusions

8.1 Report purpose

The purpose of this economic assessment is to assist NZTA to answer two fundamental questions:

1. Are there quantifiable wider economic benefits associated with the portfolio of RoNS projects, over and above conventional project-specific economic benefits?
2. If such benefits exist and are quantifiable, are they of sufficient scale to demonstrate the economic worth of an aspirational RoNS implementation program?

This assessment has been undertaken to respond to those two questions and the following conclusions can be drawn:

8.2 Conventional and wider economic evaluation approaches

i. Each RoNS has been subject to a conventional economic assessment considering traffic benefits, travel time savings, accident reductions, vehicle operating cost savings, and associated benefits and costs;

ii. WEBs have also been identified and quantified at both a regional level and a national level for each RoNS;

iii. These WEBs are generated by the RoNS program beyond those estimated through conventional economic assessment, and are of relatively considerable scale;

iv. The approach used to estimate WEBs is relatively new and as such it produces results which vary considerably – it is likely the approach will be subject to ongoing refinement for some time;

v. Precedents exist in program evaluation in Australia – specifically Infrastructure Australia's consideration of WEBs in its economic assessment considerations – where the estimated benefits applied from all WEBs have been broadly in the order of 20-30% over and above conventional assessment. It is noted that the quantum of WEBs are a function of size and population density and the UK Eddington Report estimates that agglomeration benefits alone may provide additional benefits in the order of 30% for large, high density urban areas such as London;

vi. While the above broad estimates provide a comparator with which to place WEBs in some context for the New Zealand environment, such estimates should be treated as indicators only, and not used as a substitute for thorough and robust WEB modelling and analysis using regionally specific data;

vii. In relation to the use of CGE approaches, Infrastructure Australia does not use the outputs in an additive capacity, though it remains an instructive tool when considering potential national effects associated with significant infrastructure projects. The inclusion of one component of WEBs, agglomeration benefits, is accepted (and expected) by Infrastructure Australia as being additional to conventional CBA, and it is also becoming more widely recognised in New Zealand and in the UK;

viii. **While WEBs have been considered, there have not been any interdependency (synergy) benefits associated with the portfolio of projects** – that is, the sum total of all RoNS is not greater than the sum of each individual RoNS benefits – NZTA confirmed that there is simply too great a dispersement of the projects across New Zealand to realistically consider them as truly linked for the purposes of benefit streams;

8.3 Economic assessment

ix. **Conventional assessments undertaken for each RoNS were provided by NZTA, and assessed together at a portfolio level, indicate that the RoNS portfolio generates positive economic benefits with an NPV of the portfolio of over $4.5bn and a BCR of 1.8;**

x. Estimates of regional WEBs (as undertaken by Richard Paling Consulting) and of national economic and productivity benefits (as undertaken by Infometrics Ltd) indicate that the potential exists for further additional benefits to accrue to the economy generated by the RoNS over and above conventional transport economic benefits;

xi. To assess the economic impacts of a RoNS aspirational program, the evaluation results of an indicative aspirational program have been compared against the “base case” (being an indicative compliant program);

xii. There is not a materially significant difference between the outcomes of implementing the RoNS under an aspirational versus compliant timetable;

xiii. **Notwithstanding this, the results indicate that the total benefits remain larger than total costs for the RoNS portfolio as a whole, whether delivered as an aspirational program, or a compliant program;**

xiv. Sensitivity tests have been applied to the conventional CBA, adding wider economic benefits in the form of regional WEBs and CGE. Noting concerns and lack of precedents in using such an approach (particularly in relation to CGE) the results have been used as an indicative proxy with which to assess a single investment measure that can be used to inform decision making with regards the acceleration of the RoNS program;

xv. The application of WEBs (at both a regional and national level) changes the quantum of benefits across both the aspirational and compliant programs, but it does not change the overall outcome – in that, there is not a materially significant difference between the outcomes of the two programs;

xvi. The results indicate that there would not be a major difference to the economic outcome from delivering the RoNS under an aspirational program compared to a longer timeframe, however **if funds are available to invest sooner, benefits generated by the RoNS, both conventional and wider, can be realised sooner**.

Appendices

A. Case studies
B. Evaluation Modelling Results
C. Richard Paling Consulting report – Regional WEBs
D. Infometrics report – CGE

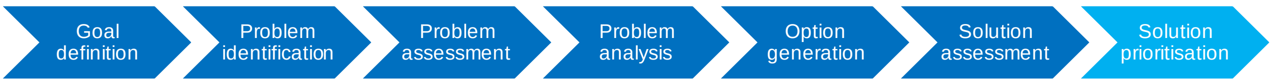
Appendix A – Case studies

Case Study 1: Infrastructure Australia

Infrastructure Australia was established in 2008 for the development and facilitation of Australia's infrastructure needs. In the 2008-09 Budget, the Australian Government announced the establishment of a Building Australia Fund, with allocations from the Fund to be guided by Infrastructure Australia's national audit and infrastructure priority list.

Infrastructure Australia implemented an Assessment Framework utilising a seven stage process, incorporating both qualitative evaluation and quantitative analysis, as illustrated in Figure A1.

Figure A1: Infrastructure Australia Assessment Framework



The first six steps form the self-assessment are undertaken by submitting agencies on each project put forward, with only the solution prioritisation stage undertaken by Infrastructure Australia.

Solution Assessment

IA's prioritisation guidelines indicate solution assessment should be based on accurate and justifiable Cost-Benefit-Analysis, but that these should include wider economic, environmental and social impacts (including agglomeration and trade impacts, carbon impacts, noise and social amenity) where possible.

The assessment stage also seeks to challenge the project to define (and quantify) why it is a national infrastructure priority through evaluation against IA's seven strategic priorities – including: improves productive capacity; builds cities and regions; increases Australia's competitiveness.

Solution Prioritisation

IA's solution prioritisation process produces a national priority list by matching the results of the CBA with national objectives and policies, such as portfolio/package issues, deliverability, risk, and affordability. The guidelines go on to say "BCRs provide the best available objective evidence as to how well solutions will impact on goals – but not the whole story."[10]

Monetised Benefits and Costs

The following provides a list of the costs and benefits that IA expects to be monetised and included in a CBA of any initiative.

---

[10] Infrastructure Australia Prioritisation Guidelines

- Financial costs and benefits
    - Capital costs
    - Operating costs
    - Revenues / fees / fares charges, traded outputs
- Economic cost or benefits to the user of the service
    - Higher/lower prices for good/service
    - Time savings
    - Deaths / injuries
- Economic cost or benefits to non-users:
    - Agglomeration impacts (1)
    - Noise impacts
- Environmental and social cost and benefits – whole of society
    - Local air pollution
    - Carbon emissions
    - Physical fitness

(1) Agglomeration impacts are noted in the guidelines as an example of 'wider economic benefits' that have traditionally not been included in CBA.

WEBs

The IA guidelines go on to indicate that IA would like to take into consideration "wider economic benefits" (WEB) of initiatives, such as agglomeration effects. These particularly apply to transport initiatives. In defining WEBs, specific mention is made that they are not the same as the economic benefits determined by CGE (computable general equilibrium) models.

Anecdotally it has been acknowledged by IA that WEBs have added additional economic benefit in the order of 20-30% on conventional CBA benefits although this was based on limited work undertaken in the UK. For example, the major Australian application of WEBs (Melbourne's East West Needs Study) substantially replicated the broad findings of the Crossrail evaluation in London with little regard for the different features between a Melbourne-wide and a City of London specific analysis.

General Equilibrium Models

In contrast, the IA guidelines stipulate that the outputs of computable general equilibrium (CGE) models do not generally play a role in CBA, and that CGE models focus on 'economic activity impacts', which are not a measure of efficiency effects. IA does not therefore encourage stakeholders to undertake CGE modeling.

Further, IA will primarily use CBA data for measuring the benefits of an initiative and will not consider CGE benefits as additive to CBA benefits. If CGE analysis outputs are submitted in support of an initiative and constitute a significant portion of the business case, IA will scrutinise the CGE model assumptions and methodology in order to ascertain any double counting.

SAHA

Portfolio approach

There were no formal methodologies to establish links and interdependencies between projects or to evaluate groups of projects on a portfolio basis under the IA processes

Case Study 2: Sydney Metro Rail

The Metro Rail Expansion Program (MREP) involved an evaluation of options to create additional PT capacity across the North West Rail Link (NWRL), the South West Rail Link (SWRL), and included options for a proposed second harbour crossing (CBDRL).

The NSW Ministry of Transport undertook a rapid economic appraisal of a series of options incorporating different heavy rail, metro and bus operations. Nineteen options including the Base Case were identified as alternative MREP configuration options. Option packages and the components were pre-determined based on reasonable combinations, and were deemed to be mutually exclusive. Linkages between components within each option package were also established.

The key learning from this case study was that the evaluation had a defined Base Case against which each individual option package was modelled independently against and compared. This allowed for a higher degree of consistency in assessing the portfolio of options due to the robustness of the evaluation approach.

Case Study 3: Melbourne City Loop Line Capacity

The Victorian Department of Infrastructure (DoI) developed an economic evaluation framework for a program of works which it had identified in its City Loop and Inner Core (CLIC) Management Plan. The purpose of the framework was to undertake project package (portfolio) evaluations for projects within the City Loop and Inner Core rail networks. The framework assessment was based on a package of projects within the metropolitan rail network, where interdependencies were evident and might be quantified.

The framework that was developed sought to identify benefits and costs attributed solely to a project in isolation. Following that step, the framework then identified additional benefits and costs for the project if other interdependent projects in the CLIC Management Plan were to proceed at later stages

Four common principles are applied in the framework:

1. Objectives setting

These formed the bases for initial assessment criteria and developing suitable options. This involved identifying all options which could satisfy the set objectives.

2. Rationalisation of options

The number of possible option combinations was potentially overwhelming, thus rationalisation was required to identify the optimal package. Most jurisdictions utilise subjective analysis (options which satisfy most policy and strategic objectives), transport modelling and some more limited CBA style assessment (such as rapid appraisal).

3. Recognition and measurement of interdependencies

A key benefit arising from packaged options over stand alone options was interdependencies. Few precedents in measuring interdependencies were available to the CLIC process from other jurisdictions, with a number of different practices being adopted by different jurisdictions. For the CLIC framework five steps were established for identification of interdependencies.

1. Establish the relative importance of projects in terms of strategic and policy objectives;
2. Identify the individual interdependencies among the projects;
3. Rationalise projects where interdependencies represented “necessary and sufficient” conditions;
4. Establish Project Groups where interdependencies wee operationally significant; and
5. Document interdependencies for each stand alone project evaluation.

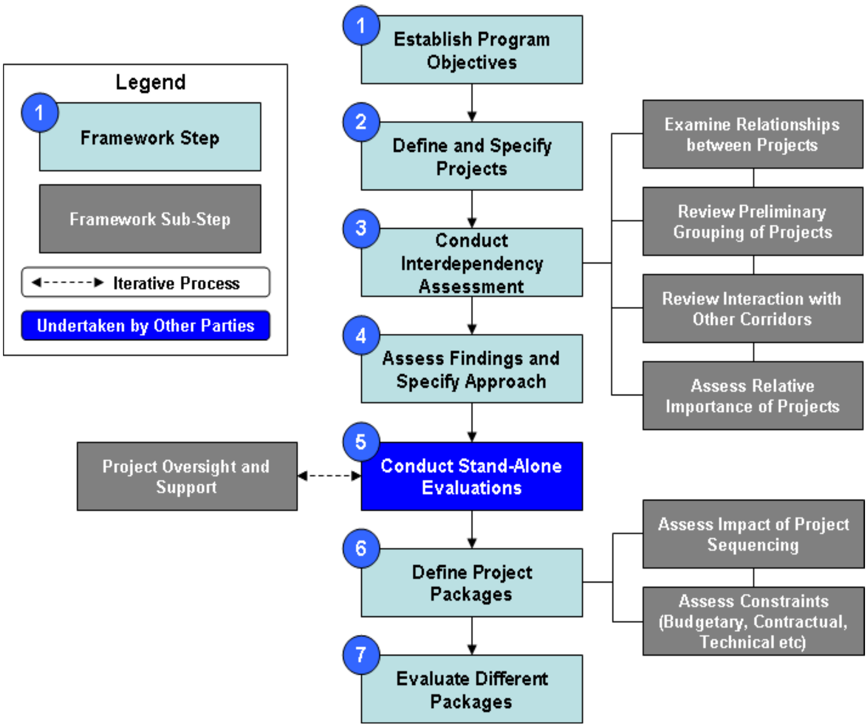
4. Timing/Sequencing of projects

Sequencing of projects could have a significant impact on NPV, and must be taken into account when conducting economic evaluations. Examples of approaches used elsewhere include using the FYRR (First Year Rate of Return) approach and sequencing according to highest NPV.

However there were limitations to both approaches, and budget and project constraints could often override these proposed timings.

The following diagram summarises the portfolio evaluation framework developed by the Victorian Department of Infrastructure (DOI).

Figure A2: DoI portfolio economic evaluation framework



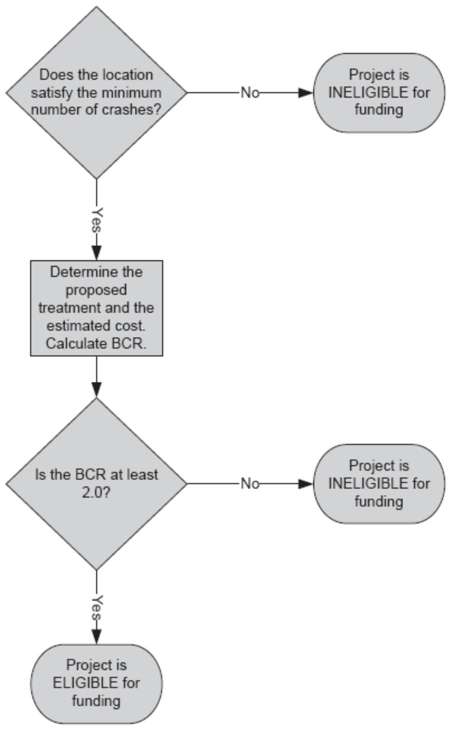
In summary, no practical mathematical methodologies were identified by DOI to assess project interdependencies and combinations to identify the optimal project package. The framework developed combines a process of subjective analysis, professional judgement, transport modelling and CBA to narrow the packages down to a select few combinations which are then tested in further detail.

Case Study 4: Auslink program

The AusLink program is administered by the Australian Department of Infrastructure, Transport, Regional Development and Local Government, providing long-term planning and targeted investment in the national road and rail networks. It also incorporated many of the projects from the former National Highway Systems Programs, Roads of National Importance and the safety-focused Black Spot Program. However, the National Highway Systems and Roads of National Importance did not lay down stringent evaluation criteria and guidelines and produced questionable outcomes. As stated in the audit carried out by the Australian National Audit Office (ANAO) on the National Highway Systems Program in 2001[11]:

"The lack of appropriate analytical considerations in the outlay of National Highway System funds could lead increasingly to the commitment of funds on maintaining the existing system without regard to the relative value of each road, and to a geographical spread of funds than one based on social and economic returns. The establishment of agreed design standards for National Highway links based on quantitative criteria would greatly improve the advice that the Department could place before Ministers in selecting projects. It would also enable better identification of achievable goals within overall funding constraints." In comparison, the Black Spot Program imposed rigorous evaluation criteria and methodologies, and was held in high regard. Project proposals based on crash history must demonstrate a BCR of 2.0[12], with minimum crash criteria which must also be satisfied. Figure A3 demonstrates the evaluation framework of the Black Spot Program:

Figure A3: Black Spot Program evaluation framework



Source: ANAO Audit, 2007[13]

[11] Audit Report No.21 2000–2001 Performance Audit, Management of the National Highways System Program, ANAO, 2001

[12] AusLink Black Spot Projects, Notes on Administration, November 2008

[13] Audit Report No.45 2006–07 Performance Audit, ANAO, 2006

The above framework was successfully imposed by the Black Spot Program, producing positive results. In a 2001 review of the program carried out by Bureau of Transport Economics, the Black Spot program generated a net present value of $1.3 billion with a benefit-cost ratio of 14[14]. The report estimated that 32 fatal accidents and more than 1500 serious accidents were prevented due to the implementation of the program.

The key learning from this case study is that stringent, quantifiable economic evaluation of projects must be carried out to ensure sound investment decisions.

[14] The Black Spot Program 1996-2003, An Evaluation of the First Three Years, Bureau of Transport Economics, 2001

Appendix B – Evaluation Modelling Results

SAHA

Appendix B1 – Compliant Program Costs and Benefits

New Zealand Transport Agency
Roads of National Significance - Economic Evaluation
Roads of National Significance Intergrated - Compliant Program

Years	Integrated RoNS - Standalone Costs and Benefits						
	Total Costs	Total Benefits	Net Benefits	WEBs	GE	GE + Net Benefits	WEBs + Net Benefits
2009	$ 308,772	$ -	-$ 308,772	$ -	$ -	-$ 308,772	-$ 308,772
2010	$ 531,312	$ -	-$ 531,312	$ -	$ -	-$ 531,312	-$ 531,312
2011	$ 505,825	$ -	-$ 505,825	$ -	$ -	-$ 505,825	-$ 505,825
2012	$ 738,087	$ -	-$ 738,087	$ -	$ -	-$ 738,087	-$ 738,087
2013	$ 771,755	$ 206,452	-$ 565,303	$ 28,289	$ 134,117	-$ 431,186	-$ 537,015
2014	$ 819,247	$ 227,168	-$ 592,079	$ 31,478	$ 150,582	-$ 441,497	-$ 560,602
2015	$ 768,912	$ 239,973	-$ 528,939	$ 107,642	$ 160,966	-$ 367,972	-$ 421,297
2016	$ 774,272	$ 266,666	-$ 507,606	$ 119,280	$ 182,319	-$ 325,287	-$ 388,326
2017	$ 822,586	$ 522,985	-$ 299,601	$ 165,035	$ 446,145	$ 146,544	-$ 134,566
2018	$ 886,739	$ 631,939	-$ 254,800	$ 217,783	$ 560,210	$ 305,409	-$ 37,017
2019	$ 784,001	$ 820,722	$ 36,721	$ 265,795	$ 859,889	$ 896,610	$ 302,516
2020	$ 583,398	$ 918,877	$ 335,480	$ 303,267	$ 1,022,130	$ 1,357,610	$ 638,746
2021	$ 402,609	$ 991,388	$ 588,779	$ 342,078	$ 1,109,310	$ 1,698,088	$ 930,857
2022	$ 282,775	$ 1,090,936	$ 808,162	$ 382,268	$ 1,271,310	$ 2,079,471	$ 1,190,430
2023	$ 133,524	$ 1,238,540	$ 1,105,016	$ 432,021	$ 1,443,632	$ 2,548,648	$ 1,537,037
2024	$ 76,793	$ 1,313,784	$ 1,236,991	$ 475,256	$ 1,549,885	$ 2,786,876	$ 1,712,247
2025	$ 77,123	$ 1,407,887	$ 1,330,764	$ 512,064	$ 1,707,089	$ 3,037,853	$ 1,842,828
2026	$ 17,880	$ 1,510,739	$ 1,492,859	$ 550,253	$ 1,834,877	$ 3,327,736	$ 2,043,112
2027	$ 22,965	$ 1,563,550	$ 1,540,585	$ 584,707	$ 1,902,334	$ 3,442,919	$ 2,125,292
2028	$ 13,433	$ 1,616,372	$ 1,602,939	$ 610,700	$ 1,969,798	$ 3,572,737	$ 2,213,640
2029	$ 12,534	$ 1,669,226	$ 1,656,692	$ 628,342	$ 2,037,320	$ 3,694,013	$ 2,285,034
2030	$ 35,084	$ 1,722,082	$ 1,686,998	$ 642,994	$ 2,104,828	$ 3,791,826	$ 2,329,992
2031	$ 19,246	$ 1,774,942	$ 1,755,695	$ 657,959	$ 2,172,347	$ 3,928,042	$ 2,413,655
2032	$ 18,164	$ 1,827,805	$ 1,809,641	$ 673,244	$ 2,239,873	$ 4,049,514	$ 2,482,885
2033	$ 11,092	$ 1,880,675	$ 1,869,583	$ 688,854	$ 2,307,417	$ 4,177,000	$ 2,558,437
2034	$ 11,262	$ 1,933,534	$ 1,922,273	$ 704,798	$ 2,374,934	$ 4,297,206	$ 2,627,070
2035	$ 17,852	$ 1,986,392	$ 1,968,540	$ 721,080	$ 2,442,447	$ 4,410,987	$ 2,689,620
2036	$ 16,214	$ 2,037,237	$ 2,021,023	$ 737,709	$ 2,508,697	$ 4,529,719	$ 2,758,731
2037	$ 20,182	$ 2,088,064	$ 2,067,882	$ 754,691	$ 2,574,903	$ 4,642,785	$ 2,822,572
2038	$ 33,420	$ 2,138,888	$ 2,105,468	$ 772,033	$ 2,641,102	$ 4,746,570	$ 2,877,501
2039	$ 18,414	$ 2,189,732	$ 2,171,318	$ 787,155	$ 2,707,349	$ 4,878,667	$ 2,958,472
2040	$ 11,092	$ 2,211,882	$ 2,200,790	$ 802,574	$ 2,745,485	$ 4,946,275	$ 3,003,365
2041	$ 13,432	$ 2,234,052	$ 2,220,620	$ 818,298	$ 2,783,667	$ 5,004,287	$ 3,038,918
2042	$ 11,262	$ 2,256,198	$ 2,244,937	$ 834,330	$ 2,821,791	$ 5,066,728	$ 3,079,267
2043	$ 13,432	$ 2,278,374	$ 2,264,942	$ 850,678	$ 2,859,987	$ 5,124,930	$ 3,115,621
2044	$ 11,092	$ 2,299,378	$ 2,288,286	$ 867,349	$ 2,895,362	$ 5,183,648	$ 3,155,635
2045	$ 13,432	$ 2,320,218	$ 2,306,786	$ 884,347	$ 2,930,340	$ 5,237,126	$ 3,191,133
2046	$ 33,420	$ 2,342,342	$ 2,308,923	$ 901,680	$ 2,968,412	$ 5,277,334	$ 3,210,603
2047	$ 25,164	$ 2,364,478	$ 2,339,314	$ 919,355	$ 3,006,511	$ 5,345,825	$ 3,258,669
2048	$ 11,092	$ 2,386,606	$ 2,375,514	$ 937,377	$ 3,044,592	$ 5,420,105	$ 3,312,891
2049	$ 13,432	$ 2,408,701	$ 2,395,269	$ 955,755	$ 3,082,594	$ 5,477,864	$ 3,351,024
2050	$ 11,092	$ 2,419,557	$ 2,408,465	$ 974,495	$ 3,104,257	$ 5,512,722	$ 3,382,959
2051	$ 13,432	$ 2,422,363	$ 2,408,931	$ 993,603	$ 3,106,534	$ 5,515,465	$ 3,402,534
2052	$ 11,092	$ 2,425,169	$ 2,414,077	$ 1,013,089	$ 3,108,811	$ 5,522,888	$ 3,427,165
2053	$ 13,432	$ 2,427,975	$ 2,414,543	$ 1,032,958	$ 3,111,088	$ 5,525,631	$ 3,447,501
2054	$ 11,092	$ 2,430,781	$ 2,419,689	$ 1,053,218	$ 3,113,365	$ 5,533,053	$ 3,472,907
Undisc.	**$ 9,752,459**	**$ 71,044,630**	**$ 61,292,170**	**$ 26,735,878**	**$ 87,098,605**	**$ 148,390,775**	**$ 88,028,049**
PV @ 4%	**$ 7,344,404**	**$ 24,473,980**	**$ 17,129,576**	**$ 8,995,803**	**$ 29,247,223**	**$ 46,376,799**	**$ 26,125,379**
PV @ 6 %	**$ 6,494,480**	**$ 15,518,602**	**$ 9,024,122**	**$ 5,637,675**	**$ 18,257,849**	**$ 27,281,971**	**$ 14,661,797**
PV @ 8%	**$ 5,796,732**	**$ 10,308,597**	**$ 4,511,865**	**$ 3,701,964**	**$ 11,922,552**	**$ 16,434,416**	**$ 8,213,828**
PV @ 10%	**$ 5,215,195**	**$ 7,138,401**	**$ 1,923,206**	**$ 2,534,548**	**$ 8,107,167**	**$ 10,030,373**	**$ 4,457,754**
PV @ 12%	**$ 4,724,782**	**$ 5,126,264**	**$ 401,482**	**$ 1,799,866**	**$ 5,712,933**	**$ 6,114,415**	**$ 2,201,349**

Standard	4%	6%	8%	10%	12%
NPV	$ 17,129,576	$ 9,024,122	$ 4,511,865	$ 1,923,206	$ 401,482
NPV/I	$ 2.33	$ 1.39	$ 0.78	$ 0.37	$ 0.08
BCR	3.33	2.39	1.78	1.37	1.08
IRR			12.61%		

Standard + GE	4%	6%	8%	10%	12%
NPV	$ 46,376,799	$ 27,281,971	$ 16,434,416	$ 10,030,373	$ 6,114,415
NPV/I	$ 6.31	$ 4.20	$ 2.84	$ 1.92	$ 1.29
BCR	7.31	5.20	3.84	2.92	2.29
IRR			20.96%		

Standard + WEBs	4%	6%	8%	10%	12%
NPV	$ 26,125,379	$ 14,661,797	$ 8,213,828	$ 4,457,754	$ 2,201,349
NPV/I	$ 3.56	$ 2.26	$ 1.42	$ 0.85	$ 0.47
BCR	4.56	3.26	2.42	1.85	1.47
IRR			15.73%		

Appendix B2 – Aspirational Program Costs and Benefits

New Zealand Transport Agency
Roads of National Significance - Economic Evaluation
Roads of National Significance Intergrated - Aspirational Program

Years	Total Costs	Total Benefits	Net Benefits	WEBs	GE	GE + Net Benefits	WEBs + Net Benefits
	Integrated RoNS - Standalone Costs and Benefits						
2009	$ 311,791	$ -	-$ 311,791	$ -	$ -	-$ 311,791	-$ 311,791
2010	$ 588,534	$ -	-$ 588,534	$ -	$ -	-$ 588,534	-$ 588,534
2011	$ 649,787	$ -	-$ 649,787	$ -	$ -	-$ 649,787	-$ 649,787
2012	$ 804,177	$ -	-$ 804,177	$ -	$ -	-$ 804,177	-$ 804,177
2013	$ 799,256	$ 206,452	-$ 592,804	$ 57,289	$ 134,117	-$ 458,687	-$ 535,515
2014	$ 854,083	$ 227,168	-$ 626,915	$ 100,753	$ 150,582	-$ 476,333	-$ 526,162
2015	$ 983,566	$ 243,894	-$ 739,672	$ 189,302	$ 170,408	-$ 569,264	-$ 550,370
2016	$ 905,434	$ 323,430	-$ 582,004	$ 213,815	$ 276,876	-$ 305,128	-$ 368,189
2017	$ 787,182	$ 547,851	-$ 239,331	$ 239,597	$ 506,033	$ 266,702	$ 266
2018	$ 746,571	$ 669,952	-$ 76,618	$ 266,269	$ 651,762	$ 575,144	$ 189,651
2019	$ 583,033	$ 906,985	$ 323,952	$ 315,251	$ 1,013,159	$ 1,337,111	$ 639,203
2020	$ 467,862	$ 1,004,313	$ 536,451	$ 353,712	$ 1,183,825	$ 1,720,276	$ 890,163
2021	$ 231,413	$ 1,109,806	$ 878,393	$ 398,716	$ 1,310,527	$ 2,188,921	$ 1,277,110
2022	$ 270,953	$ 1,182,752	$ 911,799	$ 442,862	$ 1,419,731	$ 2,331,530	$ 1,354,661
2023	$ 132,820	$ 1,286,130	$ 1,153,310	$ 476,870	$ 1,552,716	$ 2,706,026	$ 1,630,179
2024	$ 76,793	$ 1,349,309	$ 1,272,516	$ 508,706	$ 1,635,443	$ 2,907,958	$ 1,781,221
2025	$ 77,123	$ 1,407,887	$ 1,330,764	$ 533,641	$ 1,707,089	$ 3,037,853	$ 1,864,405
2026	$ 17,880	$ 1,510,739	$ 1,492,859	$ 559,468	$ 1,834,877	$ 3,327,736	$ 2,052,328
2027	$ 22,965	$ 1,563,550	$ 1,540,585	$ 584,707	$ 1,902,334	$ 3,442,919	$ 2,125,292
2028	$ 23,504	$ 1,616,372	$ 1,592,868	$ 610,700	$ 1,969,798	$ 3,562,666	$ 2,203,568
2029	$ 12,534	$ 1,669,226	$ 1,656,692	$ 628,342	$ 2,037,320	$ 3,694,013	$ 2,285,034
2030	$ 25,013	$ 1,722,082	$ 1,697,069	$ 642,994	$ 2,104,828	$ 3,801,898	$ 2,340,063
2031	$ 19,246	$ 1,774,942	$ 1,755,695	$ 657,959	$ 2,172,347	$ 3,928,042	$ 2,413,655
2032	$ 18,164	$ 1,827,805	$ 1,809,641	$ 673,244	$ 2,239,873	$ 4,049,514	$ 2,482,885
2033	$ 11,092	$ 1,880,675	$ 1,869,583	$ 688,854	$ 2,307,417	$ 4,177,000	$ 2,558,437
2034	$ 11,262	$ 1,933,534	$ 1,922,273	$ 704,798	$ 2,374,934	$ 4,297,206	$ 2,627,070
2035	$ 17,852	$ 1,986,392	$ 1,968,540	$ 721,080	$ 2,442,447	$ 4,410,987	$ 2,689,620
2036	$ 26,285	$ 2,037,237	$ 2,010,951	$ 737,709	$ 2,508,697	$ 4,519,648	$ 2,748,660
2037	$ 20,182	$ 2,088,064	$ 2,067,882	$ 754,691	$ 2,574,903	$ 4,642,785	$ 2,822,572
2038	$ 23,348	$ 2,138,888	$ 2,115,539	$ 772,033	$ 2,641,102	$ 4,756,641	$ 2,887,572
2039	$ 18,414	$ 2,189,732	$ 2,171,318	$ 787,155	$ 2,707,349	$ 4,878,667	$ 2,958,472
2040	$ 11,092	$ 2,211,882	$ 2,200,790	$ 802,574	$ 2,745,485	$ 4,946,275	$ 3,003,365
2041	$ 13,432	$ 2,234,052	$ 2,220,620	$ 818,298	$ 2,783,667	$ 5,004,287	$ 3,038,918
2042	$ 11,262	$ 2,256,198	$ 2,244,937	$ 834,330	$ 2,821,791	$ 5,066,728	$ 3,079,267
2043	$ 13,432	$ 2,278,374	$ 2,264,942	$ 850,678	$ 2,859,987	$ 5,124,930	$ 3,115,621
2044	$ 21,163	$ 2,299,378	$ 2,278,215	$ 867,349	$ 2,895,362	$ 5,173,577	$ 3,145,564
2045	$ 13,432	$ 2,320,218	$ 2,306,786	$ 884,347	$ 2,930,340	$ 5,237,126	$ 3,191,133
2046	$ 23,348	$ 2,342,342	$ 2,318,994	$ 901,680	$ 2,968,412	$ 5,287,406	$ 3,220,674
2047	$ 25,164	$ 2,364,478	$ 2,339,314	$ 919,355	$ 3,006,511	$ 5,345,825	$ 3,258,669
2048	$ 11,092	$ 2,386,606	$ 2,375,514	$ 937,377	$ 3,044,592	$ 5,420,105	$ 3,312,891
2049	$ 13,432	$ 2,408,701	$ 2,395,269	$ 955,755	$ 3,082,594	$ 5,477,864	$ 3,351,024
2050	$ 11,092	$ 2,421,360	$ 2,410,268	$ 974,495	$ 3,106,537	$ 5,516,806	$ 3,384,763
2051	$ 13,432	$ 2,425,970	$ 2,412,538	$ 993,603	$ 3,111,094	$ 5,523,632	$ 3,406,141
2052	$ 11,092	$ 2,430,579	$ 2,419,487	$ 1,013,089	$ 3,115,651	$ 5,535,138	$ 3,432,576
2053	$ 13,432	$ 2,435,189	$ 2,421,757	$ 1,032,958	$ 3,120,208	$ 5,541,965	$ 3,454,714
2054	$ 11,092	$ 2,439,798	$ 2,428,706	$ 1,053,218	$ 3,124,765	$ 5,553,471	$ 3,481,924
Undisc.	**$ 9,755,107**	**$ 71,660,292**	**$ 61,905,185**	**$ 27,459,622**	**$ 88,247,492**	**$ 150,152,677**	**$ 89,364,807**
PV @ 4%	**$ 7,466,970**	**$ 24,860,063**	**$ 17,393,093**	**$ 9,501,125**	**$ 29,974,698**	**$ 47,367,790**	**$ 26,894,218**
PV @ 6%	**$ 6,653,012**	**$ 15,830,292**	**$ 9,177,281**	**$ 6,064,788**	**$ 18,846,145**	**$ 28,023,425**	**$ 15,242,068**
PV @ 8%	**$ 5,980,500**	**$ 10,562,368**	**$ 4,581,868**	**$ 4,065,504**	**$ 12,401,955**	**$ 16,983,823**	**$ 8,647,372**
PV @ 10%	**$ 5,416,138**	**$ 7,346,455**	**$ 1,930,317**	**$ 2,846,006**	**$ 8,500,400**	**$ 10,430,718**	**$ 4,776,324**
PV @ 12%	**$ 4,936,835**	**$ 5,297,872**	**$ 361,036**	**$ 2,068,338**	**$ 6,037,383**	**$ 6,398,419**	**$ 2,429,375**

Standard	4%	6%	8%	10%	12%
NPV	$ 17,393,093	$ 9,177,281	$ 4,581,868	$ 1,930,317	$ 361,036
NPV/I	$ 2.41	$ 1.41	$ 0.78	$ 0.36	$ 0.07
BCR	3.33	2.38	1.77	1.36	1.07
IRR			12.50%		

Standard + GE	4%	6%	8%	10%	12%
NPV	$ 47,367,790	$ 28,023,425	$ 16,983,823	$ 10,430,718	$ 6,398,419
NPV/I	6.56	4.32	$ 2.90	$ 1.96	$ 1.31
BCR	7.34	5.21	3.84	2.93	2.30
IRR			20.97%		

Standard + WEBs	4%	6%	8%	10%	12%
NPV	$ 26,894,218	$ 15,242,068	$ 8,647,372	$ 4,776,324	$ 2,429,375
NPV/I	3.73	$ 2.29	$ 1.47	$ 0.90	$ 0.50
BCR	4.60	3.29	2.45	1.88	1.49
IRR			16.02%		

Appendix B3 – Aspirational Program Incremental Costs and Benefits

SAHA

New Zealand Transport Agency
Roads of National Significance - Economic Evaluation
Roads of National Significance Intergrated - Aspirational Program

Years	Total Costs	Total Benefits	Net Benefits	WEBs	GE	WEBs + Net Benefits	GE + Net Benefits
	Integrated RoNS - Incremental Costs and Benefits						
2009	$ 3,019	$ -	-$ 3,019	$ -	$ -	-$ 3,019	-$ 3,019
2010	$ 57,222	$ -	-$ 57,222	$ -	$ -	-$ 57,222	-$ 57,222
2011	$ 143,962	$ -	-$ 143,962	$ -	$ -	-$ 143,962	-$ 143,962
2012	$ 66,090	$ -	-$ 66,090	$ -	$ -	-$ 66,090	-$ 66,090
2013	$ 27,501	$ -	-$ 27,501	$ 29,000	$ -	$ 1,499	-$ 27,501
2014	$ 34,835	$ -	-$ 34,835	$ 69,275	$ -	$ 34,440	-$ 34,835
2015	$ 214,654	$ 3,920	-$ 210,733	$ 81,661	$ 9,442	-$ 129,073	-$ 201,292
2016	$ 131,162	$ 56,764	-$ 74,398	$ 94,536	$ 94,557	$ 20,137	$ 20,158
2017	-$ 35,404	$ 24,866	$ 60,270	$ 74,562	$ 59,888	$ 134,832	$ 120,158
2018	-$ 140,168	$ 38,013	$ 178,182	$ 48,486	$ 91,553	$ 226,668	$ 269,735
2019	-$ 200,969	$ 86,262	$ 287,231	$ 49,456	$ 153,270	$ 336,687	$ 440,501
2020	-$ 115,535	$ 85,436	$ 200,971	$ 50,445	$ 161,695	$ 251,416	$ 362,666
2021	-$ 171,197	$ 118,418	$ 289,615	$ 56,638	$ 201,218	$ 346,253	$ 490,833
2022	-$ 11,822	$ 91,816	$ 103,638	$ 60,594	$ 148,421	$ 164,231	$ 252,059
2023	-$ 704	$ 47,590	$ 48,294	$ 44,849	$ 109,084	$ 93,142	$ 157,378
2024	$ -	$ 35,524	$ 35,524	$ 33,450	$ 85,558	$ 68,974	$ 121,082
2025	$ -	$ -	$ -	$ 21,577	$ -	$ 21,577	$ -
2026	$ -	$ -	$ -	$ 9,216	$ -	$ 9,216	$ -
2027	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2028	$ 10,071	$ -	-$ 10,071	$ -	$ -	-$ 10,071	-$ 10,071
2029	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2030	-$ 10,071	$ -	$ 10,071	$ -	$ -	$ 10,071	$ 10,071
2031	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2032	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2033	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2034	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2035	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2036	$ 10,071	$ -	-$ 10,071	$ -	$ -	-$ 10,071	-$ 10,071
2037	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2038	-$ 10,071	$ -	$ 10,071	$ -	$ -	$ 10,071	$ 10,071
2039	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2040	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2041	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2042	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2043	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2044	$ 10,071	$ -	-$ 10,071	$ -	$ -	-$ 10,071	-$ 10,071
2045	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2046	-$ 10,071	$ -	$ 10,071	$ -	$ -	$ 10,071	$ 10,071
2047	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2048	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2049	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2050	$ -	$ 1,803	$ 1,803	$	$ 2,280	$ 1,803	$ 4,084
2051	$ -	$ 3,607	$ 3,607	$	$ 4,560	$ 3,607	$ 8,167
2052	$ -	$ 5,410	$ 5,410	$	$ 6,840	$ 5,410	$ 12,251
2053	$ -	$ 7,214	$ 7,214	$	$ 9,120	$ 7,214	$ 16,334
2054	$ -	$ 9,017	$ 9,017	$	$ 11,400	$ 9,017	$ 20,418
Undisc.	**$ 2,647**	**$ 615,662**	**$ 613,015**	**$ 723,744**	**$ 1,148,887**	**$ 1,336,758**	**$ 1,761,902**
PV @ 4%	**$ 122,567**	**$ 386,083**	**$ 263,517**	**$ 505,322**	**$ 727,474**	**$ 768,839**	**$ 990,991**
PV @ 6%	**$ 158,532**	**$ 311,690**	**$ 153,159**	**$ 427,112**	**$ 588,296**	**$ 580,271**	**$ 741,455**
PV @ 8%	**$ 183,768**	**$ 253,771**	**$ 70,003**	**$ 363,540**	**$ 479,404**	**$ 433,544**	**$ 549,407**
PV @ 10%	**$ 200,943**	**$ 208,054**	**$ 7,111**	**$ 311,459**	**$ 393,234**	**$ 318,570**	**$ 400,345**
PV @ 12%	**$ 212,054**	**$ 171,608**	**-$ 40,446**	**$ 268,472**	**$ 324,450**	**$ 228,026**	**$ 284,004**

Standard	4%	6%	8%	10%	12%
NPV	$ 263,517	$ 153,159	$ 70,003	$ 7,111	-$ 40,446
NPV/I	$ 2.15	$ 0.97	$ 0.38	$ 0.04	-$ 0.19
BCR	3.15	1.97	1.38	1.04	0.81
IRR			10.25%		

Standard + WEBs	4%	6%	8%	10%	12%
NPV	$ 580,271	$ 580,271	$ 433,544	$ 318,570	$ 228,026
NPV/I	4.73	3.66	$ 2.36	$ 1.59	$ 1.08
BCR	9.09	4.66	3.36	2.59	2.08
IRR			21.28%		

Standard + GE	4%	6%	8%	10%	12%
NPV	$ 990,991	$ 741,455	$ 549,407	$ 400,345	$ 284,004
NPV/I	$ 8.09	$ 4.68	$ 2.99	$ 1.99	$ 1.34
BCR	9.09	5.68	3.99	2.99	2.34
IRR			21.14%		

Appendix C – Richard Paling Consulting report – Wider Economic Benefits of the RoNS

- The Wider Economic Case for the Roads of National Significance (RoNS)– Richard Paling Consulting Ltd
- Peer review of Richard Paling Consulting WEBs report – Booz & Co

The Wider Economic Case for the Roads of National Significance (RoNS)

The Estimation of the Wider Economic Benefits (WEBs) of the RoNS using a Bottom Up Approach
Version 4

Richard Paling Consulting

April 2010

TABLE OF CONTENTS

The Estimation of the Wider Economic Benefits (WEBs) of the RoNS using a Bottom Up Approach

1 Introduction

The conventional economic evaluation of the impacts of transport schemes is primarily focussed on changes in travel conditions for journeys that would be made whether or not the new facility is constructed and therefore on the assumption that patterns of economic activity and land uses do not change. It is on this basis that the estimates of journey time savings, vehicle operating cost savings, accident savings and any environmental impacts which make up the main components of the appraisal are based. A wide range of evidence however suggests that the provision of new transport facilities can have a major impact on levels of economic activity and land uses. This is recognised in the recent NZ Treasury publication "Infrastructure Facts and Issues : Towards the First National Infrastructure Plan" September 2009 which states:-

> *Major transport projects of this type have a significant impact on the location and form of economic activity - they tend to shape urban development rather than follow it. For example, a third harbour crossing would likely lead to more development of the suburbs north of the harbour (in a similar manner to the growth facilitated by the existing bridge) while a CBD rail tunnel would likely result in greater intensification of the inner city, suburbs and town centres that lie along the rail network, e.g. New Lynn. Strategic decisions of this kind can lock in patterns of growth for many decades, whether good or bad*.

