NZ Transport Agency

Northern Busway Review

Annexes

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Northern Busway Review

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Northern Busway Review

Annexes

Contents

Annex: A1 Literature Review

A1.1 Review

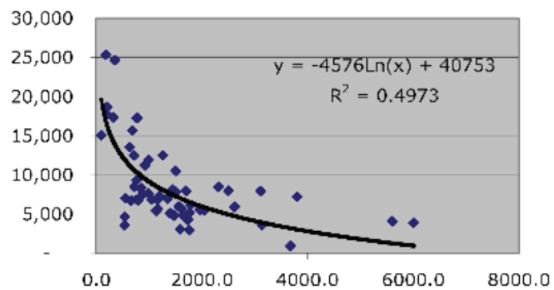
The literature review identifies recent references of relevance to the economic evaluation of NZ PT projects and services.

International references have also been quoted where these are of potential interest to NZ practice.

REF	AUTHOR	TITLE	DATE	SOURCE	COUNTRY	*Notes*
1	AECOM	Review of Economic Evaluation Procedures for Passenger Transport	2007	*Report for NZTA*	*NZ and Int.*	*'′Generally the existing Land Transport NZ Economic Evaluation Procedures for Public Transport in EEM2 are consistent with recent developments and international practice′′.* *′′…make the procedures more logical and easy to use and encourage people to take a more mode neutral approach in the formulation of proposals.′′* *′′The EEM2 makes little if any reference to the broader funding allocation process of which it is a part.′′* *′′..several people considered the valuation of time benefits for passenger transport was set too low compared to overseas procedures …* *′′ A detailed list comparing the benefit parameters given in EEM2 with ATC Nationals Guidelines and Webtag is given In chapter 5. It is suggested that a table of potential benefits of PT initiatives be developed form the list and issued as an amendment to the PT evaluation procedures.′′* See appendix to this annex for a copy of the recommended table.
2	*Aftabuzzaman M, Currie G, Sarvi M*	Evaluating the Congestion Relief Impacts of Public Transport in Monetary Terms	2010	*Journal of PT, Vol 13 No 1*	*Int*	*Discussed the fact that removal of PT would generate higher disbenefits than the equivalent benefits associated with PT improvements. This is mainly because ex-public transport users are considered likely to generate extra car travel in the form of chauffeuring trips.*
3	Bolland J	Critique of Public Transport Evaluation	2008	*Report for ARTA*	*NZ*	*Points to problems with willingness to pay values ′′…in general, existing PT users are less well-off so have a lower average VoT than car users′′ raising equity issues –(2.1 and 2.6) and refers to problems of using average time values for PT, which does not allow for potentially higher values on rail type systems. (2.1) The critique also suggests that the benefits of car use may be over-valued and the indirect benefits of PT may be undervalued (2.4) The critique also argues for a lower discount rate and longer evaluation period to be adopted.*
4	European Conference of Ministers of	Assessing the benefits of Public Transport	2001	*Report for OECD*	*Int*	*′′Arising from a multi-modal outlook is the need to define new impacts, generic measurement methods and reconcile some of the theoretical problems raised. An example of the latter is the case where the use in evaluation of different values of time by mode in the urban context can lead to public transport improvements apparently having net disbenefits*

	Transport					*rather than benefits.''*
5	Grimes A	Planning Infrastructure: Some Issues	2007	*Policy Quarterly – Volume 6, Issue 4 – November 2010*	*NZ*	*Reviews the arguments for the economic evaluation of infrastructure including circumstances where the use of a lower discount rate may be justified.*
6	Grimes A, Liang Y	Bridge to Somewhere: The Value of Auckland's Northern Motorway Extensions	2007	*Motu Working Paper 08-07*	*NZ*	*''...the Northern Motorway extensions comfortably met the New Zealand Government's requirement that major roading projects have a BC of at least 4 (using a real discount rate of 10%).''… …''.Reflecting the calculated net benefits, the extensions enabled considerable population and employment expansion near the new exits, and greatly enhanced the attractiveness (amenity value) of the resort towns to the north of Auckland. The investment therefore appears to have met the criteria required of it. In establishing this result, however, we make no claim as to whether the motorway extension provides greater or lesser benefits than would similar investments in public transport networks in this or other regions. New investments, particularly the Northern Motorway extension to Puhoi and the newly opened Northern Busway, will inevitably produce further gross benefits for the northern Auckland region.''*
7	Gwee E, Currie G, Stanley J	Evaluating Urban Rail Development Projects – an International Comparison	2008	*ARTF*	*Int*	*A case study urban public transport (passenger rail) project was evaluated using the procedures of a range of 14 different countries> The results from Australia, USA, Germany, the UK and the Netherlands all produced economically feasible BCRs in the range 1.0 to 2.61. The NZ procedures produced the second lowest BCR of 0.39. A response from with one of the authors (Currie) explains the method used to establish the validity of the comparisons made in the study as follows: ''Our approach is the only one possible with comparative international studies; first we converted all valuations (costs and benefits) used in different countries to values in same reference year using changes in inflation rates in each country. This puts valuations in 'real' terms. Then we selected an exchange rate for that year and made all values of benefits and costs relative to the same currency. This is entirely open to the problem of variations in value and exchange but that is also true of all dealings between countries. Our paper has now been published in one of the leading international transport journals (citations below) and has been presented at numerous transport forums internationally so has been through the sieve of numerous reviewers ...'' (pers. comm. March 2012). The paper has therefore used a commonly accepted approach, is the work of a leading author in public transport, has been peer reviewed by leading journals and therefore provides a useful example of PT project evaluation performance in comparison to the other countries reviewed.*

8	Infrastructure Auckland	Road and Passenger Transport Externalities	2000	*International and New Zealand Research*	*Int*	*Includes references to monetisation of externalities not currently included in NZ procedures such as: urban space use (traffic and parking rates per '000 pk Table 3), water quality (Table 8), barrier effects (Table 10). The report also includes a range of other externalities that are included in current EEM procedures and concludes: ''the presence of these externalities is a valid justification for intervention.''*
9	Institute of Transport Studies, Leeds	Transport Appraisal In Other Countries	2007	*Report for DfT*	*Int*	*Monetised benefits vary between countries, and some not currently included in NZ procedures include: social severance, biodiversity and natural resources.*
10	Institute of Transport Studies, Leeds	Option Values, Non-Use Values and Transport Appraisal	2006	*Report for DfT*	*UK*	*''Option values together with the value of consumption form two elements of the Total Economic Value (TEV) of a good. The concept of total economic value has developed in the literature to represent the maximum value of a good to the individual.'' The report considers two particular concepts: ''(1) The option of consuming a good at some point in the future….i.e. the option value (OV)'' and ''(2)The continued existence of a good…non-use values (NUV)'' (2.2)*
11	Jackson J A	Public Transport User and Resident Values in Economic Appraisal	2011	*Draft PhD Thesis for Leeds ITS*	*UK*	*Four standard elements to a social CBA are discussed, namely:* • *Producer Benefits e.g. Revenue to an operator.* • *Consumer Benefits e.g. Time saving to a passenger* • *Externalities e.g. Effects on noise or air pollution* • *Government Finance e.g. Loss of fuel duty revenue if car journeys were reduced.*
12	Kernohan D, Rognlien L	Wider Economic Impacts of Transport Investments in NZ	2011	*NZTA RR 448, SDG*	*NZ*	*…''In more recent work a doubling of public capital investment has been found to lead to between 5% and 30% increase in productivity (see the review by Quinet and Vickerman 2004) which suggested a sustained 10% increase in public transport investment would have long-term impacts of between 0.7% and 3.7% of GDP.''* 3.3.1.2
13	MoT/Treasury /NZTA	Auckland City Centre Rail Link: Business Case Review	2011		*NZ*	*The review estimated the benefit breakdown as follows: Transport Benefits 59%, Agglomeration 17%, wider economic benefits 24%. A revised BCR of between 0.3 and 0.4 was estimated by the review.*
14	NZTA	Economic Evaluation Manual, Volume 1	2008	*http://www.landtransport.govt.nz/funding/manuals.html*	*NZ*	*This volume primarily addresses road project evaluation, but contains a number of aspects relevant to public transport services, including: evaluation methodology, packages, modelling, values of time, vehicle operating costs, values for externalities, agglomeration techniques and the treatment of strategic factors.*

15	NZTA	Economic Evaluation Manual, Volume 2	2008	http://www.landtransport.govt.nz/funding/manuals.html	*NZ*	*Public Transport services are specifically covered in Volume 2 which contains full and simplified procedures for the cost benefit analysis of services.* *Advice is also provided on the treatment of packages: '' If transport services are part of a wider package, then a composite evaluation is necessary. This may involve evaluating road infrastructure components using the procedures in EEM1 and the passenger transport components using relevant procedures in this volume, and aggregating the results.''*
16	Newman P, Kenworthy J	Peak Car Use: Understanding the Demise of Automobile Dependence.	2011	*World Transport Policy and Practice: Vol 17.2*	*Int*	*''The re-urbanisation of car-based cities and the reorientation of transport priorities around transit, … can set in motion exponential declines in car use.'' The graph below (Fig. 6) illustrates the exponential decline in car use (km per capita- vertical axis) with increases in PT use (pkm per capita – horizontal axis)* 
17	OECD	Improving the Practice of Transport Appraisal, 2011	2011		*Int*	*''CBA is and remains a valuable tool for bringing structure, rationality and transparency to infrastructure decisions and strategic policy choices. The tool is not in itself sufficient to make decisions …. In order to maximize its potential value, CBA needs to be sufficiently broad. Excluding impacts on the grounds they are poorly understood becomes problematic when these impacts are essential to the project. The better approach is to account explicitly for uncertainty. …''* *'' Ignoring environmental impacts can lead to a bias across modes, e.g. favouring transport by car over public transport modes.''*
18	TRB	Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners	2002	*TRCP Report 78*	*USA*	*Identifies methodologies for treating the following benefits and savings:* *User benefits- including the calculation of consumer surplus* *Secondary benefits –including motorist option values (for using transit a certain number of times a year) and pollution (air, water, noise) values.* *Cost savings – including savings in car parking land.* *Other benefits – including agglomeration economies (increased productivity) and urbanisation economies (reduced infrastructure costs)*

19	UITP	Assessing the Benefits Of Public Transport	2009	*www.uitp.org*	*Int*	*''Current appraisal methodology does not capture the full benefits of public transport. Public transport contributes to all aspects of urban life, and consequently transport appraisal needs to consider all of the following areas:* *• **Economic** - public expenditure and income, user time savings, reliability and wider economic impacts;* *• **Environmental** - noise, air quality, greenhouse gases, landscape, townscape, historic heritage and water environment;* *• **Social** - safety, security, accessibility, mode interchange, land-use policy, physical fitness and journey ambience.* ***Cost Benefit analysis** expresses both sides of the ratio in financial terms as a benefit: cost ratio (BCR).This therefore requires the 'monetisation' of the quantified benefits of the scheme. …These aspects usually include time savings…., safety …, noise, and greenhouse gas emissions (though the appropriate value of CO2 requires further research).* ***Ex-ante example - Crossrail, London, UK:*** *by enabling more people to work in central London, increasing the pool of potential employees and customers for central London businesses, and enabling greater concentration of businesses … associated with greater productivity….This is in addition to user and business time savings. By including the wider economic benefits of the project the BCR increased from roundly 2:1 to 4:1.''*
20	Wallis I	Review of Value of Time Relativities in the Economic Evaluation Manual	2007	*For LTNZ*	*Int*	Reviews practice in NZ and concludes PT travel time values in NZ are low relative to other modes and are also low in absolute terms compared with international practice, as follows: *''Relative to real incomes, the New Zealand PT values of time are in the order of half the level of the values adopted in Australia and UK.'' and* *''In UK, PT values adopted are taken as equal to car driver and passenger values, on equity grounds. In Australia, the PT values are only slightly lower (within 20%) of the car driver and passenger values. In New Zealand, the PT values are in the order of half of the car driver and passenger values''.* The review also discussed the merits and potential difficulties of introducing equity time values across modes.