While this quotes two examples, there are very large numbers of other instances where the provision of transport facilities and accessibility has had an impact on employment and levels of activity.

The issue is also becoming increasingly recognised in Australia where in the keynote address at the Transport Infrastructure Australia conference on 20-21 May 2009, Professor Newman stated that:-

> *"Besides having to meet IA's set of strategic priorities, each project had to consider agglomeration economies in their benefit cost ratio, which Professor Newman said "threw everybody."*
> *"Agglomeration economies basically recognise that we don't build infrastructure for its own sake - we build it to make cities work...and the outcome is that you create certain scale and density opportunities that weren't there before..."*

However although the impacts of transport schemes on urban economic activity appear to exist, detailed quantitative evidence in the form of before and after studies on the impact on economic activity or on employment is very small. A major problem that exists is that these effects take time to emerge, and it may therefore be difficult to distinguish the impacts of transport projects with the effects of other changes which occur over this period. The need to track the changes over time increases the scale and complexity of the research task.

As a result, only a very limited amount of investigation has been undertaken into these effects. To at least some extent, the findings from this research will inevitably reflect the particular circumstances of the project and drawing more general conclusions which can be applied to other schemes is therefore subject to a degree of uncertainty. However while problems do exist in determining the particular impacts this should not detract from the position as evidenced in the earlier quotations that effects in addition to those incorporated in conventional economic appraisal do exist and should be taken into account in some way in the assessment of major projects such as the RoNS. While patchy, the evidence suggests that the effects of the provision of new roads has beneficial impacts on levels of economic activity and there appears to be no evidence that this has resulted in declines of activity when measured over the full area of influence of the new infrastructure.

This note considers the range of impacts which are likely to exist and sets out ways in which these might be evaluated. Following the conceptual frameworks developed overseas and in part taken up in detail by NZTA, the main impacts identified are those resulting from agglomeration, broadly representative of productivity impacts and the changes in the patterns of economic activity, primarily through employment changes which broadly represent the growth impacts.

For the purpose of analysis, the RoNS have been divided into two basic categories of projects, those which provide additional capacity within major urban areas and those which provide longer distance inter-urban or inter-regional links. For projects which include elements of both, these have been subdivided into two or more separate projects. This applies in the case of the Waikato Expressway and the Levin-Wellington project. A different approach has been taken to the analysis of these two types of projects.

For the links in the main urban areas, an assessment has been made of the agglomeration impacts using outputs from the various transport models which are available. This component of the Wider Economic Benefits is now becoming recognised by NZTA and methods to calculate this are now set out in the EEM. The EEM also recognises that:-

> *"The economic evaluation framework for transport activities in New Zealand has historically been based on evaluating the direct benefits to transport users and private transport operators (transport user surplus). Reorganisation of industry and households to take advantage of changes in accessibility created by improved transport infrastructure and services and the benefits thereof have been regarded as a lagged effect of secondary importance and difficult to quantify. Agglomeration benefits are part of these reorganisation effects."*

Agglomeration benefits as defined by NZTA in the EEM describe the productive advantages that arise from close spatial concentration of economic activity. In essence as activity becomes more concentrated it becomes more efficient. Communication becomes easier, firms can share suppliers and markets and there are greater opportunities for specialist suppliers. In addition improving accessibility can allow employers to draw from a larger pool of workers and also allows workers to have a wider range of employment opportunities. These can contribute to a better matching of skills and requirements and a thickening of labour markets again leading to increases in productivity. This approach to the calculation of agglomeration effects for the RoNS broadly follows that set out in the EEM and also takes into account new agglomeration elasticities recently developed for NZTA.

Agglomeration as defined however relates to a static position where the location and number of jobs does not change in response to changes in accessibility. The extent of changes in employment in the main urban areas and the consequent impacts have therefore considered separately. This is an area in which very little research has been undertaken and where there is a lack of well founded data and relationships. While the broad possibility of these benefits is recognised in the EEM as discussed above, there is no specific guidance on the appropriate approach or the level of benefits which might typically be achieved. The analysis has therefore been undertaken using a range of sources of data and including some limited estimates from the UK and possible impacts of schemes in New Zealand. The factors which drive the agglomeration benefits and in particular the changes in accessibility are assumed also to be the drivers of employment change in the urban areas and a simple relationship between these two components of the wider economic benefits has therefore been assumed.

For the inter-urban and inter-regional schemes, a different approach has been taken, forecasting more directly the change in employment levels and economic activity which result from the construction or upgrading of the road. This is primarily based on relationships observed overseas.

While for the employment impacts in both urban and interurban areas there are issues as to the exact extent to which the relationships may be transferable, there is a need to make some estimate of these possible effects. In the absence of other data, the use of relationships derived from overseas work was judged to be the most appropriate approach[1]. While this is not an ideal situation and any findings need to be treated with some caution, the principle needs to be recognised that employment impacts are likely to be generated. These therefore should be evaluated to ensure an assessment of the impacts of constructing the RoNS is as comprehensive as possible. The evidence from a number of schemes is that these impacts may not be insignificant.

The detailed approach to the calculation of these benefits and the results obtained are discussed below.

[1] The use of UK relationships has been used in the early advice on the estimation of agglomeration benefits where information from New Zealand is not available and the approach of using information from elsewhere is therefore not novel.

2 Agglomeration Impacts

2.1 Introduction

Agglomeration impacts have been estimated for the RoNS in the major urban centres of Auckland, Hamilton, Tauranga, Wellington and Christchurch. These use outputs from the various transport models developed for these, and broadly follow the approaches set out in the EEM.

2.2 Typical Impacts of Agglomeration

The estimation of the agglomeration impacts uses the approach initially developed in the UK and subsequently adopted by NZTA. This has been used for a number of projects in New Zealand and the UK and the results obtained are summarised in Table 2.1

Table 2.1
Alternative Estimates of Agglomeration Benefits

Mode	Scheme	Agglomeration Benefits as % of Conventional Transport Benefits
Road	Waterview Connection	22% (1)
Road	Leeds to Bradford Improved Highway.	21%
Road	Leeds Urban Area Improved Highway	22%
Road	Leeds to Sheffield Improved Highway	19%
Road	M6 Shoulder Running	12%
PT	London CrossRail	24% (2)
PT	Leeds to Bradford PT Improvements	19%
PT	Leeds Urban Area Major PT Investment	9%
Package	Leeds City Centre	25%
Package	Leeds City Region	16%
Package	AMETI Auckland	19%

Sources "Agglomeration Economies and Transport Investment" by Daniel Graham, OECD/International Transport Forum Discussion Paper No 2007-11
"The hidden benefits of transport investment in the Leeds City Region", Centre for Cities, January 2008
"Waterview Connection Interim Report" LTNZ, January 2008
"Agglomeration Impacts of the Panmure Phase of AMETI", Auckland City Council, July 2009

Notes (1) Alternative estimates were prepared of the full range of wider economic benefits for the Waterview Connection which suggested that these could represent up to 60 per cent or more of the conventional transport economic benefits ("Assessing the Wider Economic Impacts from the SH20 Waterview Connection" by Ascari Partners and Richard Paling Consulting, January 2008)
(2) Alternative estimates of agglomeration benefits by Volterra suggested that these could represent 50 per cent of the conventional transport economic benefits "Transport and the Economy" by Bridget Rosewell, Motu Public Policy Seminar Series, 02 May 2006

For major road based projects, this gives agglomeration impacts that are typically of the order of about 20 per cent of the conventional economic benefits.

2.3 Approach to the Evaluation of the RoNS

The approach to the estimation of the agglomeration benefits for the RoNS follows the guidelines set out in the EEM. Particular details for each scheme are summarised in Table 2.2. Subsequent to the work looking at the RoNS as a whole reported in the main body of this note, more detailed work was undertaken to assess the agglomeration benefits for the Wellington Northern Corridor, which included estimating these for 2 years, 2016 and 2026. The results from this appraisal are set out in Addendum 1 to this note. The effects of the revised approach were to increase the overall discounted benefits slightly, with the effects of lower estimates for 2016 being offset by higher estimates for 2026.

Table 2.2
Measures of Separation and Land Use Forecast Dates for the Calculation of Agglomeration Benefits

Urban Area/Scheme	Measure of separation	Date of land-use forecasts
Waterview	Travel Time	2016
Hamilton	Average Generalised Cost (1)	2016
Tauranga	Generalised cost from transport model	2016
Wellington	Average Generalised Cost (1)	2006 (2)
Christchurch	Average Generalised Cost (1)	2016

Notes (1) Average generalised time is estimated from the zone to zone travel times and distances with typical values attached to each of these.
(2) Based on outputs of the 2006 Census and therefore relates to Census Area Units rather than traffic zones

For Christchurch and Hamilton, the generalised cost has been derived based on the distance and time for the complete OD movement. For this, a typical journey speed of 45 kph and the vehicle operating cost which results as derived from the EEM and the average value of time for urban arterial users has been used to develop the generalised cost for each movement. This together with the estimated land–uses for 2016 has then been used to estimate the effective density for each of the zones in the traffic model for the base and test situation

A similar approach has been adopted for Wellington, although here the land use data was derived from Census employment data for 2006. Selected results from the rather more detailed traffic model employed were used to estimate the generalised costs associated with each of the zone to zone movements defined at a Census Area Unit level.

For Tauranga, where it is proposed that part of the new infrastructure will be tolled, the generalised costs are output directly by the transport model and include the effects of tolls.

For the assessment of the Waterview Connection, information was only available on travel times.

The agglomeration impact effect has been estimated by comparing the differences in effective density and applying the revised average agglomeration elasticity using the formula

$$\delta PR_i = \left(\frac{ED_i^{OPT}}{ED_i^{DM}} \right)^{\varepsilon_i} - 1$$

Where
δPR = the relative increase in productivity
OPT = the option
DM = do minimum
∑ = the agglomeration elasticity
i = zone

For this analysis, the revised average agglomeration elasticity of 0.069 as advised by NZTA has been used.

The change in productivity that results is then multiplied by the estimated output of the zone, measured as the product of the GDP per worker and number of workers within the zone to get the zonal change of output. These are then summed to get the overall impact.

The change in output implied by this process has been valued at the average GDP per worker estimated at a regional basis. Because estimates of regional GDP have not been made since 2003, early figures have been used and then updated to 2008 prices and values for the evaluation. Subsequent adjustments have been made to convert these to other values to be comparable with the outputs produced by the Infometrics CGE model and other components of the evaluation.

For the WRR schemes, use has been made of the output from the Regional Transport Model which was used in earlier appraisal work and which therefore explicitly takes into account the combination of road and public transport projects and policies in future years. Different ways of defining effective density were explored, including a more comprehensive assessment of accessibility to both employment and residents, but the appraisal reported here considers the effects based on changes in travel times only and generally follows the approach in the EEM.

The results from this have been evaluated making an allowance for differential productivities in the different areas within the Auckland region as set out in the recent paper by David Mare "Labour Productivity in Auckland Firms" Ministry of Economic Development Occasional Paper 08/09, published in August 2008. This gives differential values for the Auckland CBD and the four main cities within the region, and these have been applied to the average GDP figures for the region as a whole for the zones in the particular areas or cities. This follows the approach used earlier in the assessment of the AMETI project ("Agglomeration Benefits of the Panmure Phase of AMETI", July 2009).

Different approaches yield a range of different answers. The standard approach set out in the EEM has been used for the assessment of the forecasts set out below, although it should be recognised that this area of evaluation is still evolving. Even in the UK where there has been more experience with this, the key notes dealing with the range of wider economic benefits (WebTAGs 2.8 and 3.5.14) are still marked for consultation with the warning that the approaches currently include could change substantially as more research is undertaken.

Using the approach set out in the EEM it should however be noted that the results probably lie towards the lower end of the possible outcomes which would be derived using alternative approaches and therefore represent a fairly conservative position.

2.4 Results Achieved

The estimates of the agglomeration impacts for each of the areas investigated are set out in Table 2.3

Table 2.3
Wider Economic Benefits from the RoNS : Agglomeration Benefits
Annual Benefits in 2016 in 2008 prices ($m)

	Agglomeration benefits	Conv Ec Benefits (CEBs)	Agglomeration Benefits as % of CEBs
Puhoi-Wellsford	Not calculated	95	NA
WRR	70	305	22%
Waikato Expressway : Hamilton Bypass only	10	85	12%
Tauranga Eastern Corridor	10	70	14%
Wellington Northern Corridor: Wellington Urban Schemes only	30	130	23%
Christchurch Motorways	25	110	23%
Total	**145**	**795**	**18%**

While there are differences from scheme to scheme, overall agglomeration benefits represent about 18 per cent of the total conventional economic benefits, a figure that is within the typical range of results for road projects obtained in studies in the UK and New Zealand as outlined above in Table 2.1.

3 Economic Development Impacts and Employment Changes for New Inter-Urban Routes

3.1 Evidence from Overseas

A fairly recent summary of the position with regard to the effects of transport schemes on economic development is set out in the report "Impact of Transport Infrastructure Development on Regional Development" published by OECD in 2002. This covered a range of projects and studies and where possible attempted to quantify the impacts that new transport schemes had had on economic development. However as indicated above, the quantitative evidence was very limited. In the event usable information was only available in respect of two major projects in the UK, the construction of the M62 providing an improved route between major industrial and manufacturing areas in the north of England, and the construction of the Severn Bridge which provided a direct link between South Wales and London and southern England.

In both cases, the analysis is fairly limited but does take into account the results of a number of studies of the impacts of the schemes. Both cases included some direct surveys of industries which attempted to identify the impacts of the new infrastructure and so to some extent provide a real life assessment of these effects.

The key highlights of the studies are summarised in Table 3.1 and 3.2.

Table 3.1
Impacts of the M62 in the UK

Types of Impacts	Scale of Impacts	Notes
Transport Impacts		
Potential time savings end to end	44 minutes out of 233 minutes, for 129 miles	Savings reflect avoidance of both difficult terrain and also congested conditions
Increase in traffic across screenlines	28 per cent over 7 years compared to 25 per cent elsewhere	But significant increase in average journey length reflecting trip redistribution or generation
Estimated reduction in transport costs for typical product	Small - less than 3.5 per cent	
Employment effects		
Dodgson – modelled impacts	14,900 or 0.4 per cent of total in (rather wide) area of influence	
CEC – mixture of observed and modelled impacts		
Indigenous jobs (model)	3,670	
New jobs in manufacturing (survey)	1,500	
Total with regional multiplier and other impacts	10,011	Probably similar overall effect to Dodgson

Source: United Kingdom : The M62 Motorway – Liverpool to Hull, in Impact of Transport Infrastructure Development on Regional Development, OECD 2002

The position for the Severn Bridge is set out in Table 3.2

Table 3.2
Impacts of the Severn Bridge in the UK

Types of Impacts	Scale of Impacts	Notes
Potential time savings	Up to 2 hours from Bristol-Newport	Time savings would be less for longer distance traffic from points further east
Short term impacts		
Increase in traffic	Generation of 34 per cent	
Impact on industry	Improved prospects for industry in South Wales	
	Improved inter-action between establishments within individual firms	
Employment creation	Changes in employment - overall positive but small	
Longer Term Effects : Welsh Office Study		
Employment creation	79% of new firms said access to English motorway network was a factor and 51 per cent a major factor	
Longer Term Effects : CEC Study		
Employment impacts	Increase in employment in manufacturing in South Wales of 1.53% for existing firms and 9-12,000 in new firms. Total of 12,800 to 15,800 or 5-6.5% of total or 18,000 with some multiplier effects	
Tourism	6-7000 new jobs over long term	
Distribution	Loss of 4-5000 over long term	
Overall impact	Growth in economic activity and employment in industrial South Wales of about 4%	

The Severn Bridge represents a more substantial improvement in the transport network, providing a direct route where none existed previously (except by a very low capacity ferry) and the estimated impacts from this are much larger than those from the M62 which simply improved, (albeit quite significantly) a route which existed before its construction.

What is noteworthy about both studies is their concentration on manufacturing industries. In part, this reflected the focus of interest at the time when the work was undertaken and before the period when more attention was focussed on urban agglomeration with a heavier emphasis on service activities. For these activities, it is improvements to the movement of people rather than freight that are more important, and the distances over which effects of improved infrastructure are likely to be important are rather shorter.

3.2 Developing and Applying Possible Relationships for New Zealand

The two studies give a range of potential impacts increasing employment in the potential areas of influence by between 0.4 and 4 per cent, which represents a wide range. The position represented by the construction of the Severn Bridge may be more substantial than that associated with the construction of the RoNS and the lower figures associated with the construction of the M62 may be more relevant. As an initial step, therefore this relationship has been assumed in developing the forecasts of the impacts of the RoNS within their broad areas of influence. It should be noted that this only represents 10 per cent of the estimated impact of the Severn Bridge.

In practice, the application of this approach in the assessment of the impacts of the RoNS has been fairly conservative and the relationship derived above has been taken as the upper limit. This has been applied in a way which takes into account the nature of the scheme and the relative proximity of the area affected to the line of the route. Where appropriate, adjustments have been made to reflect the nature of the upgrading proposed, the distance of the area potentially affected from the road itself and to avoid double counting where the area is affected by more than one project. The analysis has been undertaken at a TLA level and uses employment figures for 2006.

The changes in employment generated by this approach have been valued at the average GDP per worker for the region in which the jobs are forecast to be created, in line with the approach taken for the agglomeration benefits.

In developing the business case for the Puhoi-Wellsford RoNS, an alternative approach was adopted whiched in more detail at the specific activities which might be affected in the area of influence of the road. The details of this are set out in Addendum 1. The estimates of benefits for 2016 obtained from this exercise were very similar to those estimated from the general approach developed for the RoNS as a whole, although they were applied in a slightly different way reflecting the proposed construction of the scheme in two phases.

The details of the approach are set out in Appendix A but the results are summarised in Table 3.3.

Table 3.3
RoNS Potential Employment Creation : Inter-Urban Links

	Employment Creation in 2016	**Increase in Output in 2016 ($ millions in 2008 prices)**
Puhoi-Wellsford	450	35
Waikato Expressway (1)	750	60
Tauranga Eastern Corridor	350	25
Wellington Northern Corridor (2)	550	45
Total	**2100**	**160**

Notes (1) Inter-urban sections only and excludes Hamilton Bypass
(2) Excludes Wellington urban schemes

4 Economic Development Impacts and Employment Changes for Urban Schemes

4.1 Introduction

For the estimation of the effects of transport schemes on urban employment patterns through the changes in accessibility which arise, there is very little evidence on the observed impacts of schemes. As a consequence, there are no standard evaluation procedures or rules of thumb for the scale of the benefits, either within New Zealand or overseas. However, there is considerable discussion about the potential impacts which might arise. There appears to be substantial support for the position that these effects do exist in practice, and should be included in scheme appraisal, although the difficulties of measuring these are recognised as challenging.

4.2 Experience from Overseas

In a number of studies in the UK, the effects of increases in employment have been estimated from a bottom-up approach and have been found to be substantial. The results for two of these, the Cross Rail scheme and the High Speed Rail Link to France are considered below.

The position for the CrossRail scheme is set out in Table 4.1.

Table 4.1
Welfare and GDP impacts of Crossrail

Benefits	**Welfare (£m)**	**GDP (£m)**
Business time savings	4,847	4,847
Commuting time savings	4,152	
Leisure time savings	3,833	
Total transport user benefits - conventional appraisal	**12,832**	
Increase in labour force participation		872
People working longer		0
Move to more productive jobs		10,772
Agglomeration benefits	3,094	3,094
Increased competition	0	0
Imperfect competition	485	485
Exchequer consequences of increased GDP	3,580	
Additional to conventional appraisal	7,159	
Total (excluding financing, social and environmental costs and benefits)	**19,991**	**20,069**

Source : UK Department for Transport "Transport, Wider Economic Benefits and Impacts on GDP" 2006

For Crossrail, the employment impacts are estimated at about 20-50 per cent of the total economic benefits of the project, depending on the way in which they are incorporated into the evaluation. In the welfare based analysis where they amount to about 20 per cent of the total benefits, they are broadly equivalent to the agglomeration benefits.

A similar position has been found in the analysis of the benefits for the High Speed Rail Line between the UK and France. The benefits from this are summarised in Table 4.2

Table 4.2
UK High Speed Rail Link : Summary of costs and transport benefits / WEBs (£m, 60-year PV)

Journey time savings	3,700
Congestion relief	100
TOTAL TRANSPORT BENEFITS	**3,800**
Move to more productive jobs	1,700
Pure agglomeration	1,800
Labour force participation	50
Imperfect competition	250
TOTAL WIDER BENEFITS	**3800**
Capital cost	6100
Operating costs	1600
Revenue	-3,400
TOTAL COST	**4,300**
Net Present Value (NPV)	3,300
Benefit/Cost Ratio (BCR)	1.76

Source : "Economic Impact of High Speed 1 : Final report" January 2009 for London & Continental Railways by Colin Buchanan in association with Volterra

Here again the addition of WEBs gives a doubling of the total economic benefits from the project with again employment impacts being broadly similar in scale to the pure agglomeration impacts.

4.3 Evidence from New Zealand

Although not formally evaluated in their own right, estimates of employment creation have been made as part of the AMETI project ("Agglomeration Impacts of the Panmure Phase of AMETI", Auckland City Council, July 2009). These increases in employment underlie the estimates of agglomeration benefits which have been accepted by NZTA.

The numbers of jobs estimated to be created as part of the project amount to about 11,500 in 2030 or 10500 in 2021, of which between 75 per cent and 100 per cent are considered to be new. Evaluating these following the UK guidelines set out in TAG Unit 3.5.14 and at the rates used for the estimation of the agglomeration impacts would yield benefits of approximately $1.1 billion if all the jobs were new and $0.8 billion if 75 per cent were new. This would give employment effects that lie within the range of 45 to 200 times larger than the estimated agglomeration benefits, rather higher multipliers than those derived from the UK work, but demonstrating that the employment effects can potentially be very substantial.

4.4 Estimating Urban Employment Effects for the RoNS

Given the constraints on the current work, for the urban schemes the employment impacts have been based on the agglomeration benefits. These take into account the potential for part of the employment impacts to be relocated rather than being new jobs. While the evidence discussed above covers a very range with potential employment benefits lying within the range of 1-200 times the agglomeration benefits, for the current appraisal, the assumption has been made that the employment benefits would be equal to the agglomeration benefits an approach. This lies at the lower end of the range identified above, in line with the UK experience outlined above and could be a substantial underestimate. This factor in principle makes allowance for the additional costs of accessing the new jobs and the distribution of the benefits between the workers and the exchequer.

This approach has been used for the estimation of the benefits from increased employment for the schemes affecting Auckland, Hamilton, Wellington and Christchurch. For the Tauranga Eastern Corridor which has a long inter-urban section, the employment effects have been estimated using the approach developed for inter-urban schemes which related employment growth directly to existing employment levels in the area of influence for the road.

In estimating the employment effects assumptions have had to be made about the numbers of total new jobs that might be created and the extent to which the changes in employment represent relocation within the regions affected. For this appraisal, it has been assumed illustratively that 10 per cent of the jobs are new and the balance are relocated from less-productive locations within the region. For the WRR, this approach would give a total of 1900 additional jobs located in the area of influence of the road of which about 200 would be entirely new, and 1700 relocated from elsewhere in the region.

This approach has been applied to the other urban components of the RoNS, the Hamilton Bypass, Wellington Urban Schemes and the Christchurch Motorways.

Estimates of impacts on employment within urban areas which would result using this approach are set out in Table 4.3.

Table 4.3
Potential Employment Impacts of the Urban Components of the RoNS in 2016

	New jobs	Jobs relocated from less productive locations	Total jobs affected
Puhoi-Wellsford	NA		
WRR	200	1700	1,900
Waikato Expressway	50	500	550
Tauranga Eastern Corridor	NA		
Wellington Northern Corridor	100	1050	1150
Christchurch Motorways	150	1200	1350
Total	**500**	**4450**	**4950**

Using the approach described, the RoNS would generate about 500 jobs within the urban areas and prompt the relocation of about 4,500 others. Given the scale of the investment and the nature of the projects, these estimates may be conservative.

5 Overall Benefits from New or Relocated Employment

Putting together the benefits from the urban and inter-urban sections of the RoNS, the employment effects are summarised in Table 5.1.

Table 5.1
Potential Employment Impacts of the Urban and Interurban Components of the RoNS in 2016

	New jobs	Jobs relocated from less productive locations	Total jobs affected
Puhoi-Wellsford	450		
WRR	200	1700	1,900
Waikato Expressway	800	500	1,300
Tauranga Eastern Corridor	350		
Wellington Northern Corridor	650	1050	1150
Christchurch Motorways	150	1200	1350
Total	**2,600**	**4450**	**7,050**

Overall, the 6 RoNS are estimated to generate about 2,600 new jobs and impact on the location of an additional 4,500.

The valuation of the impacts of these additional or relocated jobs follows the guidelines developed in the UK, and the figures that result are set out in Table 5.2.

Table 5.2
The Benefits from the Potential Employment Impacts of the Urban and Interurban Components of the RoNS in 2016 ($millions at 2008 prices)

	New jobs	Jobs relocated from less productive locations	Total for all jobs	Conventional Economic Benefits (CEBs)	Employment Impacts as %age of CEBs
Puhoi-Wellsford	35		35	95	39%
WRR	30	40	70	305	22%
Waikato Expressway	80	5	90	85	104%
Tauranga Eastern Corridor	30		30	70	41%
Wellington Northern Corridor	60	15	75	130	58%
Christchurch Motorways	10	15	25	110	22%
Total	**245**	**75**	**325**	**795**	**41%**

Note. Individual items may not sum to totals because of rounding

In considering employment changes particularly those generated for the inter-regional sections of the RoNS the issue arises as to the extent to which any jobs created in the area of influence of the road are new or are simply relocated from elsewhere. Evidence on this issue is particularly hard to find although the UK studies discussed above did look at broad regional impacts. However, given the potential movements in the labour market over the assumed adjustment period and the relatively small numbers of jobs forecast to be generated, it appears reasonable to assume that there could be employment creation of the level anticipated, especially if supported by local development aspirations.

For the RoNS schemes as a whole, it is estimated that the number of new jobs created over 10 years would amount to about 2-3,000 as set out in Table 5.1. At present arrivals and departures of long term migrants are running at about 170,000 per year or possibly 1.5-2 million over 10 years, and the labour force is also responding to changes in the resident population. The changes forecast for the RoNS are therefore very small in relation to overall movements in the labour force, and this would not therefore appear to act as a significant constraint. This is discussed further for selected RoNS in relation to conditions within their areas of influence in Section 6.

It is also recognised that changes in transport accessibility will only generate changes in employment when other conditions are right and that to an extent transport is a necessary but not always a sufficient condition. However changes in transport accessibility are likely to generate pressure for the complementary actions necessary to achieve the employment changes, by for example changes in zoning restrictions and investment in site preparation, and once this is done, transport changes may become the sufficient condition.

Given a sufficiently long adjustment period there is a reasonable likelihood that such changes will come about, and the analysis has therefore assumed that any adjustments take place over a period of 10 years. It should be noted that much of the analysis in the UK described above covered a much shorter period and the analysis undertaken here may therefore underestimate the full effects.

Overall, the approach taken is probably conservative and the figures set out probably represent the minimum impacts of the schemes. However, as a further check, a brief review has been undertaken of the particular conditions in some of the corridors served to determine whether the approach developed appears to produce reasonable results. This is set out in Section 6.

6 Assessment of Forecast Employment Impacts of the RoNS in Relation to Likely Corridor Growth and Development Plans

6.1 Introduction

The approach set out above provides a broad top down estimate of the potential employment generation within the areas of influence of the RoNS. To check that these are reasonable against conditions on the ground in the corridors, these impacts have been briefly reviewed against recent and forecast growth trends in each of the corridors and a selection of development plans and similar documents and other factors likely to affect regional economic activity.

6.2 Puhoi to Wellsford

6.2.1 Introduction

The employment forecasts for the Puhoi to Wellsford link amount to an increase of about 450 over a 10 year period, or about 0.25 per cent of the total workforce in the area.

6.2.2 Patterns of Recent Employment Growth

Growth in employment in the local authority areas between 2001 and 2006 is set out in Table 6.1.

Table 6.1
Puhoi to Wellsford Area of Influence : Growth in Employment by Workplace 2001-2006

Area	Employment		Growth to 2006	
	2001	2006	Percent	Number
Far North District	15,927	18,102	13.7%	2,175
Whangarei District	24,309	27,942	14.9%	3,633
Kaipara District	6,171	6,600	7.0%	429
Rodney District	21,141	25,953	22.8%	4,812
North Shore City	65,130	79,974	22.8%	14,844
Total	**132,678**	**158,571**	**19.5%**	**25,893**

Source: Statistics New Zealand

Over the 5 years between 2001 and 2006, the growth in employment has amounted to about 5,000 per year, with particularly high growth in the south of the area of influence. Rodney, the area most directly affected by the new road has experienced an increase of almost 1000 jobs per year.

6.2.3 Planning Background

Within the Auckland region, the main growth centres identified within the Regional Growth Strategy are at Orewa, Albany, Warkworth and Wellsford, with new business development areas identified at Silverdale North and Silverdale South. These growth areas are also reflected in Planning Rodney, which again emphasises the role of Warkworth and Wellsford and Orewa and Silverdale as "Primary urban centres - growth management focus". These are all areas which are well positioned to take advantage of the opportunities offered by the increased accessibility resulting from the improvement of SH1. The development at Silverdale North of a proposed "Knowledge Zone" is expected to generate 3,000 jobs, and would also be matched by further expansion of the activities at Silverdale South.

Further north Whangarei District Council has identified the Marsden Point/ Ruakaka area as an important focus for industrial and commercial development, complementing the range of economic activities undertaken within the main urban area.

6.2.4 Tourism and Freight

SH1 carries about 1000 heavy vehicle movements a day. It provides the main freight connection between primary producers in Northland and markets particularly of major export commodities such as dairy products and timber products and commodities such as aggregates used on the domestic markets.

The volumes of timber harvested in Northland are large and are likely to grow substantially over the future as existing forests are harvested. For the timber industry, the choice is essentially between exporting basic products such as logs and woodchips via Marsden Point or exporting higher value added products such as boards and sawn and engineered timber to markets either in New Zealand further south or to international markets accessed via the ports in Auckland and Tauranga. Discussions with members of the timber industry have indicated that the maintenance of reliable and high quality road connections between the producing areas in Northland and potential markets for value added products further south is an important factor in the continuation or development of value added activities in the region.

More generally, Northland is an important tourist area. In 2004, total visitor expenditure in the region was estimated at about $650 million and the industry employed over 10 per cent of the work force representing about 4000-5000 jobs. The sector has a heavy dependence on the Auckland market. Examination of the position following the opening of earlier sections of SH1 the ALPURT B1 scheme from Greville Road to Orewa showed that this coincided with an increase in visitor activity in Northland after a decline over the preceding period. The road connections with Auckland and conditions on SH1 are therefore likely to be particularly significant in promoting growth in this sector. The reductions in journey times and travel time unreliability on the main route connecting Northland with its main sources of visitors would help this sector.

6.2.5 Overall Assessment

The forecasts of an increase in employment as the result of the construction of Puhoi-Wellsford Link have been made, against a background of:-

- Recent growth of employment in the area of influence of the Puhoi Wellsford scheme of over 25,000 between 2001 and 2006,
- The identification of a number of nominated growth centres along SH1 in the Auckland and Northland regions in regional and local development plans, including Albany, Silverdale, Orewa, Warkworth, Wellsford and Whangarei
- The importance of the route in serving the tourist industry in Northland and also in the northern parts of Rodney
- The importance of the route as the main freight connection between Northland and markets and suppliers further south in New Zealand and overseas accessed by the ports in Auckland and Tauranga

Against this background, the forecasts of increased employment along the route of about 450 over a ten year period appear reasonable and indeed may be conservative.

6.3 Western Ring Route : Waterview Connection and SH16 Widening

6.3.1 Introduction

The employment forecasts for the Waterview Connection and SH16 Widening amount to about 200 new jobs and 1700 relocated jobs. To put this growth into context, the increases forecast are somewhat smaller than the 9,000-11,500 new jobs forecast to be generated with the Panmure component of AMETI.

6.3.2 Patterns of Recent Employment Growth

Growth in employment in the local authority areas between 2001 and 2006 is set out in Table 6.2.

Table 6.2
Waterview Connection Area of Influence : Growth in Employment by Workplace 2001-2006

Area	Employment		Growth to 2006	
	2001	2006	Percent	Number
Waitakere City	38,292	43,254	12.9%	4962
Auckland City	223,758	256,839	14.8%	33081
Manukau City	82,260	98,916	20.2%	16656
Total	**344,310**	**399,009**	**15.9%**	**54699**

Source: Statistics New Zealand

Over the five years between 2001 and 2006, employment in the local authority areas potentially served by the Waterview Connection has increased by almost 55,000 or an average of 11,000 jobs per year. Within Auckland City, the distribution of growth by broad corridors is set out in Table 6.3.

Table 6.3
Employment Growth within Auckland City

Corridor	Employment Change 2001-2006	Per Cent of Total
CBD	6,740	21%
SH20	5,270	16%
SH16	1,430	4%
SH1	8,300	25%
Other	11,050	34%
Total Auckland City	32,790	100%

Notes (1) The definitions of the corridors are set out in Appendix B

The areas directly served by the Waterview Connection accounted for about 40 per cent of the growth in employment within Auckland City, or about 13,500 jobs within the period.

6.3.3 Planning Background

The Waterview Connection serves directly one of the prioritised development areas within Auckland City at Rosebank. Rosebank is seen as a key development zone and the Rosebank 2030 Draft Strategy aims to increase employment in the area by 10,000 by 2030. Over the period from 2001 to 2006, the area has experienced higher than average growth with employment increasing by 24 per cent, and the high growth targeted for the future would represent a continuation of this trend.

Other major growth centres which would be affected by the Waterview connection would be the CBD in Auckland City and the growth areas at Westgate/Massey/Hobsonville corridor in Waitakere City, for which employment growth of 14,000 is targeted, and around Auckland Airport and Wiri/Manukau Central in Manukau City. The new road would also provide improved connections further afield to the major growth centres in Albany where employment has been growing very strongly and in the Onehunga-Mount Wellington area in Auckland City. All of these areas would provide potential for increases in employment.

6.3.4 Overall Assessment

The construction of the Waterview Connection very much supports the development proposals of the local authorities most affected, particularly in Auckland City, Waitakere and Manukau. Against this background and the substantial growth experienced over recent years in the corridor, the forecasts of relocated and increased employment in the corridor of 200 new jobs and 1700 relocated jobs seem reasonable and indeed may be very conservative.

6.4 Waikato Expressway

6.4.1 Introduction

The employment forecasts for the Waikato Expressway amount to an increase of about 800 over and above the numbers of jobs likely to come about in the absence of the project.

6.4.2 Patterns of Recent Employment Growth

Growth in employment in the local authority areas served by the road between 2001 and 2006 is set out in Table 6.4.

Table 6.4
Waikato Expressway Area of Influence : Growth in Employment by Workplace 2001-2006

Area	Employment		Growth to 2006	
	2001	2006	Percent	Number
Manukau	82,260	98,919	20.3%	16,659
Papakura	11,781	13,572	15.2%	1,791
Franklin	15,537	18,402	18.4%	2,865
Waikato	10,962	11,988	9.4%	1,026
Hamilton	50,412	60,816	20.6%	10,404
Waipa	13,098	14,745	12.6%	1,647
South Waikato	8,412	7,491	-10.9%	-921
Matamata-Piako	11,973	12,642	5.6%	669
Total	**204,435**	**238,575**	**16.7%**	**34,140**

Employment growth in the corridor has been strong with the total number of jobs increasing by an average of almost 7,000 per year. Particularly substantial growth has been experienced in Hamilton City, reflecting its growing role as a regional manufacturing and service centre, serving both the Waikato Region but also its central location within the Golden Triangle.

6.4.3 Planning Background

The Waikato Expressway forms an important linkage in the Golden Triangle of Auckland, Waikato and Bay of Plenty, an area which includes a substantial proportion of the population of New Zealand, and which provided a focus for considerable economic and population growth in recent years.

Considering a more local position, the traffic modelling work undertaken for the Waikato Expressway has predicted considerable continuing employment growth in the Hamilton area with a further increase of 13,000 expected over the period from 2006 to 2016, although in the light of the figures set out in Table 6.4, this may be conservative.

One of the drivers of recent growth has been the establishment of a number of industries serving the Auckland and particularly the South Auckland markets and also export markets located in the northern parts of Hamilton, particularly around Te Rapa,. By locating in Hamilton, these industries have aimed to avoid the high costs and congestion associated with operation within Auckland itself. Reflecting this, employment in Te Rapa itself has increased by almost 60 per cent from 5,600 to 8,700 in just 5 years and pressure for development continues.

Other growth areas identified for the corridor comprise sites in South Auckland including Wiri/South Manukau, Takanini and Drury, the Hampton Downs Business Park and other sites in Hamilton including the CBD, Rotokauri and Rototuna, where again substantial growth is expected. At a smaller scale, development opportunities have also been identified in local economic development plans at:-

- Cambridge, in part linking with equine activities in the area and also extending the industrial area at Hautapu
- Horotiu, extending the Te Rapa development area northwards; and
- Huntly

For all of these, the improvements to SH1 through Waikato would provide enhanced opportunities to serve the wider markets within the Golden Triangle.

6.4.4 Freight

The Waikato Expressway forms part of the main highway linkage between Auckland and the Waikato and also between Auckland and regions further south. Currently heavy vehicle flows typically amount to about 2300 per day (AADT). Information on a selection of the key commodities moved along the route is available from the National Freight Demands Study and is summarised in Table 6.5 and Figure 6.1

Table 6.5
Estimated Breakdown of Inter-Regional Freight Flows on RoNS by Commodity (Flows in 2006-07 in million tonnes pa)

Commodity	Waikato Expressway North	Waikato Expressway South
Liquid Milk and Dairy Products	0.48	0.14
Meat	0.03	0.03
Horticultural products	0.33	0.49
Logs and timber products	1.07	0.00 (1)
Coal	0.07	0.08
Aluminium and Steel	0.16	0.15
Chemicals, Fertiliser and Minerals	0.51	0.86
Retail and Courier	2.07	1.25
Aggregates	NA	NA
Petroleum	0.64	0.07
Total Identified	**5.36**	**3.07**
Total estimated flow by road including non-identified flows	10.9	6.8
Implied Heavy Vehicle traffic (AADT)	2500	1500
Observed Heavy Vehicle traffic (AADT)	2300	1500

Notes (1) Most of the logging in the Waikato region is in the south and east and so movements to and from the Bay of Plenty would not use the Expressway corridor

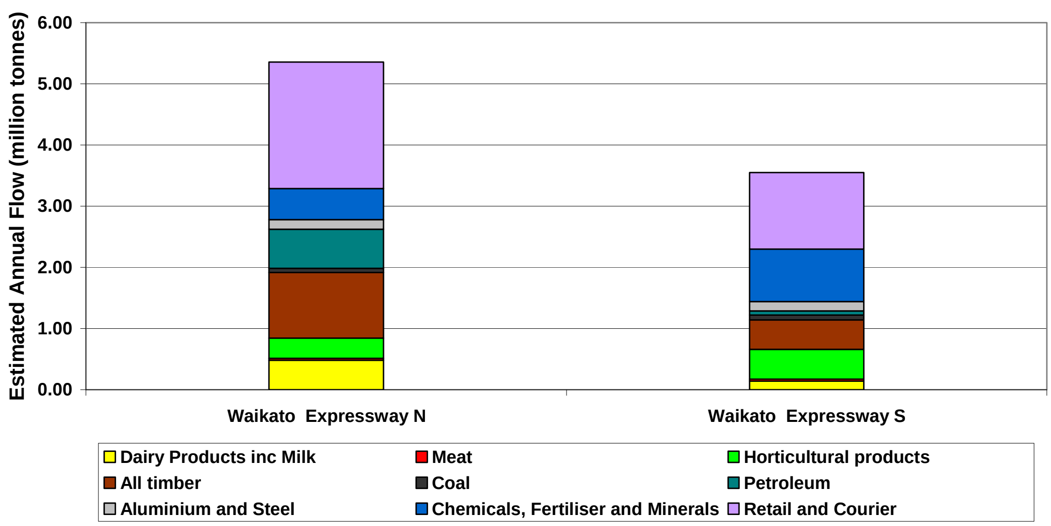


Figure 6.1
Breakdown of Waikato Expressway Corridor Inter-Regional Freight Traffic by Commodity (percent of identified commodities)

Waikato Expressway North

The key freight flows on the northern part of the Waikato Expressway can be divided into four main categories:-

Exports from the Waikato Region to the major markets in Auckland and to overseas via the port and airport in Auckland

The key products identified are:-

- Dairy products
- Meat
- Wood and timber products
- Limestone

The first three of these are primarily focussed on export markets with diary and timber exports being particularly important.

The Waikato is a very important dairy area, processing almost a third of the national liquid milk production (4.7 million tonnes in 2006-07) into about 0.6 million tonnes of finished product, most of which is exported. The northern part of the Waikato Expressway provides a link into the major dairy plant at Te Rapa north of Hamilton for liquid milk from the north of the Waikato and also the southern parts of the Auckland region and also provides the road connection to Auckland, the main port used for exports. While rail is used extensively, the greater flexibility offered by road and the desire to maintain a balance between modes means that the volumes carried by road are also substantial at about 0.2 million tonnes per year worth about $1 billion per annum.

Waikato is also a major wood producing area accounting for about 15 per cent of the total plantings of exotic forests. The wood produced in the area is used for a variety of purposes including processing in a variety of ways. A high proportion of processed log products are sent to Auckland either for use in the domestic market or are exported to overseas markets via the port. The volumes transported through the northern parts of the Waikato Expressway corridor are substantial. The share of the traffic carried by rail is relatively small, in part reflecting the dispersal of the main domestic markets within the Auckland area.

The Waikato is also a major production area for export meat and again much of this is exported via Auckland. Again, although rail has quite a high share of this market, at times there is a need for the flexibility and rapid delivery times offered by road, which has over a third of the market.

The other major commodity identified delivered into the Auckland region is limestone. This is produced in the south of the Waikato and delivered to a range of customers in the Auckland region, including the steel mill at Glenbrook.

Inputs for manufacturing and Construction in the Waikato

These would comprise

- Petroleum
- Cement
- Steel and Aluminium

Petroleum is supplied to the northern and central parts of the Waikato by road from the pipeline terminal at Wiri. Cement is supplied from the ports in Auckland, some from Onehunga and some from the facilities on the Waitemata Harbour mainly having being delivered to those locations from the manufacturing plants at Whangarei or Westport by coastal shipping. Steel and aluminium is supplied from manufacturing plants in Auckland or via the port.

Products for Waikato Consumers

Auckland acts as major manufacturing and distribution centre for a very range of retail goods and these comprise a large proportion of the traffic in the Expressway corridor. This traffic would include both traffic to the Waikato itself and also longer distance movements to areas further south. For movements to the Waikato, road is probably the only realistic alternative for the majority of these goods, given the relatively short distance and the range of origins in Auckland and destinations in the Waikato. For the longer distance movements the traffic is typically shared with rail and for movements to the South Island with coastal shipping, but the flexibility, reliability and quicker transit times offered by road mean that it is able to attract a substantial part of this market. The role of road is also likely to increase if the widespread use of larger vehicles as is currently being proposed is permitted

Other Commodities

Although there is no detailed information, the flows identified above would be supplemented by a range of other commodities especially intermediate and semi-manufactured goods moving between suppliers and manufacturers in Auckland and the main manufacturing and processing centres in the Waikato particularly in Hamilton City.

Waikato Expressway South

The Waikato Expressway South provides for two types of interregional freight flows, shorter distance movements between Waikato and Bay of Plenty and longer distance movements between Waikato and Auckland and areas further to the south including the South Island.

The key flows on the route as set out in Table 6.5 include:-

Waikato – Bay of Plenty

- Liquid milk and dairy products
- Chemicals, fertiliser and minerals

Auckland and Waikato – South

- Horticulture
- Retail goods

Considering the shorter distance movements between Waikato and Bay of Plenty, although Auckland is currently the main port for the export of dairy products from Waikato, there is some also export via Tauranga which is mainly transported by road. The other major traffics are the movement of limestone to the Bay of Plenty to support a variety of agricultural and industrial uses, movements of fertiliser into Waikato, again to support agriculture and also movements of cement into Waikato.

Longer distance movements are dominated by horticultural products moving in both directions and movements of retail goods primarily moving south from Auckland.

Overall Assessment of Freight Issues

The analysis of the commodity movements on the Waikato Expressway indicate that these include substantial volumes of products that are either:-

- key exports, such as dairy products and forest products,
- important inputs to agriculture and manufacturing such as fertiliser, cement and steel; or
- consumer goods.

Commodities in the first group represent about 30 per cent of the commodities identified on the northern part of the Waikato Expressway and about 6 per cent of the flows identified on the southern section. Inputs to agriculture and industry represent about 20 per cent of the flows on the northern part of the Waikato Expressway and about 35 per cent of the flows on the southern part and consumer goods including horticulture about 45 percent of the total on the northern part and 55 per cent on the southern part. The roles of the two parts of the Expressway are therefore clearly different, the southern section supporting longer distance flows with a greater emphasis on domestic movements of consumer goods and the northern part having a greater emphasis on export movements and support for agriculture and industry.

Each of these commodity groups plays an important role in the New Zealand economy and the completion of the Waikato Expressway will assist in their efficient distribution. Parallel work has indicated that while transit times are important, the greatest weight in transport related decisions is reliability and by bypassing the urban areas and settlements along the route, this will be improved. The completion of the Waikato Expressway will therefore provide important benefits to the movement of freight improving the reliability of supply chains and allowing goods to be distributed more cheaply and efficiently.

6.4.5 International Links

In conjunction with the motorway links in Auckland, the Waikato Expressway forms the connection between Auckland Airport, the main entry point to New Zealand for international visitors and the Waikato and areas further south. For international firms wishing to establish or expand facilities in the Waikato this is probably a vital link and measures to improve journey times and possibly more significantly to improve journey time reliability can have a major impact on the attractiveness of the area for international investors.

6.4.6 Tourism

The Waikato is an important tourist area, and in 2007 the areas within the Waikato RTO and the Lake Taupo RTO achieved some 8 million visitor-nights, about 8 per cent of the total for New Zealand as a whole. The majority of visitors come from the north either as international visitors through Auckland airport or as domestic visitors from the Auckland region and these almost entirely travel by road. In 2007, these were estimated to account for about 55 per cent of the total for the Waikato or about 4.5 million visitor nights.

The Waikato Expressway Corridor therefore forms a very important route for tourists from the north giving access to the major tourist attractions of Hamilton itself, Waitomo, Lake Taupo and further afield to Rotorua and points further south. Improving the linkages and in particularly reducing travel times and travel time reliability will make these areas more attractive to tourists both domestic and international. Increasing the volume of tourism, especially if this is new to New Zealand rather than diverted from other regions can have particularly high benefits. The proximity to the large international market in Australia suggests that there is potential for increasing tourism from this source and the provision of more efficient linkages away from Auckland Airport to the south will assist in this.

6.4.7 Overall Assessment

The Waikato Expressway will help reinforce the strong patterns of development that have been occurring and that are identified for the future within its corridor. A number of distinct development proposals have been identified which would be supported by the Expressway and its completion would emphasise the role of Hamilton as the key regional centre for the Waikato. The upgrading of the links between Hamilton and Auckland would improve the connections between manufacturers and producers in the Waikato and the most important domestic market and also overseas markets served by the port and airport in Auckland. Improving the route would also improve the supply of raw materials and manufactured products and consumer items into the Waikato, supporting the local producers especially those in the agricultural sector.

In relation to the background of growth and key economic linkages, the forecast of employment and wider economic benefits generated by the RoNS, including about 800 new jobs spread over 10 years is possibly very conservative when compared against total employment in the area affected of about 250,000 in 2006 and an historical growth rate of 6,000-7,000 per year.

6.5 Tauranga Eastern Corridor

6.5.1 Introduction

The employment forecasts for the Tauranga Eastern Motorway amount to an increase of about 350 over and above the numbers of jobs likely to be generated in the absence of the new link.

6.5.2 Patterns of Recent Employment Growth

Growth in employment in the local authority areas served by the road between 2001 and 2006 is set out in Table 6.6.

Table 6.6
Tauranga Eastern Motorway : Growth in Employment by Workplace 2001-2006

Area	Employment		Growth to 2006	
	2001	2006	Percent	Number
Tauranga	34527	44,127	27.8%	9600
Western Bay of Plenty	11850	13,296	12.2%	1,446
Rotorua	23,910	26,331	10.1%	2,421
Kawerau	2,850	3,048	6.9%	198
Whakatane	10,131	11,271	11.3%	1,140
Total	**83268**	**98073**	**17.8%**	**14,805**

Source: Statistics New Zealand

Over the five years between 2001 and 2006, the growth in employment has amounted to almost 15,000 with particularly high growth being experienced in Tauranga City. The growth in the other areas has been rather more modest, reflecting the increasing importance of Tauranga as the main focus of activity in the corridor.

6.5.3 Planning Background
The area served by the Tauranga Eastern Motorway forms part of the SmartGrowth Eastern Corridor for which a relatively detailed planning framework has been developed. This includes major expansion at a number of locations within the corridor including Papamoa and Te Puke and the development of a major business park of 148 ha potentially served directly by the new link at Rangiuru. The resident population of Papamoa is expected to increase by about 40,000 between 2006 and 2051 and that for Te Puke to increase by 6500 over the same period, with additional employment in Papamoa East of about 8,500 and possibly a similar level on the Rangiuru Business Park

6.5.4 Freight Issues
The Tauranga Eastern Motorway would provide the key link between the primary producing areas in the east of the Bay of Plenty and in Gisborne and the port of Tauranga and the main domestic markets within New Zealand in the upper North Island. This is particularly important to the dairy and forestry industries supporting movements from the dairy plant at Edgecumbe, timber processing plants at Kawerau and Whakatane and the movement of export logs from the forests in the central North Island and Gisborne. The volumes of these are expected to increase substantially as existing forests are harvested. The maintenance of reliable links to markets is seen as an important factor in the maintenance and development of value added activities in the timber industry, and the upgrading of SH2 provided by the Tauranga eastern Motorway make an important contribution to these.

6.5.5 Overall Assessment
Against this background of rapid recent growth in employment, plans for further substantial expansion of both residential and employment activities focussed on the corridor and the role of the road in supporting primary producers in the area, the forecasts of employment creation of 350 jobs over a ten year period appears reasonable and may be significantly conservative.

6.6 Wellington Northern Corridor - SH1 Levin to Wellington Airport

6.6.1 Introduction
The employment forecasts for the Wellington Northern Corridor amount to an increase of about 650, over and above the numbers of jobs likely to come about in the absence of the project.

6.6.2 Patterns of Recent Employment Growth
Growth in employment in the local authority areas served by the road between 2001 and 2006 is set out in Table 6.7.

Table 6.7 Wellington Northern Corridor Area of Influence : Growth in Employment by Workplace 2001-2006				
Area	**Employment**		**Growth to 2006**	
	2001	**2006**	**Percent**	**Number**
Palmerston North	33,798	38,100	12.7%	4,302
Manawatu	8,862	9,285	4.8%	423
Horowhenua	9,084	9,321	2.6%	237
Kapiti Coast	10,770	11,901	10.5%	1,131
Porirua	11,514	12,765	10.9%	1,251
Hutt	35,514	36,930	4.0%	1,416
Wellington City	100,539	111,660	11.1%	11,121
Total	210,081	229,962	9.5%	19,881

Over the five years from 2001 to 2006, employment in the corridor has increased by about 10 per cent or by about 4,000 jobs per year. Much of the growth has been in the two main cities at the ends of the route, Wellington and Palmerston North, with a particular focus in Wellington.

6.6.3 Planning Background

The area served by the new route connects a number of identified development areas including the Wellington City CBD, a new development area at Grenada North, aiming to attract up to 2000 jobs, Porirua City CBD, the Aotea Business Park and the town centre in Paraparaumu. There are also smaller scale plans to encourage limited development at the local centres along the route, although further north in Palmerston North, the bulk of development is either anticipated in the CBD or north of the city in Manawatu District.

For the local authorities in the area of influence of the route in the Greater Wellington Region, the medium growth forecasts by the Regional Council included in the traffic modelling suggest that employment will increase by about 44,000 or 22 per cent between 2006 and 2026. While still demonstrating substantial growth this represents a rather slower rate of growth than has been observed historically and so may be conservative.

6.6.4 Freight Issues

Freight movements along SH1 are substantial increasing southwards from about 1400 heavy vehicles AADT at the regional boundary to about 1500 at Paekakariki and about 3,000 in between Ngauranga and Aotea Quay after the merge of SH1 and SH2 in Ngauranga. Between the CBD and the airport, flows are lower at about 1700 south of Evans Bay Parade.

The main freight commodities handled by the longer distance traffic on the route fall into three main groups:-

- Commodities transported from producers north of the Wellington region or in the northern parts of the Wellington Region to the port of Wellington for export or to consumers and manufacturers in the main urban areas in the Region.

- Commodities transported northwards from the port or alternatively manufacturers or producers in the Wellington area for industry and consumers further north.

- Retail and consumer products either distributed from the main distribution centres and manufacturing plants in Auckland or from subsidiary distribution centres in Palmerston North for delivery in Wellington, or from distribution centres in Wellington for delivery further north. The route also provides the connection between Auckland and the main centres in the South Island. Although much of this longer distance traffic is shared with rail and coastal shipping, the advantages that road can offer in terms of transit times, reliability and flexibility means that despite higher costs, it still retains a significant part of this longer distance market and this position is expected to continue in the future.

The longer distance road movements on SH1 between areas north of the Wellington region and the South Island were estimated to be about 2 million tonnes in 2006-07. The balance of the longer distance inter-regional traffic on the road of just over 4 million tonnes represents more local movements to or from the Wellington region itself, showing that the route is important both for longer distance and shorter-distance traffic.

The Wellington Northern Corridor serves the port directly and provides improved linkages between it and the major primary producing areas further north. One area where the port specialises is in the handling of logs and timber products. There is expected to be substantial growth in the volumes harvested in the north of the Wellington region and further north in Manawatu/Wanganui of between 250 and 300 per cent by 2031 as existing forests are harvested. It is anticipated that these would mainly be exported through Wellington in either the form of logs or of value added timber products, including sawn timber and pulp and paper. While it is proposed that a significant portion of this traffic will be handled by rail and NZTA has approved several ATR submissions to support this, it is also likely that given the substantial overall growth in the volumes harvested and processed there will considerable increases in the volumes potentially transported by road.

6.6.5 Overall Assessment

While the growth in the Wellington Northern Corridor is not as substantial as that recorded for the other RoNS, between 2001 and 2006 employment in the catchment area has increased by about 20,000 and a further increase of more than twice this, 44,000, is expected for the period up to 2026. The route also serves a number of identified growth areas particularly in the southern parts of the route, which is where much of the growth of employment is predicted to occur.

Given these reasonable levels of growth and the support for proposed development areas that the road would offer, the forecast increase in employment of 650 over 10 years appears reasonable.

6.7 Christchurch Motorways

6.7.1 Introduction

The employment forecasts for the Christchurch Motorways amount to about 150 new jobs and 1200 relocated jobs.

6.7.2 Recent Employment Growth

Growth in employment in the Christchurch City between 2001 and 2006 is set out in Table 6.8.

Table 6.8 Christchurch Motorways Area of Influence : Growth in Employment by Workplace 2001-2006				
Area	**Employment**		**Growth to 2006**	
	2001	**2006**	**Percent**	**Number**
Christchurch City	142,968	166,062	16.2%	23094
Total	**142,968**	**166,062**	**16.2%**	**23094**

Source: Statistics New Zealand.

Over the five years between 2001 and 2006, employment in Christchurch City has increased by about 23,000 or an average of 4,600 jobs per year.

6.7.3 Planning Background

For the traffic modelling growth in employment between 2006 and 2016 over a slightly larger catchment area was forecast at about 23,000 or about 12 per cent. Given the growth experienced over the last 5 years this may be rather conservative.

In terms of the patterns of economic activity, the Christchurch Motorways could play an important role in supporting existing areas of industrial and commercial activity. The relationship of the new links to key industrial and commercial areas is set out in Figure 6.2.

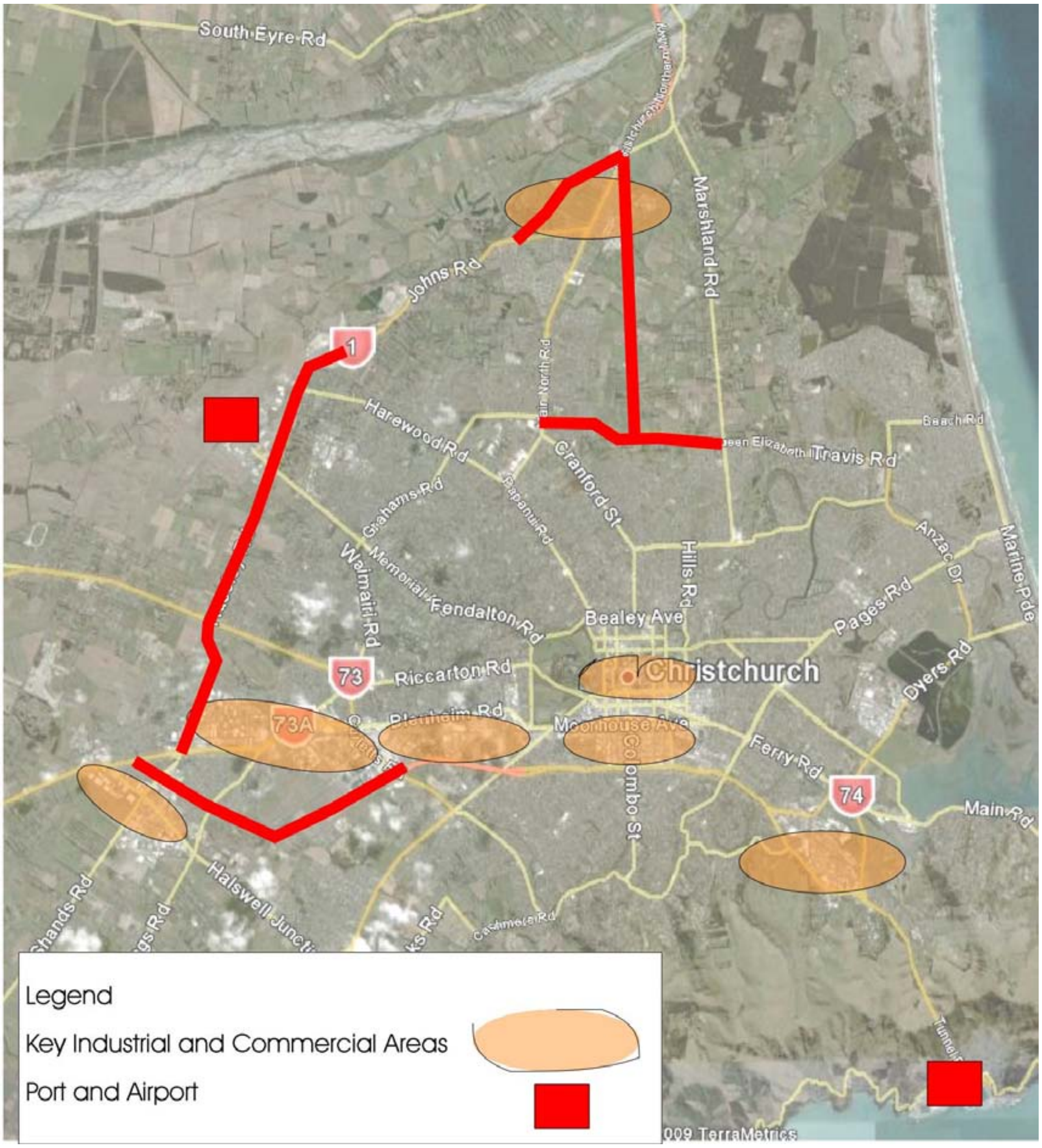


Figure 6.2
The Christchurch Motorways and Major Industrial and Commercial Areas

Together with the existing motorway network, the new links would:-

- Support activity in the key Moorhouse Road/Blenheim Road corridor and link this with the port
- Form part of the longer distance route from the port to the south and west and north via SH1
- Provide improved links between the airport and industrial and commercial areas to the north and south
- Connect Belfast with the main industrial areas to the south
- Provide a better route for through traffic

The improved linkages between the industrial areas will enable them to interact more effectively helping them gain the benefits of operating in larger cluster of firms and of being able to serve their markets more effectively and hence would tend to encourage increased employment. Particular benefits would arise if this facilitated the development or expansion of export related activities supported by the improved links to the port and airport.

Good airport links are also an important consideration in encouraging new development by overseas firms and agencies and the international airport at Christchurch forms a key component of this. The improvements in accessibility and in journey time reliability that the Christchurch motorways will deliver will therefore play a part in this.

6.7.4 Freight Movements

The Christchurch Motorways will serve both longer distance through traffic as well as more local movements within or to or from the Christchurch area.

The volume of longer distance traffic is probably fairly small. From the NFDS, it was estimated that the volume of inter-regional traffic by road passing through Canterbury was about 0.5 million tonnes per year, mainly retail commodities moving from the Auckland area to Otago and Southland. This would be equivalent to about 150-200 heavy vehicles per day. The current freight flows on the main routes through Christchurch are much higher indicating that the majority of the freight traffic represents more local movements associated with manufacturing and distribution activity within the Christchurch and broader Canterbury areas.

6.7.5 Movements through Port of Lyttelton

A key function of the Christchurch Motorways is to serve the port of Lyttelton and distribute the port traffic through the Christchurch area. The total volume of international traffic handled at Port of Lyttelton in 2008 was about 5 million tonnes made up of 1.6 million tonnes of imports and about 3.4 million tonnes of exports and the volumes through the port have generally been increasing. This is set out in Figure 6.3.

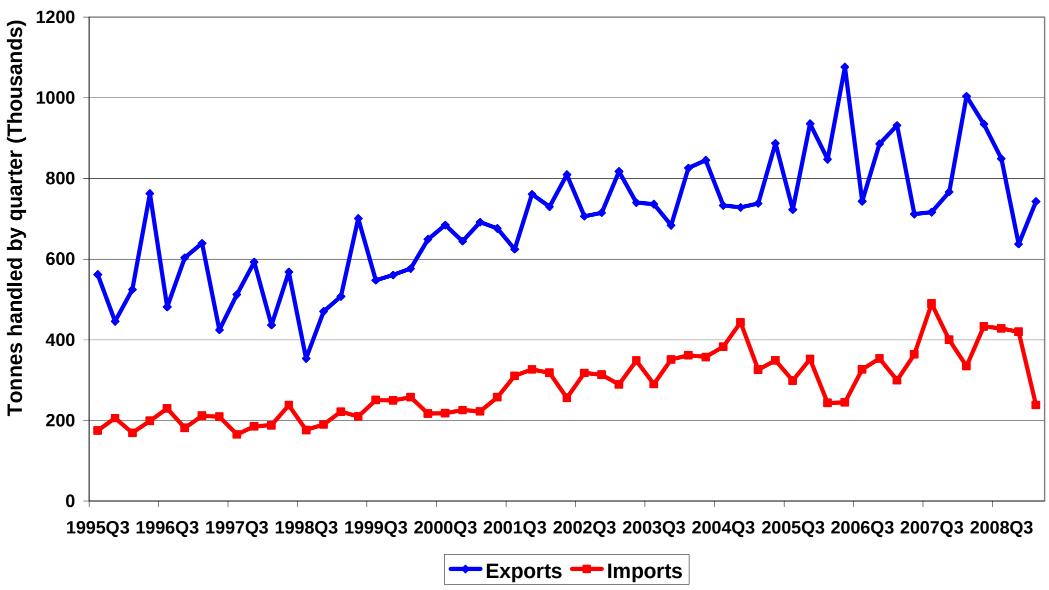


Figure 6.3
International Trade through Lyttelton Port 1995-2008
(Thousand tonnes per quarter)

Detailed information on the breakdown of traffic is available for 2006-07 when the total volumes handled amounted to about 1.3 million tonnes of imports and 3.3 million tonnes of exports. Outbound traffic is dominated by coal which is transported by rail, but other commodities exported included:-

- dairy products (0.12 million tonnes),
- logs and timber products (0.39 million tonnes),
- meat and wool (0.13 million tonnes),
- fish and other agricultural products (0.18 million tonnes),
- food and beverages (0.10 million tonnes) and
- other minerals and manufactured goods (0.20 million tonnes)

The main imports included:-

- Petroleum (0.36 million tonnes)
- Fertiliser and other minerals (0.36 million tonnes)
- Metals and chemicals ((0.11 million tonnes)
- Food and beverages ((0.27 million tonnes)
- Manufactured goods (0.27 million tonnes)

The port of Lyttelton has an important regional function providing a route to export goods grown or produced locally and also a route for the imports necessary to support manufacturing and other economic activity and the population in the area. While considerable volumes are transported to the port using rail, road links are very important for those commodities which cannot be effectively handled by rail or coastal shipping and also to supplement and balance these other modes.

6.7.6 Christchurch International Airport

Christchurch International Airport is also an important gateway to the region, both for passengers and freight. Although the volume of freight transported is relatively low at about 25,000 tonnes per year, its value is relatively high amounting to about $1.4 billions in 2006-07 or about 28 per cent of the value of commodities handled by Lyttelton Port. Air freight with its emphasis on rapid delivery is very dependent on a fast and reliable road system to collect and distribute the goods and documents handled.

The airport currently handles about 6 million passengers per year, of which about 75 per cent are domestic passengers and about 25 per cent international. To the extent that these passengers are visitors to the region rather than residents returning home, the airport therefore makes an important contribution to the international and domestic tourism sectors.

6.7.7 Tourism

Canterbury is a major tourist area and in 2007 attracted over 10 million tourist nights. In that year, it was estimated that 57 per cent of these nights were in respect of international visitors and it is likely that a high proportion of these will travel via the airport. Improving the connections to the airport will facilitate the movement these tourists. This may be a particular issue for tourists from Australia who make up about 12 per cent of the total nights spent in Canterbury but who tend to come for stays that are shorter than those for international visitors in general (12 nights compared to an average of 22 nights for all visitors). For these visitors on relatively short stays improving the transport network allowing a wider range of destinations and activities to be reached in a constrained time period may be particularly important in encouraging the growth of this market

6.7.8 Overall Assessment

This assessment of the potential impacts of the completion of the Christchurch Motorways has indicated the forecast employment increases are fairly modest in relation to recent growth and also to the potential increases in economic activity across a range of sectors which should be generated by the new road links.

6.8 Overall Findings in Relation to the RoNS Employment Forecasts

The assessment of the forecast increases in employment within the areas of influence of the RoNS indicates that these are in all cases modest in relation to recent growth. The RoNS are typically supportive of the development and plans and strategies for the regions and territorial authorities in which they are located and in general are supportive of the movements of primary products between producing areas and markets both within New Zealand and overseas via the key ports of Auckland, Tauranga, Wellington and Christchurch. These would tend to support the forecasts of increased employment.

7 The Results of the Evaluation of the WEBs for the RoNS

7.1 Benefits in 2016

The preliminary results of the evaluation of the wider economic benefits of the RoNS in 2016 including the agglomeration/productivity effects and the employment/growth effects are brought together and summarised in Table 7.1. For comparative purposes, these also include estimates of the benefits as derived from the GE model assuming fixed rates of return and the conventional transport economic benefits estimated for 2016.

Because of the approach taken the benefits derived from the agglomeration and employment impacts can be taken as additive to the total benefits derived from the conventional economic appraisal. The GE model benefits however do include some overlapping with the conventional economic benefits, and this is taken into account in the final column.

Table 7.1
Wider Economic Benefits from the RoNS : Low Forecasts
Annual Benefits in 2016 in 2008 prices ($m)

	Agglom	Emp Changes	Total WEBs – bottom up approach	Conv Ec Benefits (CEBs)	CEBs+ WEBs	GE Model Benefits (GEBs) (1)	GEBs+ adj CEBs
Puhoi-Wellsford	NA	35	35	95	130	130	190
WRR	70	70	135	305	440	285	490
Waikato Expressway	10	90	100	85	185	145	210
Tauranga Eastern Corridor	10	30	40	70	110	80	115
Wellington Northern Corridor	30	75	105	130	235	220	310
Christchurch Motorways	25	25	50	110	160	100	175
Total	**145**	**325**	**465**	**795**	**1260**	**965**	**1490**

Note. Individual items may not sum to totals because of rounding
(1) The GE model benefits are those assessed for each scheme individually. These are slightly higher than the totals which would be achieved if the programme as a whole was assessed.

The estimate of the WEBs derived from the assessment of the agglomeration impacts is about 15-20 per cent of the conventional economic benefits, a figure that is broadly in line with the results obtained elsewhere. The estimates of the employment impacts are rather higher at about 40 per cent of the conventional economic benefits, but for this component, there are no established guidelines. In total the estimates of WEBs from agglomeration and employment benefits amount to about 60 per cent of the conventional economic benefits, possibly demonstrating the importance of these routes in contributing to increased productivity and economic activity.

The impacts of the WEBs estimated from this bottom up approach ($465 millions) would be approximately two thirds of the increment to benefits estimated by the GE modelling ($1490-$795 or $695 million). The total benefits for the schemes including the WEBs are overall about 85 per cent of those which incorporate the results of the GE modelling, indicating that the two approaches give results of similar orders of magnitude.

The results are also summarised graphically in Figure 7.1.

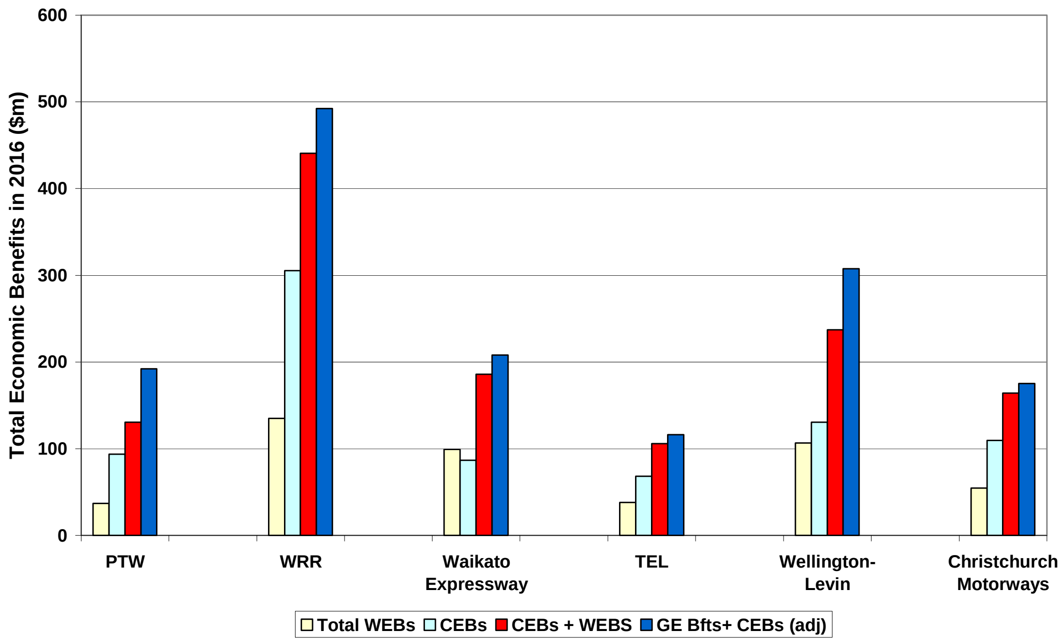


Figure 7.1
Wider Economic Benefits from the RoNS : Low Forecasts ($m in 2016)

While the position varies from scheme to scheme, the incorporation of the wider economic benefits typically increases the economic returns significantly.

7.2 Ramping Up of Impacts

In accordance with the procedures set out in the EEM, it has been assumed that agglomeration benefits arise quickly and no specific ramp –up factors have been assumed. The forecast employment changes, the achievement of which may require complementary action on the part of other agencies are however likely to take longer to come about and a fairly conservative ramp-up period of 10 years has been assumed over which the share of the full level of benefits is assumed to grow linearly.

8 Overlaps and Differences between the Bottom-up Approach and the GE Model

In principle, the GE model and the bottom up approach largely aim to measure a similar item, the change in the output of the economy, although there are differences in the mechanisms by which this is assumed to be achieved and the ways in which this are estimated. At a broader level, there are however variations between the two approaches in respect of:-

- The spatial coverage of the models
- The extent to which the labour force is assumed to be fixed

The bottom up approach outlined above only takes into account influences within the area of influence of the road which in part is defined by the extent of any traffic modelling and in part reflects the area over which significant employment effects are likely to be experienced. The GE modelling on the other hand considers the linkages and impacts across the economy as a whole and is not confined to the road corridor. In principle, therefore it would be easier to identify the impacts associated with the bottom up approach although as discussed there are very substantial challenges with this, as the effects are likely to occur over extended time periods and it may be difficult to isolate the effects of road building from other changes which have taken place over this period.

The GE model also assumes that the labour force is effectively fixed, whereas the bottom up approach assumes that this changes in response to the employment opportunities arising as the result of changes in accessibility with the new or improved routes.

It is not possible to estimate the magnitude of these impacts or the overall effect that these might have on the total estimate of benefits, since this is probably masked by the different approaches to the estimation of the core element of the benefits.

9 Overall Assessment

The conventional economic analysis of the impacts of transport schemes primarily focuses on changes in travel conditions for journeys that would be made whether or not the new scheme was in place. It does not therefore include the impacts that road building might have on the level and patterns of economic activity and employment. However, a wide range of evidence suggests that road building may indeed have these wider economic impacts but to date there have only been limited attempts to quantify these. In part, this reflects the length of time over which these impacts might emerge and the difficulty of distinguishing the effects of road building from other possible influences. Despite these problems, agencies around the world are increasingly recognising the importance of WEBs and procedures for estimating at least some of their components are becoming embodied in standard evaluation procedures.

Notwithstanding the limited data available, an assessment of wider economic benefits of the RoNS has been made, taking into account both the agglomeration impacts (the productivity effects), likely to arise within major urban areas, and the employment impacts (growth effects) likely to be experienced more widely.

For the agglomeration impacts, the broad approach set out in the EEM has been followed. For the employment effects, for interurban schemes use has been made of the results of studies from overseas which have suggested that new roads can increase the numbers employed in the broad area of influence of the road by between 0.4 per cent and 4 per cent. For urban schemes, use has been made of the relationships between employment impacts and agglomeration derived from a limited number of overseas studies and also taking cognisance of recent work undertaken in New Zealand on the AMETI scheme.

On the basis of this approach the wider economic benefits generated by the RoNS are estimated to amount to about 65 per cent of the conventional economic benefits, with agglomeration representing about 20 per cent and employment effects the remaining 45 per cent. In the light of the evidence available , the approach taken is probably conservative, and while there are issues with the limited data available and with the use of results from different schemes and countries, the findings suggests that the wider economic benefits from the RoNS are likely to be substantial in relation to the benefits traditionally calculated. This indicates the importance of these schemes in improving productivity and raising economic output in New Zealand.

Appendix A

Details of the Calculation of Employment Benefits on Inter-Urban Links

1 Introduction

This appendix sets out the details of the calculation of the impacts on employment and the benefits that might result for the inter-urban sections of the RoNS. These include:-

- Puhoi-Wellsford
- Tauranga Eastern Corridor
- Waikato Expressway North
- Waikato Expressway South
- Foxton to Mackays Crossing
- Mackays Crossing to Ngauranga

The background to the approach has been set out in detail in the main report. For the calculation of these impacts there is no standard approach and there is only very limited evidence on the potential effects from overseas. This appendix sets out how the approach was applied for each of the RoNS sections identified.

2 Parameters used in the Appraisal

2.1 Potential Employment Creation

The level of employment likely to be generated by the RoNS has been based on the analysis of the position following the construction of the M62 motorway and of the Severn Bridge, both in the UK. The range of employment creation was estimated to lie within the range of 0.4 per cent to 4 per cent of the employment within the broad area of influence of the road. The higher figure was associated with the Severn Bridge, which provided a fairly significant step change in accessibility in the South Wales area, replacing either a ferry or a very circuitous route with a direct bridge and motorway connection. This may represent an improvement in accessibility that is rather more substantial than that likely to arise with any of the inter-urban RoNS. The analysis has therefore been based on the response identified for the M62 while recognising that this does lie at the lower end of the range observed and which may therefore be conservative.

The potential employment generation factor of 0.4 per cent has also been used as a maximum figure for the impact on specific areas within the broad area of influence of the RoNS and lower figures have been used in a number of instances, where areas are more remote from the scheme. In practice because of this, the average increases in employment achieved were less than 0.4 per cent, a further element of conservatism in the forecasts.

It was also recognised that employment effects would take time to become realised. For the analysis, it was therefore assumed that these effects would start emerging when the scheme was opened and would take 10 years to be fully achieved.

2.2 Employment Estimates

Employment estimates were derived from the results of the 2006 Census on the basis of employment by workplace by TLA.

2.3 Estimates of GDP per worker

The evaluation uses estimates of average GDP/head for 2006 in 2008 prices. The derivation of these figures has been set out in WP6, but the figures used for appraisal are set out in Table A2.1 for all areas excluding Auckland and in Table A2.2 for the areas within the Auckland Region.

Table A2.1
Estimated Values of GDP per worker 2006 in 2008 Prices

Region	GDP per worker 2001 in 2001 Prices	GDP per worker 2006 in 2008 Prices
Northland	56511	70500
Auckland	75446	94000
Waikato	62095	77500
Bay of Plenty	60886	76000
Gisborne	53610	67000
Hawke's Bay	60028	75000
Taranaki	99930	124500
Manawatu-Wanganui	53235	66500
Wellington	81610	101500
Average North Island	70926	88500
Tasman / Nelson	51838	64500
Marlborough	53516	66500
West Coast	54134	67500
Canterbury	56516	70500
Otago	53935	67000
Southland	63211	79000
Average South Island	56061	70000
Average New Zealand	**67139**	83500

Table A2.2
Adjustments for the Auckland Region

Area	Average Value Added per worker (VAPW) in 2006 ($)	Percentage of Auckland Regional Average	Average GDP/ Worker 2006 at 2006 prices	Average GDP/ Worker 2006 at 2008 prices
Auckland Region	65135	100%	**88400**	**94000**
Auckland City	76930	118%	104000	110900
Auckland CBD	106873	164%	144500	154200
Manukau City	63274	104%	92100	98000
Waitakere City	40058	61%	53500	56900
North Shore	53714	82%	72900	77600
Rodney	38237	59%	51900	55200
Papakura/Franklin	54625	84%	74100	78900

Source : MED Occasional Paper 08/09 and Consultants Estimates

2.4 Level of Assessment of Employment Generation Potential

The employment impacts were estimated at a TLA level, and for areas outside the Auckland Region, the appropriate **regional** GDP per worker was applied to this figure. Other than for areas within the Auckland region, no attempt was made to establish a more disaggregated estimate of GDP per worker.

3 Analysis of Individual Schemes

The details of the estimation of the employment impacts for the various RoNS components are set out in Tables A3.1 to A3.6. The level of response for each of the individual areas is based on its proximity to the route and also to a limited extent on the nature of the upgrading proposed, with the smaller scale works proposed for Foxton-Mackays Crossing having a smaller impact than the other more significant upgrading work proposed elsewhere.

Typically, because of the way in which the individual components are estimated, the employment effects are 0.3 per cent of less of the total employment in the defined area of influence of the scheme, and the tables include the average figure. The exception to this is for the Tauranga Eastern Corridor, where the provision of the new road is specifically linked to the development of the Rangiuru Business Park.