21	Wallis !	Research report 471 The benefits of public transport - option values and non-use values	2012	*For NZTA*	*NZ and Int*	This research was undertaken in New Zealand in 2010-11 to investigate the economic concepts of option values and non-use values as applied to public transport services, and to undertake primary market research in New Zealand to estimate approximate valuations. The primary market research involved telephone-based surveys of a random sample of households in four peri-urban/semi-rural communities within the outer catchment area of major urban centres. The surveys used contingent valuation methods to establish household willingness-to-pay for the provision of enhanced public transport services to/from the nearest main centre, and to estimate the various components (consumer surplus, option value, non-use value) of the overall willingness-to-pay value. The survey results were used to derive the average willingness-to-pay per household; the component of this that is not included in conventional transport economic appraisals; and the underlying factors (e.g. service and household characteristics) influencing the willingness-to-pay values. The results were also compared with the equivalent findings from the small number of research studies undertaken internationally on this topic. Recommendations were made on an appropriate set of default option/non-use values (per household) for use in the economic appraisal of public transport projects in New Zealand.
22	VTPI	Evaluating Public Transit Benefits and Costs, Best Practice Guidebook	2011	*www.vtpi.org*	*Int*	*Common errors in comparing transit and automobile costs and benefits are suggested :* • *Confusing efficiency and equity objectives.* • *Comparing average rather than marginal costs*. • *Ignoring parking costs.*. • *Underestimating vehicle cost savings.* • *Undervaluing safety and health benefits.* Safety • *Ignoring transportation diversity benefits.* • *Ignoring non-drivers interests* • *Ignoring generated traffic impacts*. • *Ignoring strategic land use objectives.* • *Ignoring construction impacts.* • *Undervaluing congestion reductions.* • *Ignoring consumer preferences and latent demand.* • *Ignoring strategies for increasing transit benefits.*

A1.2 Literature Appendix – EEM Benefit Parameters

Table 1: Comparison of EEM2 Benefit Parameters with Other Values (AECOM 2007)

Benefit category	**Section in EEM2**	**Comment and References**
Existing PT user benefits		
Change in generalised cost of travel, including:		Should be based on users perceived net benefits. This is discussed in EEM2 Sec 3.2, Page 3-2. However this is the TDM chapter and PT project analysts may not see this. For more background see Section 3 of the ATC National Guidelines and the UK Wet bag Unit 3.5.3. The latter contains information on treatment of taxes when deriving unit values.
In-vehicle time	EEM1	subject of separate review by Ian Wallis
Access time		Includes walking time (value from EEM1) but can also include other modes. Access time unit values are usually expressed as multiple of in-vehicle value of time. See Table 1.6.1 and Section A.4 and Table A.3 in ATC National Guidelines.
Waiting time		Expected and unexpected waiting time is inter-related with frequency and reliability respectively and care should be taken to avoid double counting. See Table 1.6.1 and Section A.5 in ATC National Guidelines.
Frequency benefit	Sec 7.2, Pg 7-6	This section includes both existing and new user benefits. New user benefits should be removed from here. See Waiting time above and Table 1.6.1 and Section A.5 in ATC National Guidelines.
Transfer Penalty	Sec 7.2, Pg 7-7	This section includes both existing and new user benefits. New user benefits should be removed from here. See Waiting time above and Table 1.6.1 and Section A.6 in ATC National Guidelines.
Reliability		Reliability is inter-related with unexpected wait time. See Table 1.6.1 and Section A7 in ATC National Guidelines. The UK Webtag Unit 3.5.7 on reliability is of limited relevance.
Mode specific factors		The perceived benefit of higher quality modes is not currently mentioned as a potential benefit in the EEM2. See Section A8 and Table A.10 in the ATC National Guidelines for recommended values
Vehicle and infrastructure *soft benefits*		Benefits associated with features of PT vehicles or infrastructure such as comfort, amenity and security are intended to be covered by EEM2 Section 7.3 Pg 7-8. However this section is extremely general and of little practical help. Results of research undertaken by BAH in New Zealand (in 2000) and in the UK should be referenced or included either as default values or guidance. See table A.11 and Table A.12 in the note that UK research has found that a total value attributed to soft benefits should be capped relative to time based benefit measures.

Benefit category	Section in EEM2	Comment and References
Fare changes	Sec 7.2 Pg7-	The advice in this section of the EEM2 is inadequate. Advice on the correct treatment of fares and fare changes should be improved and expanded - also see resource cost correction discussion below
Crowding	Sec 7.2 , Pg 7-9	See Section A.3 and Table A.2 in ATC National Guidelines for more background and unit values for crowing disbenefit. The existing section in Sec 7.2 of the EEM2 considers crowding as a negative consequence of a PT improvement initiative, but reduced crowding can also be a benefit of PT initiatives. EEM2 discussion and unit values should be expanded to cover positives as well as negative impacts of PT initiates on crowding.
New and diverted PT user benefits		
As for existing PT user benefits		Should be derived from existing PT user benefits based on the rule of a half
Resource cost corrections		Resource cost corrections are required for resource cost impacts experienced by new PT users that are not taken into account in their decision to change mode. The need for these is mentioned in the TDM evaluation section of the EEM2 (Sec 3.2 at bottom of PG 3-2) but no further discussion of unit values are provided in this or the PT evaluation section. PT evaluators may not appreciate that these effects also apply to PT Evaluations. The PT Evaluation procedures should provide unit values for each of the following:
Unperceived vehicle operating costs		Motorists are considered not to take account of fixed costs of vehicle use and ownership when making travel decisions. These unperceived resource cost savings should be included as a benefit.
Fuel tax		Fuel tax is perceived as a cost (in the mode change decision) but is only a transfer and should therefore be deducted (i.e. Applied as a negative resource cost correction.
Car Parking	Sec 10.6, Pg 10-7	There is no mention in the PT evaluation sections of the EEM2 that unperceived car parking resource costs that can be avoided as a result of PTR initiative should be included as a benefit. This is covered in Section 10 of the EEM2 but should also be included in the PT evaluation section or at least discussed and cross referenced. Also see Section 3.4.2 Pg 29, and Section 6.5 of the ATC National Guidelines.

Benefit category	Section in EEM2	Comment and References
Fares		Fares are perceived as a cost (on the mode choice decision) but are only a transfer. Further consideration of the appropriate treatment of fares in the Land Transport NZ evaluation framework appears to be required. This needs to include consideration of consumer surplus / producer surplus split, integration with BCR formula which omits fare revenue as well as the resource cost correction for fares being perceived as a cost when they are only a transfer.
Externality benefits		These are the benefits (or disbenefits) to other users or the transport system as well as to society and the environment resulting from PT initiative
Reduced road congestion (time and VOC)	Sec 7.3, Pg 7-10	This Section in the EEM2 is too detailed and should perhaps be an appendix. Consider replacing with a table like the one in Section 3.8 Pg3-19 but with the various components (time, VOC, induced traffic effect) itemised separately as well as aggregated.
	SP9, Pg13-29 , Table 2	Benefit values in this table also include accident and CO reduction per vehicle-km removed. As showed the values of each of the components as well as the total.
Accident cost savings	Sec 7.4, Pg 7-15	This section in the EEm2 is too detailed and it would be surprising if many analysts use it. Instead, it would be useful to have a table of typical accident cost per vehicle-km for different private and PT vehicle types and put the detailed procedures in an appendix. Such a table appears in the TDM evaluation chapter (Sec 3.8, Pg 3-21) and this should be included or referenced in the PT evaluation procedures.
Environmental Benefits · Greenhouse gas, · Air Pollution, - Noise	EEM1	It would be useful to have a table of typical environmental costs per vehicle-km for different private and PT vehicle types in the EEM2

Benefit Category	Section in EEM2	Comment and references
Severance		Severance could be a negative impact of some PT initiatives (e.g. A new rail line). It is unlikely to be significant for most PT initiatives in New Zealand so it is suggested that the effect be mentioned for consideration when evaluating large new PT projects but that further work such as researching unit values is not a high priority in the context of improvements to the PT evaluation procedures.
Other		
Disbenefits during implementation / construction	Sec 7.5, Pg 7-19	Not covered in other references
Other benefits and national strategic factors	Sec 7.6, Pg 7-20	Refers to Sections 2 and 3 and Appendix A8 of EEM1. See UK Webtag Units 2.8 and 3.5.8 for more guidance on wider economic benefits
Option value		See section 3.2.3, Pg 24 of the ATC National Guidelines and UK Webtag Unit 3.6.1

It is suggested That a table of potential benefits of PT initiatives be developed from the above list and issued as an amendment to the PT evaluation procedures. The table should include where each benefit is covered in the EEM2 and where analysts can look for additional information.

Annex 2 Detailed Cost Benefit Analysis

Further descriptions and details of the review of benefits / assumptions, together with the decision on whether or not to include the benefit/assumption within the economic evaluation sensitivity testing, are provided below:

A2.1 Benefits Considered

Potential Benefit	Benefit/Assumption Description	Benefit/Assumption Detail	Decision
PT User Value of Time (VOT) (used to evaluate the benefits to existing and new PT users)	PT VOT could be treated as being equivalent to car user values given the high car availability of existing and new users.	The EEM was amended in 2008 to allow new PT users who were formerly car drivers to retain their higher value of time when switching mode. For other situations, the EEM treats existing bus users (and new bus users who have not switched from car mode) as having a lower value of time (at $4.70 ph) than car drivers at $7.80 ph for commuting purposes. In addition all car drivers have their time values increased by $3.15 ph in congested conditions (car passengers have a lower congestion supplement of $2.35) whilst almost all PT users remain at $4.70 (or 43% of the car driver value). Only those who are standing on PT, a small minority, have their time raised to $6.60 per hour. The contrast between car and bus is even greater for non-work travel purposes. Whilst this approach may be justified for some PT evaluation purposes, a different approach appears justified in the case of all NB users (i.e. not simply those who have been identified as switching mode due to a particular system improvement). This is because a high proportion of existing and newly generated users of the NB have high car availability. This means that there is a strong case, for all PT user time values to be equivalent to car time values. In other words, the average NB user time value (whether seated or standing) is taken to be equal to the value of the car alternative. As all the evaluation is undertaken for weekday peak periods, there is also an argument to also apply the commuter time congested condition supplement. This approach would substantially increase the value of PT user time. This approach is probably also justified for other types of rapid transit systems (rail or light rail for example) that also have a high proportion of car available users.	✓
Vehicle Operating Costs (VOC)	VOC costs linked to time and distance savings	Taken from EEM	✓

Safety	Changes in the social costs of road crashes.	Taken from EEM	✓
CO2	Changes in the scale of CO2 emissions	Taken from EEM	✓
Agglomeration	CBD and corridor impacts.	Agglomeration benefits have been adopted based on recent assessments of similar scale projects in the UK, Australia and NZ. The scale of agglomeration benefits assumed for the NB is 25% of conventional time savings benefits. This is equivalent to 15.5% and 16.5% of total benefits for Scenarios E and F (Appendix A2.4) and is consistent with the 17% of total benefits, due to agglomeration, accepted in the City Centre Rail Loop review. (Annex A1.1 ref 13) Comments on other wider economic benefits (WEBS) are provided below.	✓
Decongestion Benefits and Peak Spreading	Extension of benefits to reflect peak spreading peak shoulder periods and other high demand periods.	The original evaluation assumed that decongestion benefits occurred only in the 2hr AM and PM weekday peak periods. This is a very conservative and unlikely scenario, and some acknowledgement of benefits occurring in other periods, especially in the peak shoulder periods, is required. To illustrate this, the latest ART model includes a 4 hr peak period to assist in accounting for peak spreading and the shoulder periods getting busier. There are also arguments to make some allowance for inter-peak and leisure peak periods, although the data to support this approach is less clear and there are counter arguments, including relatively quiet periods such as some school holiday periods when there may be more limited weekday congestion problems that may not extend over the full two hour peaks. However on balance, given that we are looking ahead at least 30 yrs, some allowance of additional decongestion benefits (i.e. beyond the 2 hour peak periods) is needed, for example, an allowance for the peak shoulder. In the absence of a full analysis of peak spreading trends, 25% has been added to the decongestion benefits (representing an extra 30 mins on 2 hours).	✓

Reliability	Increased reliability using a dedicated busway, allowing for reduced wait time and travel time.	The difference between the more reliable NEX and other services in terms of average lateness is 2.19 mins and then using car driver value of $7.80 but ignoring the congestion premium (of $3.15) to approximate for the non-commuter element of travel, gives the following annual $ benefit for each peak: (3.9/60)*($7.8)*2.195*7,926*260 = $2,292,509 (as per the EEM manual formula)	✓
Car User – Option Values	Values from car users using the SH1 corridor to have PT available on some days.	in several references including TRB, TRCP Report 78: Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners and also more recent material commissioned by the DfT (Oxera) the concept of a financial market bid price option value for having a PT service available is described. the TRB technique assumes that motorists along a given corridor and who generally do not use the bus would be willing to pay a small amount to have the option of using a bus service a few times each year when the marginal cost of doing so would be attractive, i.e. when they do not have a car available or there is some other problem with private road based travel. In fact this is what happens in practice as a small part of the tax raised from motorists who use PT very infrequently does go into PT, but that NZ procedures do not include this value in PT economic evaluation. Exactly what the values are and how to apply them in any one case is not certain (to know this we would need the standard deviation of car travel, the marginal cost of a PT trip and the frequency with which the PT option was likely to be exercised by car travellers, plus some specific WTP surveys. However, drawing on the US experience provides a potential conservatively based rationale, as follows: o There are currently approximately 150,000 car trips per day in the corridor (over the harbour bridge) o The TRB technique has a worked example that assumes an annual value of US4.44 in 2002 prices on the basis of an average 2x use per year, applied to >45,000 passengers which continue to use cars and non-express buses in a corridor after the introduction of express bus services. o On the basis of adopting an approach that assumes that 50% of the daily volume could make use of the express services if it wanted to (i.e. their O/Ds were compatible with the PT service on offer) and an average value of NZ$5.00 per year, this would give an annual car traveller option value of $375,000 per year. This is additional to and separate from the concept of a ‘community based option value discussed immediately below.	✓