Table A3.1
Estimation of Employment Impacts : Puhoi-Wellsford

TAs in Area of Influence	Employment in Area of Influence 2006	Employment Generation Factors	Increase in Employment	GDP/ worker 2008 2006 prices	Total Increase in GDP in 2006 2008 prices ($m)
Far North	18,102	0.2%	36	70500	2.6
Whangarei	27,942	0.4%	112	70500	7.9
Kaipara	6,603	0.4%	26	70500	1.9
Rodney	25,953	0.4%	104	55211	5.7
North Shore	79,974	0.2%	160	77560	12.4
Total	**158,574**	***(0.28%)***	**438**		**30.4**

Table A3.2
Estimation of Employment Impacts : Waikato Expressway North

TAs in Area of Influence	Employment in Area of Influence 2006	Employment Generation Factors	Increase in Employment	GDP/ worker 2008 2006 prices	Total Increase in GDP in 2006 2008 prices ($m)
Manukau	98,919	0.2%	198	98025	19.4
Papakura	13,572	0.2%	27	78875	2.1
Franklin	18,402	0.4%	74	78875	5.8
Waikato	11,988	0.4%	48	77400	3.7
Hamilton	60,816	0.2%	122	77400	9.4
Total	**203,697**	***(0.23%)***	**468**		**40.5**

Table A3.3
Estimation of Employment Impacts : Waikato Expressway South

TAs in Area of Influence	Employment in Area of Influence 2006	Employment Generation Factors	Increase in Employment	GDP/ worker 2008 2006 prices	Total Increase in GDP in 2006 2008 prices ($m)
Hamilton	60,816	0.2%	122	77,400	9.4
Waikato	11,988	0.2%	24	77,400	1.9
Waipa	14,745	0.4%	59	77,400	4.6
S Waikato	7,491	0.4%	30	77,400	2.3
Matamata-Piako	12,642	0.2%	25	77,400	2.0
Total	**107,682**	***(0.24%)***	**260**		**20.1**

Table A3.4 **Estimation of Employment Impacts : Foxton-Mackays Crossing**					
TAs in Area of Influence	Employment in Area of Influence 2006	Employment Generation Factors	Increase in Employment	GDP/ worker 2008 2006 prices	Total Increase in GDP in 2006 2008 prices ($m)
Palmerston North	38,100	0.1%	38	66,363	2.5
Manawatu	9,285	0.1%	9	66,363	0.6
Horowhenua	9,321	0.2%	19	66,363	1.2
Kapiti Coast	11,901	0.2%	24	101,735	2.4
Porirua	12,765	0.1%	13	101,735	1.3
Total	**81,372**	***(0.13%)***	**103**		**8.1**

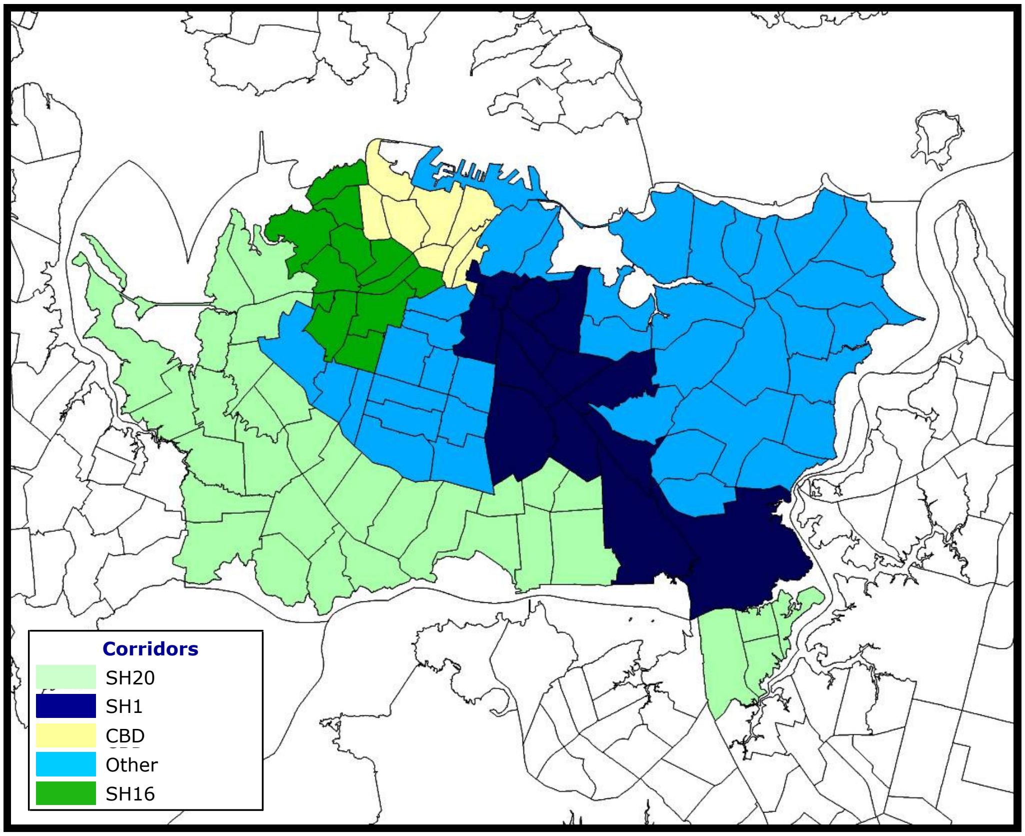
Table A3.5 **Estimation of Employment Impacts : Mackays Crossing-Wellington North**					
TAs in Area of Influence	Employment in Area of Influence 2006	Employment Generation Factors	Increase in Employment	GDP/ worker 2008 2006 prices	Total Increase in GDP in 2006 2008 prices ($m)
Horowhenua	9,321	0.2%	19	66363	1.2
Kapiti Coast	11,901	0.2%	24	101735	2.4
Porirua	12,765	0.2%	26	101735	2.6
Hutt	36,930	0.2%	74	101735	7.5
Wellington	111,660	0.2%	223	101735	22.7
Total	**182,577**	***(0.2%)***	**365**		**36.5**

Table A3.6 **Estimation of Employment Impacts : Tauranga Eastern Corridor**					
TAs in Area of Influence	Employment in Area of Influence 2006	Employment Generation Factors	Increase in Employment	GDP/ worker 2008 2006 prices	Total Increase in GDP in 2006 2008 prices ($m)
Tauranga	44,127	0.4%	177	77408	13.7
Western Bay of Plenty	13,296	0.4%	53	77408	4.1
Rotorua	26,331	0.2%	53	77408	4.1
Kawerau	3,048	0.2%	6	77408	0.5
Whakatane	11,271	0.2%	23	77408	1.7
Total	**98,073**	***(0.31%)***	**311**		**24.1**

In total, the inter-urban sections of the RoNS are estimated to generate about 2,000 new jobs over 10 years. This can be compared to a total of about 630,000, within the areas of influence of the schemes.

Appendix B

Strategic Corridors in Auckland City



Addendum 1

More Detailed Assessments of Wider Economic Benefits for Puhoi-Wellsford and Wellington Northern Corridor

1 Puhoi-Wellsford RoNS

In parallel with the assessment of the wider economic benefits of the RoNS in general, a more detailed assessment was made of these benefits as part of the development of the detailed Business Case for the Puhoi-Wellsford RoNS. This was based on a review of the particular activities which would be affected by the improvement of the route. Attention was focussed on two areas, tourism and the forestry sector.

The assessment of the impact on tourism took into account the changes that had occurred following the construction of the Northern Motorway to Orewa. From this, it was estimated that the reductions in journey times and improvements in travel time reliability particularly for trips from the main Auckland urban area would generate net benefits to the tourism sector of about $20 millions per year.

For the forestry sector, it was considered that the upgrading of the connection between the major growing areas in Northland and Auckland would encourage the production of value added products destined either for the main domestic market in New Zealand or overseas markets accessed via the port in Auckland. This production would substitute for the export of unprocessed logs and woodchip directly through Marsden Point. The benefits from this were estimated very conservatively at about $10-15 million per year at current levels. The total impact of the RoNS on economic output was therefore estimated at about $35 million in 2016.

It is proposed that the route be constructed in two phases starting with Puhoi to Warkworth opening in 2019 and Warkworth to Wellsford opening ten years later. The total wider economic benefits were split between these two parts of the project in the ratio 60:40, broadly in line with the conventional economic benefits. The WEBs were also assumed to grow at the same rate as the traffic benefits, at about 4 per cent per year between 2016 and 2026 and 1.5 per cent subsequently. This compares with the assumption of a constant 2 per cent per year growth factor in the general RoNS analysis.

The total discounted WEBs incorporated into the Puhoi-Wellsford RoNS business case amount to about $160 million. This takes into account the effects of staging the construction of the route. The total of $160 million compares with a total of about $170 million, estimated using the general approach to the estimation of WEBs for the RoNS described in the main body of the report with the scheme opening fully in 2019 and with a standard 2 per cent per year growth throughout the evaluation period.

2 Wellington Northern Corridor RoNS

For the Business Case for the Wellington Northern RoNS, the initial assessment of the agglomeration benefits undertaken for the general approach to the RoNS was replaced by a more detailed assessment of these impacts. In particular, this estimated the detailed agglomeration elasticities for each zone, calculated on the basis of the breakdown of employment set out in the 2006 Census rather than using the average figure for New Zealand in general. The detailed analysis for the Wellington Northern RoNS also calculated the agglomeration benefits for two separate years, 2016 and 2026 rather than just for 2016 as was used in the general RoNS analysis.

The more detailed approach gave estimates of agglomeration benefits of $25 million for 2016 and $41 million for 2026. This compared with the earlier estimate of $30 million for 2016, which using the assumed growth factor would increase to about $37 million by 2026. Taking these two factors into account, the lower value in 2016 but the faster growth rate to 2026, the total value of the agglomeration benefits was estimated. The effect of the more detailed approach was to increase the overall discounted agglomeration benefits over a 30 year period by about 10 per cent, from an estimated value of $177 million implied by the general RoNS approach to the $195 million reported in the Wellington RoNS Business Case. Converting to a 2008 year zero would give values of $188 million and $208 million respectively.

3 Overall Conclusions for the Puhoi-Wellford and Wellington Northern Corridor RoNS

Alternative approaches to the standard approach initially developed have been developed for the calculation of wider economic benefits to be used in the detailed Business Cases for the Puhoi-Wellsford RoNS and to the calculation of agglomeration benefits for the Wellington Northern Corridor RoNS. While there are some differences in approach, the net impact on the total values estimated for these are small. For the Puhoi-Wellsford RoNS the different approach and the application of the benefits in line with the proposed staging of the project reduces the total NPV of the wider economic benefits from about $170 million to $160 million and for the Wellington Northern Corridor the more detailed approach increases the reported agglomeration benefits from $177 million to $195 million.

booz&co.

To	Dave Gennard	*Date*	30 November 2009
From	Ellen Burnes	*City*	Sydney
Subject	Review of Richard Paling's Report, *The Estimation of the Wider Economic Benefits (WEBs) of the RoNS using a Bottom Up Approach*	*cc*	Richard Hancy

memo

This memo provides peer review comments for Richard Paling's report, ***The Estimation of the Wider Economic Benefits (WEBs) of the RoNS using a Bottom Up Approach*** (The Paling Report). This report was part of a larger overview assessment completed by SAHA (September 2009) to address the first of two key questions:

1. Are there quantifiable ***wider economic benefits*** associated with the portfolio of RoNS projects?, and
2. If such benefits exist and are quantifiable, are they of sufficient scale to justify accelerating the implementation of the RoNS as a portfolio?

Overview

Population size and distance between economic centres have long been recognised as key drivers of economic activity. Gravity models, which weight population centres by their distance from one another are one way of calculating the relative influence of economic centres. Recently, travel time between centres has also been added to the models. This supports the development of transport planning from 'simply' connecting places, to connecting more efficiently. Agglomeration methods link employment and travel time to economic output. Agglomeration work developed and applied in the United Kingdom as part of the The Eddington Transport Study[1], demonstrated that it was possible to quantify the additional economic benefits stemming from 1) decreased transport costs 2) higher employment 3) firm-level efficiencies due to proximity to production inputs, and 4) cross-firm efficiencies from access to knowledge and innovation.

Richard Paling's work applies recently recommended New Zealand agglomeration factors to the RoNS projects and demonstrates that there are additional, quantifiable indirect benefits which may be generated by new roads investments.

---

[1] *The Eddington Transport Study was completed in December 2006examine the long-term links between transport and the UK's economic productivity, growth and stability, within the context of the Government's broader commitment to sustainable development. The agglomeration methods developed and applied within this study have set a global standard for calculating and interpreting the wider economic benefits associated with agglomeration.*

Such agglomeration benefits are largest for service industries and lowest for resource-based industries. When assessing the order of magnitude of likely effects through an agglomeration elasticity measure, it should be viewed through the local industry mix.

Agglomeration elasticity *measures the change in productivity as a result in the change of 'effective density', the ratio of changes to employment over changes in travel costs.*

Two WEBs Addressed in Paling Report

The Paling report addresses two potential sources of WEBs: agglomeration and employment effects of agglomeration. Each of these WEBs is addressed in the following sections.

1. Agglomeration

The recent recommendations by Graham and Mare (Agglomeration Elasticities in New Zealand, NZTA Research Report 376) to the NZTA were used for this work. The agglomeration elasticity used across the regions was 0.069. This may be somewhat higher than those proposed by Graham and Mare but sensitivity studies completed by Richard Paling during this review indicate that agglomeration benefits occur at approximately the same level.

Furthermore, the level of benefits achieved demonstrates the expected higher levels in the larger cities of Wellington and Christchurch, and lower levels in Hamilton and Tauranga. Hence, one could draw the conclusion that the model is likely well calibrated for the economies it is being used to assess.

In summary, the agglomeration methods followed in the Richard Paling report are consistent with those recommended by the NZTA in the EEM. The results are within expected bounds of an agglomeration study.

2. Employment

As Richard Paling notes, modelling on the employment benefits under agglomeration is less well developed. If the employment benefits were the deciding factor for the roads, there would be less confidence in the measures obtained. However, as they are placed in the current report, they are a useful indicator that agglomeration and production efficiency may have further positive follow effects.

Through other measures, the Infometrics report also validates this work. *It should be noted that it is not possible to separate GE and agglomeration employment effects and these should correspondingly NOT be added in order to avoid double counting.*

The section that presents the modest employment effects within the various regions is useful to demonstrate the relatively small effect that agglomeration driven employment would possibly have in a region.

In summary, given the limited data the employment numbers appear feasible. The process is well-documented, and the careful regional analysis indicates that the employment effects are consistent with regional levels of economic development and employment activity.

Conclusion

While it would be useful to see more detail on the functional form and modelling, it appears that Richard Paling has undertaken thorough consideration of the literature, the models developed to date in New Zealand, and the data available for populating the model.

Sensitivity studies undertaken as a result of conversations during the peer review process indicate that the order of magnitude of the results is robust. Hence, Richard Paling's work indicates an affirmative response to the questions which his work was intended to inform: there are wider economic benefits to transport projects, and they can be quantified (with qualification).

SAHA

Appendix D – Infometrics report – General Equilibrium Analysis of RoNS

- Update to General Equilibrium Analysis of RoNS – Infometrics
- General Equilibrium Analysis of RoNS – Infometrics
- Peer review of Infometrics CGE report – Booz & Co
- Response to peer review – Infometrics
- Graphical representation of CGE – Booz & Co

General Equilibrium Analysis of Roads of National Significance (updated Waikato Expressway)

report to
New Zealand Transport Agency

Prepared by Infometrics Ltd

May 2010

CONTENTS

Authorship

This report has been prepared by Dr Adolf Stroombergen.

Email: astro@infometrics.co.nz

All work and services rendered are at the request of, and for the purposes of the client only. Neither Infometrics nor any of its employees accepts any responsibility on any grounds whatsoever, including negligence, to any other person or organisation. While every effort is made by Infometrics to ensure that the information, opinions and forecasts are accurate and reliable, Infometrics shall not be liable for any adverse consequences of the client's decisions made in reliance of any report provided by Infometrics, nor shall Infometrics be held to have given or implied any warranty as to whether any report provided by Infometrics will assist in the performance of the client's functions.

1. WAIKATO EXPRESSWAY

This paper updates Infometrics (2009)[1] with revised data for the Waikato Expressway.

The revised input data has approximately double the travel time savings, vehicle operating costs changed from a net cost to a net benefit, and a small increase in safety benefits. In addition, property costs have been excluded from capital costs, as from an economy-wide perspective this is merely a transfer of ownership of an existing asset. Table 1 shows the results.

Table 1: Macroeconomic Effects of Waikato Expressway (Fixed Rates of Return)

			BAU	2020 Run 1 WEX		2020 Run 1b WEX	
			$m(05/06)	Δ %	Δ $m	Δ %	Δ $m
	Consumption (private +govt)		180086	0.07%	125	0.14%	254
	Exports		71630	0.09%	63	0.17%	121
	Imports		78169	0.05%	36	0.09%	74
	GDP		232576	0.08%	193	0.17%	385
	RGNDI		231284	0.07%	167	0.14%	335
	Population ('000)		4734	0.00%	0	0.00%	0
	RGNDI/capita ($)		48856	0.07%	35	0.14%	71
	Real wage rate (index)		1.3882	0.04%		0.08%	
	Household effective income tax rate (%)		15.83	0.13%		-0.06%	
	CO_2 emissions (kt) [$100/t]		74761	0.11%	80	0.15%	115
		Source					
A	Capital cost undiscounted	NZTA	$m		1619.4		1454.4
B	Typical yearly maintenance & operation	NZTA			1.4		1.4
C	Tolls	NZTA					
D=0.06A-B	Financing charge at 6% (less tolls)				97.2		87.3
E=F+G+H	Total gross benefit in 2020		$m		86.8		186.3
F	Safety	NZTA	$m		19.3		20.1
F1	Loss of life & permanent disability^				13.8		13.8
F2	Lost output				0.7		0.7
F3	Health care				0.3		0.4
F4	Vehicle repair				4.3		5.0
F5	Legal				0.2		0.2
G	Vehicle operating costs	NZTA			-11.7		6.3
H	Travel and congestion time	NZTA	$m		79.2		159.9
I	Travel and congestion time	NZTA	m hrs		4.3		8.8
I1	Work				1.7		3.4
I2	Commuting				0.4		0.8
I3	Other				2.3		4.6
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*		$m		24.0		74.3
K1	Change in RGNDI from model	model			167.3		334.7
K2	- inflated to 2008 prices	1.072			179.3		358.8
L=K2/J	Ratio GE benefits to market benefits				7.46		4.83
M=(K2+E-J)/E	Overall increase in total benefits				2.79		2.53

Notes: ^Assume Run 1b as for Run 1
*Pro rata on travel time.

[1] Infometrics (2009): *General Equilibrium Analysis of Roads of National Significance*, report to New Zealand Transport Agency.

Run 1 is the original and Run 1b has the updated input data. For these runs the capital closure rule is such that rates of return are held constant. This allows the model to increase investment and thus the size of the economy if rates of return are subject to upward pressure caused by the productivity increases associated with the RONS. Fixed capital stock versions are discussed below.

It was noted in the previous report, that the economy-wide benefits of all the RONS combined are less than the linear summation of the economy-wide benefits of the individual RONS. There are two reasons for this:

- The percentage compounding effect. For example if two RONS projects each improve labour productivity by 0.5%, their combined effect is 1-0.995^2=0.9975%, not 1%.

- Diminishing marginal utility. The price of a good has to fall by ever increasing amounts to maintain the utility of further increments in consumption.

The same reasons are why the economy-wide benefits of the revised scenario (Run 1b) increase by less than the direct increase in benefits. In addition though, while any reduction in vehicle operating costs (whether via lower fuel costs, lower repair costs or a lower replacement rates) is a direct benefit to the consumer or motorist, the net economic benefit is only as large as the increment to economic welfare achieved by resources (labour and capital) moving out of vehicle repairs and oil refining and into other industries. The size of this benefit is generally much less than the gross value of the savings to the consumer.

Notwithstanding these points, the macroeconomic differences are still significant with the change in RGNDI (real gross national disposable income) being double the earlier figure.[2] The change in real wage rates is also double and instead of household tax rates having to rise to offset the government's spending on roads, there is now enough growth in the economy for tax rates to fall.

Table 2 shows the situation under the alternative capital closure rule where the total capital stock is fixed at the BAU level. Run 1a is the original run and Run 1c has the updated data.

The capital closure rule constrains the model to produce roughly the same benefits as are fed into it. In the case of the Waikato Expressway though some additional benefits arise from improvements in allocative efficiency.

The change in RGNDI more than doubles compared to Run 1a, so the proportional effect is greater under this variant of the capital closure rule, but of course the absolute change is much smaller than between Runs 1 and 1b.

The ratios in rows L and M decline in Run 1c compared to Run 1a, again reflecting nonlinear and diminishing returns.

[2] RGNDI is equal to gross domestic product (GDP) plus net factor payments overseas plus an allowance for changes in the terms of trade. It is a better measure of the real income available to New Zealanders than GDP.

Table 2: Macroeconomic Effects of Waikato Expressway (Fixed Capital Stock)

			2020 Run 1a WEX		2020 Run 1c WEX	
			Δ %	Δ $m	Δ %	Δ $m
	Consumption (private +govt)		0.01%	27	0.04%	68
	Exports		0.03%	24	0.07%	47
	Imports		0.02%	13	0.04%	29
	GDP		0.02%	47	0.05%	109
	RGNDI		0.02%	41	0.04%	92
	Population ('000)		0.00%	0	0.00%	0
	RGNDI/capita ($)		0.02%	9	0.04%	19
	Real wage rate (index)		-0.04%		-0.06%	
	Household effective income tax rate (%)		0.19%		0.00%	
	CO_2 emissions (kt) [$100/t]		0.06%		0.07%	
		Source				
A	Capital cost undiscounted	NZTA		1619.4		1454.4
B	Typical yearly maintenance & operation	NZTA		1.4		1.4
C	Tolls	NZTA				
D=0.06A-B	Financing charge at 6% (less tolls)			97.2		87.3
E=F+G+H	Total gross benefit in 2020			86.8		186.3
F	Safety	NZTA		19.3		20.1
F1	Loss of life & permanent disability^			13.8		13.8
F2	Lost output			0.7		0.7
F3	Health care			0.3		0.4
F4	Vehicle repair			4.3		5.0
F5	Legal			0.2		0.2
G	Vehicle operating costs	NZTA		-11.7		6.3
H	Travel and congestion time	NZTA		79.2		159.9
I	Travel and congestion time	NZTA		4.3		8.8
I1	Work			1.7		3.4
I2	Commuting			0.4		0.8
I3	Other			2.3		4.6
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*			24.0		74.3
K1	Change in RGNDI from model	model		41.5		91.9
K2	- inflated to 2008 prices	1.072		44.5		98.5
L=K2/J	Ratio GE benefits to market benefits			1.85		1.33
M=(K2+E-J)/E	Overall increase in total benefits			1.24		1.13

Notes: ^ Assume Run 1b as for Run 1
*Pro rata on travel time.

2. ALL RONS

Tables 3 and 4 updates Tables E1 and E2 of the previous report. In each case the All RONS scenarios have also been revised as a consequence of the changes to the Waikato Expressway.

Table 3 shows a total change in RGNDI of approximately $1.4 billion in 2008 prices, or about 0.6% of RGNDI. This allows for an annual financing charge of about $0.6 billion, which the government obtains from tax revenue to repay the debt incurred in building the RONS.

For modelling purposes all of the RONS are assumed to be fully operational in 2020. Clearly this will not happen, but we may interpret the 0.6% of RGNDI as being an estimate of the annual benefit of the RONS in whatever year they become fully operational, and thereafter over their lifetime.

Under the fixed capital stock closure rule (Table 4) the change in RGNDI is only about $0.4 billion, the same as the partial equilibrium benefits that are fed into the model.

With the investment response shut off, the only additional benefits that a GE model can reveal are those attributable to changes in allocative efficiency. In most cases these are high enough to deliver a benefit-cost ratio that exceeds the comparable ratio from partial equilibrium benefit-cost analysis. However, there are two cases where data issues corrupt the comparison – and these are large enough to distort the All RONS result.

- Tauranga Eastern Link (TEL): Work travel time savings are inserted into the model in terms of hours, not dollars. If the model values time savings at the same rate as is assumed in NZTA's benefit-cost analysis this difference is of little consequence. In the case of TEL, however, the implicit value of time in the benefit-cost analysis is higher at around $50/hour. This value goes into the calculation in line J, thereby lowering the ratio in line L.

- Victoria Park Tunnel (VPT): For VPT the same effect occurs, but by a different mechanism. Here it is not that the value of travel time is high, but rather that the share of travel time savings attributable to work related travel is 22% when expressed in hours, but 49% when expressed in dollars. For the other RONS the dollar figure for work travel time in line I1 is calculated as a *pro rata* proportion of the total dollar value of travel time. This accords with the treatment in NZTA's benefit-cost analysis where travel time savings in dollars are split in the same proportions as the travel time savings by hours.

Different analytical techniques will rarely produce exactly the same answers. However, under a general equilibrium analysis with no dynamic investment response to enhancements in productive efficiency we find that allocative efficiency benefits on their own are small. Thus the general equilibrium model largely reproduces the economic benefits that are fed into it from partial equilibrium benefit-cost analysis. In contrast, if an investment response is allowed the economic benefits are more than double those estimated by partial equilibrium benefit-cost analysis.

Table 3: Summary of Model Results (fixed rates of return)

			BAU	2020 Run 1b WEX		2020 Run 2 WRR		2020 Run 3 TEL		2020 Run 5 PTW		2020 Run 6 VPT		2020 Run 7 CHC		2020 Run 8 WLG		All RONS	2020 Run 9 All RONS	
			$m(05/06)	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ $m	Δ %	Δ $m
	Consumption (private +govt)		180086	0.14%	254	0.14%	253	0.04%	65	0.06%	113	0.11%	205	0.05%	86	0.11%	194		0.54%	973
	Exports		71630	0.17%	121	0.19%	133	0.03%	25	0.07%	53	0.13%	94	0.06%	42	0.13%	92		0.72%	516
	Imports		78169	0.09%	74	0.09%	71	0.02%	16	0.04%	33	0.08%	59	0.03%	25	0.07%	56		0.36%	281
	GDP		232576	0.17%	385	0.17%	397	0.04%	96	0.07%	171	0.13%	307	0.06%	130	0.13%	293		0.66%	1533
	RGNDI		231284	0.14%	335	0.14%	330	0.04%	90	0.07%	152	0.12%	268	0.05%	115	0.11%	255		0.55%	1275
	Population ('000)		4734	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0		0.00%	0
	RGNDI/capita ($)		48856	0.14%	71	0.14%	70	0.04%	19	0.07%	32	0.12%	57	0.05%	24	0.11%	54		0.55%	269
	Real wage rate (index)		1.3882	0.08%		0.08%		0.03%		0.04%		0.06%		0.02%		0.06%			0.29%	
	Household effective income tax rate (%)		15.83	-0.06%		0.00%		0.00%		0.06%		-0.19%		0.00%		0.25%			0.38%	
	CO_2 emissions (kt) [$100/t]		74761	0.15%	115	0.17%	127	0.01%	8	0.07%	49	0.09%	68	0.06%	45	0.12%	88		0.36%	266
		Source																		
A	Capital cost undiscounted	NZTA	$m		1454.4		1510.7		492.5		1644.9		456.0		782.1		2600.2	8940.8		8940.8
B	Typical yearly maintenance & operation	NZTA			1.4		11.3		2.4				0.0		0.6		0.0	15.7		15.7
C	Tolls	NZTA							6.0									6.0		6.0
D=0.06A-B	Financing charge at 6% (less tolls)				87.3		90.6		23.6		98.7		27.4		46.9		156.0	530.4		530.4
E=F+G+H	Total gross benefit in 2020		$m		186.3		305.4		68.2		93.6		246.2		109.5		130.6	1139.9		1139.9
F	Safety	NZTA	$m		20.1		-1.0		1.8		26.3		0.0		5.5		25.3	77.9		77.9
F1	Loss of life & permanent disability				13.8		-0.8		1.5		22.4		0.0		4.5		23.2	64.5		64.5
F2	Lost output				0.7		0.0		0.0		0.1		0.0		0.0		1.7	2.5		2.5
F3	Health care				0.4		0.0		0.1		1.1		0.0		0.3		0.1	2.0		2.0
F4	Vehicle repair				5.0		-0.1		0.2		2.3		0.0		0.4		0.2	7.9		7.9
F5	Legal				0.2		0.0		0.0		0.5		0.0		0.2		0.1	1.0		1.0
G	Vehicle operating costs	NZTA			6.3		3.3		11.2		6.1		22.2		-0.5		4.8	53.5		53.5
												$m								
H	Travel and congestion time	NZTA	$m		159.9		303.1		55.2		61.2	224.0			104.6		100.5	1008.5		1008.5
I	Travel and congestion time	NZTA	m hrs		8.8		12.0		1.1		3.3		12.6		4.2		6.8	48.7		48.7
I1	Work				3.4		3.8		0.4		1.3	109.8	2.8		1.3		2.7	15.6		15.6
I2	Commuting				0.8		1.9		0.1		0.3	22.4	1.8		0.7		0.6	6.2		6.2
I3	Other				4.6		6.2		0.6		1.7	91.9	8.1		2.2		3.5	26.9		26.9
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*		$m		74.3		100.1		29.7		33.8		132.0		33.9		44.4	448.3		448.3
K1	Change in RGNDI from model	model			334.7		330.3		89.6		152.4		268.4		114.7		255.1	1545.2		1275.1
K2	- inflated to 2008 prices	1.072			358.8		354.1		96.1		163.3		287.7		123.0		273.5	1656.5		1366.9
L=K2/J	Ratio GE benefits to market benefits				4.83		3.54		3.23		4.83		2.18		3.63		6.15	3.70		3.05
M=(K2+E-J)/E	Overall increase in total benefits				2.53		1.83		1.97		2.38		1.63		1.81		2.75	2.06		1.81
Notes:	*Pro rata on travel time except for VPT									Stage 2 brought forward 10 yrs				Uses 2020/21		Some cost & benefits brought forward		Assume linearity		

Table 4: Summary of Model Results (fixed capital stock)

			2020 Run 1c		2020 Run 2a		2020 Run 3a		2020 Run 5a		2020 Run 6a		2020 Run 7a		2020 Run 8a		2020 Run 9	
			WEX		WRR		TEL		PTW		VPT		CHC		WLG		All RONS	
			Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m
	Consumption (private +govt)		0.04%	68	0.04%	74	0.01%	11	0.01%	23	0.03%	63	0.01%	24	0.03%	52	0.17%	300
	Exports		0.07%	47	0.07%	52	0.01%	4	0.03%	18	0.05%	37	0.03%	18	0.05%	36	0.32%	229
	Imports		0.04%	29	0.04%	32	0.00%	3	0.01%	11	0.03%	26	0.01%	11	0.03%	22	0.16%	128
	GDP		0.05%	109	0.05%	119	0.01%	16	0.02%	38	0.04%	97	0.02%	39	0.04%	83	0.22%	508
	RGNDI		0.04%	92	0.04%	100	0.01%	15	0.01%	32	0.04%	84	0.01%	33	0.03%	71	0.17%	400
	Population ('000)		0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
	RGNDI/capita ($)		0.04%	19	0.04%	21	0.01%	3	0.01%	7	0.04%	18	0.01%	7	0.03%	15	0.17%	84
	Real wage rate (index)		-0.06%		-0.06%		-0.01%		-0.03%		-0.04%		-0.02%		-0.04%		-0.24%	
	Household effective income tax rate (%)		0.00%		0.06%		0.00%		0.06%		-0.13%		0.06%		0.32%		0.69%	
	CO_2 emissions (kt) [$100/t]		0.07%		0.08%	61	-0.01%	-11	0.02%	15	0.03%	19	0.03%	24	0.05%	39	0.28%	209
		Source																
A	Capital cost undiscounted	NZTA		1454.4		1510.7		492.5		1644.9		456.0		782.1		2600.2		8940.8
B	Typical yearly maintenance & operation	NZTA		1.4		11.3		2.4				0.0		0.6		0.0		15.7
C	Tolls	NZTA						6.0										6.0
D=0.06A-B	Financing charge at 6% (less tolls)			87.3		90.6		23.6		98.7		27.4		46.9		156.0		530.4
E=F+G+H	Total gross benefit in 2020			186.3		305.4		68.2		93.6		246.2		109.5		130.6		1139.9
F	Safety	NZTA		20.1		-1.0		1.8		26.3		0.0		5.5		25.3		77.9
F1	Loss of life & permanent disability			13.8		-0.8		1.5		22.4		0.0		4.5		23.2		64.5
F2	Lost output			0.7		0.0		0.0		0.1		0.0		0.0		1.7		2.5
F3	Health care			0.4		0.0		0.1		1.1		0.0		0.3		0.1		2.0
F4	Vehicle repair			5.0		-0.1		0.2		2.3		0.0		0.4		0.2		7.9
F5	Legal			0.2		0.0		0.0		0.5		0.0		0.2		0.1		1.0
G	Vehicle operating costs	NZTA		6.3		3.3		11.2		6.1		22.2		-0.5		4.8		53.5
											$m							
H	Travel and congestion time	NZTA		159.9		303.1		55.2		61.2	224.0			104.6		100.5		1008.5
I	Travel and congestion time	NZTA		8.8		12.0		1.1		3.3		12.6		4.2		6.8		48.7
I1	Work			3.4		3.8		0.4		1.3	109.8	2.8		1.3		2.7		15.6
I2	Commuting			0.8		1.9		0.1		0.3	22.4	1.8		0.7		0.6		6.2
I3	Other			4.6		6.2		0.6		1.7	91.9	8.1		2.2		3.5		26.9
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*			74.3		100.1		29.7		33.8		132.0		33.9		44.4		448.3
K1	Change in RGNDI from model	model		91.9		100.2		15.5		31.8		83.8		32.8		70.6		399.9
K2	- inflated to 2008 prices	1.072		98.5		107.5		16.6		34.1		89.8		35.2		75.7		428.7
L=K2/J	Ratio GE benefits to market benefits			1.33		1.07		0.56		1.01		0.68		1.04		1.70		0.96
M=(K2+E-J)/E	Overall increase in total benefits			1.13		1.02		0.81		1.00		0.83		1.01		1.24		0.98
Notes:	*Pro rata on travel time except for VPT								Stage 2 brought forward 10 yrs				Uses 2020/21		Some cost & benefits brought forward			

INFOMETRICS

General Equilibrium Analysis of Roads of National Significance

report to New Zealand Transport Agency

Prepared by Infometrics Ltd

December 2009

CONTENTS

Authorship

This report has been prepared by Dr Adolf Stroombergen.

Email: astro@infometrics.co.nz

All work and services rendered are at the request of, and for the purposes of the client only. Neither Infometrics nor any of its employees accepts any responsibility on any grounds whatsoever, including negligence, to any other person or organisation. While every effort is made by Infometrics to ensure that the information, opinions and forecasts are accurate and reliable, Infometrics shall not be liable for any adverse consequences of the client's decisions made in reliance of any report provided by Infometrics, nor shall Infometrics be held to have given or implied any warranty as to whether any report provided by Infometrics will assist in the performance of the client's functions.

1. Executive Summary

In this report we use a computable general equilibrium model to estimate the wider economic benefits of the Roads of National Significance.

Standard benefit-cost analysis is a partial equilibrium technique; well-suited to the analysis of investment projects that will no have a significant national effects. The RONS projects, however, have the potential to change New Zealand's gross domestic product. A general equilibrium model is one tool that can be used to estimate the size of the economy-wide effects. As well as incorporating the changes in productive efficiency that are addressed in partial equilibrium analysis, a general equilibrium model also captures flow-on effects and the effects of changes in allocative efficiency – the gains in economic welfare that emanate from improvements in the allocation of resources between industries in accordance with consumer preferences.

For the RONS projects our analysis suggests that the generation of wider economic benefits can be substantial, amounting to about $1200m, compared to around $400m using standard benefit-cost analysis. Non-market benefits (such as lives saved) which are not included in the general equilibrium modelling, add another $600m. Thus overall benefits increase by about 80%.

However, the existence of flow-on economic benefits depends crucially on whether there is an investment response to the potentially higher rates of return that would result from the productivity improvements generated by the RONS. Without such investment the model produces no increase in the value of benefits over that estimated in traditional benefit-cost analysis. Indeed the value of market benefits at about $370m is 7% less than estimated by benefit-cost analysis.

International practice in general equilibrium modelling leans towards allowing investment to respond to rates of return. Ultimately, though, this is a judgement call that we as modellers do not claim to be any better at making than anyone else. Still, if investment does not respond to profitable opportunities then much analysis of economic growth policy is flawed.

Some limitations of the modelling approach should be noted.

- The estimates of the wider economic benefits still contain whatever error margins exist in the standard benefit-cost analysis.

- The consumption of petrol and diesel may be a poor proxy for the allocation of benefits if the RONS users are not representative of all road users.

- Agglomeration benefits are sometimes cited as a type of wider economic benefit from investment in transport infrastructure. The relationship between such benefits and those encompassed by GE model is unclear. They are not necessarily additive.

2. METHODOLOGY

Overview of Methodology

For small projects at a local or regional level traditional benefit-cost analysis is appropriate, but for projects that have nation-wide impacts B-C analysis has two major short-comings; it is a partial equilibrium technique and it deals only with productive efficiency. General equilibrium analysis incorporates productive efficiency effects plus additional welfare benefits derived from a larger economy and from allocative efficiency effects – improving the allocation of resources between, not just within industries.

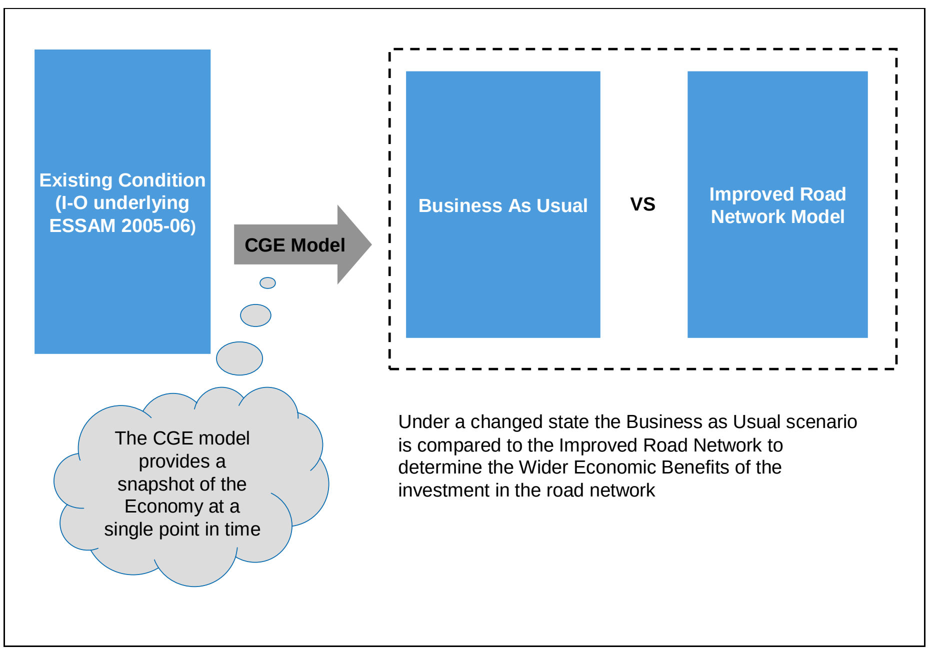
In partial equilibrium analysis variables and events that are defined as being outside the issue of interest are assumed unchanged. For example a benefit-cost analysis of relieving congestion on Auckland's motorway system would probably consider the favourable effect on the international competitiveness of New Zealand manufacturing, which could have a flow-on impact on the standard of living. In contrast a general equilibrium model would pick up such an effect.

In this report we use the ESSAM computable general equilibrium (CGE) model to examine the RONS projects. Appendix A has discussion on CGE modelling and a description of the ESSAM model is given in Appendix B.

Presentation of results

The results of modelling the RONS are expressed relative to a 'Business as Usual' (BAU) scenario without any RONS investments – see Figure 1.

Figure 1: CGE Modelling of RONS[1]



[1] Source: Booz & Co.

The BAU is not necessarily the most likely forecast of what the economy might look like. It will inevitably be wrong. Rather it is intended to be a plausible projection of the economy that can constitute a frame of reference against which the RONS scenarios may be compared. Further detail on the BAU is given in Appendix C.

In all RONS scenarios the following macroeconomic closure rules apply.

1. Labour market closure: Total employment is held constant at the BAU level, with wage rates being the endogenous equilibrating mechanism. While employment may be more variable than wage rates in the short run, in the medium term the nature of the labour market and employment law in New Zealand mean that how the economy adjusts to a better roading network is more likely to affect wage rates than employment.

2. Capital market closure: Two options are considered, one where rates of return on capital (plant, equipment, buildings etc) are held constant at BAU levels, with capital formation being the equilibrating variable. For example, potentially higher rates of return to capital will result in more investment and thus a larger capital stock. The other closure option is the reverse situation, where the total capital stock of the economy is fixed at the BAU level and rates of return are the equilibrating mechanism.

Capital Closure

The Australian Productivity Commission (2008) notes that fixed rates of return is a standard long-run capital closure for policy analysis:

In (modelling trade liberalisation in) a long-run CGE framework, it is common to assume that capital adjusts to changes in after-tax rates of return. In the long run, risk-adjusted rates of return are equalised across industries, and capital is reallocated to its best use, both domestically and internationally, once the economy has fully adapted to the modelled changes. This is the usual setting used in long-run comparative static models such as the ORANI model.

The alternative view is that the aggregate level of investment in the economy is affected more by expectations of future demand and Keynes' "animal spirits" than by the rate of return. Consequently a small change in confidence can outweigh the effects of a change in the rate of return. This perspective takes into account the uncertainty surrounding how business confidence might be affected if the RONS projects are perceived as delivering poor value for money that burden taxpayers for many decades. On the other hand confidence might be lifted if government is seen to be taking action to improve some of the country's worst roading bottlenecks.

3. External closure: The balance of payments is a fixed proportion of nominal GDP, with the real exchange rate being endogenous. This means that any adverse shocks are not met simply by borrowing more from offshore, which is not sustainable in the long term.

4. Fiscal closure: The fiscal surplus is held constant at the BAU level, with personal income tax rates being endogenous.

Our main measure of economic welfare is Real Gross National Disposable Income (RGNDI). RGNDI measures the total incomes New Zealand residents receive from both domestic production and net income flows from the rest of the world and adjusts for changes in the terms of trade.[2]

Most industries can expect to grow considerably over the coming decade. This means that is highly unlikely that any industry will suffer an absolute reduction in size as a result of a RONS being implemented. The worst that would happen is that in any given RONS scenario, an industry that does not benefit from better roading, such as rail transport perhaps, would grow at a somewhat slower rate than in the BAU scenario. Thus at no stage does the model convert locomotives into trucks. What it does do over the next decade is direct somewhat more new investment into trucks than into trains, relative to what would occur under BAU.