<table>
<tr>
<td>Community Option Values</td>
<td>Values from relatively peripheral parts of the North Shore PT catchment area.</td>
<td>
Community based option and non-use values have been the subject of a recent and unpublished NZTA research paper which obtained survey derived community WTP values for peripheral parts of the PT catchment area of larger centres. These values can be included in economic evaluation as they are additional to conventional transport related benefits.
In the case of the North Shore it is not expected that values for community based options would be high, as these are likely to be relevant only to the more peripheral parts of the PT network served by less frequent feeder services.
To make some allowance for this, in the absence of a detailed assessment of potential option values, it has been assumed that 10% of the 72,000 HH on the North Shore fall into the peripheral category and the loss of the busway would take them down from medium service to low service (i.e. adding 10 mins + unreliability) from the table of values below (taken from the NZTA research report 471), to a loss in value of $40 per year (i.e. $75-$35) then this would equate to community based option and non-use benefits of 7,200 x $40 = $288,000 per annum. See values below taken from NZTA RR 471.
Table 9.1 Proposed default OV/NUVs for economic evaluation
<table>
<tr><th>Category</th><th>Notes on typical characteristics</th><th>Typical catchment area (km radius)</th><th>Default value (2010 $pa/ household)</th><th>Surveyed OVs within category (and additionality values)</th></tr>
<tr><td>High</td><td>• Good level of service (frequency, reliability, travel time, etc)
• Car alternative relatively poor (congestion, difficult road conditions, etc)
• Service well-matched to desired origins/destinations (stop locations, etc)</td><td>20–35km</td><td>$130</td><td>• Featherston – rail ($132)
• Carterton – rail ($216)</td></tr>
<tr><td>Medium</td><td>• Between ‘high’ and ‘low’ characteristics[a]</td><td>10–25km</td><td>$75</td><td>• Tuakau – rail ($86)
• Oxford – direct bus ($59)</td></tr>
<tr><td>Low</td><td>• Poor level of service (frequency, travel time, need to transfer, etc)
• Car alternative relatively good
• Service poorly matched to desired origins/destination (eg rail station away from town centre)</td><td>10–15km</td><td>$35</td><td>• Oxford – indirect bus ($40)
• Te Kuiti – bus ($35)
• Featherston – bus ($34)
• Tuakau – bus feeder ($25)
• Te Kuiti – rail ($25)</td></tr>
</table>
</td>
<td>✓</td>
</tr>
</table>

Extended Evaluation Period (60 years)	Maximum foreseeable period.	Whilst this is really a variation in methodology rather than a benefit category, the effect on benefits of varying the evaluation period is potentially large. The effects of extending the evaluation period to 60 years (double the maximum evaluation period within the current EEM) is consistent with international good practice for major infrastructure such as the NB. Beyond the initial 30 years it has also been assumed that no further growth in benefits occurs and that benefits continue at a constant rate in the second half of the evaluation period. The reason for adopting this assumption is the difficulty of forecasting this far into the future and general limits to growth.	✓
Reduce Discount rate to 4%	Minimum foreseeable discount	This again is not a benefit category, but has been included due to the potential effect on the scale of benefits. The use of 4% is included within the current EEM as a recommended sensitivity test.	✓
Health	Increased walk distance (to/from and interchange) of those transferring to PT.	There is considerable potential for increased active mode use associated with the NB on the basis that car drivers/passengers who transfer to bus are likely to walk further, especially at the destination end of the trip. In literature PT is often classified with active modes for this very reason and it seems indisputable that PT offers health benefits over car based travel modes. A range of literature points to this and these health benefits are additional to transport related benefits. The approach adopted has assumed the following:: ○ Given the high car availability of the bus way users, and applying the EEM (Vol 2 Table 8.2) which refers to $2.60 health benefits for walking for new facilities (based on an average walk distance of 1km) ○ Literature indicates that PT users walk further than car users, for example by >1km a day (Ugo Lachapelle and Lawrence D. Frank (2009), "Transit and Health: Mode Of Transport, Employer sponsored Public Transit Pass Programs, And Physical Activity," *Journal Of Public Health Policy* www.palgrave-journals.com/jphp), Vol. 30, www.palgravejournals.com/jphp/journal/v30/nS1/full/jphp200852a.html, pp. S73-S94; ○ Then $2.60 x users who would actually transfer back to car if the busway was no longer available (say approx. 25% of the 7,926 inbound 7am-9pm users) and taking this approach would give a total annual health benefit of $1,339,424.	✓
PT Fare and Consumer Surplus	Alternative method to establish PT user benefits.	This technique is appropriate for the introduction of completely new services and represents an alternative method of calculating PT user benefits. In this review this method has not been adopted as existing services within the corridor were reorganised and improved in association with the introduction of the NB.	✕

Headway	Reduced headway as a result of higher frequency services, allowing for reduced wait time and travel time	The improvement of PT service frequencies in the corridor has been considerable and this has resulted in reduced headways between service vehicles. However, a detailed assessment would be needed to calculate exactly what the headway reductions have been for different O/D pairs. It is possible that the reduction of already small headways for the most frequent services may or may not result in significant benefits. Because of this uncertainty it has been decided not to quantify this benefit for the purposes of this review.	✕
Wider Economic Benefits (WEBS)	Additional economic benefits over and above other identified 'conventional transport economic benefits' and 'agglomeration benefits' referred to above.	The peak period capacity constraint over the harbour bridge and other corridors leading into Auckland CBD has been partly alleviated by the introduction of NEX services and the busway. The result of this additional capacity has been to allow increased employment demand within the CBD and along the corridor as a whole, to be met. This meeting of demand has allowed the CBD to continue growing in economic terms. These wider economic benefits (with the exception of agglomeration benefits, see above) have not been included, due to the current difficulties and uncertainties associated with the identification and quantification of WEBS. The categories of potential benefits include: (i) imperfect competition (ii) labour supply (iii) productivity gains from job relocation. It should be noted that these benefits can be significant, and in the case of the City Centre Rail Loop review (Annex A1.1 ref 13), contributed 24% to the total benefits for the project. In addition, other categories of wider economic benefit may also apply, for example: ○ The presence of high quality/capacity PT systems is a pre-condition for the introduction of road pricing, and the realisation of associated efficiency and productivity gains. ○ Additional economic benefits may arise if CBD car parking land could be released for more productive purposes.	✕

A2.2 Scenario Summary Results

Procedures	Original Forecasts	Actual Effects Revised Forecasts	Actual Effects Revised Forecasts Extended Benefit Range	Actual Effects Revised Forecasts Lower Discount Rate Longer Period	Original Forecasts Lower Discount Rate Longer Period
Original PEM/ATR method: 2004	*(Scenario A)*	*(Scenario C)*	*(Scenario E)*	*(Scenario G)*	*(Scenario I)*
Benefit Cost Ratio	**BCR 1.2**	**BCR 1.3**	**BCR 2.0**	**BCR 4.8**	**BCR 3.8**
Comparative Index relative to original BCR	*100*	*108*	*167*	*400*	*317*
Current EEM method: 2011	*(Scenario B)*	*(Scenario D)*	*(Scenario F)*	*(Scenario H)*	
Benefit Cost Ratio	**BCR 1.5**	**BCR 1.8**	**BCR 2.6**	**BCR 5.2**	
Comparative Index relative to original BCR	*125*	*150*	*217*	*433*	

Actual outturn BCR (1.3 Scenario C) is higher than original BCR estimate of 1.2, mainly due to better than forecast PT patronage growth.

If a greater range of benefits had been used in the original evaluation then the BCR would have been even higher at 2.0 (Scenario E)

With a longer evaluation period and a lower discount rate the range of BCR would have been between 3.8 and 4.8 (Scenarios G and I respectively) and this this has the greatest effect of all the variations tested

If alternative methods had been employed, namely to apply the current EEM to the original benefits and forecasts, then the original BCR would have been appreciably higher at 1.5 (Scenario B).

The application of current EEM techniques would have increased this to 1.8 (Scenario D) and with extended benefit range to 2.6 (Scenario F).

Applying an extended evaluation period and a reduced discount rate to Scenario F could increase the BCR to 5.2 (Scenario H).

The results indicate the following differences and incremental effects of adjusting forecasts and modifying methodologies:

- Between actual and forecast effects, the BCR increases by between +0.1 (A to C) and +0.3 (B to D)
- Between 2001 and 2011 methods, the BCR increases by between +0.3 (A to B) and+ 0.5. [C to D]
- As a result of an enhanced benefit range, the BCR increases further by between +0.7 (C to E) and +0.8 (D to F)
- A reduced discount rate/extended evaluation period, the BCR increases further by +2.6 (A to I) , +2.6 (E to G) and +2.8 (F to H)

The table also indexes the BCRs relative to the original BCR of 1.2.

The total variation on the BCR range of between 1.2 and 5.2 may initially seem surprising, but this illustrates just how important the core assumptions adopted when undertaking the evaluation are. For example, the highest BCR reduces to 2.6 if the tests relating to discount rate and evaluation period are excluded

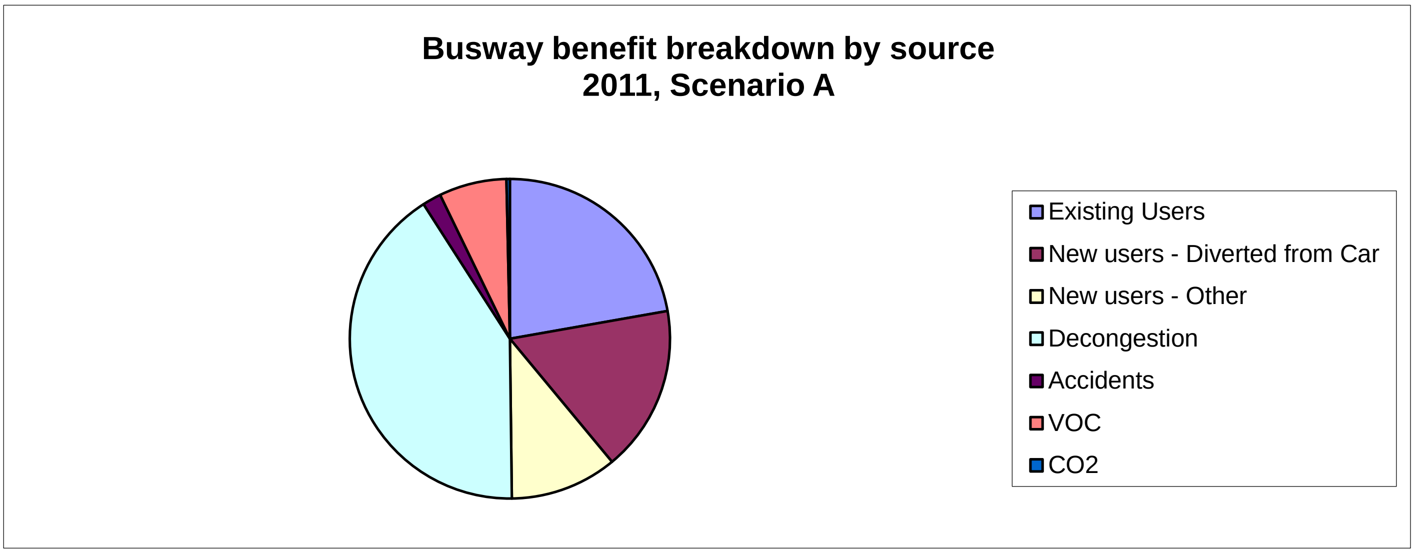
The longer evaluation period (of 60 years compared with the EEM 30 year period) reflects the fact that major infrastructure is constructed as a long term investment.

The original evaluation BCR of 1.2 represents a very conservative approach covering a narrow benefit range, whilst the highest BCR of 5.2 is closer to international practice and represents a more comprehensive benefit range.

A2.3 Detailed Scenario Testing Results

Scenario	BCR: Bare Stations with P & R	PV(B) $m	PV(C) $m	EEM version	Discount Rate	Costs, Patronage Forecast or Actual	Key Inputs
A	1.16	$198.8	$172.1	2001	10%, 25 years	Original Forecast	Forecast patronage and costs as in the original Beca evaluation
B	1.52	$377.5	$249.0	2011, including 2011 update factors and "equity" value of time for existing users	8%, 30 years	Original Forecast	As for scenario A
C	1.29	$234.8	$182.3	2001	10%, 25 years	Actual effects (subject to data availability)	Patronage 6% above forecast (from surveys) Capital cost 6% above forecast (outturn cost) Annual patronage growth 8% (actual was 11% but this is unlikely to be maintained for the full evaluation period) No allowance for any change in car transfers (since we have no information on the actual VKT moved from car to bus)
D	1.78	$468.7	$263.7	2011 (as for scenario B)	8%, 30 years	Actual effects	As for scenario C
E	1.96	$358.2	$182.3	2001 plus enhanced benefits	10%, 25 years	Actual effects	As for scenario C with addition of benefits for reliability, health, option values, peak spreading and agglomeration
F	2.60	$684.5	$263.7	2011 plus enhanced benefits	8%, 30 years	Actual effects	As for scenario C with addition of benefits for reliability, health, option values, peak spreading and agglomeration
G	4.77	$1,025.5	$215.2	2001 BUT with lower discount rate	4%, 60 years	Actual effects	As for scenario C
H	5.16	$1,526.9	$295.9	2011 BUT with lower discount rate	4%, 60 years	Actual effects	As for scenario C
I	3.78	$769.1	$203.5	2001 BUT with lower discount rate	4%, 60 years	Original Forecasts	As for scenario A

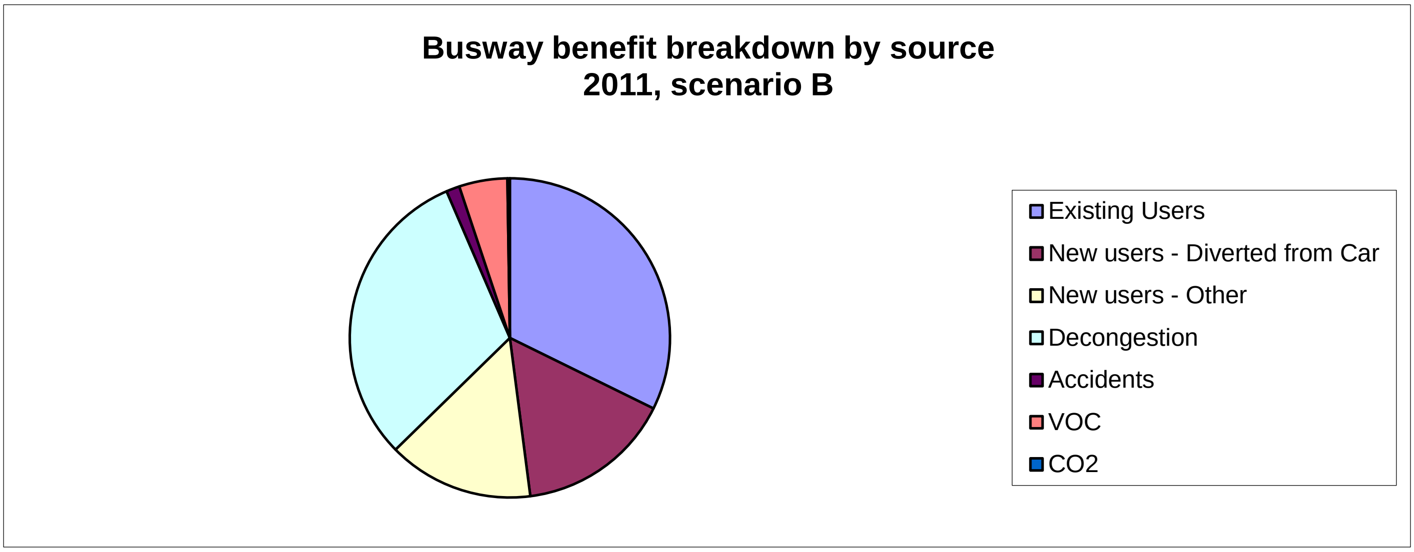
A2.4 Benefit Breakdown



Scenario A; Original BCR (PEM/ATR) 2004

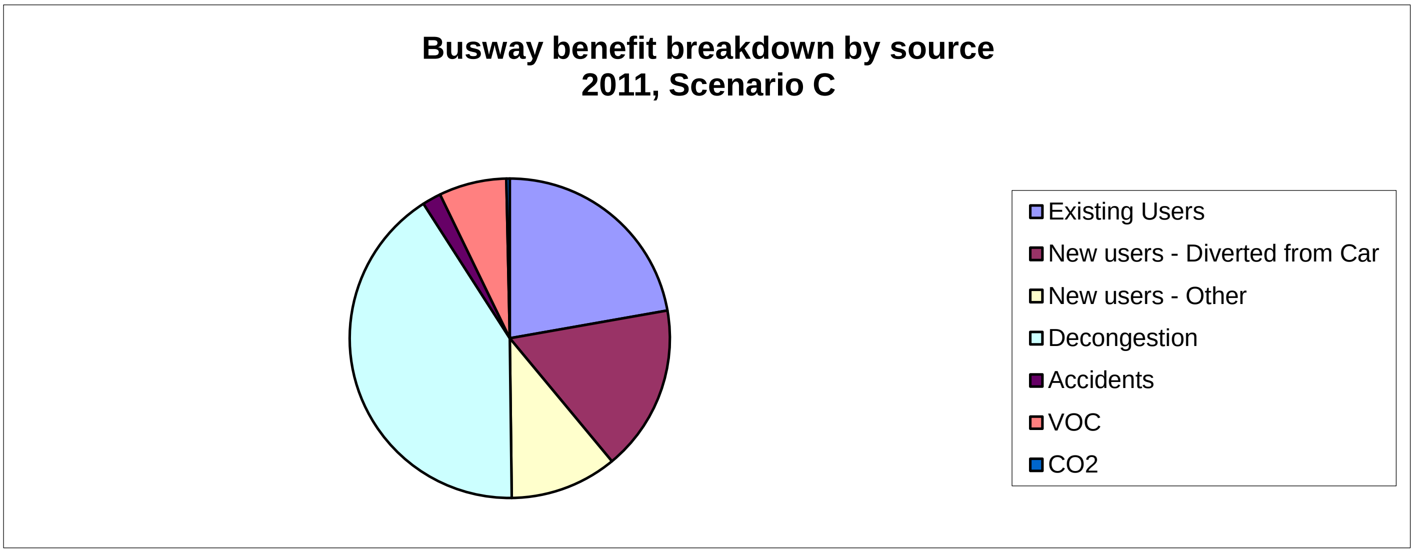
Total BENEFITS (A), 2011	$	
Existing Users	5,571,958	22.2%
New users - Diverted from Car	4,206,255	16.8%
New users - Other	2,712,422	10.8%
Decongestion	10,314,254	41.1%
Accidents	475,519	1.9%
VOC	1,711,867	6.8%
CO2	86,458	0.3%
TOTAL	25,078,733	

Note: Scenario I has same % benefit breakdown as Scenario A – but with an extended evaluation period and reduced discount rate.



Scenario B: Original Forecasts using current EEM

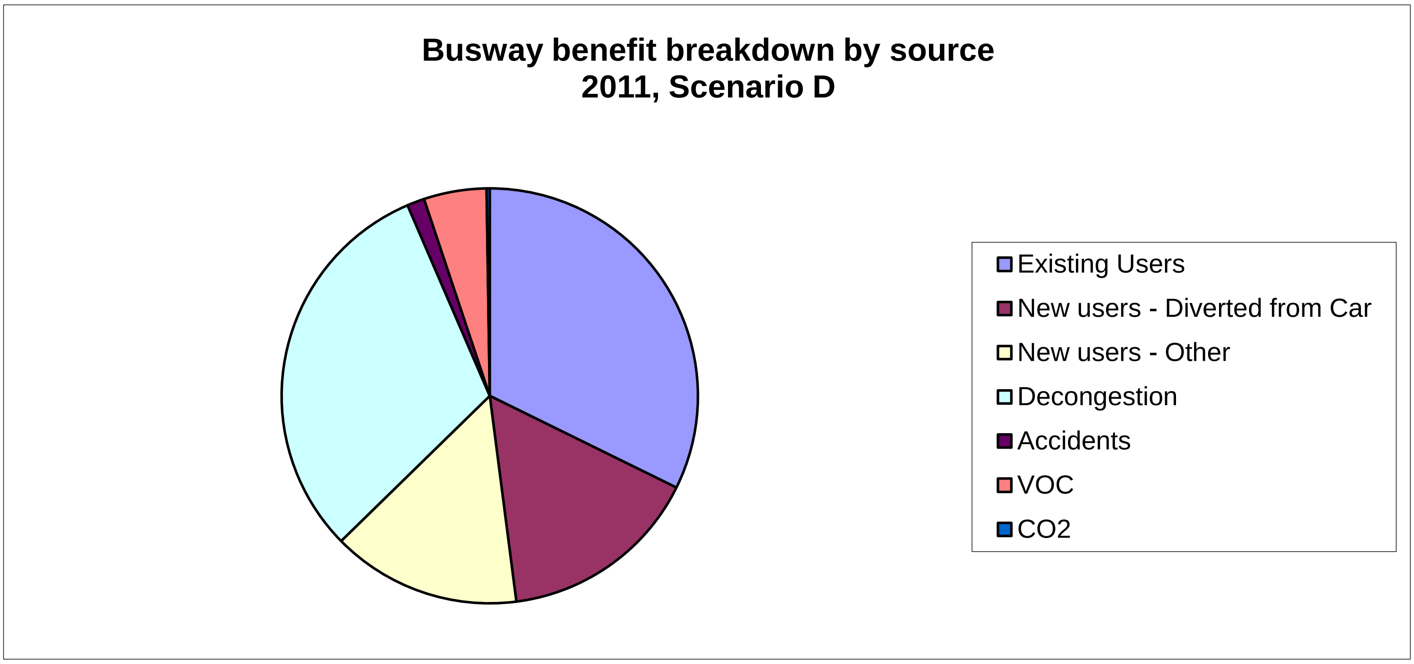
Total BENEFITS (B), 2011	$	
Existing Users	11,352,229	32.3%
New users - Diverted from Car	5,510,194	15.7%
New users - Other	5,169,230	14.7%
Decongestion	10,853,371	30.9%
Accidents	475,519	1.4%
VOC	1,711,867	4.9%
CO2	86,458	0.2%
TOTAL	35,158,867	



Scenario C; Original Method PEM/ATR) 2004 using Actual Data/Revised Forecasts (PIR evaluation)

Total BENEFITS (C), 2011	$	
Existing Users	5,906,275	22.2%
New users - Diverted from Car	4,458,631	16.8%
New users - Other	2,875,168	10.8%
Decongestion	10,933,109	41.1%
Accidents	504,050	1.9%
VOC	1,814,579	6.8%
CO2	91,645	0.3%
TOTAL	26,583,457	

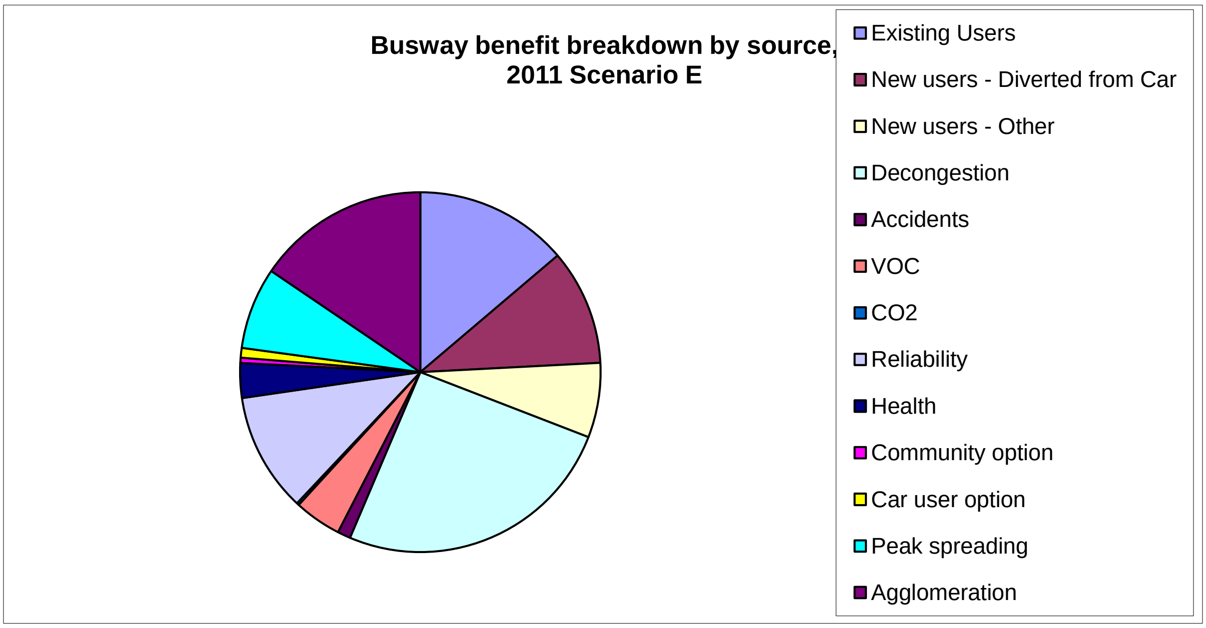
Note: Scenario G has the same % breakdown of benefits as Scenario C – but with an extended evaluation period and reduced discount rate.