[2] See Statistics New Zealand (1999).

3. WIDER ECONOMIC BENEFITS

RONS Projects

Seven RONS projects are analysed:

1. Puhoi to Wellsford (PTW)
2. Auckland western ring road (WRR) – completion of, and Waterview
3. Victoria Park tunnel (VPT)
4. Waikato expressway (WEX)
5. Tauranga eastern link (TEL)
6. Wellington northern corridor (WLG)
7. Christchurch motorway projects (CHC)

As noted above the GE model takes a snapshot of the economy in (or around) 2020 without any of the RONS, and then with each RON one at a time and all combined. For this approach to yield sensible results each RON should be fully operational by 2020. In most cases this is accords with the envisaged construction profile, but some of the projects contain stages that are tentatively not destined for completion until 2030. For these projects we simply bring forward the benefit profile by a decade, in effect assuming that construction had begun ten years earlier?

The model is not well suited to studying changes in the timing of projects. The model's strength is in comparing alternative pictures of the economy at an approximate point in time.

Input Data

In broad terms the input data required by the model is that same as that which will have been used for the original benefit-cost analysis of the RONS projects, notably:

1. Change in work related travel time, in units of time. This is simulated in the model as an increase in labour efficiency.

2. Change in vehicle operating and repair costs – disaggregated at least into fuel costs, repair costs and distance-related depreciation costs.

3. Change in accident related costs – disaggregated into vehicle repair, medical treatment and rehabilitation costs. The latter two are simulated as reductions in government consumption.

It is desirable to have information on the distribution of the benefits across different industries and households (private motorists). However, this information is not (yet) available for the RONS. As a proxy we use consumption of petrol and diesel for road transport. This introduces a degree of error insofar as the mix of road users for any given RON differs from the national average.

Non-market benefits are excluded from the general equilibrium modelling. In particular:

1. Commuting travel time is excluded, the assumption being that it substitutes largely for leisure. Similarly leisure travel is excluded.
2. The value of life is excluded and there is no permanent loss of economic output from deaths or injury.
3. Valuations for pain and suffering or loss of enjoyment of life are also excluded.

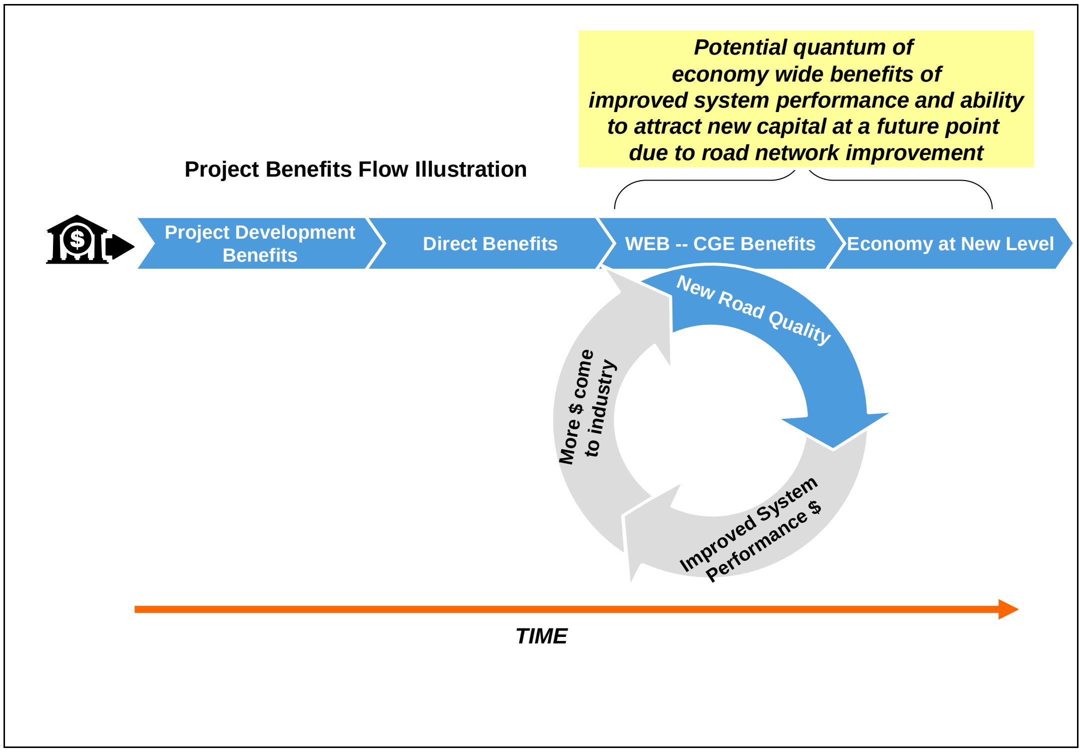
Construction of the RONS is not modelled. We assume that funding is secured by way of government borrowing and that the debt is repaid over the life of the asset. With the exception of the TEL which will raise some revenue from tolls, it is assumed that debt repayment is financed by raising personal income tax rates – if the economic stimulus provided by the RONS does not sufficiently improve the fiscal position.

We make no changes to rates of road user charges or fuel excise duty, but clearly this is an alternative to raising income tax rates. The model takes into account the extra revenue from these sources that occurs if the economy is stronger.

Results

Figure 2 illustrates a way of thinking about how the RONS could generate additional economic benefits. A more detailed diagram and explanation is presented in Appendix D.

Figure 2: Illustration of Role of GE in Measuring RONS Benefits[3]



[3] Source: Booz & Co.

The main driver of the expansion in economic activity is the enhanced resource productivity of transport-dependent commercial and industrial activities. As less time and money is spent transporting goods between suppliers and consumers, between cities, and between ports and factories etc, more investment can be directed to increasing other productive assets such as hotels, telecommunications infrastructure energy efficient appliances.

Industries that are critical to the economy such as dairy processing, forestry and tourism are key direct beneficiaries of better roads. The second round effects of more investment activity impact favourably on industries such as construction, base metals and metal fabrication.

Higher wage payments by these industries raise consumer demand, adding further fuel to the economic expansion. Ultimately better roads provide benefits to virtually all industries. The flow-on effect of the success or failure of road transport in supporting economic development is further underscored by the Input-Output tables, which show that Trade (wholesale and retail) is the largest user of road freight transport services.[4]

Table 1 shows the changes in RGNDI from the model for each of the RONS and for all RONS combined.

Table 1: RONS Benefits in 2020 ($m)

	Change in RGNDI from GE Model		Benefits from B-C Analyses	
	Fixed Capital Stock	Endogenous Capital Stock	Market Benefits (approx)	Total Benefits
PTW	163	34	34	94
WRR	354	107	100	305
VPT	288	90	132	246
WEX	179	44	24	87
TEL	96	17	30	68
WLG	274	76	44	131
CHC	123	35	34	110
All RONS	1197*	368*	398	1040

* In the GE model columns All RONS is not the linear sum of the individual RONS.

The total change in RGNDI from all of the RONS combined is estimated at almost $1200m, compared to about $400m in the B-C analyses; a roughly three-fold increase. However, these benefits are crucially dependent on the capital closure assumption. If investment is not responsive to rates of return, implying a total capital stock that is fixed at the BAU level, the increase in market benefits across all RONS combined is just under $370m; a <u>reduction</u> of 7% compared to the B-C results. The main

[4] Stroombergen (2008).

contributors to this result are TEL and VPT, which have high values for work travel time. See Appendix E.

Closing off the responsive of investment to rates of return means prevents the economy from expanding. That is, there is essentially no opportunity for the benefits that are fed into the model to generate any wider economic benefits through multiplier effects. Not surprisingly then, the output of the model is much the same as what goes in – namely the benefits from the B-C analysis. While one might expect to see some additional benefit from gains in allocative efficiency (as resources flow to where they are most valued), such gains do not seem to be strong enough to offset various negative savings in vehicle operating costs and accident costs under some of the RONS, and of course the annual maintenance costs and financing charge.

The model is not sophisticated enough to determine the appropriate capital closure specification. Ultimately this is a judgement call that we as modellers do not claim to be any better at making than anyone else. Still, if investment does not respond to profitable opportunities then much analysis of economic growth policy is flawed.

Perhaps rather than decide which capital closure specification is more appropriate, policy makers should look at how government can manage expectations such that business confidence is not jeopardised by poor decisions around RONS funding, cost escalation and so on. In other words, manage expectations to increase the chances of obtaining the investment response on which the wider economic benefits of the RONS so depend.

Caveats

Some limitations on the above results should be noted:

1. The estimates of the wider economic benefits still contain whatever error margins exist in the standard B-C analysis. We understand that some of them have not been finalised.

2. The use of petrol and diesel may be a poor proxy for the allocation of benefits if RONS users are not representative of all road users. For example, the Wellington to Levin RONS is unlikely to carry the national share of forestry traffic. Thus when we model the Wellington-Levin RONS the model will overstate the benefits to the forestry industry. Similar concerns exist with all of the RONS, although all of them combined hopefully have a mix of users that is closer to the national average.

3. The results tell us nothing about the regional incidence of benefits. Some projects such as the Waikato Expressway may have more regionally dispersed benefits than the Puhoi to Wellsford connection.

4. Agglomeration benefits are sometimes cited as a type of wider economic benefit. It is unclear exactly what is covered under this umbrella, so we would not advise adding any agglomeration benefits to the GE benefits.

REFERENCES

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).

Allen Consulting Group and Infometrics (2004): *Benefits of Investing in New Zealand's Road Infrastructure*. Report to New Zealand Automobile Association.

Australian Productivity Commission (2008): *Modelling Economy-wide Effects of Future Automotive Assistance*, Technical Supplement.

Australian Treasury (2008): *Australia's low pollution future: the economics of climate change mitigation*. Online at http://www.treasury.gov.au/lowpollutionfuture/report/default.asp

Beckman, J., and T. Hertel. (2009): 'Why Previous Estimates of the Cost of Climate Mitigation are Likely Too Low'. *GTAP Working Paper No. 54*.

Booz and Company (NZ) Ltd. (2009): Economic Development benefits of Transport Investment. Report to New Zealand transport Agency.

Concept Economics (2008): *A peer review of the Treasury modelling of the economic impacts of reducing emissions*. Report for Australian Senate Select Committee on Fuel and Energy.

Kehoe, T.J. (2003): *An Evaluation of the Performance of Applied General Equilibrium Models of the Impact of NAFTA*. Federal Reserve Bank of Minneapolis, Research Department Staff Report 320.

Ministry of Economic Development (2006): *New Zealand's Energy Outlook to 2030*.

NZIER and Infometrics (2009a): *Economic Modelling of New Zealand Climate Change Policy.* Report to Ministry for the Environment.

NZIER and Infometrics (2009b): *Macroeconomic impacts of climate change policy: Impact of Assigned Amount Units and International Trading.* Report to Ministry for the Environment.

New Zealand Transport Agency (2008): *Managing transport challenges when oil prices rise*, Research Report 04/08.

Peterson, S. (2003): *CGE models and their application for climate change policy analysis*. Presentation to 1st International Workshop on Integrated Climate Models: An interdisciplinary assessment of climate impacts and policies, 30 September – 3 October 2003, ICTP, Trieste, Italy

Statistics New Zealand (1999): *New Zealand System of National Accounts (1998).* http://www.stats.govt.nz/analytical-reports/nz-system-national-accounts-1998/part-2-national-accounting-system.htm)

Stroombergen, A. (2008): "ESSAM General Equilibrium Model: Estimation of 2005/06 Input-Output Tables", *Motu Working Paper* 08-01.

APPENDIX A: GENERAL EQUILIBRIUM MODELLING

What is CGE modelling?[5]

Computable General Equilibrium (CGE) models are commonly used tools for policy analysis. Such models typically consist of a database that represents an economy benchmarked for a particular time period based on input-output tables. The database specifies the interactions and relationships between various economic agents including firms, workers, households, the government and overseas markets.

The base case model is then 'shocked' by changing a policy variable or an assumption about one or more parameters outside the model (so-called exogenous variables). Values for all other variables inside the model (so-called endogenous variables) are calculated from equations describing the economy, given numerical values for the parameters and the variables outside the model (Peterson, 2003). The equations describing the relationships between economic agents exhibit a number of common features based on neoclassical economics (Peterson, 2003):

- Consumers maximise their utility subject to their budget constraints. They purchase goods and services from firms, and provide firms with their labour inputs.
- Producers maximise their profits by buying intermediate goods and inputs (labour and capital) and selling outputs to other domestic and international firms, households and government.
- There is a market for each commodity (goods and intermediates) and in equilibrium market prices are such that demand equals supply in all input and output markets.
- Under the standard assumption of constant returns to scale firms earn zero pure profit.

By comparing the pre- and post-shock databases, we can then observe the effects of the shock in question in terms of changes to GDP, employment, wages, etc. In static CGE models, we observe the economy after all adjustments have taken place. Dynamic models, on the other hand, allow us to examine in each intervening period how variables adjust from the time when a shock is implemented to the time when all of its effects have worked through the economy (which may be a number of years).

Strengths of CGE modelling

The most important advantage of CGE modelling is that it considers how policy shocks affect the allocation of resources between all sectors and

[5] This section draws on NZIER and Infometrics (2009a).

markets in an economy. This is essential if we are to get a good macroeconomic understanding of how policy changes might affect the structure of an economy. Concept Economics (2008, p4) note that "high quality CGE modelling is a powerful tool that can assist policy makers and stakeholders in understanding the effects of mitigation actions, especially at an economy wide level". In addition, such models "examine complex issues rigorously and in an internally consistent way across long timeframes" (Australian Treasury, 2008, p21). Computable General Equilibrium models have been used extensively for analysing macroeconomic policy because they can examine adjustments across all sectors of the economy to changes in supply and prices via changes in factor proportions and sectoral output levels.

Sector-specific partial equilibrium models, on the other hand, tend not to consider what happens to resources outside of the sector in question. While they can be useful for more disaggregated sectoral analysis, they are not well-suited for capturing the inter-sectoral resource re-allocation that could result from policy changes such those related to the RONS.

Limitations of CGE modelling – generic

One important aspect of CGE modelling is 'database dependency'. By this we mean that the accuracy of CGE modelling results is highly dependent on the quality and suitability of the initial database. To the extent that there are problems with the database, there may also be problems with the results. In modelling of the RONS the model structure is based on the snapshot of the economy as measured by estimated input-output tables for 2005/06, which in turn are based on Statistics New Zealand's 2002/03 Supply and Use Tables. See Stroombergen (2008). Structural changes to the economy over the last few years are therefore not captured in the model database, but the more significant ones are captured in the Business as Usual scenario which is described later.

An oft-used criticism of CGE models, at least historically, is that, given the vast amount of data, parameters, equations and assumptions required to compute outcomes, such models can be somewhat of a 'black box' in nature. That is, it is sometimes difficult to identify exactly how certain results were obtained. This is true only to the extent that modellers are not transparent regarding what data they have put into the model, how they have modelled policy changes and how they have interpreted the results. As such, any allegations of a lack of transparency should usually be levelled at the modellers rather than at the models.

A more valid criticism is that CGE model estimates are not often tested ex-post against actual outcomes. This makes it difficult to ascertain how accurate CGE modelling results are in practice (Kehoe, 2003). Such ex-post testing is rare because retrospectively isolating the specific effects of any individual policy changes from other economic changes is very difficult. In static CGE modelling, we generally have to assume that apart from policy shocks, everything else remains constant or behaves in the way that we have told the model to react. In reality of course economies adjust constantly in response to good or bad news, relative price changes, availability of resources, exchange rate movements, shifts in preferences, changes to global markets, other policy changes and so on.

Partly as a result of not knowing whether or not previous studies have been accurate, there is relatively little focus on ensuring that the parameters contained within a model remain appropriate. Econometrically estimating these parameters is a complex and expensive process, but it is widely accepted that "in order for CGE models to gain prominence in policy analysis, more must be done to ensure the model is an accurate representation of the real economy" (Beckman and Hertel, 2009, p.7).

As noted above, CGE models typically assume a neoclassical world. If these neoclassical assumptions are not believed to hold true in reality, then the model results could be seen as not portraying likely outcomes. However, alternative representations of economic behaviour can be incorporated into CGE models if judged to be more appropriate.

Another limitation of static CGE models, such as that employed in this report, is that they usually assume that economic variables adjust smoothly to policy shocks. Such models do not capture step-wise industry adjustments but assume smooth and continuous changes. In reality, industries with large capital resources face discrete production and investment decisions. Along similar lines, comparative static models report the likely change in the economy at a given point in time; they do not capture the gradual implementation effects of a shock as the economy adjusts over time. This is more of a concern for short run modelling scenarios. In the long run, it is assumed that the economy can adjust to the desired point, although different models use different approaches to the movement of labour and capital to allow this adjustment.

Limitations of CGE modelling of roading investment

Applying CGE modelling to investment in roading infrastructure is not common, but is not without precedent. See for example Allen Consulting Group (1993), and Allen Consulting Group and Infometrics (2004).

One reason for this is that GE models are economy-wide models and so not suited to studying projects at a fine spatial level, nor projects that are too small to have macroeconomic effects. Some roading projects, however, involve billions of dollars, which makes them large enough to have macroeconomic effects, even if the those effects are spatially quite disparate. The RONS, or perhaps some of them, fit this description.

Given then, that a project has the potential to have measurable economy-wide effects, are there limitations additional to those discussed above of which one should be aware?

The most significant limitation is the quality of the roading project data that is fed into the GE model. The main inputs are nothing other than a subset of the output of traditional partial equilibrium cost-benefit analysis – reductions in work-related travel time, lower vehicle operating costs and reductions in accident-related expenditure. Any error in these estimates will translate directly into comparable error margins on the GE results.

Another limitation is that non-market costs and benefits are not captured in GE models. For example, GE models do not generally capture the value of pain and suffering associated with accident trauma, nor the value of savings in travel time where the travel is related to leisure activities. Travel for commuting is also excluded in our analysis as it is assumed that savings in commuting time would be taken as additional leisure, rather than as more working hours. If this assumption is considered unreasonable it is a straightforward matter to simulate the situation where some or all commuting time substitutes for work time.

Unless information is provided to the contrary – information which does not usually feature in roading cost-benefit analysis – it is assumed that savings in (work) travel time are allocated to industries on the basis of their direct use of petrol and diesel for transport. Firms that do not operate their own vehicle fleet obtain their benefit indirectly through the effects on commercial transport industries. The same procedure applies to vehicle operating costs and legal costs associated with accidents, except that households are also included.

Savings in health care costs are modelled as a reduction in government spending on health. While some medical expenditure is private, with regard to accident costs the private expenditure proportion is small.

Clearly then the user mix of benefits should be seen as approximate, albeit no more approximate than what is implicit in the usual cost-benefit analysis. In this sense a GE model cannot add empirical content. For most projects this limitation probably has second order effects, but for projects that (are targeted to) benefit particular industries it may be worthwhile to test the robustness of results to alternative assumptions about the incidence of benefits across road users.

Because GE models are structural models they are also not well suited to capturing subtle differences in the timing of projects, whether with respect to their costs or their benefits. Our preferred strategy is to compare the economy with and without a given RON, at some future date when the RON is fully operational. For convenience we focus on 2020, but even if a given project is not actually likely to be completed by then, we can still evaluate it as if it would be completed.

The strength of the model is in comparisons between scenarios, not in exactly specifying the calendar time at which an event is judged to occur.

We do not model the construction phase. Thus in our notional year when a project is fully operational, the only costs that are tracked are those that relate to ongoing road maintenance, and any increases in fuel excise duties, tolls and so on.

In this connection, apart from the Tauranga Eastern Link RON, which has an element of toll funding, all investment is assumed to be funded by government borrowing, meaning that there is an ongoing capital finance charge to be paid by the government. If the higher economic growth that would ostensibly be effected by the RONS does not generate sufficient income to the government to pay the annual finance charge, it is assumed that personal income taxes will be adjusted.

Other means of financing such as increases in road user charges (RUC) and fuel excise duties (FED) can also be modelled. We expect, however, that the effects of different financing mechanisms will be second order.

Firstly this is because the existence or not of any ongoing charge is more significant than how that charge is levied, although there maybe efficiency differences. However, and this is the second reason for suspecting second order effects, RUC and FED are imperfectly modelled. While the existing industry incidence of RUC is in the model, any changes to RUC can only be proxied by changes in diesel use. Thus the model does not capture changes in axle loads for example, if this changes because of a RON project. Similarly, changes to FED are proxied by changes in petrol use.

Not all researchers believe that is valid to add the results from a GE model to non-market benefits such as savings in leisure travel. See for example Booz and Company (2009, p52). One of their criticisms is that savings in non-work travel time might be used for additional consumption. If so then the value of non-work travel should not be added to the change in private consumption that emerges from the GE model as it would constitute double counting. However, the change in private consumption that emerges from the model is driven entirely by the set of input shocks fed into the model, a set that excludes non-work travel time. So while it is possible that savings in non-work travel time might indeed promote additional consumption, this does not constitute double counting. On the contrary, it is an omission from the analysis that should ideally be added.

Booz and Company (2009, p23) also state that CGE models do not measure economic efficiency or net benefits. This is incorrect. With the labour and capital closure rules set to fixed employment and fixed capital stock, net benefits due to changes in efficiency are precisely what a CGE model measures.

Summary

Despite the caveats outlined above, we firmly believe that CGE modelling is a useful tool for assessing the wider economic effects of investment in large, nationally significant roading projects. As with any model, CGE models can only be an approximation of the highly complex real economy. CGE models are dependent on the database used, the credibility of the assumptions incorporated into the base data and policy scenarios, and the 'closure' framework employed (Concept Economics, 2008, p4) – as explained previously. Therefore the results can only ever be indicative. The interpretation of CGE results should centre on their direction (up or down) and broad magnitude (small, medium or large), rather than on the precise point estimates that the model produces. Essentially we are modelling scenarios: such modelling "does not predict what will happen in the future. Rather, it is an assessment of what could happen in the future, given the structure of the models and input assumptions" (Australian Treasury, 2008, p.16).

CGE modelling can usefully be augmented with industry and sector-specific partial equilibrium modelling and other quantitative and qualitative research approaches, particularly with regard to difficult topics such as ascertaining regional economic effects and agglomeration effects. It is outside the scope of this report to undertake such research.

APPENDIX B: 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 the main 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:

- 53 industry groups, as detailed in the table below.
- Substitution between inputs into production - labour, capital, materials, energy.
- for 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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

Industry Classification

The 53 industries identified in the ESSAM model are defined on the following page. Industries definitions are according to Australian and New Zealand Standard Industrial Classification (ANZSIC).

Input-Output Table

The derivation of the underlying input-output table is given in Stroombergen (2008).

1	**HFRG**	Horticulture and fruit growing
2	**SBLC**	Livestock and cropping farming
3	**DAIF**	Dairy and cattle farming
4	**OTHF**	Other farming
5	**SAHF**	Services to agriculture, hunting and trapping
6	**FOLO**	Forestry and logging
7	**FISH**	Fishing
8	**COAL**	Coal mining
9	**OIGA**	Oil and gas extraction, production & distribution
10	**OMIN**	Other Mining and quarrying
11	**MEAT**	Meat manufacturing
12	**DAIR**	Dairy manufacturing
13	**OFOD**	Other food manufacturing
14	**BEVT**	Beverage, malt and tobacco manufacturing
15	**TCFL**	Textiles and apparel manufacturing
16	**WOOD**	Wood product manufacturing
17	**PAPR**	Paper and paper product manufacturing
18	**PPRM**	Printing, publishing and recorded media
19	**PETR**	Petroleum refining, product manufacturing
20	**CHEM**	Fertiliser and other industrial chemical manufacturing
21	**RBPL**	Rubber, plastic and other chemical product manufacturing
22	**NMMP**	Non-metallic mineral product manufacturing
23	**BASM**	Basic metal manufacturing
24	**FABM**	Structural, sheet and fabricated metal product manufacturing
25	**MAEQ**	Machinery and other equipment manufacturing
26	**OMFG**	Furniture and other manufacturing
27	**EGEN**	Electricity generation
28	**EDIS**	Electricity transmission and distribution
29	**WATS**	Water supply
30	**WAST**	Sewerage, drainage and waste disposal services
31	**CONS**	Construction
32	**TRDE**	Wholesale and retail trade
33	**ACCR**	Accommodation, restaurants and bars
34	**RDFR**	Road freight transport
35	**RDPS**	Road passenger transport
36	**RAIL**	Rail transport
37	**WATR**	Water transport
38	**AIRS**	Air transport and transport services
39	**COMM**	Communication services
40	**FIIN**	Finance and insurance
41	**REES**	Real estate
42	**EHOP**	Equipment hire and investors in other property
43	**OWND**	Ownership of owner-occupied dwellings
44	**SRCS**	Scientific research and computer services
45	**OBUS**	Other business services
46	**GOVC**	Central government administration and defence
47	**GOVL**	Local government administration
48	**SCHL**	Pre-school, primary and secondary education
49	**OEDU**	Other education
50	**HOSP**	Hospitals and nursing homes
51	**OHCS**	Other health and community services
52	**CULT**	Cultural and recreational services
53	**PERS**	Personal and other community services

APPENDIX C: THE BAU SCENARIO

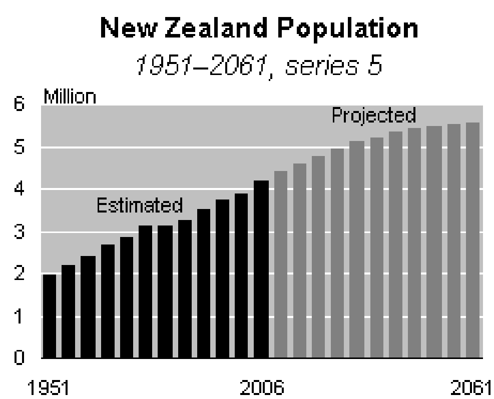
The 'Business as Usual' (BAU) scenario is intended to be a plausible projection of the economy that can constitute a frame of reference against which other scenarios may be compared. It is not necessarily the most likely forecast of what the economy might look like in 2020. It will inevitably be wrong.

The BAU to 2020 for the RONS modelling is equivalent to Scenario 4 as described in the recent modelling for the Ministry for the Environment. See NZIER and Infometrics (2009b). The main input assumptions are described below.

Our BAU projects RGDNI to rise from around $165 billion in 2009 to around $231 billion by 2020. In per capita terms, this is an increase from around $38,500 to $48,900.

Population

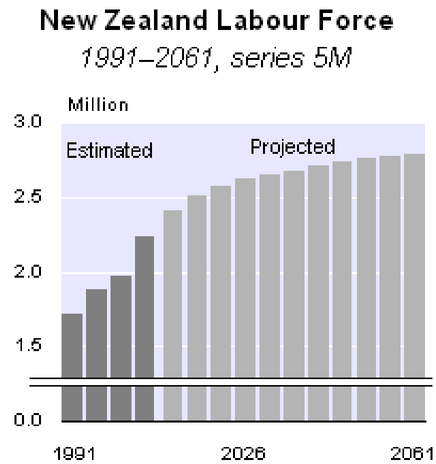
Population is projected using Statistics New Zealand's (SNZ) Series 5, shown in the graph below. It is based on a middle path with respect to fertility, mortality and migration; namely medium fertility, medium mortality and net immigration of an average 10,000 people per annum. This yields a projected population in 2019/20 of 4,734,000, implying an average growth rate from the model's 2005/06 base year of 0.88% per annum.



Labour Force

The projected labour force is 2,555,000, again based on SNZ Series 5, with medium (as opposed to low or high) labour force participation rates. Implied growth from 2005/06 ids 1.18% pa.

The model requires either total employment or the average wage rate to be set exogenously. Our preferred approach for the BAU is to make an assumption about the rate of unemployment and let the model produce whatever profile of wage rates is consistent with this, rather than the other way around.



In a modern economy the rate of unemployment in the long run is driven primarily by demographic factors and labour market regulations, whereas wage rates are ultimately a function of the growth of the economy. Thus it is more plausible to assume some rate of unemployment that society is prepared to tolerate, which is likely to cover a fairly narrow range, than to assume some set growth path for wages – which could easily produce totally unrealistic projections of unemployment.

We assume an unemployment rate of 4.5%; on the low side of historical rates, but recognising the projected aging of the population and the associated slow growth in labour force.

Energy and Energy Efficiency

The model requires projections of rates of improvement in energy efficiency, often referred to in energy models as the AEEI; the autonomous energy efficient improvement parameter. This is fuel specific and hence is required for coal, natural gas, oil products and electricity.

Typically in our modelling we have used 1% pa for all fuels except for electricity use by households where a lower rate of 0.5% pa has been used. This is not because the efficiency of household appliances is assumed to improve at a slower rate than industrial machinery. Rather it is a crude way to capture the increasing use of electrical appliances (such as computers and television decoders) that were previously less prevalent and that are frequently left on, even if only in stand-by mode, for extended periods of time. To this one might add the increasing use of clothes driers associated with the move to apartment living, and heat pumps which, while very efficient, are often used for air conditioning in homes which had no air conditioning prior to installation of a heat pump.

In MED (2006) the AEEI is about 0.5-1.0% pa. We assume 1.0% pa for industrial and commercial use of all non-transport fuels, and 0.5% pa for household electricity use, as a crude balance between the increasing technical efficiency of household appliances, the use of in-home solar power and the offsetting effect of more appliances.

Private road transport is a particularly difficult area, with improvements in vehicle fuel efficiency and diesel-petrol substitution being offset by a trend to larger petrol vehicles and diesel SUVs (at least up to the 2008 sharp increases in oil prices). Further offset comes from the increasing weight of cars caused by more stringent safety standards. Based on MED (2006) estimates which take into account real income growth, greater diesel use, better technical energy efficiency and a changing fleet mix, the implicit efficiency gain is about 1.2% pa up to 2020. For commercial vehicle use we assume a lower figure of 1% pa, as the relative shift to diesel vehicles is much smaller.

Another issue around transport energy is the large scale 'step changes' that could occur with a shift to plug-in electric or hybrid vehicles, or the widespread use of biofuels in transport. We assume that these do not achieve significant market penetration by 2020.

Carbon Price

Forecasting the international price of carbon in 2020 is difficult. Critical factors are which countries participate in international agreements to lower emissions, the tightness of international obligations, and the path of emissions over the first Kyoto commitment period 2008 to 2012. We assume that:

- New Zealand maintains an Emissions Trading Scheme.
- There is no free allocation of permits by 2020.
- New Zealand takes responsibility for all emissions above 1990 levels.
- The carbon price is $100/tonne, approximately equal to 50 Euro/tonne.

Without the effect of the $100 carbon charge, the level of emissions in the BAU is the same as projected by the Ministry for the Environment, as discussed in NZIER and Infometrics (2009b).

Oil Price

The oil price is as difficult to forecast as the price of carbon. We defer to the comprehensive discussion and analysis in NZTA (2008) which shows a number of projections for the price of oil in 2028 ranging between US65/bbl and US$230/bbl, with an average of about US$115/bbl (all in 2008 prices). We assume a price of US$105/bbl in 2020, *en route* to US$115/bbl in 2028.

Balance of Payments

We presume that New Zealand's long record of pronounced balance payments deficits cannot continue. With other countries improving their economic management and providing profitable opportunities for investment, New Zealand will find it more difficult to attract foreign investment to cover a persistent balance of payments deficit. Hence we assume that the balance of payments deficit improves to 3% of GDP by 2020.

APPENDIX D: THE TRANSMISSION OF RONS BENEFITS THROUGH THE ECONOMY

Figure D1 illustrates the main mechanisms by which the RONS affect the economy. The yellow boxes contain non-market benefits that are not included in the GE modelling.

The ovals denote the benefits as supplied by NZTA from standard benefit-cost analysis. These are converted into model inputs shown by turquoise boxes. As mentioned previously, travel time savings are treated as increases in labour productivity, savings in VOC and accident property damage are simulated as changes in the composition of spending, and savings in accident healthcare costs are treated as a reduction in costs to government. Note that some savings could be negative. Maintenance and finance charges are treated as increases in government costs.

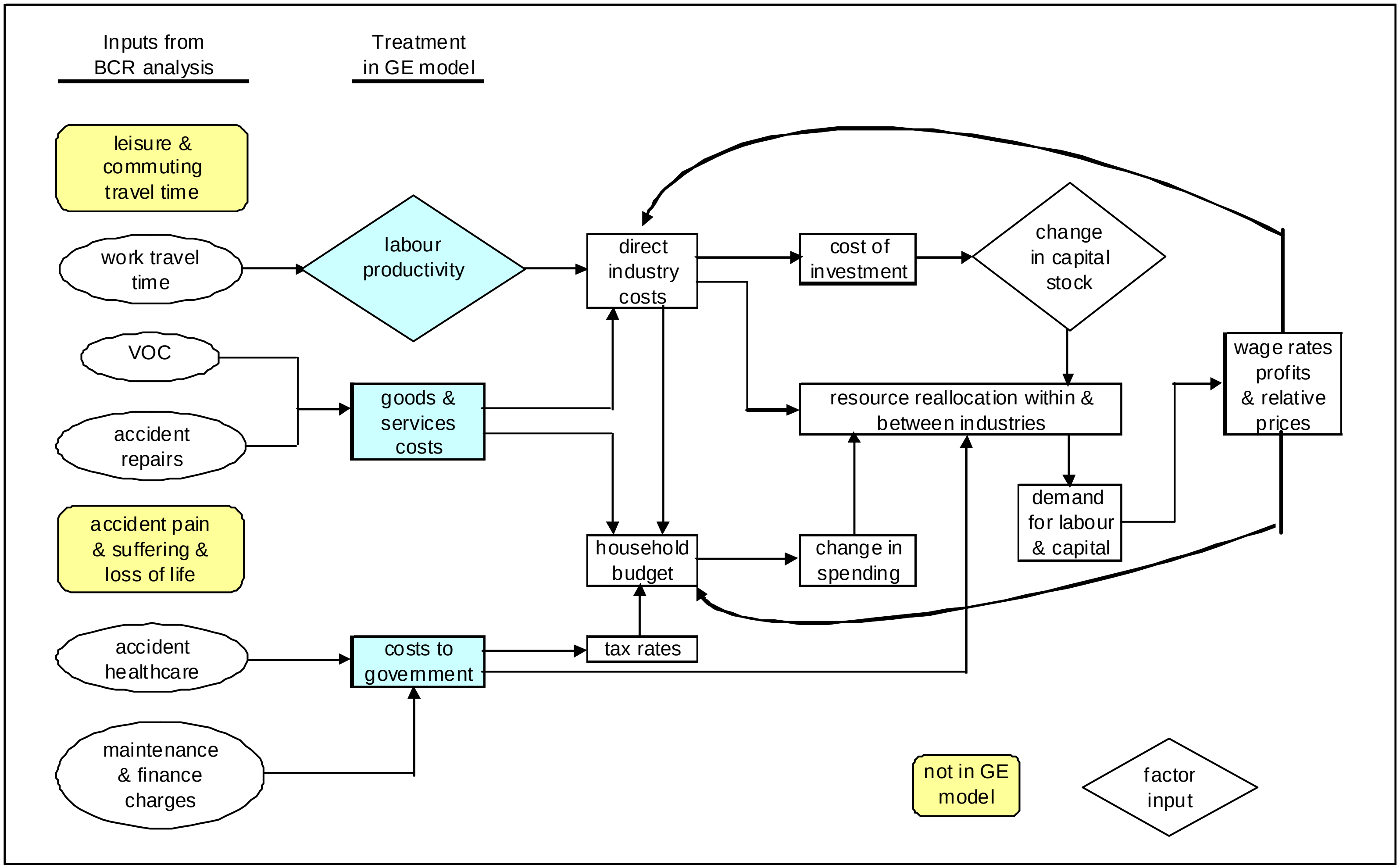
Higher labour productivity and less spending on repairs and maintenance lowers industry costs. Households also benefit from less spending on repairs and maintenance, from lower prices of other goods and services, and from lower tax rates – as long as the net costs to government decline. All of these changes alter the mix of household spending, leading to resources being allocated differently than in the BAU.

Lower costs and improved profitability also boost capital formation which leads to further resource reallocation. The demand for labour and capital changes with consequential effects on wage rates and profit rates. This in turn changes industry costs and household incomes, and so the process continues – denoted by the bold arrows. Eventually a new equilibrium is reached.

The key drivers of a potentially larger economy are denoted by the rhombuses – higher labour productivity and an increase the economy's total capital stock (under that specification of the capital closure rule). Apart from the effect of greater fuel use efficiency, all other potential contributions to growth essentially come from flow-on effects and improvements in allocative efficiency such as:

- Lower tax rates if the cost of RONS debt servicing does not exceed the savings in healthcare costs.
- Allowance for the fact that the value of time is not the same in all industries.

Figure D1: Schematic of RONS in GE Modelling



Appendix E: Reconciliation between GE Results and B-C Analyses

Tables E1 and E2 show the details of how the GE results relate to those of the standard B-C analyses provided by NZTA, for endogenous and exogenous capital formation respectively.

- Except for line D, which is our assumed capital financing charge, Lines A to I summarise the information supplied by NZTA.
- Line J sums the market savings as discussed above. These constitute the benefit side of the model's inputs. Note though that with respect to work travel time the model input is in units of time, not dollars. Except for the VPT project the dollar figure for work travel time in line J is calculated as a *pro rata* proportion of the total dollar value of travel time. This accords with the treatment in the B-C analysis where travel time savings in dollars are split in the same proportions as the travel time savings by hours. However, even if different values of time are used for different types of travel, as for VPT, there is no guarantee that the model's value on a hour of travel time is the same as in the B-C analysis. For example in the case of TEL the implicit value on travel time is around $50/hour. This value goes into the calculation in line J, but the model may place a different value on travel time.

  Thus the figures in line J are not exact. Line J is used in Line L to derive a ratio that can be applied to the full time profile of market benefits as calculated in B-C analysis supplied by NZTA. See the accompanying report by Saha International.

- Line K1 is model's change in RGNDI, adjusted by a price index in line K2 to bring it up to 2008 prices.
- Line L shows the ratio of the net change in RGNDI to total market benefits estimated in line J from the B-C analysis.
- Line M shows the overall benefit escalation factor by adding the non-market benefits to the change in RGNDI and dividing by the total benefits as calculated in the B-C analysis.

For the endogenous capital scenarios, the ratios in L range from about 2 to 7. As noted above though, they are not accurate measures of the proportions by which the model raises the value of the market benefits relative to what is in the B-C analysis. **What line L provides is a ratio that can be applied to the flow of market benefits over time as calculated in B-C analysis.**

The final two columns of Table E1 show all RONS combined, firstly by just adding the results of the individual RONS and secondly by running the model with all RONS incorporated. The latter shows a somewhat smaller aggregate benefit for two reasons:

- The percentage compounding effect. For example if two RONS projects each improve labour productivity by 0.5%, their combined effect is $1-0.995^2$=0.9975%, not 1%.

- Diminishing marginal utility. The price of a good has to fall by ever increasing amounts to maintain the utility of further increments in consumption.

Overall, we would expect the results for all RONS combined to be more reliable than any individual RON, as the mix of users is likely to be closer to the national mix.

Table E3 shows a decomposition of the change in GDP into the change due to the increase in labour productivity, the change due to more capital formation (where allowed) and a residual, which is largely made up of the effects of changes in allocative efficiency – refer the discussion in Appendix D.

Table E3: Growth Decomposition

		change in labour productivity	change in investment & capital	contribution to change in RGDP from			
				labour	capital	other	total
Fixed rates of return							
WEX	Waikato expressway	0.05%	0.10%	0.03%	0.04%	0.01%	0.08%
WRR	Auckland western ring route	0.10%	0.21%	0.06%	0.09%	0.02%	0.17%
TEL	Taurangs eastern link	0.01%	0.05%	0.01%	0.02%	0.01%	0.04%
PTW	Puhoi to Wellsford	0.03%	0.09%	0.02%	0.04%	0.01%	0.07%
VPT	Victoria Park Tunnel	0.08%	0.15%	0.04%	0.07%	0.02%	0.13%
CHC	Christchurch by-pass	0.04%	0.07%	0.02%	0.03%	0.00%	0.06%
WLG	Wellington to Foxton	0.07%	0.14%	0.04%	0.06%	0.02%	0.13%
All	All RONS combined	0.38%	0.68%	0.21%	0.30%	0.07%	0.58%
Fixed total capital stock							
WEX	Waikato expressway	0.05%	0.00%	0.03%	0.00%	-0.01%	0.02%
WRR	Auckland western ring route	0.10%	0.00%	0.06%	0.00%	-0.01%	0.05%
TEL	Taurangs eastern link	0.01%	0.00%	0.01%	0.00%	0.00%	0.01%
PTW	Puhoi to Wellsford	0.03%	0.00%	0.02%	0.00%	0.00%	0.02%
VPT	Victoria Park Tunnel	0.08%	0.00%	0.04%	0.00%	0.00%	0.04%
CHC	Christchurch by-pass	0.04%	0.00%	0.02%	0.00%	0.00%	0.02%
WLG	Wellington to Foxton	0.07%	0.00%	0.04%	0.00%	0.00%	0.04%
All	All RONS combined	0.38%	0.00%	0.21%	0.00%	-0.02%	0.19%

Numbers may appear not to add exactly due to rounding.

It is apparent that without the expansionary effect of more gross fixed capital formation there is not enough growth in the economy for changes in allocative efficiency to have a net positive effect.