Scenario D; Current EEM (2011) using Actual Data/Revised Forecasts

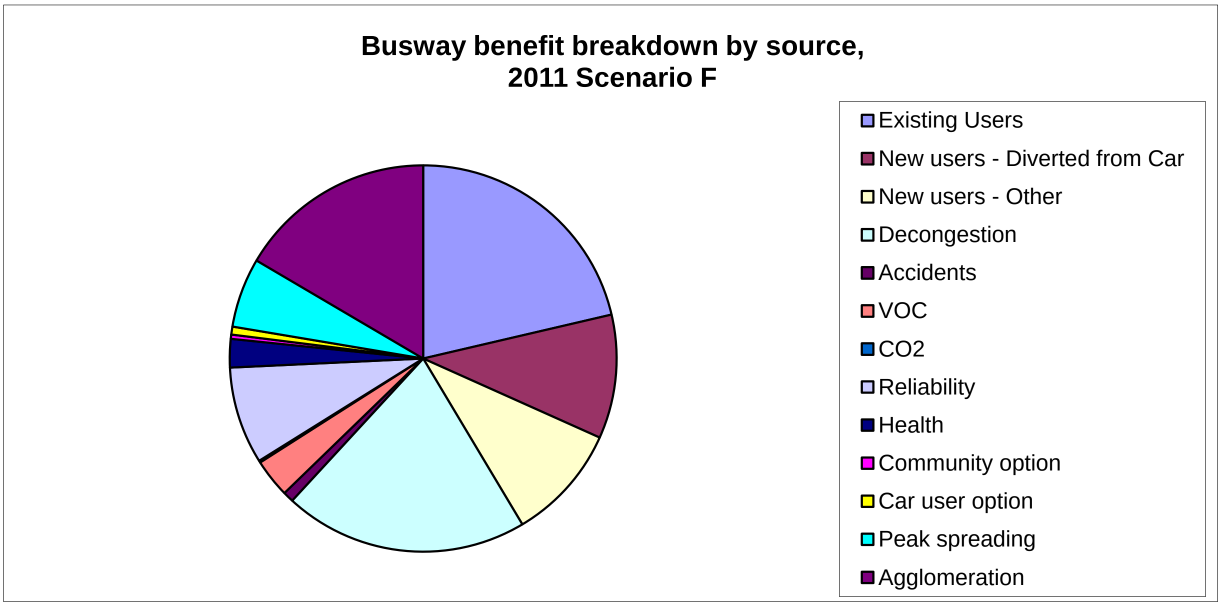
Total BENEFITS (D), 2011	$	
Existing Users	12,033,362	32.3%
New users - Diverted from Car	5,840,806	15.7%
New users - Other	5,479,384	14.7%
Decongestion	11,504,573	30.9%
Accidents	504,050	1.4%
VOC	1,814,579	4.9%
CO2	91,645	0.2%
TOTAL	37,268,399	

Note: Scenario H has the same % breakdown of benefits as Scenario D – but with an extended evaluation period and reduced discount rate.



Scenario E; Original Method PEM/ATR) 2004 using Actual Data/Revised Forecasts and Extended Benefit Range.

Total BENEFITS (E), 2011	$	
Existing Users	5,906,275	13.8%
New users - Diverted from Car	4,458,631	10.4%
New users - Other	2,875,168	6.7%
Decongestion	10,933,109	25.5%
Accidents	504,050	1.2%
VOC	1,814,579	4.2%
CO2	91,645	0.2%
Reliability	4,585,018	10.7%
Health	1,339,424	3.1%
Community option	200,000	0.5%
Car user option	375,000	0.9%
Peak spreading	3,147,024	7.3%
Agglomeration	6,645,864	15.5%
TOTAL	42,875,787	



Scenario F: Current EEM (2011) using Actual Data/Revised Forecasts and Extended Benefit Range

Total BENEFITS (F), 2011	$	
Existing Users	12,033,362	21.3%
New users - Diverted from Car	5,840,806	10.4%
New users - Other	5,479,384	9.7%
Decongestion	11,504,573	20.4%
Accidents	504,050	0.9%
VOC	1,814,579	3.2%
CO2	91,645	0.2%
Reliability	4,585,018	8.1%
Health	1,339,424	2.4%
Community option	200,000	0.4%
Car user option	375,000	0.7%
Peak spreading	3,281,803	5.8%
Agglomeration	9,317,100	16.5%
TOTAL	56,366,744	

Scenarios G, H and I

- *Scenario G same breakdown as Scenario C - but with an extended evaluation period and reduced discount rate.*
- *Scenario H same breakdown as Scenario D - but with an extended evaluation period and reduced discount rate.*
- *Scenario I same breakdown as Scenario A - but with an extended evaluation period and reduced discount rate.*

A2.5 PT Package Evaluation – Experimental Model

Approach

The original economic evaluation of the NB was 'compartmentalised' to comply with funding rules applying at the time. As a result, the main economic evaluation was undertaken only for the road infrastructure component, namely the busway itself. This has been the subject of the PIR and sensitivity testing undertaken in the main report.

It is not known if any economic evaluation was undertaken for: (a) the proposed change in PT services that were planned in conjunction with the busway or, (b) the stations and associated parking facilities.

In order to address the partial nature of the original evaluation method, sensitivity testing of the economic evaluation of a comprehensive package of PT services, stations and busway construction has been conducted, using an experimental PT evaluation model.

The basis used for this testing has been to extend the scope of the project to include all capital and operational costs and at the same time to extend the range of benefits to be more consistent with good international practice.

Model Features

The model[1] is excel and VB based and provides a simple two screen rapid testing tool primarily for the purpose of preliminary economic evaluation feasibility testing of PT services and infrastructure packages. The model includes the following PT sub-modes: bus, rail, rapid transit and ferry.

The model can also be used to illustrate the potential effects of alternative assumptions and approaches to public transport economic evaluation for training and education purposes.

All of the features of the model could be replicated by constructing one-off bespoke calculation worksheets, however, these are not as accessible, do not encourage evaluation consistency and take much longer to use.

The model incorporates facilities to import saved input data sets and to export results into excel format for further analysis when required.

Input Data

The information sources used for the work include samples of patronage surveys, operational and revenue information. From this information, factored estimates of overall costs, revenues and benefits were obtained.

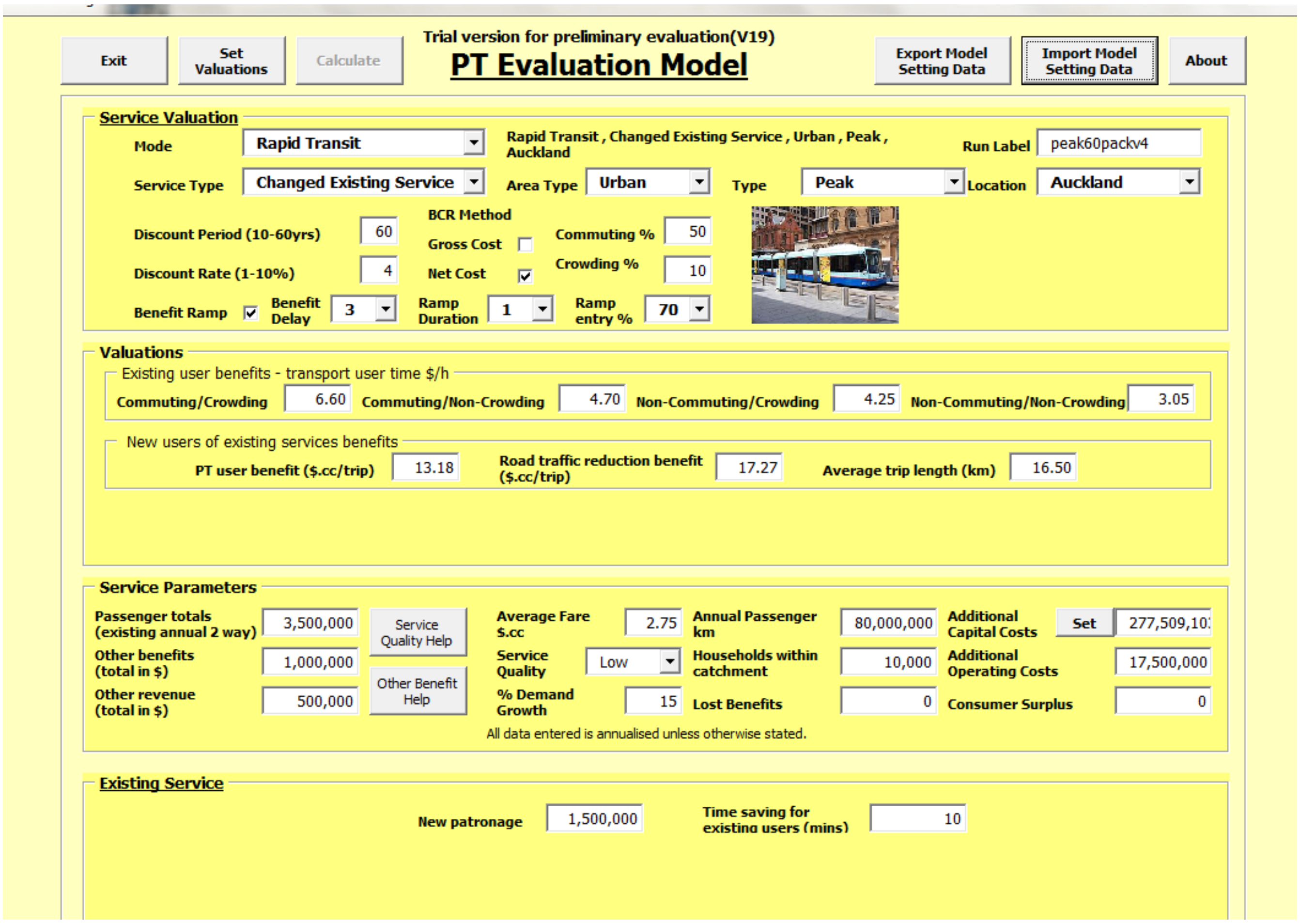
Other assumptions were also included, for example with respect to option values, taken from comparable evaluations undertaken elsewhere, for sensitivity test purposes. All of this means that the model is currently calibrated to provide broadly representative but illustrative results only at this stage.

It is also important to note that further data and detailed analysis is needed prior to any final conclusions being drawn on the indicative findings to date.

However, given these qualifications, initial (peak and non-peak) modelled sensitivity tests have been undertaken.

[1] The model does not require specialist software and is available for demonstration purposes on request at: www.transportfutures.net

The input data used for the evaluation of an illustrative PT package (busway infrastructure, services and stations) for peak conditions are shown on the following screen:



Input parameters are consistent with the EEM and default valuations (for example: user benefits and road traffic reduction benefits) have been incorporated wherever possible.

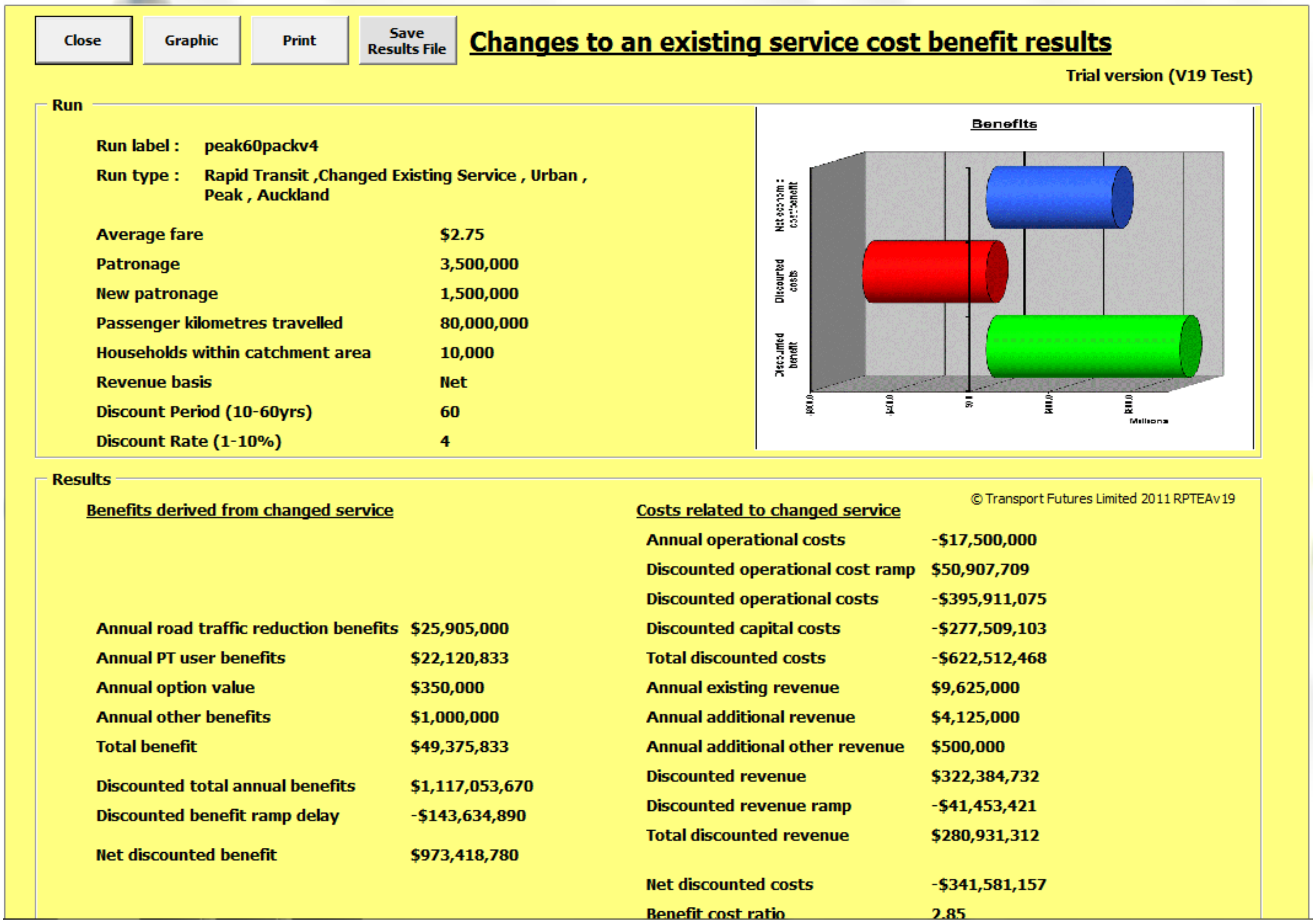
The above evaluation has been based on the simplified procedure from EEM 2 SP10 for changes to existing peak urban PT services in Auckland. Given the rapid transit nature of the busway services and stations, default values for train (rather than bus) have been adopted.

The input parameters (shown above) also assume: the calculation of a government (net cost) BCR, benefit delay and ramp up periods, commuting and crowding proportions, a 60 year evaluation period and a 4% discount rate.

Other aspects worth noting in the above evaluation are as follows:

- A capital cost of $300m has been assumed, representing a discounted cost over a three year construction period of $277.5m.
- Peak patronage totals, operational costs and revenues have been factored based on the relationship of NEX patronage to the other bus services making use of the busway. The annual estimates and average fare used are therefore only approximate.
- Other benefits could include a variety of categories, including health, car option values and reliability (see Annex A2.1) and an annual nominal value ($1m p.a.) has been included to reflect the fact that some additional benefits are anticipated.
- The option value included assumes that 10,000 peripheral North Shore households which have a low level of PT service would ascribe values to the NB (NZTA RR 471).

The results screen for the above peak scenario is shown below:


Close | Graphic | Print | Save Results File

Changes to an existing service cost benefit results

Trial version (V19 Test)

Run

Run label :	peak60packv4
Run type :	Rapid Transit ,Changed Existing Service , Urban , Peak , Auckland
Average fare	$2.75
Patronage	3,500,000
New patronage	1,500,000
Passenger kilometres travelled	80,000,000
Households within catchment area	10,000
Revenue basis	Net
Discount Period (10-60yrs)	60
Discount Rate (1-10%)	4

Results

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Benefits derived from changed service

Annual road traffic reduction benefits	$25,905,000
Annual PT user benefits	$22,120,833
Annual option value	$350,000
Annual other benefits	$1,000,000
Total benefit	$49,375,833
Discounted total annual benefits	$1,117,053,670
Discounted benefit ramp delay	-$143,634,890
Net discounted benefit	$973,418,780

Costs related to changed service

Annual operational costs	-$17,500,000
Discounted operational cost ramp	$50,907,709
Discounted operational costs	-$395,911,075
Discounted capital costs	-$277,509,103
Total discounted costs	-$622,512,468
Annual existing revenue	$9,625,000
Annual additional revenue	$4,125,000
Annual additional other revenue	$500,000
Discounted revenue	$322,384,732
Discounted revenue ramp	-$41,453,421
Total discounted revenue	$280,931,312
Net discounted costs	-$341,581,157
Benefit cost ratio	2.85

The above results show that benefits are dominated by road traffic reduction benefits and PT user benefits. This is partly because a conservative approach has been taken to the inclusion of option and other benefits in the absence of more detailed information.

Discounted capital costs are $277.5m and operational costs ($345m) exceed revenues ($281m) by $64m.

The above results were combined with inter-peak results to produce estimated BCRs as follows:

		30 Years and 8% Discount Rate	60 Years and 4% Discount Rate
		Scenario K	*Scenario L*
Package (Capital and Operational) Evaluation	Benefits	$481m	$1,089m
	Costs	$341m	$420m
	Benefit Cost Ratio	**BCR 1.4**	**BCR 2.6**

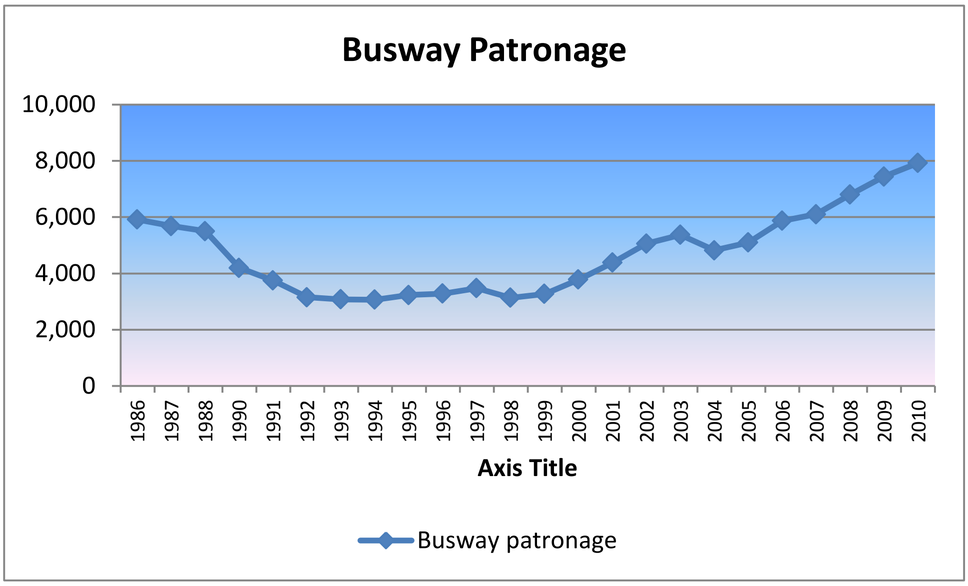
Treating the project as an integrated package (in terms of including additional costs, revenues and adjustments to the treatment of benefits) results in a viable BCR of 1.4 over a 30 year evaluation period at an 8% discount rate.

Increasing the evaluation period to 60 years and lowering the discount rate to 4% results in a substantial increase in the forecast BCR to 2.6.

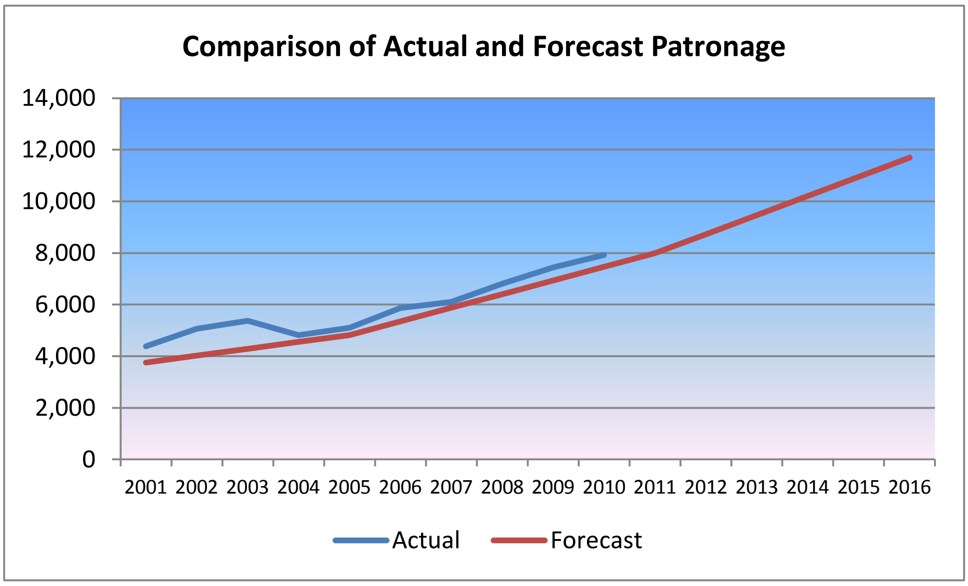
Annex 3: Data

A3.1 PT Patronage

AM peak southbound bus patronage has fluctuated over the past 24 years (see below) but a series of service improvements and the introduction of the NB in the past 5 years resulted in substantial patronage growth. More detail on patronage growth in busway and non-busway services is contained in Annex 4.



Actual patronage levels have been consistently higher than pre-implementation modelled forecasts, as illustrated below:



PT Reliability

Changes in PT reliability have been estimated using the difference between bus timetable arrival times and sighting times from available data supplied by Auckland Transport.

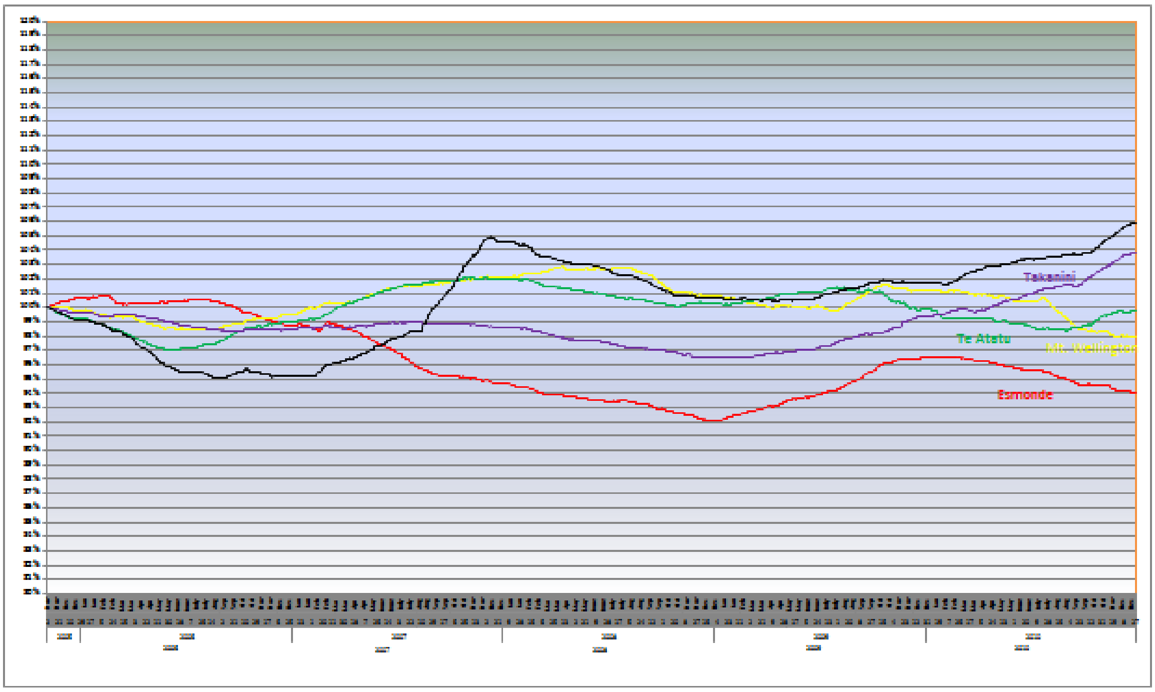
Post-implementation bus service reliability has been calculated from NEX data which has been assumed to be representative of all services using the busway.

Pre-implementation bus service reliability data was not available and therefore data from current non-busway services (875 and 76) on the North Shore was used as an approximation for pre-busway service reliability. The analysis is summarised below and indicates that busway services experience less late running and lower levels of timing variability of service performances.

Service	Average Late	Standard Deviation
875	*207.3 secs.*	*577.4 secs.*
76	*346.4 secs.*	*426.1 secs.*
Non-Busway Average	*276.8 secs.*	*501.8 secs*
NEX (busway)	145.2*secs*	274.9 *secs*
Difference secs.	*-131.7 secs*	*-226.8 sec.*
Mins Difference	**2 min 12 secs**	**3 min 47 secs**

A3.2 Traffic

The graph below represents flows on 5 Auckland motorways, showing the change in flows up to 2010. From this it appears that southbound traffic volumes (on SH1 at Esmonde in red) have reduced: (i) in absolute terms and (ii) also relatively compared to other motorways.



The effective first opening date of the project was November 2005, with the NEX services and the first two bus/P&R stations.

The traffic analyses have therefore been based against the average weekday traffic volumes over the 12 months November 2004 to October 2005 which has been indexed at 100.