In summary then, the general equilibrium modelling analysis shows that all of the RONS produce an economy-wide benefit as measured by RNGDI (or GDP). Savings in work travel time alone are sufficient to generate this result. The case for wider economic benefits, however, depends critically on the responsiveness of investment to rates of return. Where new investment can occur to the point where rates of return are the same as those in the BAU, the RONS deliver substantial flow-on economic benefits, but if investment is prevented from responding to rates of return, the flow-on effects are negligible.

Table E1: Summary of Model Results (fixed rates of return)

			BAU	2020 Run 1 WEX		2020 Run 2 WRR		2020 Run 3 TEL		2020 Run 5 PTW		2020 Run 6 VPT		2020 Run 7 CHC		2020 Run 8 WLG		All RONS	2020 Run 9 All RONS	
			$m(05/06)	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ $m	Δ %	Δ $m
	Consumption (private +govt)		180086	0.07%	125	0.14%	253	0.04%	65	0.06%	113	0.11%	205	0.05%	86	0.11%	194		0.47%	852
	Exports		71630	0.09%	63	0.19%	133	0.03%	25	0.07%	53	0.13%	94	0.06%	42	0.13%	92		0.64%	461
	Imports		78169	0.05%	36	0.09%	71	0.02%	16	0.04%	33	0.08%	59	0.03%	25	0.07%	56		0.31%	245
	GDP		232576	0.08%	193	0.17%	397	0.04%	96	0.07%	171	0.13%	307	0.06%	130	0.13%	293		0.58%	1350
	RGNDI		231284	0.07%	167	0.14%	330	0.04%	90	0.07%	152	0.12%	268	0.05%	115	0.11%	255		0.48%	1116
	Population ('000)		4734	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0		0.00%	0
	RGNDI/capita ($)		48856	0.07%	35	0.14%	70	0.04%	19	0.07%	32	0.12%	57	0.05%	24	0.11%	54		0.48%	236
	Real wage rate (index)		1.3882	0.04%		0.08%		0.03%		0.04%		0.06%		0.02%		0.06%			0.24%	
	Household effective income tax rate (%)		15.83	0.13%		0.00%		0.00%		0.06%		-0.19%		0.00%		0.25%			-0.76%	
	CO_2 emissions (kt) [$100/t]		74761	0.11%	80	0.17%	127	0.01%	8	0.07%	49	0.09%	68	0.06%	45	0.12%	88		0.55%	412
		Source																		
A	Capital cost undiscounted	NZTA	$m		1619.4		1510.7		492.5		1644.9		456.0		782.1		2600.2	9105.8		9105.8
B	Typical yearly maintenance & operation	NZTA			1.4		11.3		2.4				0.0		0.6		0.0	15.7		15.7
C	Tolls	NZTA							6.0									6.0		6.0
D=0.06A-B	Financing charge at 6% (less tolls)				97.2		90.6		23.6		98.7		27.4		46.9		156.0	540.3		540.3
E=F+G+H	Total gross benefit in 2020		$m		86.8		305.4		68.2		93.6		246.2		109.5		130.6	1040.4		1040.4
F	Safety	NZTA	$m		19.3		-1.0		1.8		26.3		0.0		5.5		25.3	77.1		77.1
F1	Loss of life & permanent disability				13.8		-0.8		1.5		22.4		0.0		4.5		23.2	64.5		64.5
F2	Lost output				0.7		0.0		0.0		0.1		0.0		0.0		1.7	2.5		2.5
F3	Health care				0.3		0.0		0.1		1.1		0.0		0.3		0.1	1.9		1.9
F4	Vehicle repair				4.3		-0.1		0.2		2.3		0.0		0.4		0.2	7.3		7.3
F5	Legal				0.2		0.0		0.0		0.5		0.0		0.2		0.1	1.0		1.0
G	Vehicle operating costs	NZTA			-11.7		3.3		11.2		6.1		22.2		-0.5		4.8	35.5		35.5
												$m								
H	Travel and congestion time	NZTA	$m		79.2		303.1		55.2		61.2	224.0			104.6		100.5	927.7		927.7
I	Travel and congestion time	NZTA	m hrs		4.3		12.0		1.1		3.3		12.6		4.2		6.8	44.2		44.2
I1	Work				1.7		3.8		0.4		1.3	109.8	2.8		1.3		2.7	13.9		13.9
I2	Commuting				0.4		1.9		0.1		0.3	22.4	1.8		0.7		0.6	5.8		5.8
I3	Other				2.3		6.2		0.6		1.7	91.9	8.1		2.2		3.5	24.6		24.6
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*		$m		24.0		100.1		29.7		33.8		132.0		33.9		44.4	398.1		398.1
K1	Change in RGNDI from model	model			167.3		330.3		89.6		152.4		268.4		114.7		255.1	1377.8		1116.2
K2	- inflated to 2008 prices	1.072			179.3		354.1		96.1		163.3		287.7		123.0		273.5	1477.0		1196.5
L=K2/J	Ratio GE benefits to market benefits				7.46		3.54		3.23		4.83		2.18		3.63		6.15	3.71		3.01
M=(K2+E-J)/E	Overall increase in total benefits				2.79		1.83		1.97		2.38		1.63		1.81		2.75	2.04		1.77
Notes:	*Pro rata on travel time except for VPT									Stage 2 brought forward 10 yrs				Uses 2020/21		Some cost & benefits brought forward		Assume linearity		

Table E2: Summary of Model Results (fixed capital stock)

			2020 Run 1a WEX		2020 Run 2a WRR		2020 Run 3a TEL		2020 Run 5a PTW		2020 Run 6a VPT		2020 Run 7a CHC		2020 Run 8a WLG		2020 Run 9 All RONS	
			Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m	Δ %	Δ $m
	Consumption (private +govt)		0.01%	27	0.04%	74	0.01%	11	0.01%	23	0.03%	63	0.01%	24	0.03%	52	0.14%	259
	Exports		0.03%	24	0.07%	52	0.01%	4	0.03%	18	0.05%	37	0.03%	18	0.05%	36	0.29%	205
	Imports		0.02%	13	0.04%	32	0.00%	3	0.01%	11	0.03%	26	0.01%	11	0.03%	22	0.14%	111
	GDP		0.02%	47	0.05%	119	0.01%	16	0.02%	38	0.04%	97	0.02%	39	0.04%	83	0.19%	443
	RGNDI		0.02%	41	0.04%	100	0.01%	15	0.01%	32	0.04%	84	0.01%	33	0.03%	71	0.15%	344
	Population ('000)		0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
	RGNDI/capita ($)		0.02%	9	0.04%	21	0.01%	3	0.01%	7	0.04%	18	0.01%	7	0.03%	15	0.15%	73
	Real wage rate (index)		-0.04%		-0.06%		-0.01%		-0.03%		-0.04%		-0.02%		-0.04%		-0.22%	
	Household effective income tax rate (%)		0.19%		0.06%		0.00%		0.06%		-0.13%		0.06%		0.32%		-0.51%	
	CO_2 emissions (kt) [$100/t]		0.06%		0.08%	61	-0.01%	-11	0.02%	15	0.03%	19	0.03%	24	0.05%	39	0.27%	202
		Source																
A	Capital cost undiscounted	NZTA		1619.4		1510.7		492.5		1644.9		456.0		782.1		2600.2		9105.8
B	Typical yearly maintenance & operation	NZTA		1.4		11.3		2.4				0.0		0.6		0.0		15.7
C	Tolls	NZTA						6.0										6.0
D=0.06A-B	Financing charge at 6% (less tolls)			97.2		90.6		23.6		98.7		27.4		46.9		156.0		540.3
E=F+G+H	Total gross benefit in 2020			86.8		305.4		68.2		93.6		246.2		109.5		130.6		1040.4
F	Safety	NZTA		19.3		-1.0		1.8		26.3		0.0		5.5		25.3		77.1
F1	Loss of life & permanent disability			13.8		-0.8		1.5		22.4		0.0		4.5		23.2		64.5
F2	Lost output			0.7		0.0		0.0		0.1		0.0		0.0		1.7		2.5
F3	Health care			0.3		0.0		0.1		1.1		0.0		0.3		0.1		1.9
F4	Vehicle repair			4.3		-0.1		0.2		2.3		0.0		0.4		0.2		7.3
F5	Legal			0.2		0.0		0.0		0.5		0.0		0.2		0.1		1.0
G	Vehicle operating costs	NZTA		-11.7		3.3		11.2		6.1		22.2		-0.5		4.8		35.5
											$m							
H	Travel and congestion time	NZTA		79.2		303.1		55.2		61.2	224.0			104.6		100.5		927.7
I	Travel and congestion time	NZTA		4.3		12.0		1.1		3.3		12.6		4.2		6.8		44.2
I1	Work			1.7		3.8		0.4		1.3	109.8	2.8		1.3		2.7		13.9
I2	Commuting			0.4		1.9		0.1		0.3	22.4	1.8		0.7		0.6		5.8
I3	Other			2.3		6.2		0.6		1.7	91.9	8.1		2.2		3.5		24.6
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*			24.0		100.1		29.7		33.8		132.0		33.9		44.4		398.1
K1	Change in RGNDI from model	model		41.5		100.2		15.5		31.8		83.8		32.8		70.6		343.6
K2	- inflated to 2008 prices	1.072		44.5		107.5		16.6		34.1		89.8		35.2		75.7		368.4
L=K2/J	Ratio GE benefits to market benefits			1.85		1.07		0.56		1.01		0.68		1.04		1.70		0.93
M=(K2+E-J)/E	Overall increase in total benefits			1.24		1.02		0.81		1.00		0.83		1.01		1.24		0.97
Notes:	*Pro rata on travel time except for VPT								Stage 2 brought forward 10 yrs				Uses 2020/21		Some cost & benefits brought forward			

booz&co.

To	Richard Hancy	*Date*	25 August 2009
From	Ellen Burnes	*City*	Sydney
Subject	Peer Review of General Equilibrium Analysis of Roads of National Significance, Draft 2; prepared by Infometrics; August 2009		

memo

OVERVIEW

The paper demonstrates that an investment in the seven Roads of National Significance results in a significant economic expansion for the New Zealand economy under conditions of "open" capital stocks (as opposed to fixed), relative to a 'business as usual' (no action) case.

In particular, the primary driver of the expansion is the increased resource productivity of transport-dependant commerce and industries. As less time and money is spent transporting goods, more investment can be made on increasing the productive assets, and increasing wages, which continue to fuel economic expansion and consumer level demand.

It is easy to imagine that improving the efficiency of road-based transport leading to primary cities and ports (as these seven roads do) would have such an effect. According to *Statistics New Zealand*, the value of New Zealand exports was NZ $43 Billion for the year ending December 2008, while GDP was approximately NZ$170 billion. The ability to efficiently move industrial and agricultural goods is critical to the New Zealand economy. The effect of the success (or failure) of road transport in supporting economic development is further underscored by the Input-Output tables produced in 2005-06 that demonstrate trade as the largest contributor to the gross output value of roads[1].

HIGHER ORDER ISSUES

While the overview presented above seems largely positive, drawing this conclusion is difficult based on the material presented. Should this overview be consistent with the author's intent, the report would benefit by refocusing on the strengths and genuine contributions of a CGE model, and leaving much of the detail out, or in an appendix.

It should be noted that this review has not evaluated the underlying code, structural or mathematical relationships underlying the results. Based on the level of contribution that Dr. Stroombergen and Infometrics have made to develop a strong intellectual capital foundation for General Equilibrium analysis in New

[1] *As cited in Stroombergen, Adolf. 2008. ESSAM General Equilibrium Model: Estimation of 2005/06 Input-Output Tables. MOTU Working Paper.*

Zealand, the model's integrity is assumed. Further, material changes to the outcomes and implications of findings would likely not occur commensurate with the cost in dollars and time it would take to undertake such an assessment. The quality of the results is influenced more by applying the model to questions appropriate for a CGE model, rather than questioning the details of the model's construction.

In addition to re-assessing the level of detail, the following areas would also help the reader:

- Improve accessibility by providing an intuitive rationale for its process and results.
- Clearly state the role of the CGE relative to a policy objective
- Focus discussion of inputs on salient issues
- Avoid inconsistency in results presentation with other elements of presentation

Each of these bullets is addressed in the following sections.

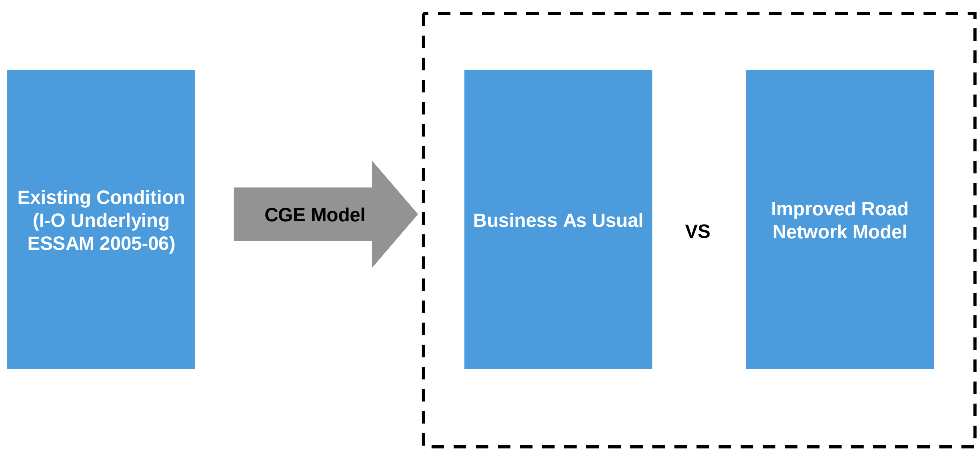
INTUITIVE RATIONALE

Clarifying the role of the CGE is policy analysis. **Figure 1** depicts an illustration of the understanding of the role and place of CGE in determining the potential benefits of an infrastructure investment in the roads network.

1. The benefits determined under CGE are separate from those determined through the traditional B-C methods to assesses the project's direct benefits.
2. There is no temporal element. The CGE is a comparison of a one snapshot moment after the investment, the new road quality is achieved, system efficiency and performance is demonstrated, and additional capital flows to the industry/system. **Figure 1** illustrates the understanding of the CGE basis for calculation and comparison.

Figure 1

Understanding of Underlying Economy Relationships and Basis of Comparison in CGE

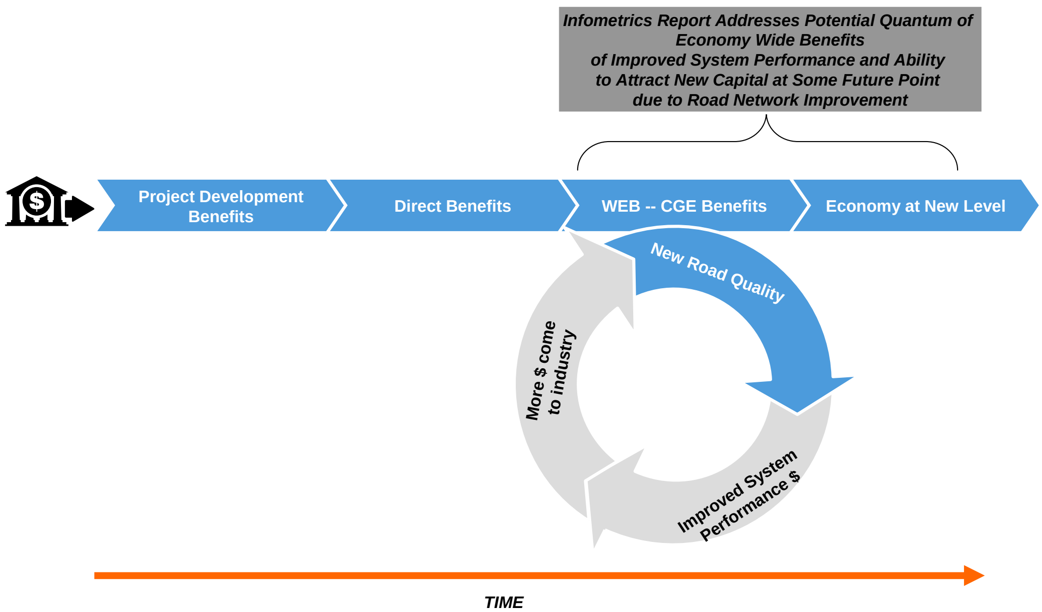


Under a changed state the business as usual is compared to the Improved road network to determine the Wider Economic Benefits of the investment in the road network

3. The implication of the distinctive methods and role of CGE is that they are not additive across benefits areas. The collection of project benefit areas demonstrated in **Figure 2** is more like creating a fruit salad – where the parts are still unique and distinguishable – rather than a biscuit that represents a unique new good.

Figure 2

Illustration of Role of CGE in Measuring Investment Benefits



4. That this CGE is not assessing the project development benefits is not a caveat, but rather, a note to policy makers that earlier, more certain benefits not dependant on structural shifts are likely. The I-O models of 2005-06 underlying the ESSAM project suggest that the initial benefits of construction are even more positive – construction is an even greater contributor to GDP – has ~ 5.86 times the effect on gross output. Given the current high levels of unemployment, this seems like an important point to make in a document to support a policy case for Road Building.

ROLE OF THE CGE

The objective of the analysis is to support decision making according to economic criteria of Project Benefits relative to the opportunity costs of undertaking RONS. The project benefits include traditional direct project benefits (calculated through a different system, under a different group), and *wider economic benefits* – indirect project benefits calculated through a macroeconomic calculation using CGE methods.

CGE is not intended to support the decision that the government *should* follow an investment path, but rather, that it would make economic sense. CGE does not evaluate a particular path relative to other investment opportunities, that is, relative to its *opportunity cost*.

A CGE model is not intended to support an investment or funding quantum decision, but rather, to support a policy question such as what are the likely follow on (economy-wide) benefits if additional performance were achieved through the roads sector. In fact, under the scenario analysed in the Infometrics report, it is the efficiency gains and corresponding capital accumulation that appears to drive the benefits scenario.

As the report suggests, "…Therefore the results can only ever be indicative. The interpretation of CGE results should centre on their direction (up or down) and broad magnitude (small, medium or large), rather than on the precise point estimates that the model produces".

INPUTS

It seems that a key driver of the model is the I-O model underlying the ESSAM model. The natural strengths of the IO dynamics are lost. A discussion of the dynamics of the road transport sector with other economic sectors would help with the intuition. In particular, the interface with trade, agriculture, dairy, and forestry appears strong.

The BAU scenario is difficult to follow. In particular point 2 (p. 9) -- it is not clear how "For example, higher rates of return to capital will result in more investment and thus a larger capital stock" follow from "rates of return on capital are held constant, with capital stock being endogenous.

The role and dynamics of the ETS (p. 10) are unclear. It is noted that this is an important policy undertaking of the New Zealand government. However, this particular point is addressed in considerably greater detail than other, likely more influential model parameters. What is the author's expectation of the implications of the ETS on the CGE model and its outputs?

Further, rather than simply referring to a separate document, it would be useful to include the scenario details directly. As this report is intended to support decision making on a significant investment, it would be useful to have key input considerations directly accessible (e.g. p. 10 reference to NZIER and Infometrics (2009b) is noted, but its absence contributes toward credibility problem).

The role of "capital cost" presented on p. 11, point 4 under input data is still unclear. Is this the same "cost" as the investment that is the basis for the structural shift that the CGE is measuring?

How did you arrive at the rationale for using petrol and diesel as a proxy for transport? Understanding the rationale, when presented on p. 7 would help interpret the input discussion on p. 12 when scepticism is introduced. " The statement " it is assumed that savings in (work) travel time are allocated to industries on the basis of their direct use of petrol and diesel for transport" This seems like it would be a fine assumption, but where is this in the underlying ESSAM model. How is petrol/diesel demand traced through economy?

RESULTS

Rather than present results consistent with the policy objective, and the strengths of a CGE model in establishing the quantum and allocation of macroeconomic benefits, the results section over-extends the role of a CGE and thereby introduces scepticism into the process, model and results.

Some examples include:

p. 14 "As noted above though they are not really measures of the proportions by which the model raises the value of the market benefits relative to what is in the B-C analysis". The table presentation format obfuscates the message that there are economic growth opportunities due to structural shifts in the economy under the RONS investment scenario. Additionally, comparing a static assessment with no temporal element to a B-C analysis that addresses benefit and cost flows over time is not accurate. Each is a valid result on its own, and supports further policy consideration of the RONS investment.

If not really measures, why report? The CGE has a valid role in informing policy and imposing an artificial role diminishes its strength.

p. 16 – caveat that "The use of petrol and diesel may be a poor proxy for the allocation of benefits if RONS users are not representative of all road users." Raises concerns about model robustness. It seems that this is again a case of trying to overstate model's role leading to doubt in results.

The tables (1 and 2) require different explanation. The flow diagram and discussion is onerous. It is not clear what the role of A-D are in the table. Total capital costs and annual operations and maintenance costs are neither comparable to one another, nor to a single benefits measure (that is, all must be made either annual or total).

Does Row J imply that the investment upon which the CGE is based is the economic savings (NZ$398.1 million) rather than the capital cost, NZ$9.1 billion? It is not clear how the basis of comparison was determined, and why a comparison is necessary.
If one were to compare the CGE macroeconomic calculations with the microeconomic drivers underlying a benefits assessment, why wouldn't you compare the gross benefits (laying aside the temporal and discount rate issues).

The presentation and rationale for the results needs additional attention. It is recommended that the results be presented as the CGE accomplishments relative to the question – Does an investment in Roads of National Significance result in structural changes that benefit the New Zealand economy?

CONCLUSIONS

The paper indicates that a highly technical, rigorous CGE model may be developed to support and understanding of the relative structural shifts and their corresponding benefits from an investment in Roads of National Significance in New Zealand.

To increase the effectiveness and credibility of the results, it is recommended that:

- greater clarity is provided with respect to the policy objective/question being addressed
- attempts to over-extend the model and its application are avoided
- a 'first principles' approach is taken that provides intuition for the process, as well as a review of key underlying features (such as the I-O tables underlying the ESSAM model)
- the presentation of results is summarised to be consistent with the policy objective while detailed tables are left for appendices

Response to Booz & Co's *Peer Review*

1. *The report would benefit by refocusing on the strengths and genuine contributions of a CGE model, and leaving much of the detail out, or in an appendix.*

   The report has been restructured with shorter chapters on methodology and results, and detailed material appearing in appendices. Figures 1 and 2 have also been included.

2. *Capital closure*

   Either rates of return are fixed and the capital stock is endogenous or the reverse applies. Hopefully this is clearer with the above revisions.

3. *Emphasis on ETS*

   The emphasis on the Emissions Trading Scheme in the Business as Usual scenario was inappropriate. It has been reduced.

4. *Insufficient detail on Business as Usual Scenario*

   An appendix now has more detail on the BAU. We stress, however, that the BAU is intended to be a plausible projection, not a best forecast, of what the economy may broadly look like in 2020. It will be wrong, but that is not the point. The point is that the ways in which it will be wrong are unlikely to have a significant effect on the results of the RONS analysis – which does not mean that sensitivity testing would not be worthwhile. Assumptions such as the capital closure assumption have a far greater effect on the results than specific BAU assumptions such as the price of carbon or the rate of efficiency increase in energy use.

5. *The role of "capital cost" ....is still unclear.*

   The only function of this is to determine the financing charge.

6. *How did you arrive at the rationale for using petrol and diesel as a proxy for transport? ... " The statement " it is assumed that savings in (work) travel time are allocated to industries on the basis of their direct use of petrol and diesel for transport" This seems like it would be a fine assumption, but where is this in the underlying ESSAM model. How is petrol/diesel demand traced through economy?*

For each industry and household type the model has data on energy consumption in energy units (PJ) by four types of energy: coal, oil, gas and electricity. The MED's Energy Data File allows us to estimate uses of oil that are not for land transport, such as oil used for heating, stationary engines or air and water transport. The residual is oil products, essentially petrol and diesel, used for road transport.

Industries and household either purchase petrol and diesel directly for their transport needs, or they purchase transport services from the Transport industry – in which case it is the Transport industry that purchases the fuel.

At any point in time, as opposed to over time, petrol and diesel use will be a reasonable proxy for road use. The problem arises in the case of particular roading projects that cater to a mix of traffic that is not representative of all road users. For example, let us assume that the forestry industry is a major user of roads (not unreasonable), but the Wellington to Levin RONS for example is unlikely to carry the national share of forestry traffic. Thus when we model the Wellington-Levin RONS the model will overstate the benefits to the forestry industry. Similar concerns exist with all of the RONS, although all of them combined hopefully have a mix of users that is closer to the national average.

Note that it would be straightforward to insert into the model different patterns of direct RONS benefits by industry. Indeed we asked for this information, but unfortunately it does not exist in any of the standard RONS B-C analyses.

7. *Results ... the results section over-extends the role of a CGE and thereby introduces scepticism into the process, model and results. The table presentation format obfuscates the message that there are economic growth opportunities due to structural shifts in the economy under the RONS investment scenario. Additionally, comparing a static assessment with no temporal element to a B-C analysis that addresses benefit and cost flows over time is not accurate. Each is a valid result on its own, and supports further policy consideration of the RONS investment.*

   The present value ratios have been removed and the associated details relegated to an appendix.

8. *caveat that "The use of petrol and diesel may be a poor proxy for the allocation of benefits if RONS users are not representative of all road users." Raises concerns about model robustness. It seems that this is again a case of trying to overstate model's role leading to doubt in results.*

   See above. The statement is indeed a deliberate warning about the robustness of results.

9. *The flow diagram and discussion is onerous.*

   The diagram and accompanying text have been placed in an appendix, and replaced it in the main report with the better diagram suggested by the reviewer.

10. *It is not clear what the role of A-D are in the table. Total capital costs and annual operations and maintenance costs are neither comparable to one another, nor to a single benefits measure (that is, all must be made either annual or total)*

    All of this is now in an appendix. The capital cost is used only to calculate the capital financing charge.

11. *Does Row J imply that the investment upon which the CGE is based is the economic savings (NZ$398.1 million) rather than the capital cost, NZ$9.1 billion? It is not clear how the basis of comparison was determined, and why a comparison is necessary.*

    The GE model results are based on the $398m, subject to the caveat discussed around the interpretation of line J. The comparison is necessary so that Saha have a factor that they can use to scale up the market benefits over the entire RONS period. Again all of this material is now in an appendix.

12. *If one were to compare the CGE macroeconomic calculations with the microeconomic drivers underlying a benefits assessment, why wouldn't you compare the gross benefits (laying aside the temporal and discount rate issues).*

    The revised tables in an appendix should address this issue.

13. *The presentation and rationale for the results needs additional attention. It is recommended that the results be presented as the CGE accomplishments relative to the question – Does an investment in Roads of National Significance result in structural changes that benefit the New Zealand economy?*

    The restructured report hopefully meets that recommendation.

Booz & Company

Auckland/Wellington, June 7th 2010

Roads of National Significance

Distribution of ΔRGNDI

This document is confidential and is intended solely for
the use and information of the client to whom it is addressed.

What makes these roads nationally significant?

"These are seven of our most essential routes as a country, that require work to reduce congestion, improve safety and support economic growth," says Transport Minister Steven Joyce.

"The purpose of listing roads as "nationally significant" is to allow the government to have input into the development of the land transport programme and the National Infrastructure Plan from a nationwide perspective.

"These roads are already very important in their respective regions. We want to signal to the NZ Transport Agency through the Government Policy Statement their significance to the country as a whole.

"All seven are the most urgent projects within, or adjacent to, our five largest population centres.

booz&co.

Location of Roads of National Significance

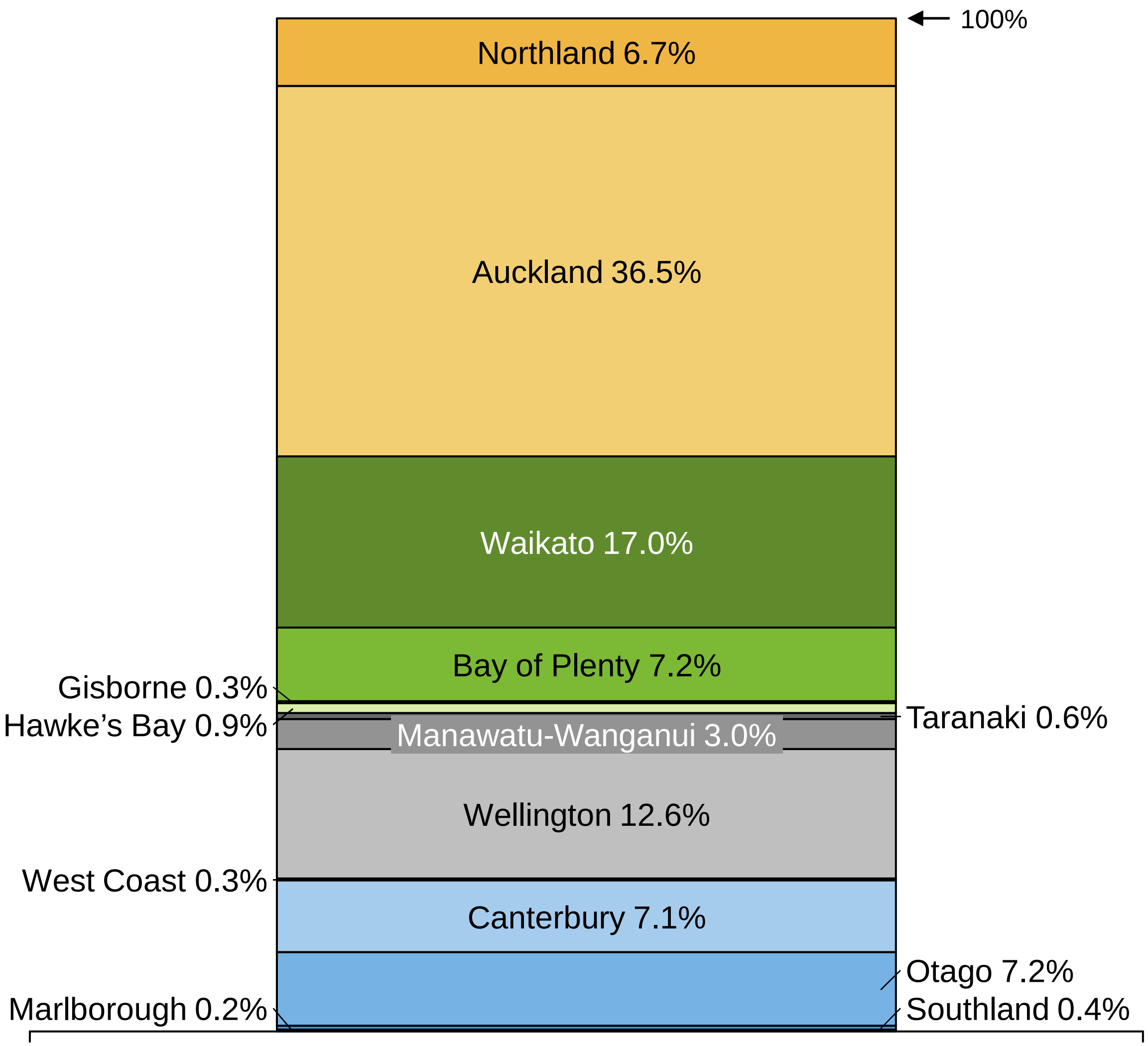
The initial list of roads of national significance identified seven routes that have high traffic volumes, and that require work to reduce congestion, improve safety, and support economic growth.

NZ TRANSPORT AGENCY
WAKA KOTAHI

New Zealand Government

booz&co.

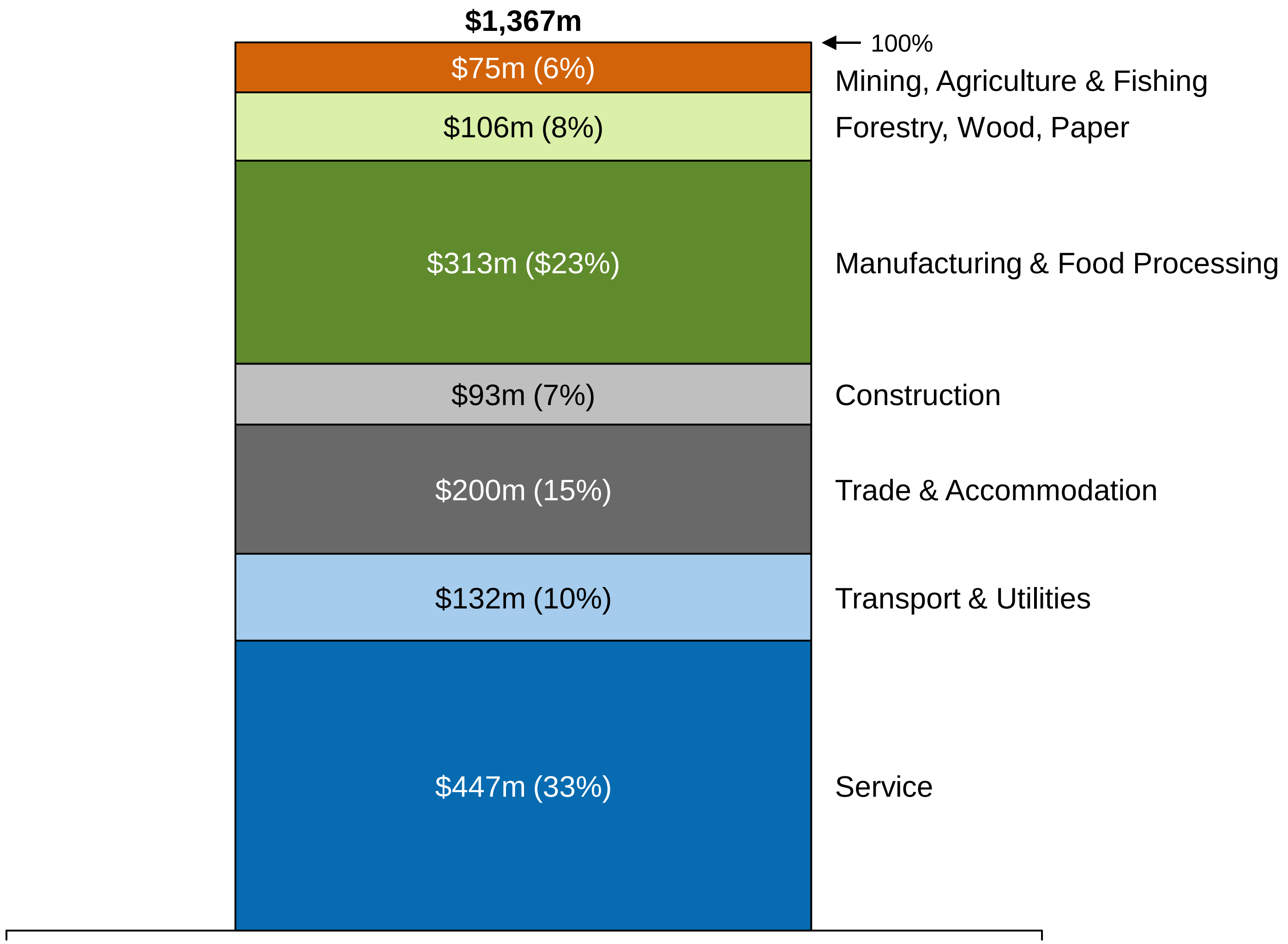
Roads of National Significance
Real Gross National Disposable Income $1,367m



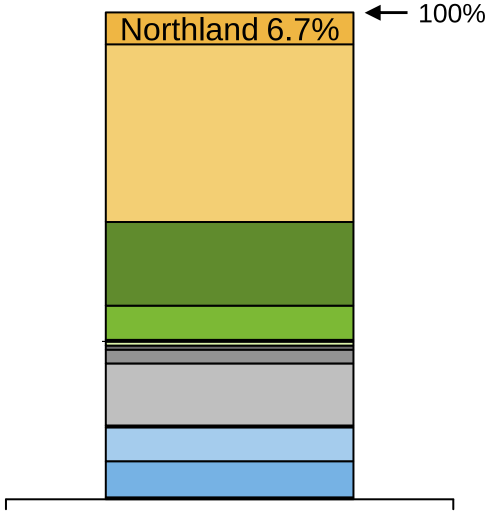
Real Gross National Disposable Income (RGNDI)

Measures the total incomes of New Zealand residents adjusted for changes in terms of trade.