The chart shows 12 month moving averages of traffic volumes (06.00-10.00 hrs AM weekday, inbound) at 5 motorway points: SH1N-Esmonde Rd; SH1S-Takanini, Mt Wellington; SH16E-Te Atatu, and St Lukes.

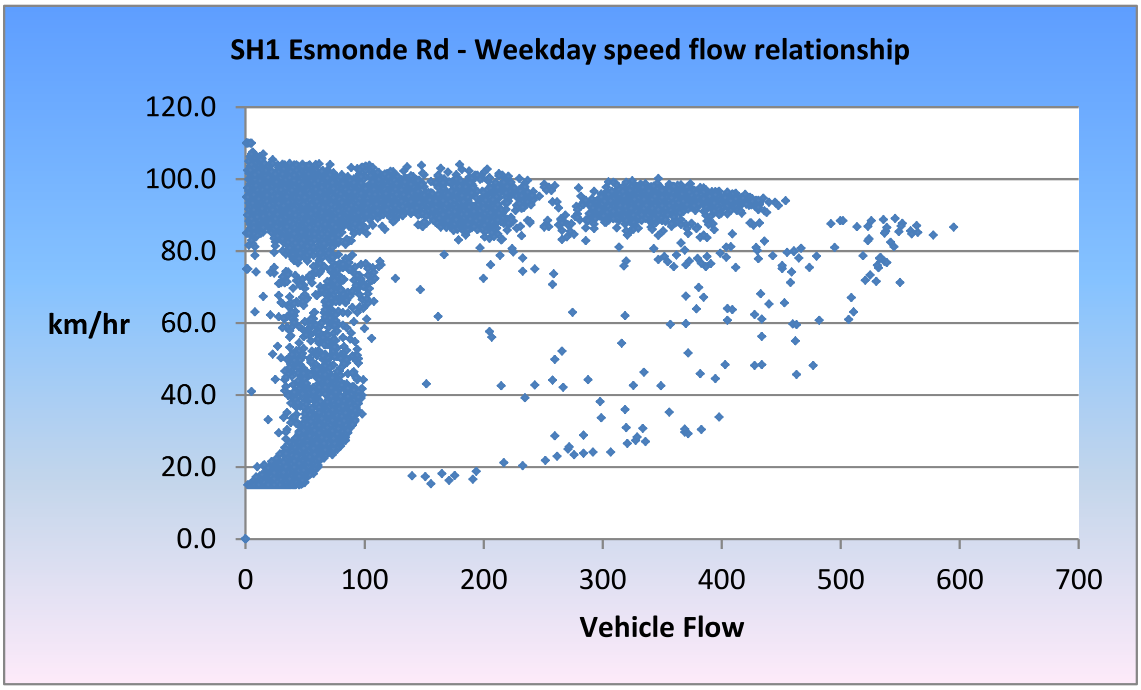
It is seen that after an initial slow start, the Esmonde Rd traffic volumes decreased relative to all the other points and have remained lowest, by a substantial margin, ever since early 2007. Fairly consistently since mid/late 2007, the Esmonde Road volumes have been a minimum of c4% lower than the next lowest point (generally Takanini) and for most of this period c6%-8% lower than the others.

While there is difficulty in being conclusive on 'cause and effect', a reasonable hypothesis would be that the NB has resulted in a reduction in traffic volumes through the Esmonde Rd count point (and hence likely across the AHB) in the range of 4% to 8% since 2007.

SH1 Esmonde Road Speed-Flow Data

In non-congested and in very congested conditions, small reductions in traffic due to modal transfer may not make a great deal of difference to the general traffic travel times. However, in some circumstances where flow breakdown can be avoided, especially in the peak shoulder periods, time savings due to mode transfer are likely to be substantially greater than 'averages' derived using the conventional traffic modelling often used for evaluation purposes.

To illustrate this issue, the speed-flow profile on SH1 near Esmonde Road on weekdays in March 2011 is shown below. Each data point represents a 3 minute 'bin' of volume and the associated average speed during each of the 14,000 individual periods.



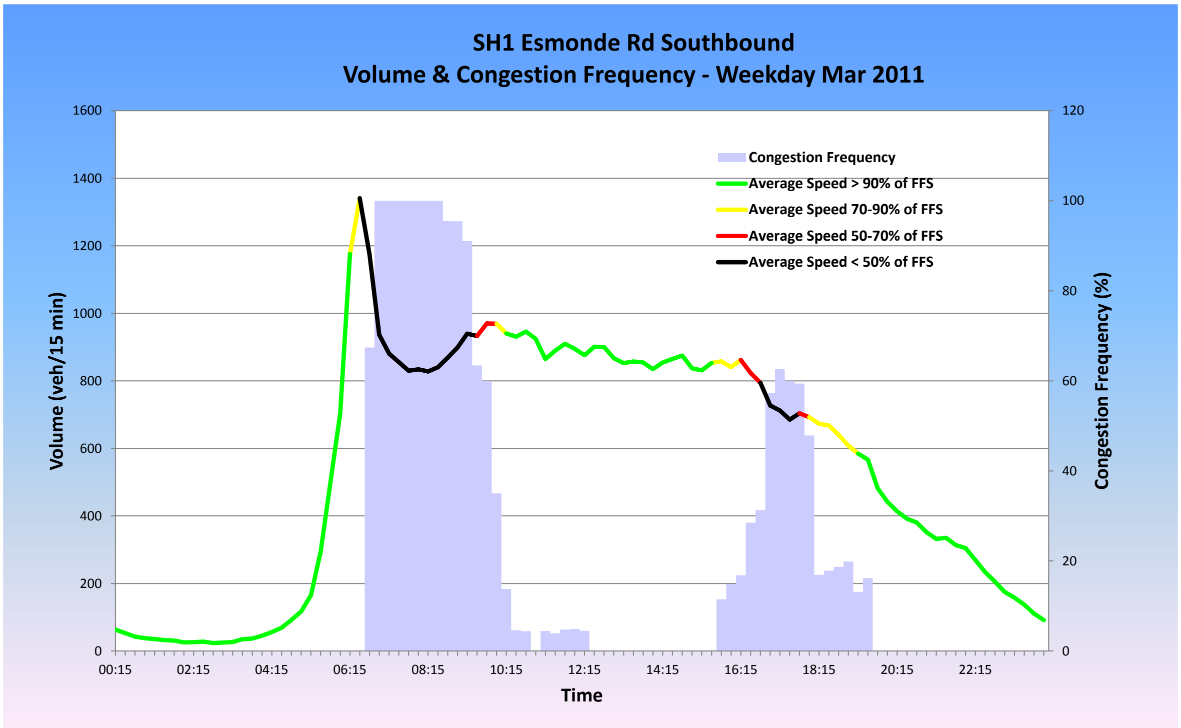
The primary speed flow relationship appears to be a decline from 100 km/hr to 80 km /hr as volumes increases. Visually interpreting the data, flow breakdown appears to occur at flow volumes over 400 vehicles and at around 90 km /hr. A minority of data points can reach up to 600 vehicles approaching 80 km/hr until flow and speed breakdown occurs.

Once the relationship between speed and flow has broken down, two trends occur. Firstly, a minority of traffic continues to move at reasonable volumes (here between 100 and 600 vehicles) but at highly variable speeds, the lower boundary of which forms a secondary minimum speed flow curve.

Secondly, once congested conditions are established, volumes for the majority of data points fall below 100 vehicles, with speeds between 15 and 80 km/hr. Average speeds below 50 km/hr typically indicate stop/go conditions. When modal transfer prevents or reduces the extent of flow breakdown, then higher travel speeds will be experienced.

SH1 Esmonde Congestion Analysis

The extent of congestion, the average volume profile through the working day and the associated travel speeds are illustrated below:



Congestion periods wider than those assumed in the evaluation, i.e. the band of weekday congestion in the peak direction is currently over three hours (6.45-9.30 >60% congestion level and 7.00-9.15 >90% congestion) the original evaluation assumed only two hours.

Southbound weekday congestion is currently over three hours (i.e. between 6.45-9.30 AM is above the 60% congestion level and between 7.00-9.15 AM is above the 90% congestion level).

The original evaluation only assumed that decongestion benefits would only occur for a two hour period between 7.00-9.00 AM for the whole of the 25 year evaluation period.

It is likely that peak spreading will continue to occur throughout the remainder of the evaluation period unless demand management is introduced or other forms of constraint on growth arise (say, due to external factors such as fuel costs)

A3.3 Modelling

The original evaluation made use of two models, namely the Auckland Public Transport (APT) model and the corridor traffic management (SATURN) model.

For the purposes of this review some tests were undertaken using the multi-modal Auckland Regional Transport (ART3) for the 4 hour morning peak period 6 am-10 am.

This model has been used for a number of recent studies, including the Waitemata Harbour Crossing review (2010).

A test was undertaken to estimate the current effects of the NB in 2011 in modelled terms. This involved comparing a 2011 with-Busway scenario to a new modelled scenario in 2011 that removes the NB.

The purpose of this test was to identify any wider effects that might not be picked up in reviews of localised monitoring data.

The model tests produced the following results:

	Percentage Change 'With NB'		
	AM Peak	Inter-Peak	PM Peak
PT Patronage (AHB)	18%	9%	12%
PT Time (Albany to CBD)	-38%	-29%	-28%
Traffic Volumes (AHB)	0%	0%	0%
Traffic Times (Albany to CBD)	-2%	-1%	-1%

The increase in PT patronage and reduction in PT travel time are both substantial and generally consistent with observed effects.

However, peak travel volumes over the Harbour Bridge remained constant in model tests with and without the NB. Travel times for general traffic from Albany to the CBD were also little changed. This indicates that the model is predicting that re-timed and re-routed traffic will fill any 'spare' capacity released due to mode transfer from car to PT in the peak period.

The tests were useful but confirmed that due the strategic nature of the ART3 model means that it cannot be relied on as a primary forecasting tool for detailed economic evaluation purposes.

Annex 4: PIR Case Study

Centre	Scheme	Status	Notes	Reference Sources
AKL	**Northern Busway**	Operational	• Segregated busway and supporting facilities.	Refer A4.11

A4.1 Scheme Description

The project aims were to:

- *''increase accessibility to public transport*
- *provide an alternative mode of transport between the Northern and Auckland City*
- *reduce travel times of ...HOVs and bus users along SH1*
- *increase person carrying capacity of harbour bridge*
- *minimise adverse environmental effects of private motor vehicle use*
- *enhance activity in city centres by improving accessibility and capacity'' (19)*

The original project concept was developed by the Auckland Regional Council in the early 1980's in response to level of congestion and the difficulties experienced by bus services in peak periods.

Bus use of the shoulder on the northern motorway dates back at least to the early 1990's. The shoulder speed limit was 50km/hr and its use was normally limited to peak use only. In practice, the sections of shoulder available for bus use changed over time and were not continual, requiring bus merging manoeuvres with motorway traffic. Even so, reportedly the use of the shoulder was found to improve bus travel times.

Concepts for a dedicated busway were investigated in detail between 1988 and 1992 and a scheme assessment report (SAR) was produced by Works Consultancy Services for a preferred option, which was for a dedicated busway at a cost of approximately $35m. The project was then modified after a series of meetings chaired by Transfund NZ, resulting in the 1997 proposal to allow HOVs to use the busway.

Following work by consultant MRC for North Shore City Council, NSCC in 1998 the project was modified to increase the scale of construction required for the busway and the development of associated stations and facilities, resulting in a capital cost requirement of $130m.

The project was designed with the potential for later conversion to rail and a number of other aspects of the project improving access for pedestrians, cyclists and heavy vehicles were also incorporated into the final design. (8)

The busway and associated works and service changes were implemented over the period between July 2005 (commencement of new services) and February 2008 (busway opening). Subsequent park and ride extensions were added in 2009. Service frequencies have also been continuously reviewed since 2005, in response to demand.

As defined[2] in the latest evaluation (7) the project comprises:

- A dedicated busway from Constellation to Onewa, potentially available to high occupancy vehicle (HOV) traffic. This operates as a two-way, two lane facility between Constellation and Akoranga stations (6.2km) and one-way, one lane facility (2.5km) between Akoranga and south of Onewa Road interchange;
- Improvements at Onewa Interchange to permit dedicated busway operation;
- Associated basic stations, park/kiss and ride facilities at Akoranga, Westlake, Sunnynook, Constellation and Albany;
- Extension of the existing HOV lane along Onewa Road;
- Provision of bus-only ramps from SH1 to the Albany station.

The Northern Busway (NB) project was previously referred to as the 'North Shore Busway'.

A4.2 Scheme Costs

The scope of the project for the final evaluation (7) prior to funding approval was constrained to certain works in the NSCC area, namely: the busway itself at $162.2m, extension of Onewa Road HOV lane $6.0m, basic station (civil) costs $28.9m, property $17.5m giving a total capital cost for evaluation purposes of $214.6m (7).