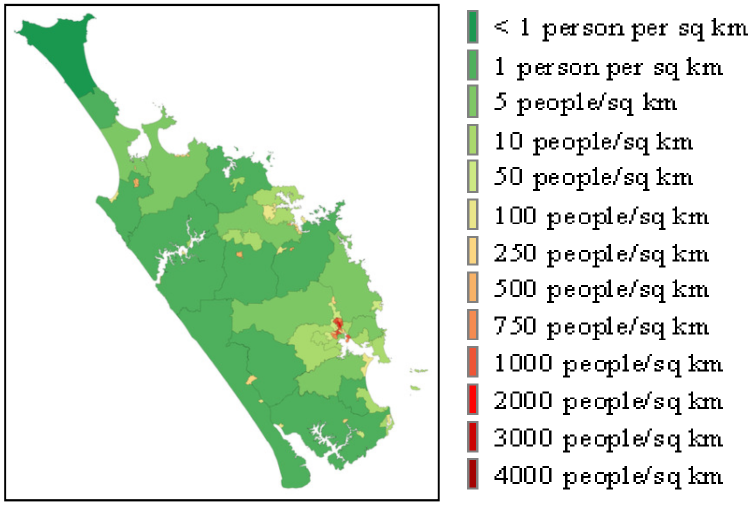
RGNDI by industry type

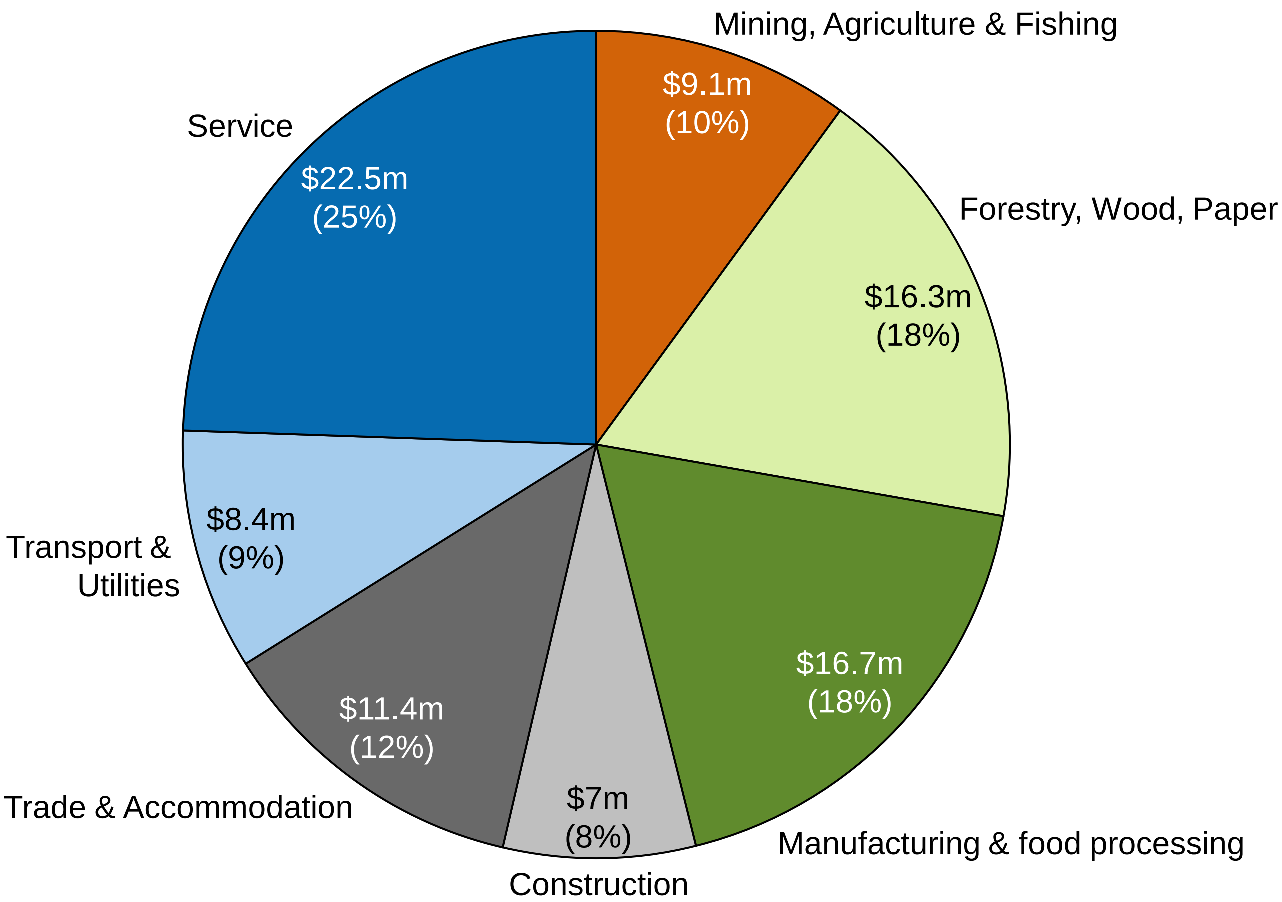


Distribution by industry - Northland 6.7% $91.4m



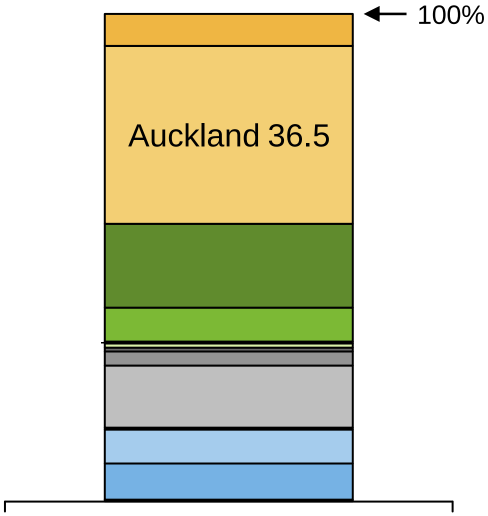
Population density



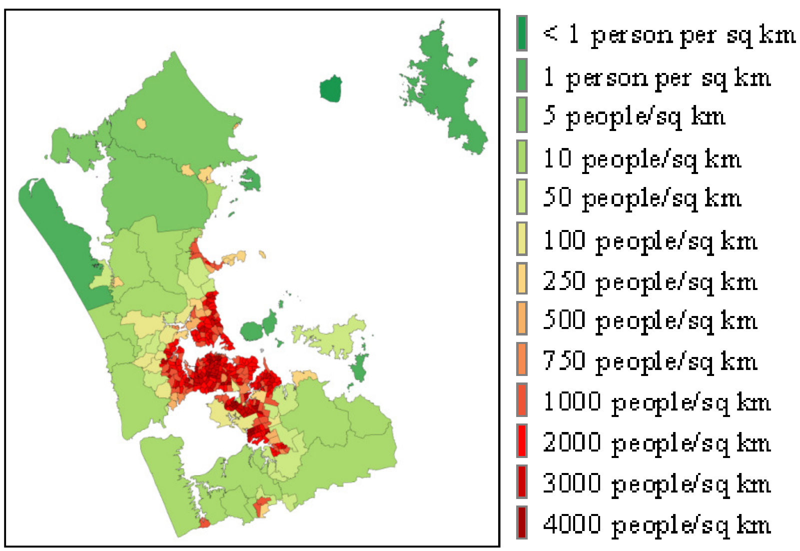


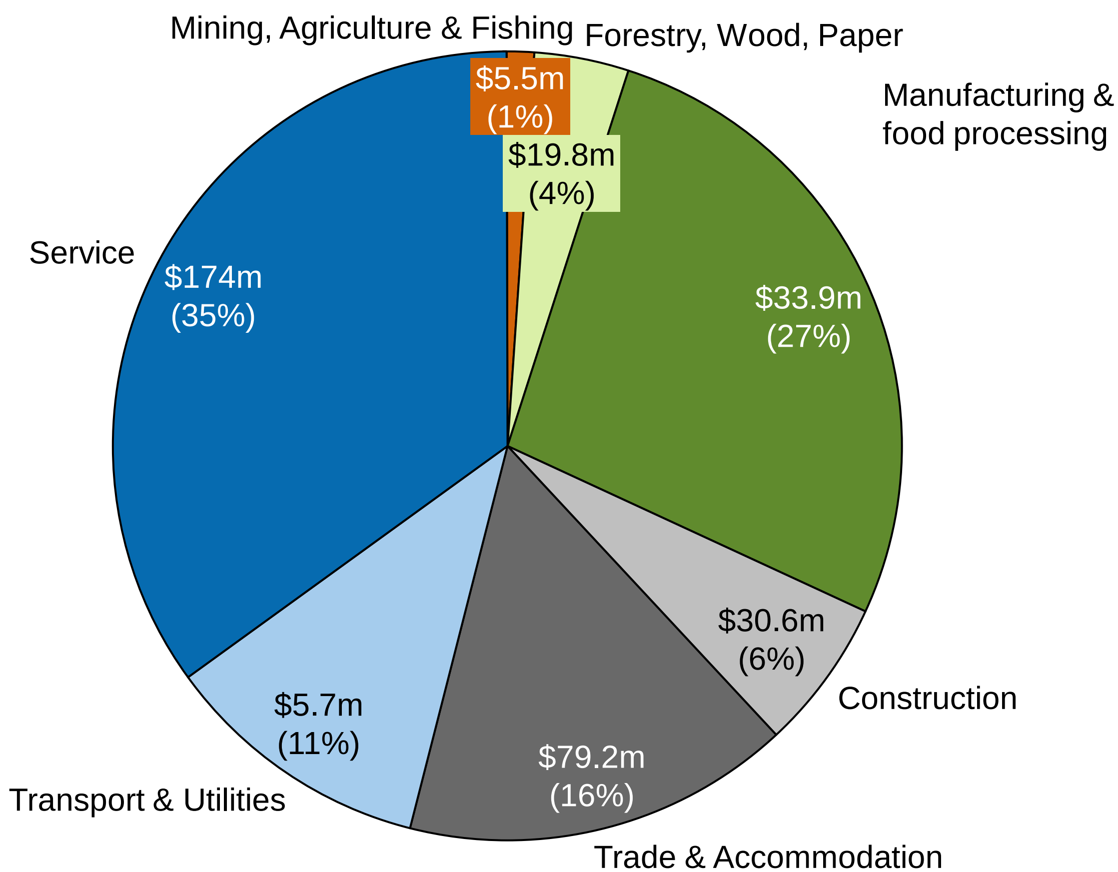
booz&co.

Distribution by industry - Auckland 36.5% $498.8m

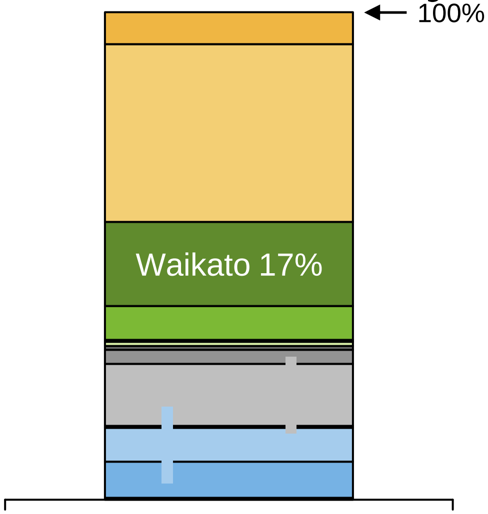


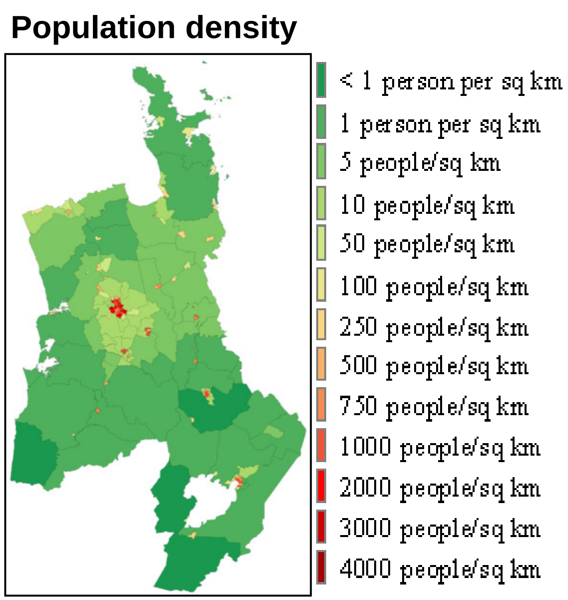
Population density

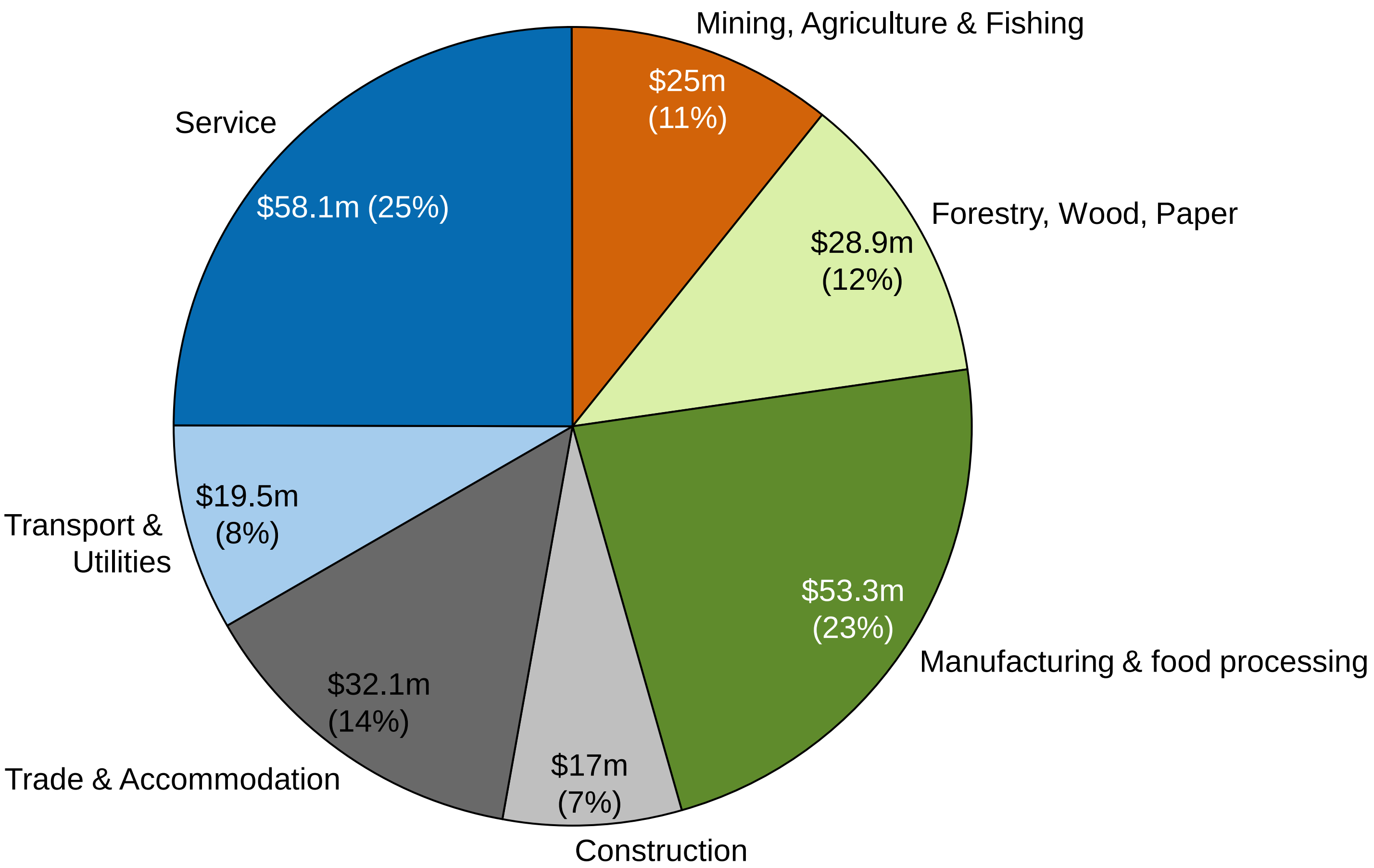




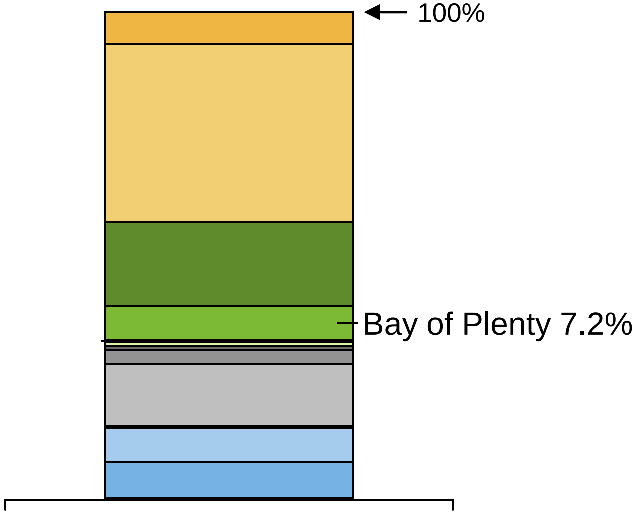
Distribution by industry - Waikato 17% $232.6m



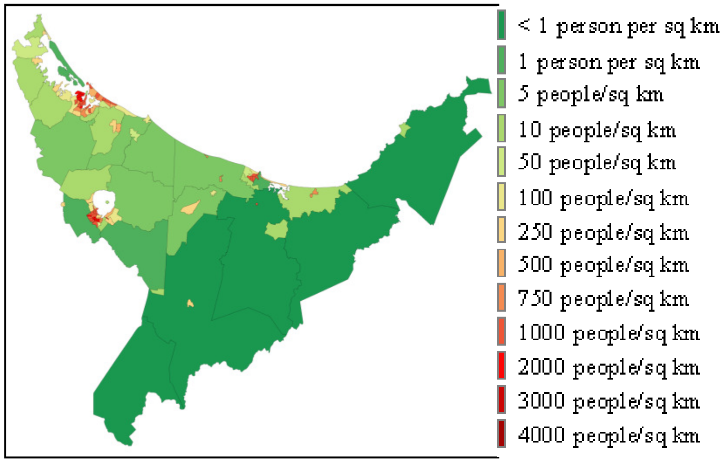


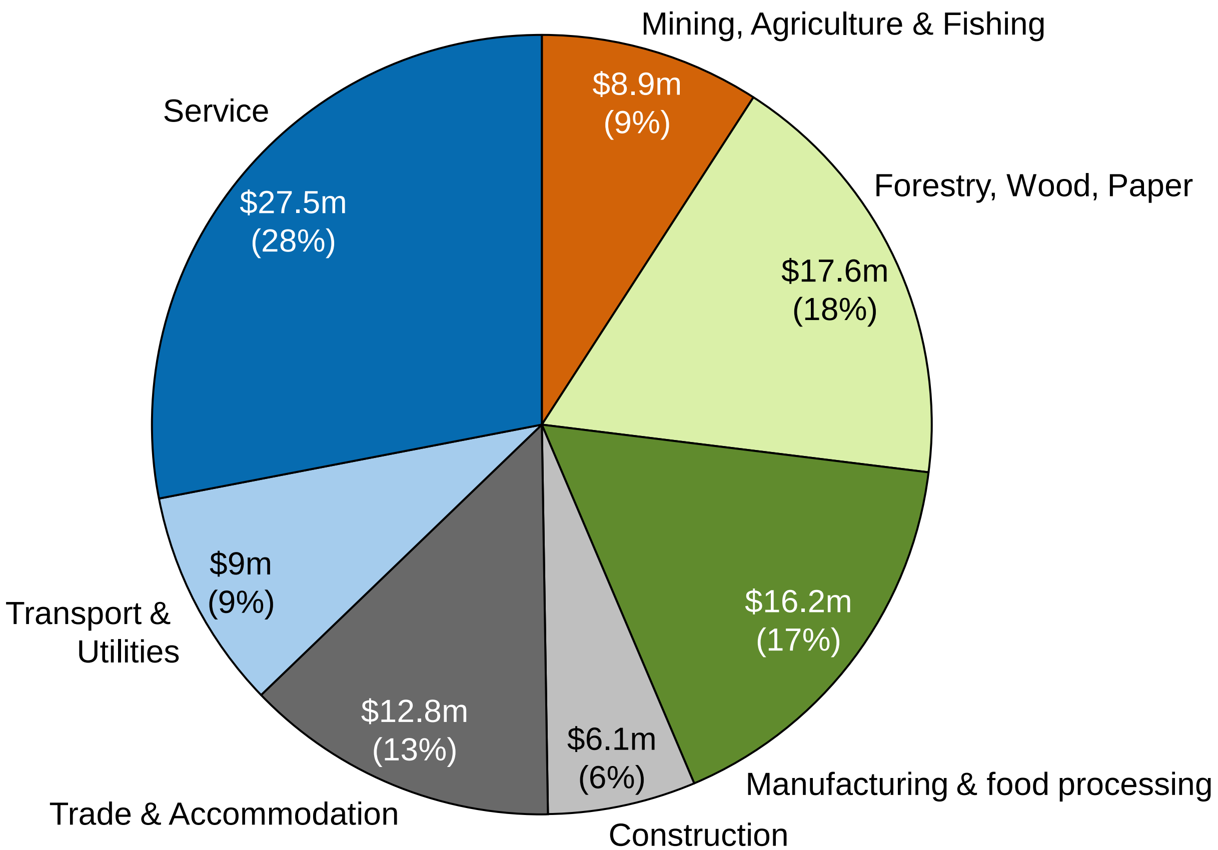


Distribution by industry - Bay of Plenty 7.2% $98m

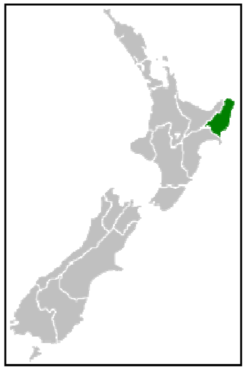


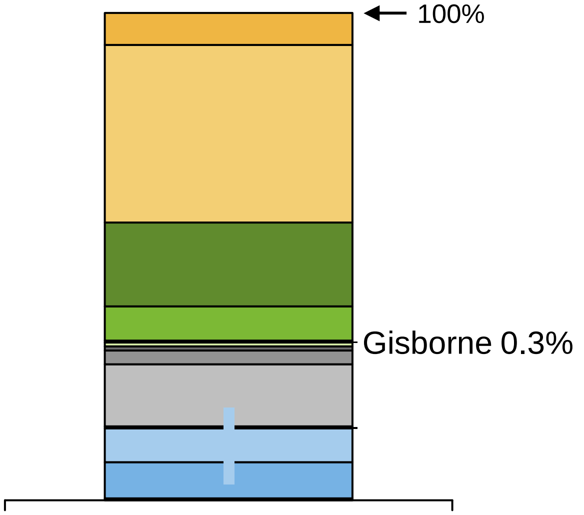
Population density



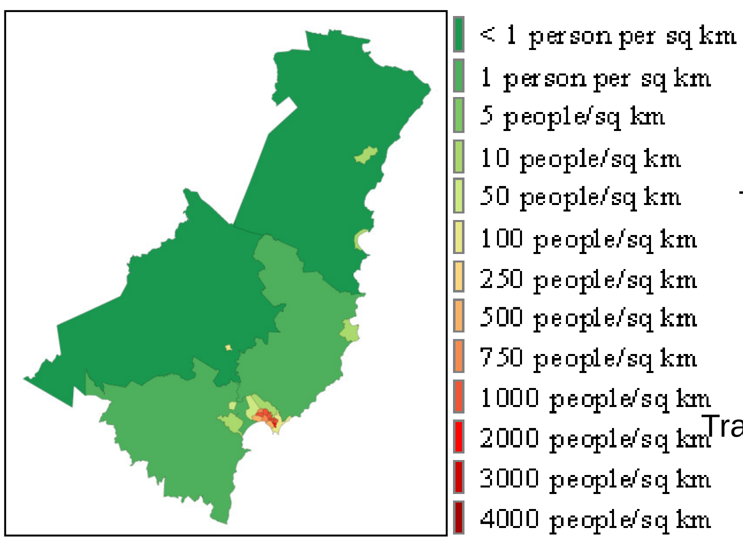


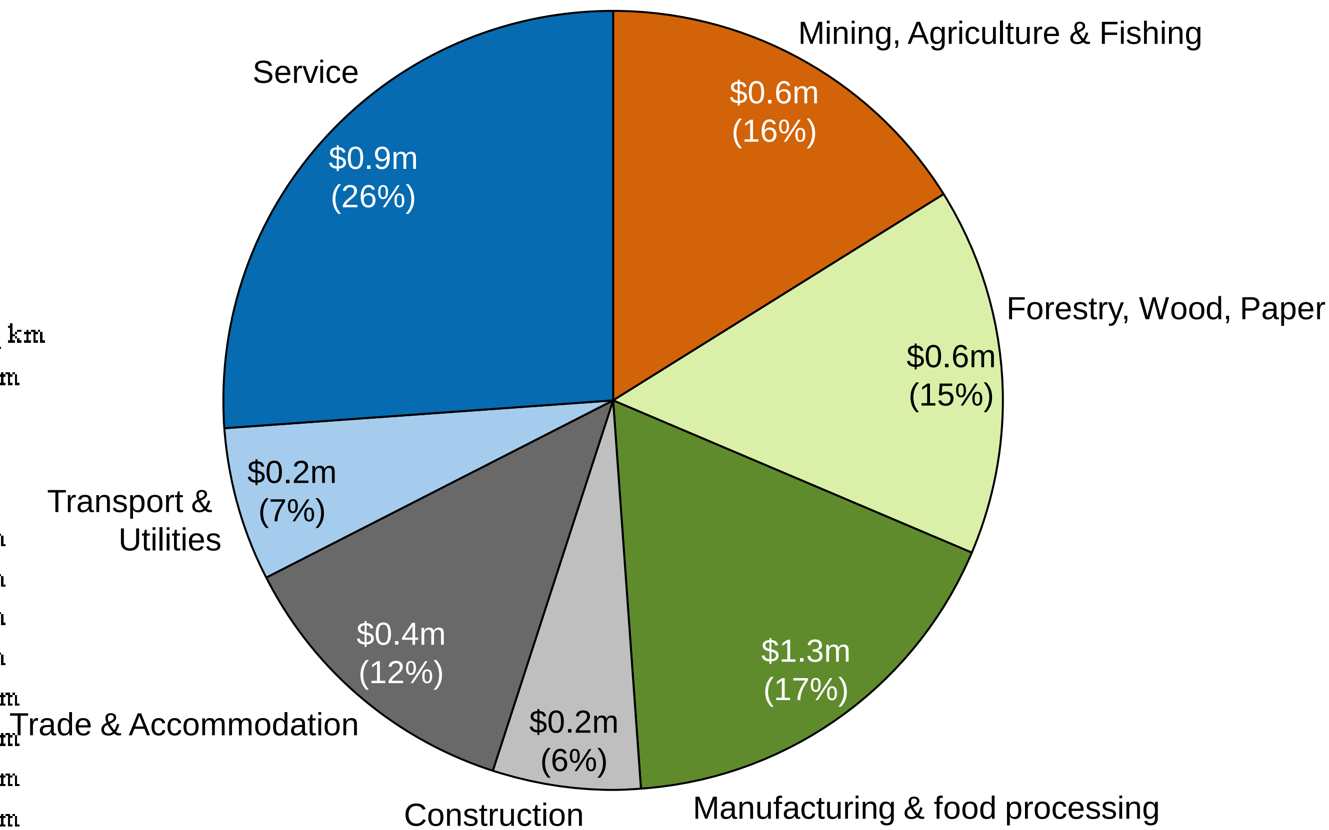
Distribution by industry - Gisborne 0.3% $3.6m



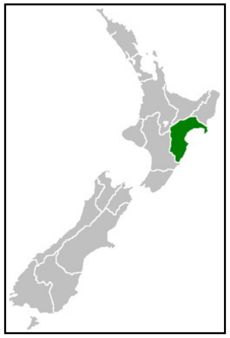


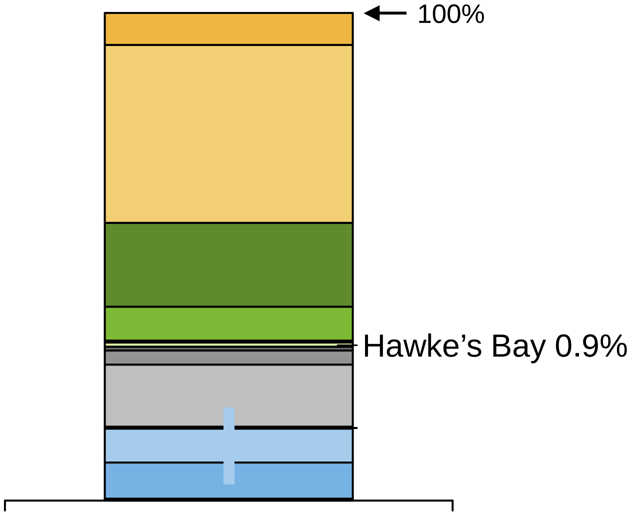
Population density



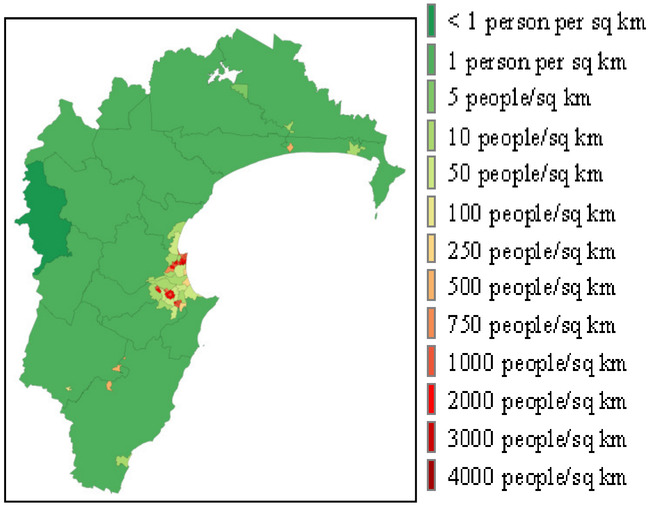


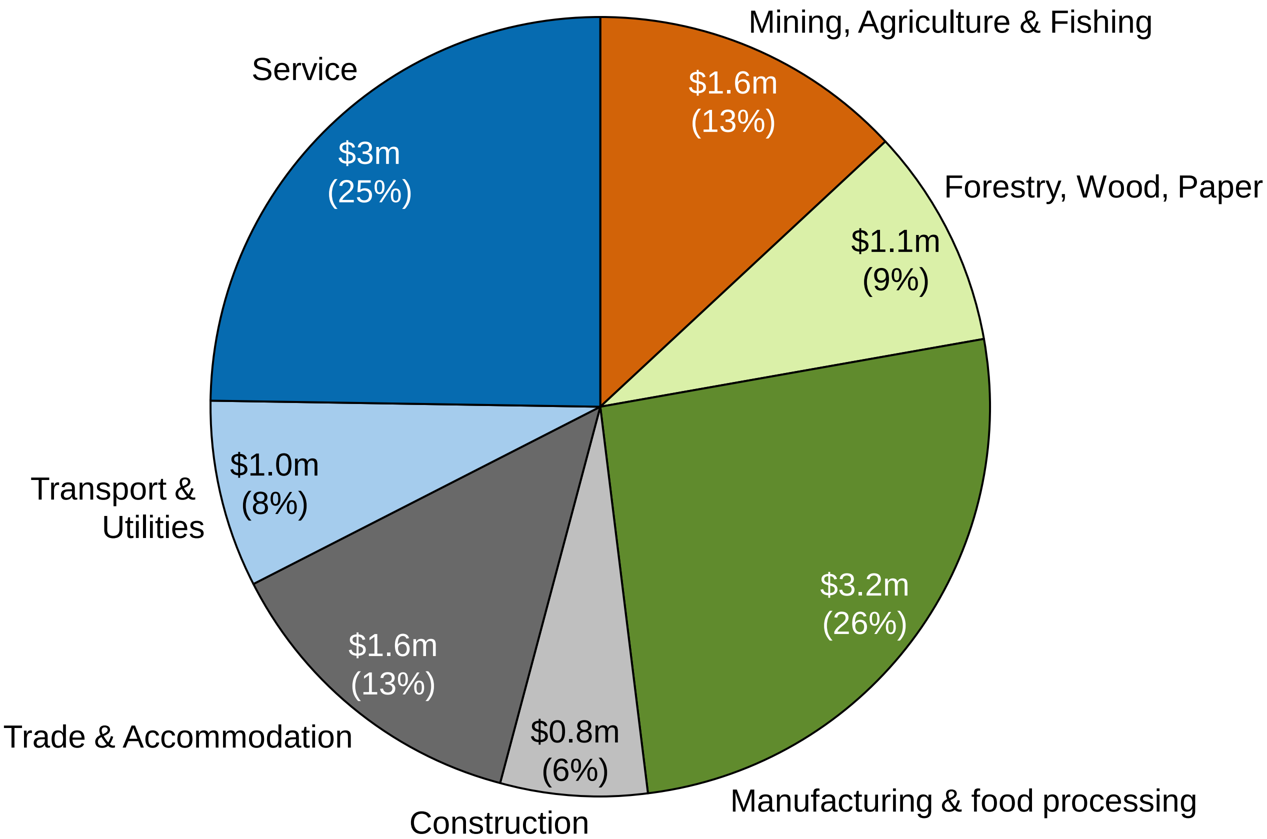
Distribution by industry - Hawke's Bay 0.9% $12.2m



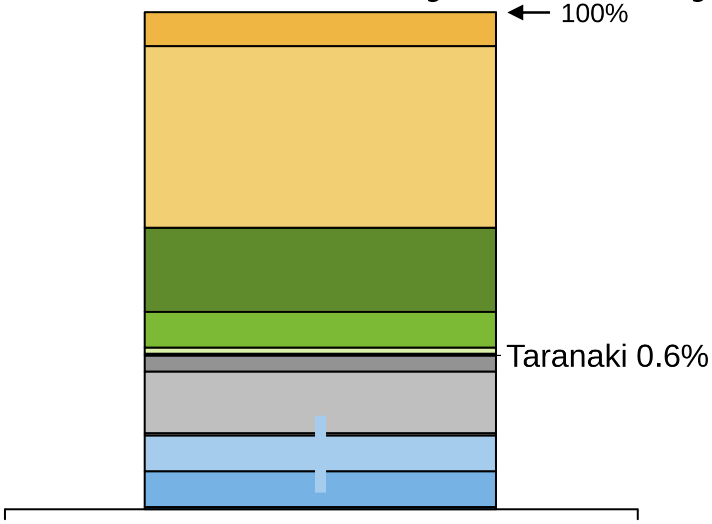


Population density

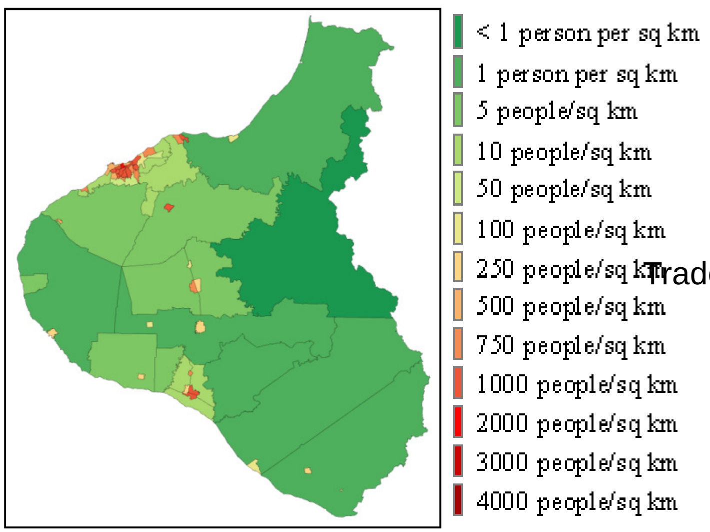


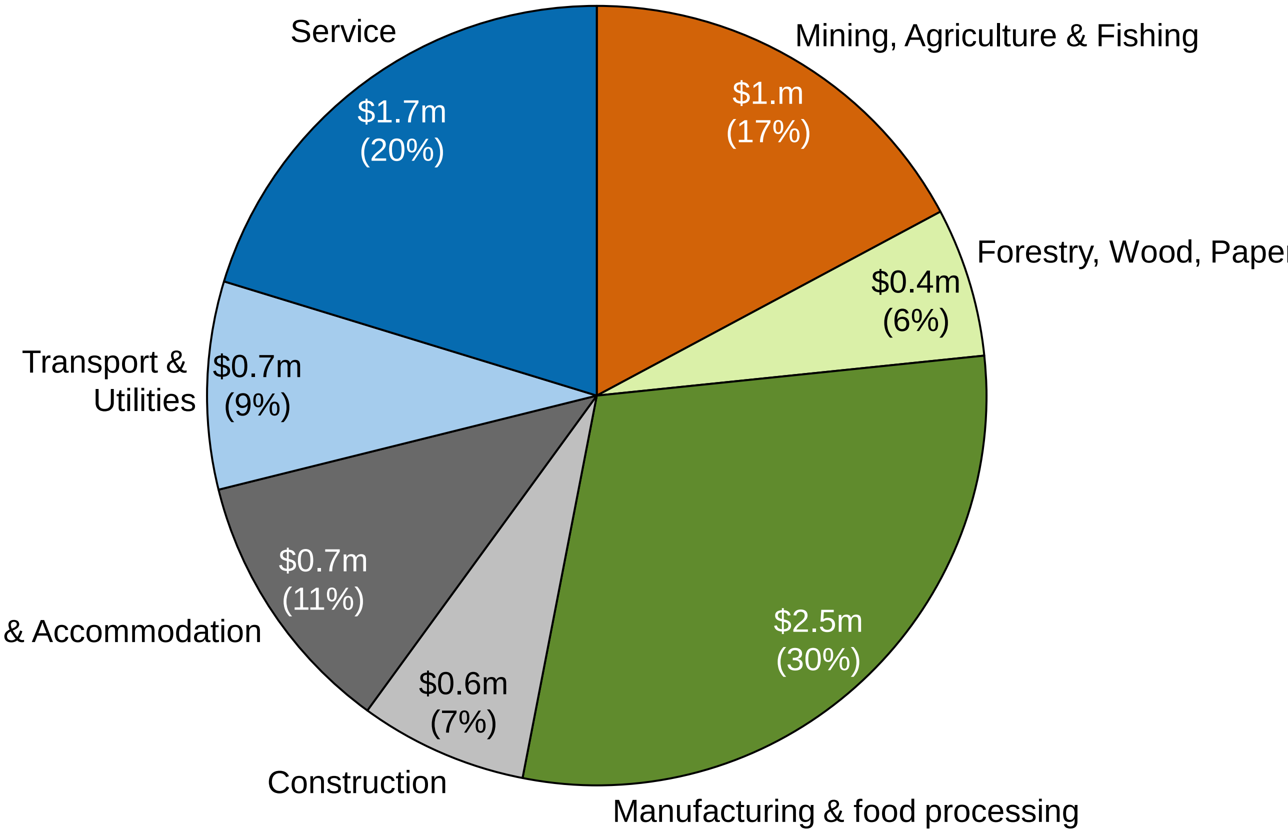


Distribution by industry - Taranaki 0.6% $8.4m



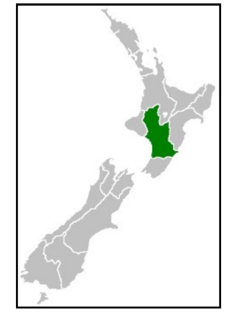
Population density

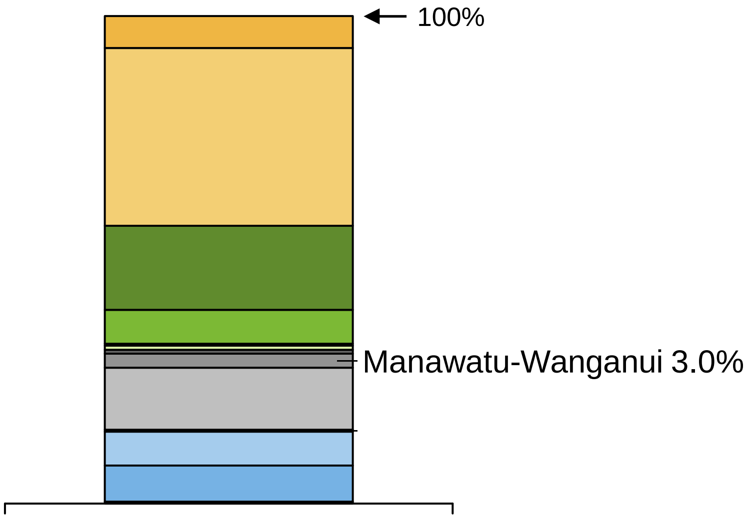




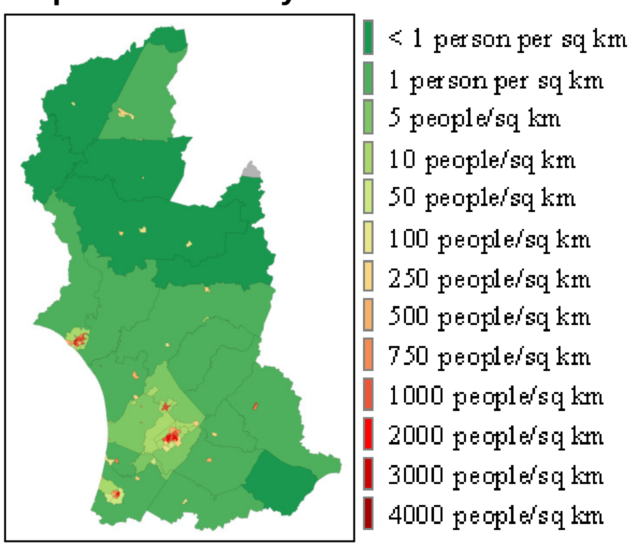
booz&co.

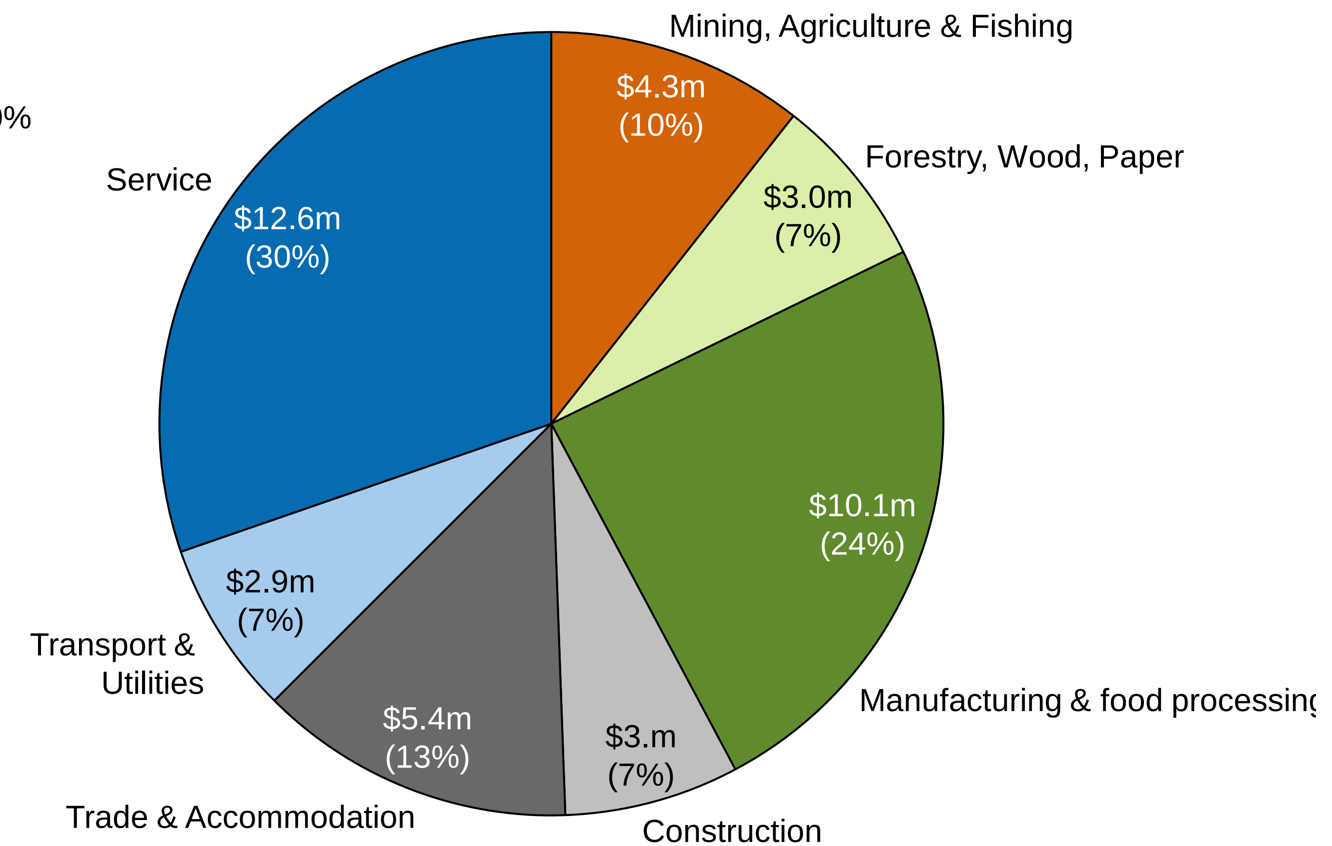
Distribution by industry- Manawatu- Wanganui 3% $41.5m



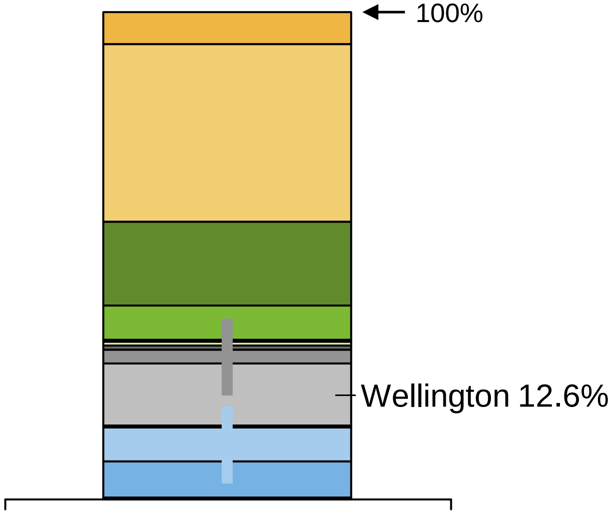


Population density

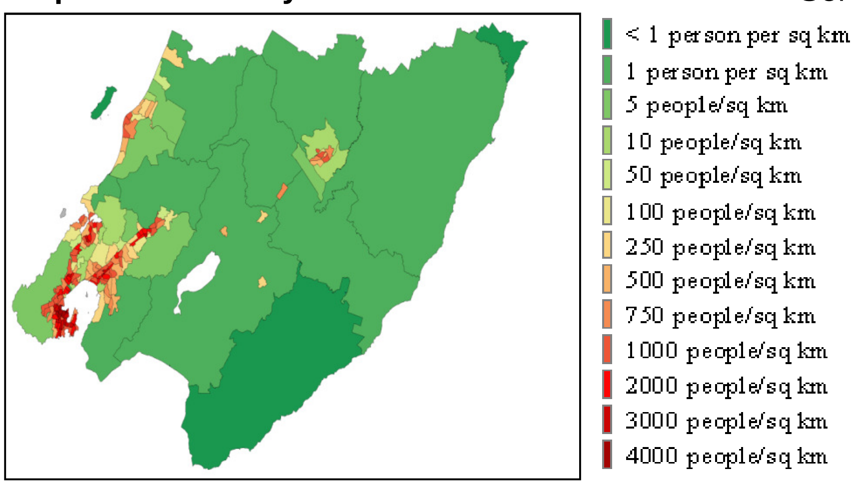


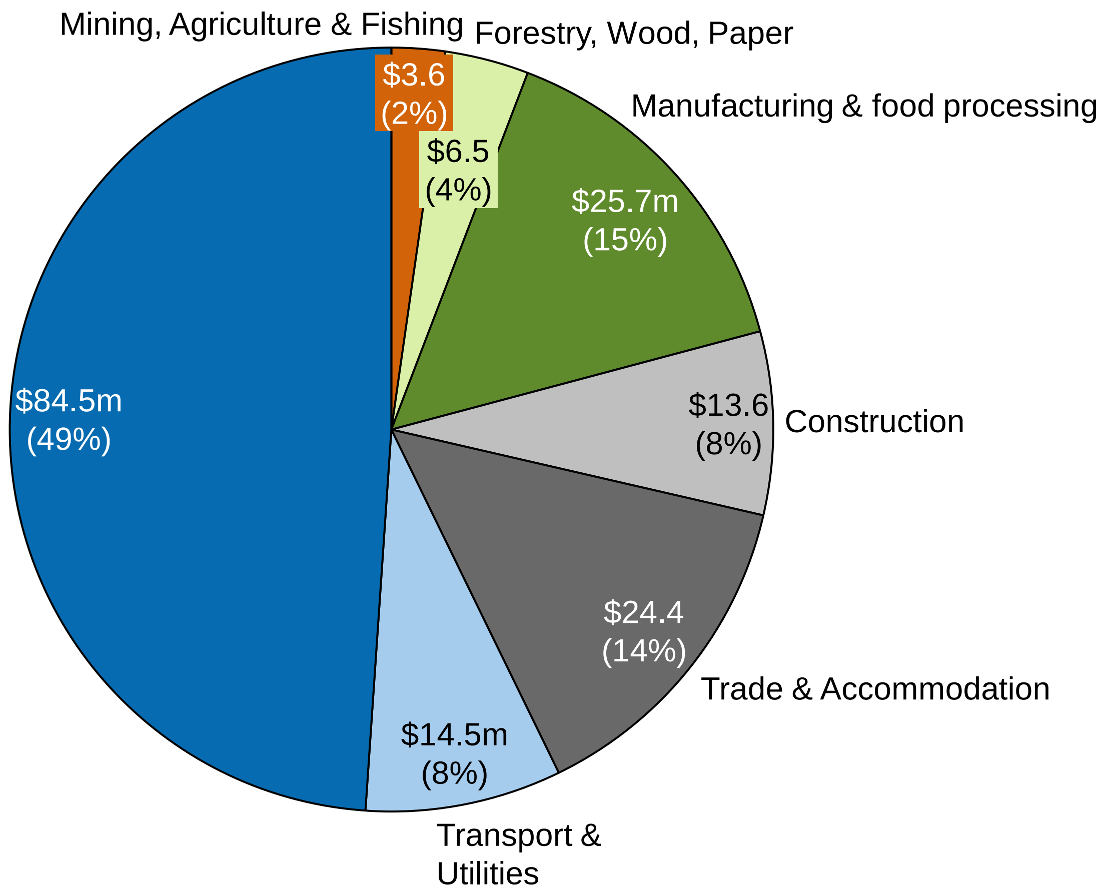


Distribution by industry - Wellington 12.6% $172.9m

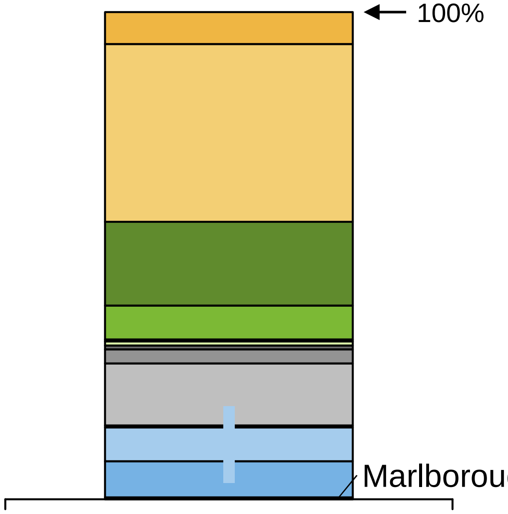


Population density

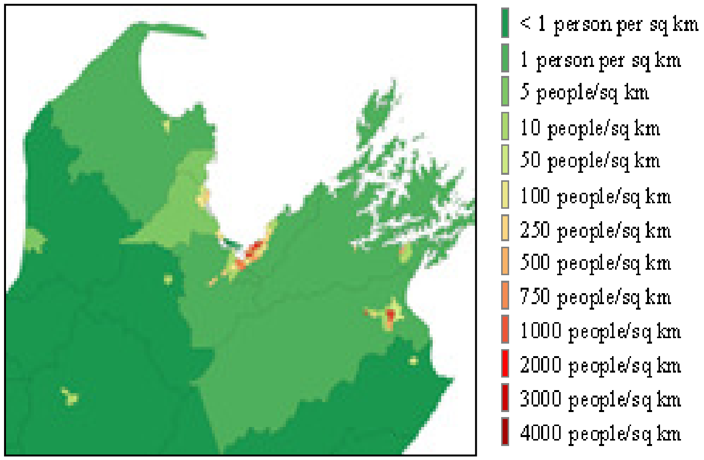


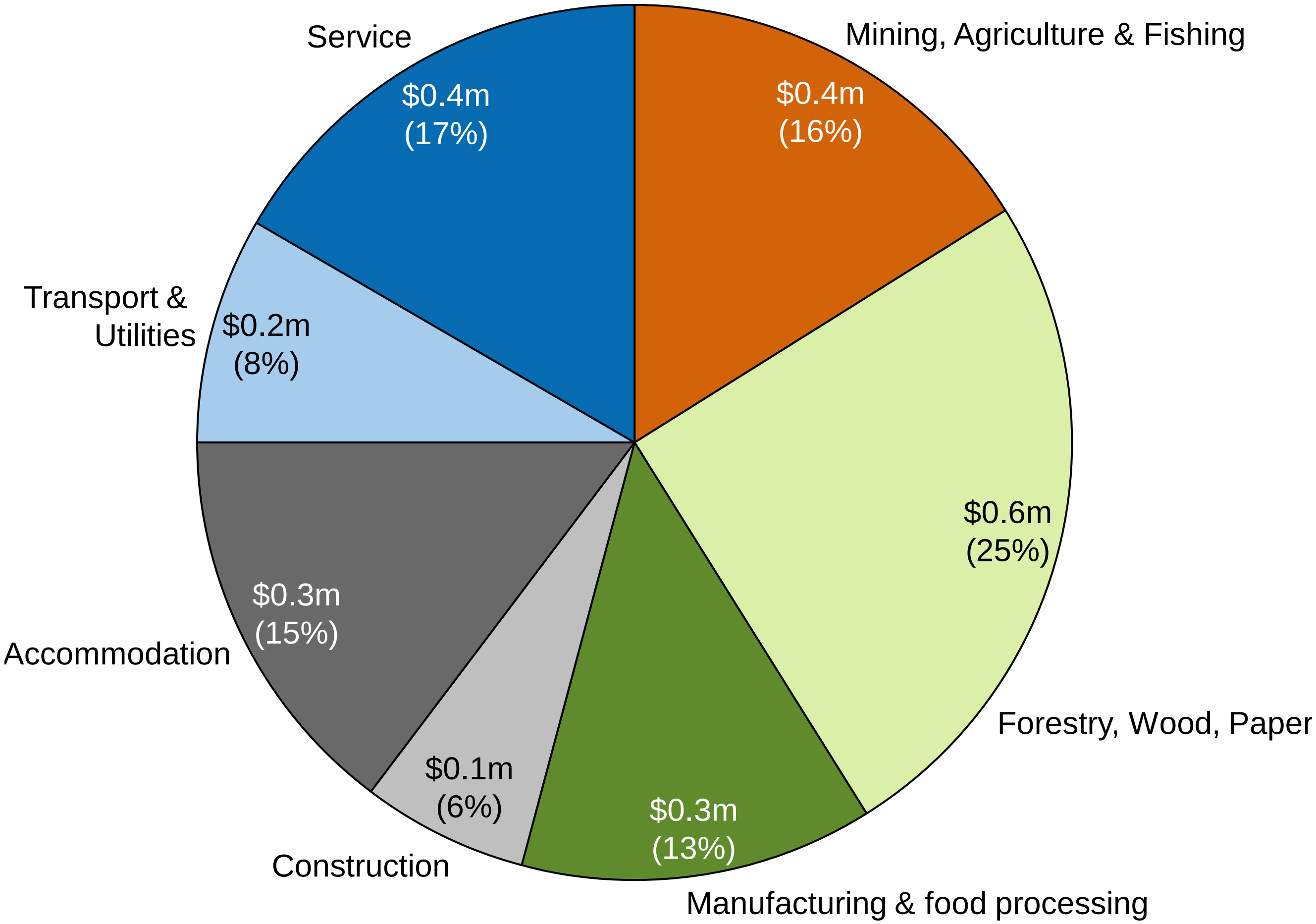


Distribution by industry - Marlborough 0.2% $2.3m

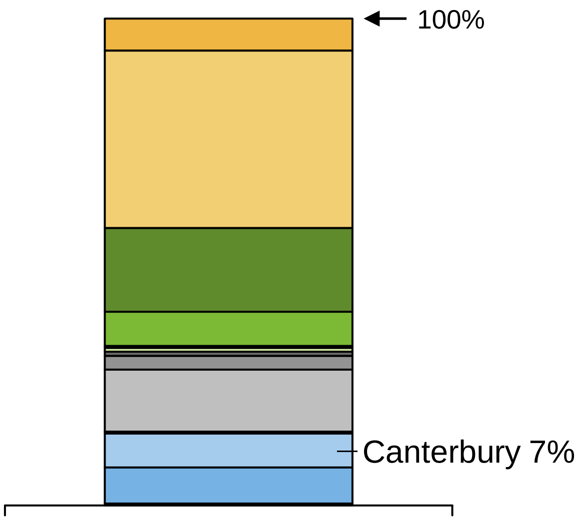


Population density

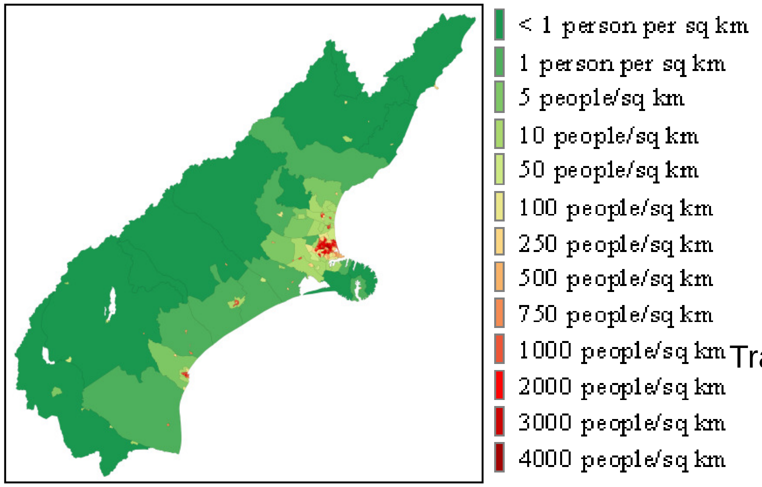


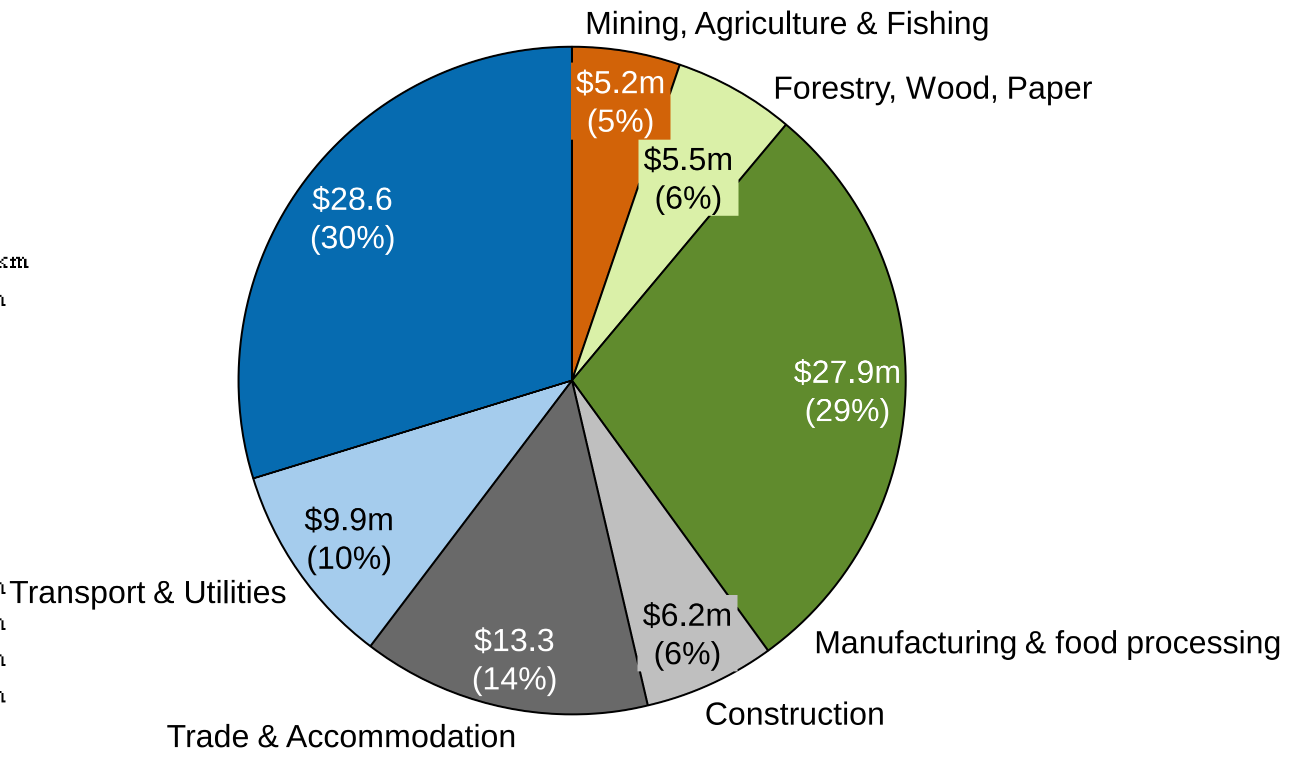


Distribution by industry - Canterbury 7% $96.7m



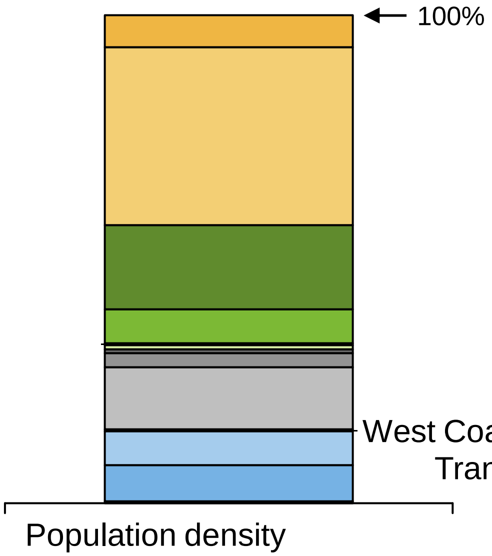
Population density

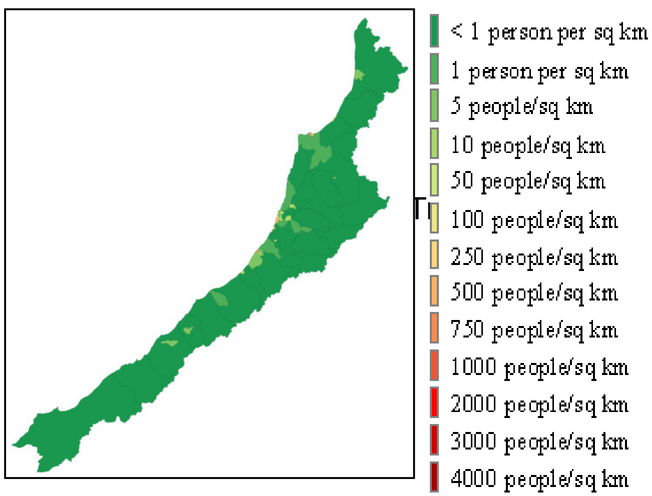


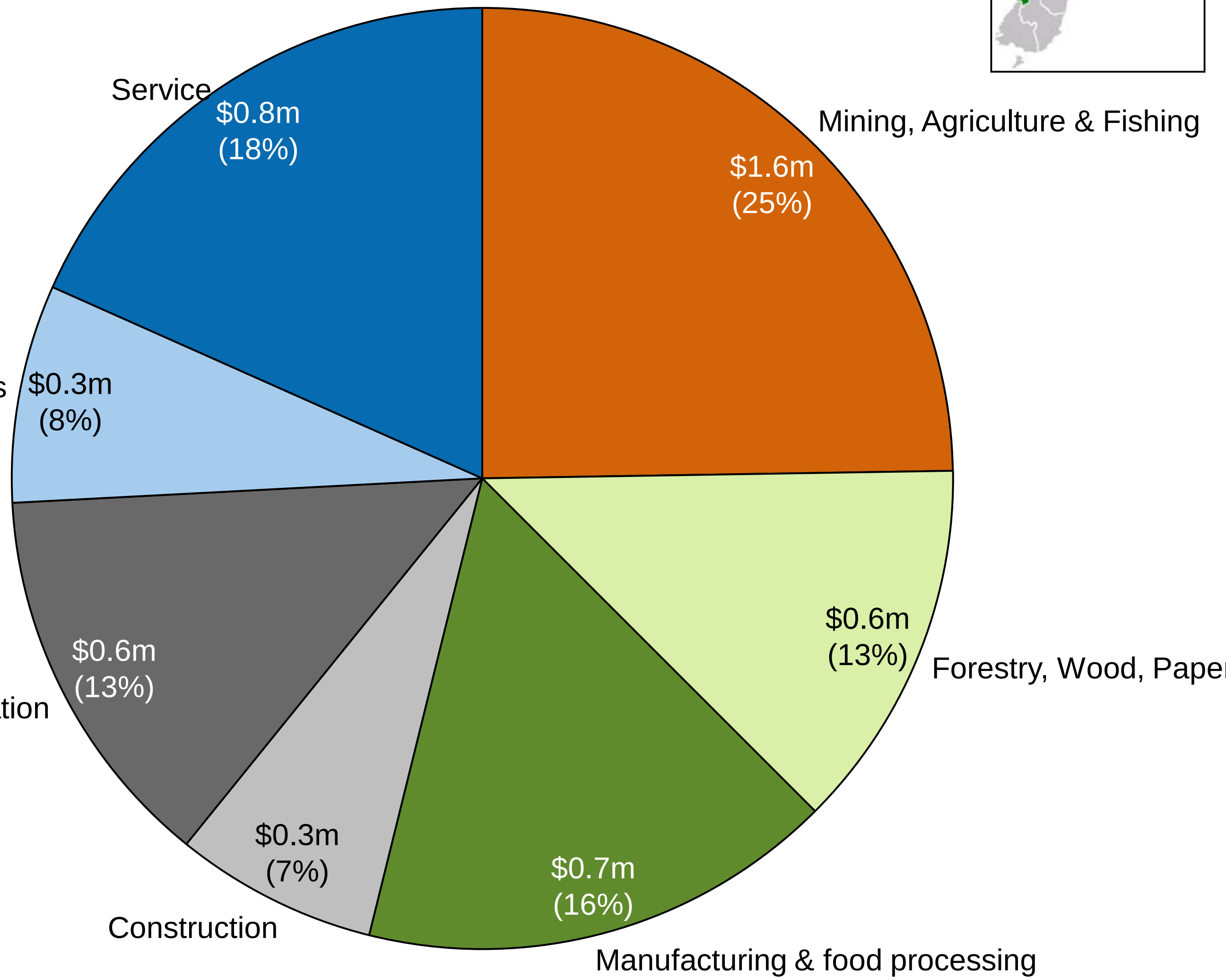


booz&co.

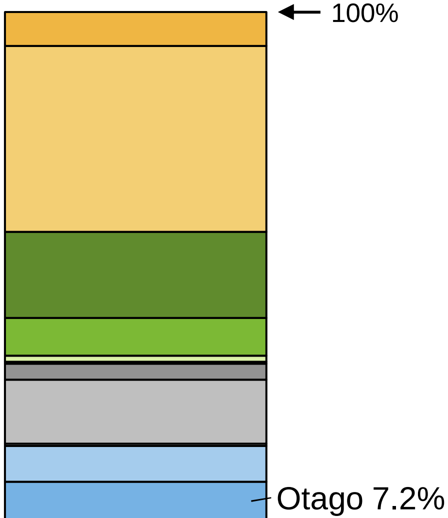
Distribution by industry - West Coast 0.3% $4.4m



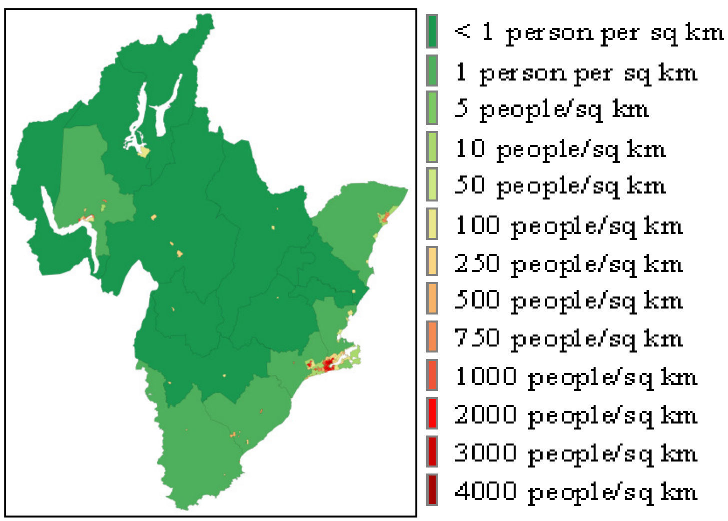


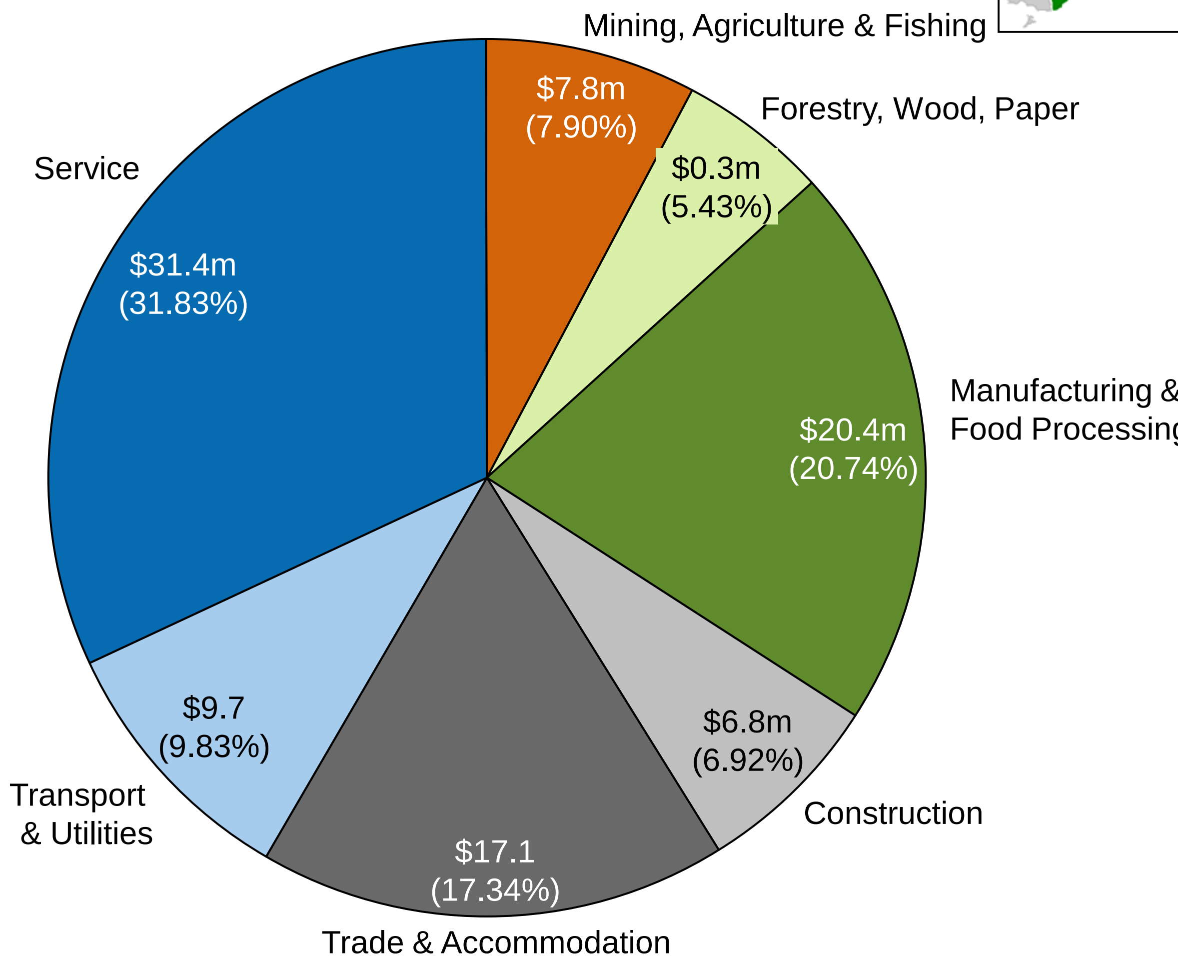


Distribution by industry - Otago 7.2% $98.6m



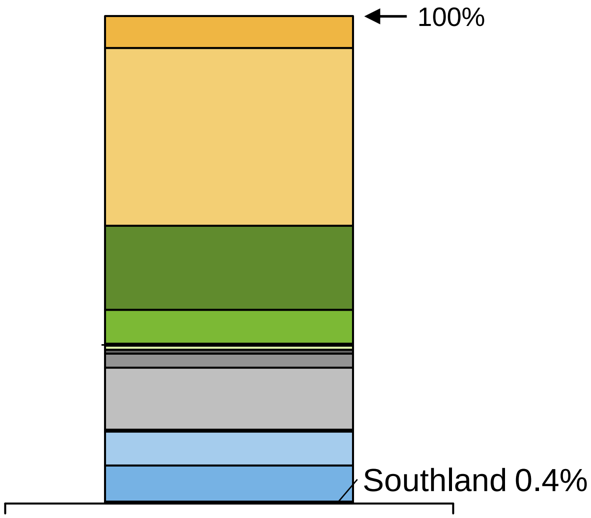
Population density



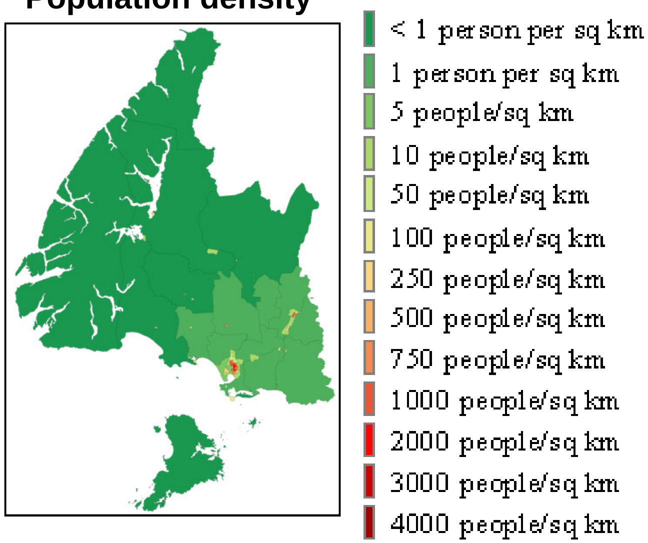


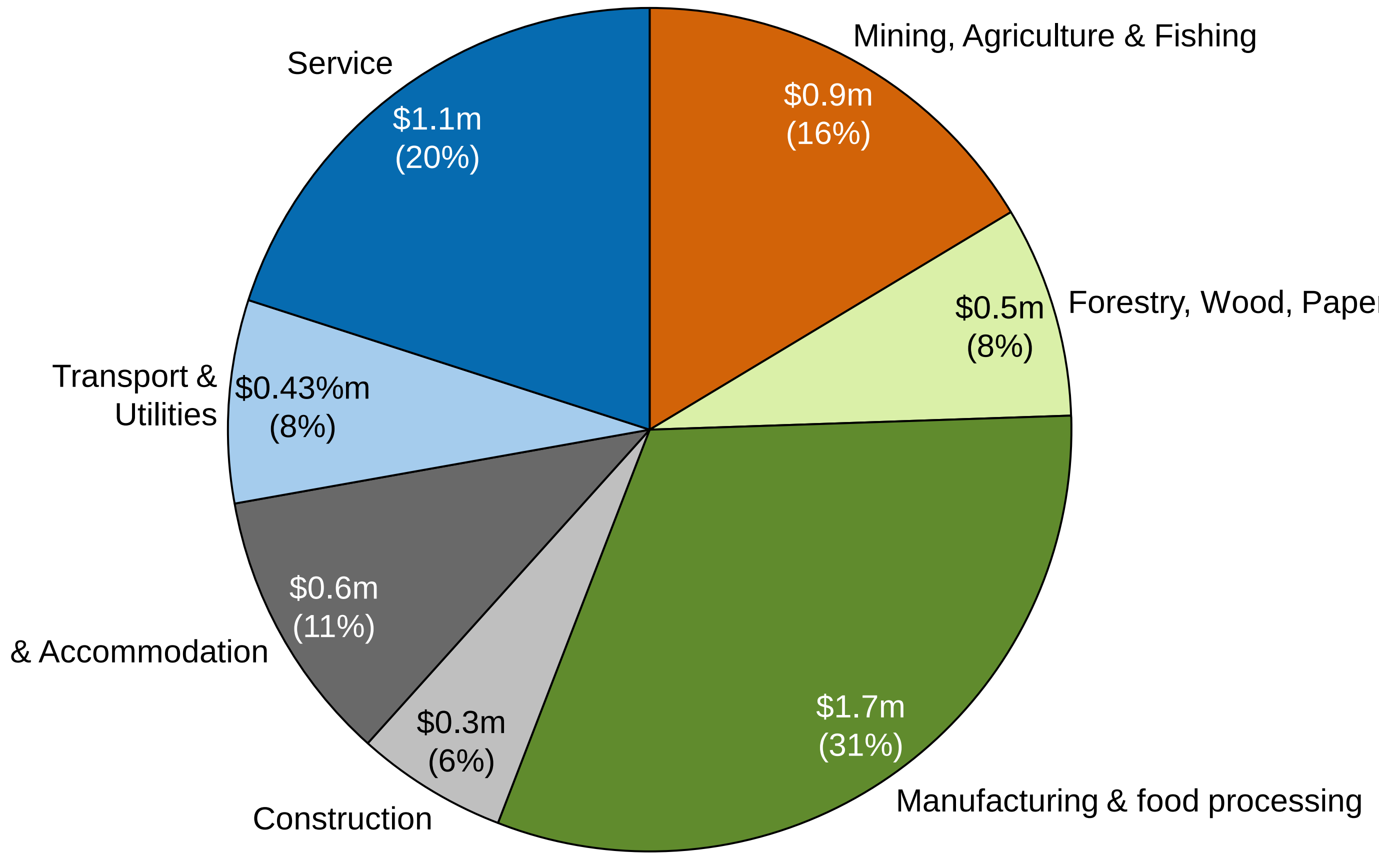
booz&co.

Distribution by industry - Southland 0.4% $5.5m



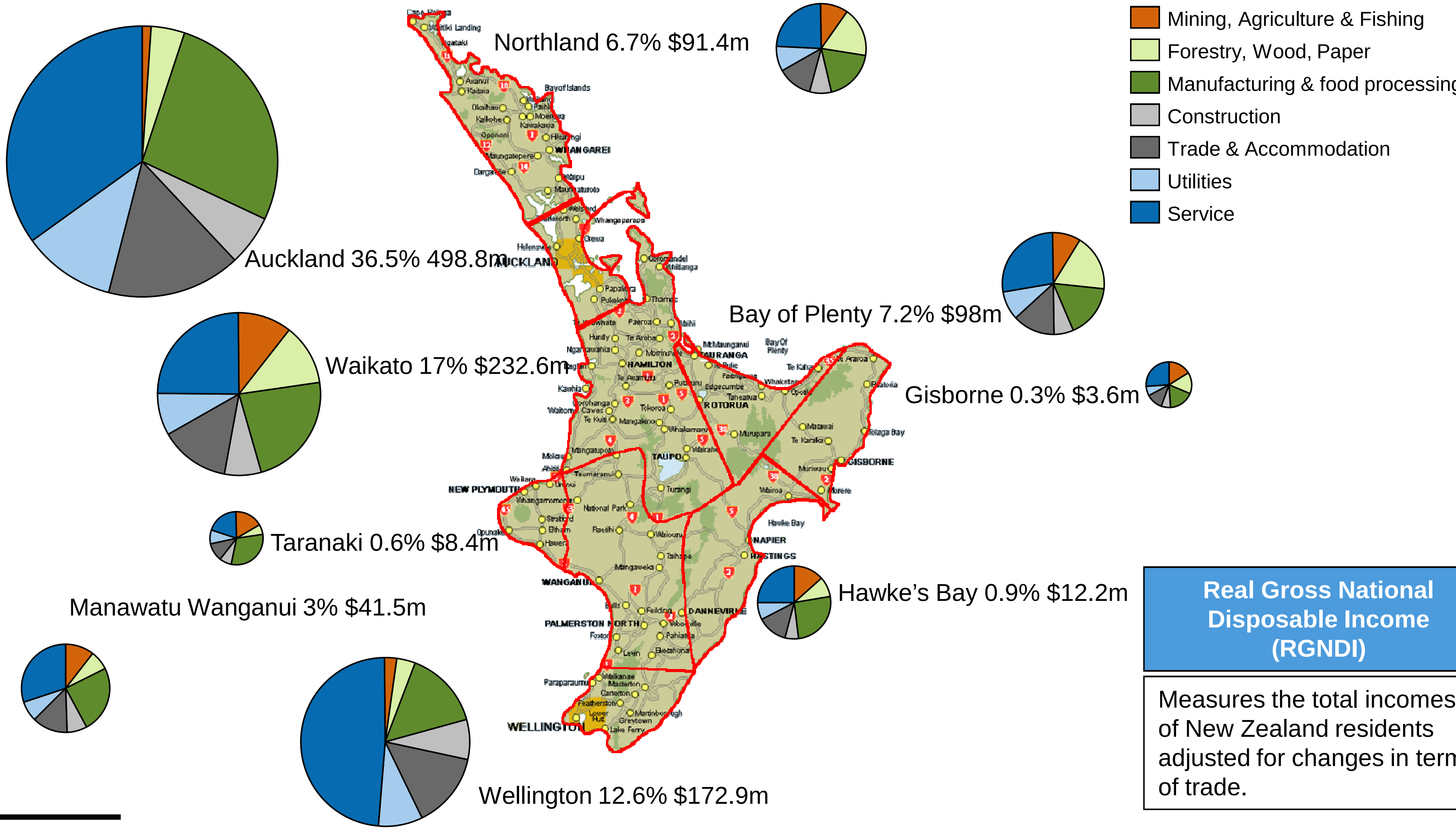
Population density





booz&co.

Roads of National Significance
North Island Real Gross National Disposable Income $1,159m 82%

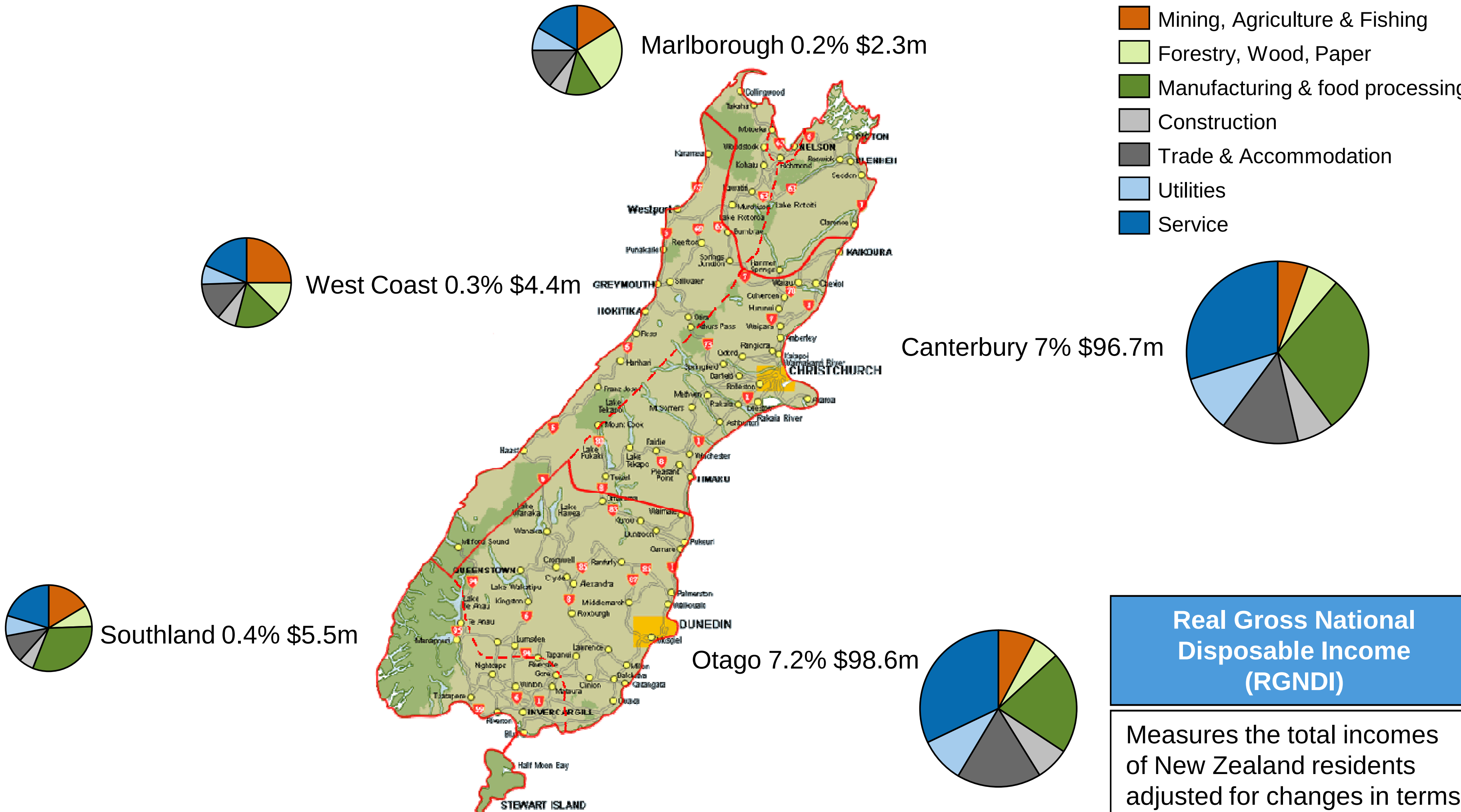


Real Gross National Disposable Income (RGNDI)

Measures the total incomes of New Zealand residents adjusted for changes in terms of trade.

booz&co.

Roads of National Significance
South Island Real Gross National Disposable Income $207m 18%



Real Gross National Disposable Income (RGNDI)

Measures the total incomes of New Zealand residents adjusted for changes in terms of trade.