Table1: Costs

<table>
<tr><th></th><th>Evaluation Costing (2004)</th><th>Approval Cost (2005)</th><th>Outturn Cost (2008)</th></tr>
<tr><td>Busway</td><td>$162.2m</td><td>$180.0m</td><td>$190.5m</td></tr>
<tr><td>Total Station Cost</td><td>Not Included</td><td>Not funded by NLTF</td><td>($85m)</td></tr>
<tr><td>'Basic' Stations</td><td>$28.9m</td><td>Not funded by NLTF</td><td>N/A</td></tr>
<tr><td>Property</td><td>$17.5m</td><td rowspan="2">$30m
(unspecified)</td><td rowspan="2">$30m
(assumed)</td></tr>
<tr><td>HOV lane</td><td>$6.0</td></tr>
<tr><td>Total</td><td>$214.6m</td><td>$210m</td><td>$220.5m</td></tr>
</table>

The above costs also exclude any increases in road capacity on SH1 for general traffic, for example, improvements to the Onewa Interchange (open June 2008), major improvements to the Esmonde Interchange (open May 2007), other local road works required in NSCC and works to the south of the

[2] Scope definition remains an issue in interpreting this project as NLTP funding approval was essentially for 'busway only' construction.

Harbour Bridge, all of which were evaluated separately.

The funding approval cost for the project was $210m (total) of which $180m was for the busway construction cost (2004); the actual outturn cost was $190.5m (14).

The construction of the five busway stations was funded by the North Shore City Council ($35 million) and Auckland Regional Transport Authority ($50 million, $40 million of which was granted by the now disbanded regional funding agency Infrastructure Auckland).

From the perspective of the National Land Transport Fund, the out-turn cost of the project was $190.5m, representing a 6% increase on the originally approved cost of $180m. This increase was due to minor variations in estimates required during the course of project implementation.

A4.3 Method (Modelling, Forecasting and Evaluation Techniques)

Pre Implementation analysis was undertaken using a mixture of different models, including: ART2, APT, SATURN project model and the NSCC TRACKS model. The two procedures used for NB evaluation were the (then) Transfund NZ project evaluation manual (PEM) and the alternatives to roading manual (ATR). The programming and funding manual (PFM) was also relevant to the final funding decision.

This was a complex project requiring joint funding and management approaches, between Transit, Transfund, NSCC, ARC, ARTA, Infrastructure Auckland, and others (including Transpower). The funding policy during the main period of project specification and evaluation (1999 to 2003) required certain thresholds to be reached for benefit cost ratios (BCRs) and efficiency ratios (ERs). Roading and ATR projects were in competition with each other on the basis of their respective 'ratios'. A range of evaluation techniques were therefore considered for the NB project, including a full evaluation of the whole project under the ATR procedures; however, the final NB project evaluation treated the proposal as a 'road' based on the PEM procedures, although the actual funding of the overall project was divided between a number of parties. In particular, the busway ended up being funded as a state highway (at 100%) and the stations were funded our of local/regional funds with no contribution from the NLTF. Service costs were shared between the regional and central authorities.

Legislative complexity in interpreting the Transit Act at the time meant that the treatment of the evaluation for the NB was particularly contentious. However, at the actual time of the construction funding of the NB, the Land Transport Management Act (LTMA) had been enacted allowing a more broadly based transport funding decision to be taken (in December 2003 and February 2004) and this allowed the Transfund NZ Board more discretion in project funding approval.

Post-implementation monitoring of journey time surveys, volume counts and patronage surveys and some post-implementation model tests using ART3 have been undertaken (5).

A4.4 Actual Base Year Conditions

2005 traffic volumes on SH1 were over 7,000 vehicles per hour (one way southbound) over the Harbour Bridge in the AM peak period (5).

Travel times were relatively slow for general traffic between Albany and the CBD due to the presence of stop / start driving conditions (5). ARTA staff involved at the time report that the introduction of limited bus priority measures through hard shoulder use immediately prior to the construction of the busway did not substantially improve bus travel times.

The social cost of road crashes on the relevant section of SH1 is substantial at $8.6m p.a. (at current year costs) (13).

A4.5 Actual Post-implementation Conditions

The travel times for buses (35min) from Albany to the CBD were slightly higher than for cars (34min 30s) prior to the introduction of the busway in 2005 (5).

By 2009, bus travel times had reduced by 36% (12min 40s) to 23min 20s whilst car travel times had increased by 5% (1min 54s) to 36min 24s. Over the same period, busway southbound patronage increased by 46% during the AM peak period (5).

Traffic volumes remain high, but monitoring indicates that southbound AM peak period traffic volumes fell in absolute terms by around 2% over the period 2005 to 2009 (5).

A slight change in car occupancy was also recorded over the same period from 1.21 to 1.28 although this was not as a result of any planned HOV initiatives none of which to date (June 2011) have been implemented.

It appears doubtful that following the success (and increased frequencies) of the bus operation any significant amount of HOV use of the existing busway could be achieved without negative impacts on bus operations (5).

There has been a reduction in the social cost of road crashes of $0.6m per annum. This is the average annual difference between 5 year pre and post-implementation periods (i.e. either side of the commencement of busway implementation) and hence will include periods, post 2005, where off-line construction was taking place (13).

In terms of the potential impact on the BCR, costs have exceeded earlier assumptions, bus patronage is greater than previously forecast, and an absolute reduction in SH1 traffic demand has been recorded together with a small deterioration in car travel times due to unrelated road works (5).

As a result, applying the original evaluation methods produces an actual outturn BCR of 1.3, a slight increase on the original evaluation BCR of 1.2.

The predictive accuracy of the original evaluation[3] can be summarised as follows:

Project	Cost Change	Benefit Change	BCR Change	Comment
Auckland Northern Busway	$172m / $182m	$199m / $235m	1.2 / 1.3	This is good in terms of predictive accuracy, when comparing immediate pre and post-implementation conditions.
	+6%	+18%	+12%	

A4.6 Forecast Do-Minimum Conditions (No implementation)

Modelling was undertaken using project SATURN modelling (Beca for Transit), the Northern Tracks model (Gabites Porter for NSCC), the APT model (ARC/ARTA) for bus and patronage forecasts and the use of ART 2 (ARC) for mode split estimates. However, documented details of this modelling or other detailed information (on projected volumes and travel times ‘without the busway’) do not appear to have been maintained and are not therefore currently available.

More recent (retrospective) testing has also being undertaken for a current post-implementation review being conducted for the NZTA, to estimate conditions with and without the busway in 2011, using the Auckland Council ART3 model.

Background traffic volumes in the absence of the project were forecast to grow steadily over the evaluation period.

In the absence of the busway, the project evaluation assumed that no reduction in casualties or serious / fatal casualties would have occurred.

[3] Costs and benefits are discounted back to a common year for evaluation purposes. This means that the costs are not the same as pre-implementation cost estimates or post-implementation recorded out-turn costs.

A4.7 Forecast Post-implementation Conditions

The forecast benefits for the busway elements of the scheme (excluding HOV use) were: existing PT users 22%, new PT users (diverted from car) 17%, new PT users (other) 11%, decongestion 41%, safety 2%, VOC 7%, CO2 0.3%,resulting in a BCR of 1.2. (7)

With HOV use the BCR rose to 1.7, as a result of increased travel time savings and despite a marginal increase in estimated cost. The benefit split for this scenario was: travel time savings, for PT and traffic (81%), vehicle operating costs (15%) safety (3%) and Co2 (1%) (7). The HOV proposal was forecast to both give benefits to the HOVs themselves and lead to decongestion for general traffic.

Forecast safety benefits at $0.5m p. a. are very close to the actual reduction in social costs recorded on the CAS system (7).

A4.8 Performance Statistics

TABLE 2: KEY PERFORMANCE STATISTICS – BASE, ACTUAL & FORECAST CONDITIONS

	Base	Actual	Forecast DM	Forecast DS	% Difference *(Actual vs Base/DM)*
Costs	Total project cost used for evaluation $214.6m (7)	Total outturn cost $220.5m (see 5.2)			*Total costs +5% over base.*
Pre Bus Patronage (ALL) 2002-2005	2002 AM S/B: 4,782 (4)	2005 AM S/B: 5,249 (4)			+9.8% over base (approx. 3% p.a.)
Post Bus Patronage (ALL) 2005-2010	2006 AM S/B: 5,249 (4)	2010 AM S/B: 7,508 (4)			+43% over base (approx. 7.5% p.a.)
Post Bus Patronage (Busway Services) 2006-2010	2006 AM S/B: 2,614 (4)	2010 AM S/B: 4,142 (4)			+58.5% over base (approx. 9.5% p.a.)
Post Bus Patronage (Non-Busway Services) 2006-2010	2005 AM S/B: 2,656 (4)	2010 AM S/B: 3,035 (4)			+29.5% over base (approx. 5 % p.a.)
Vehicle Demand	2005 AADT: 166,130 (5)	2009 AADT: 158,102 (5)			-4.8% less than base (2005 to 2010)
Vehicle Demand	2005 AM S/B: 14,729 (5)	2009 AM S/B: 14,482 (5)			-1.7% less than base
Car Passengers	2005 AM S/B: 17,822 (5)	2009 AM S/B: 18,537 (5)			+4% over base
Bus Mode Split	2005 AM S/B: 22.2%	2009 AM S/B: 28.7%			+6.5% over base

Car Transfer		2007 AM S/B Previous mode car 26% all bus passengers, 43% Northern Express. (2)			
Bus Travel Time	2005 AM S/B: 35.0 min (5)	2009 AM S/B: 22.3 min (5)			-36% less than base
Car Travel Time	2005 AM S/B: 34m 30s (5)	2009 AM S/B: 36m 24s (5)			+6% over base
SH1 speeds	22.6 km/hr (4)	19.8 km/hr (4)			-12% over base
Road Safety: Average annual social cost	2001-2005 $18.0 m pa (CAS) (13)	2006-2010 $17.4 m pa (CAS) (13)			-3% less than base (13)
Road Safety: Casualties (fatal, serious, minor, total)	2001-2005 (5 years) casualties: 5f/s, 71m, 76t (CAS) (13)	2006-2010 (5 years) casualties: 3f/s, 79m, 82t (CAS) (13)			+8% (total casualties) over base
BCR				2004 BCR 1.2 (up to 1.7 with +2 HOVs) (7)	

Note: the AM peak period referred to in the above table is 07.00-09.00 hrs on mon-fri working days – i.e. excluding holidays.

A4.9 Summary of Scheme Impacts

This project has been subject to extensive modelling, forecasting, evaluation and monitoring, although only a limited amount of relevant archive material has been located. This is partly due to pre-implementation efforts being (understandably) directed towards fulfilling the funding requirements at the time, which were largely BCR driven, rather than recording forecasts that could be used for project review purposes.

From the material available, the conclusions drawn on the scheme impacts are summarised in Table 5 below, with further comments as follows:

Costs

- Component costs are described in section A4.2 above.
- The overall outturn costs were very similar to earlier estimates used for evaluation and funding approval, although the scope of works covered by these costs changed during the planning and implementation period.

Traffic

New/Improved Roads:

- **Volumes:** The implementation of the busway and associated station and service changes has been accompanied by a reduction in traffic volumes on the parallel state highway that seems similar in scale to that originally predicted. This has meant that traffic delays have stabilised to some extent and have not grown at the rate expected to occur without the busway.

- **Induced travel effects:** There is no evidence of induced traffic effects, although it is possible that small induced effects could have lead to reductions in traffic volumes being slightly less than anticipated.
- **Travel times/speeds:** Travel times for buses are lower (and speeds higher) than would be anticipated in the absence of the busway. On the basis of a small bi-annual moving observer sample, general traffic travel times on SH1 appear to have continued to increase (in absolute terms) in the post-implementation period. The reasons for this seem likely to include temporary delays south of the Harbour Bridge as a result of the Victoria Park and Newmarket Viaduct projects and works on SH1 itself to provide additional lane merge capacity.
- **Reliability:** Although detailed information is not available, it is likely that there has been little if any improvement in road traffic reliability in the post-implementation period and it may well have worsened in keeping with increased travel times for general traffic. Applying a similar reasoning, bus reliability has probably significantly improved in keeping with the significant reduction in bus travel times experienced.

Effect on Other/Local Roads

- The effects on other / local roads are likely to have been small but positive, due to the removal of some traffic demand due to mode shift.

Effect on Other Modes

- There has been a significant reduction in PT travel times, improved reliability and increased service frequency, leading to substantial growth in post-implementation bus patronage (7.5% p.a.) compared with prior growth rates (3% p.a.)
- The growth in post-implementation busway services has been 9.5% p.a. compared with 5% p.a. growth in non-busway services.
- There has been an increase in the number of people (+13.4%) using the busway to access the CBD as a result of PT and car passenger growth (4).
- If Onewa services are included the total PT patronage in the peak two hours inbound over the harbour bridge and the vehicle mode split increases) to 9,143 which takes the overall PT mode share to 33.1%. This is consistent with the target range of the ARLTS and ATP of 28% to 38% for 2001 to 2016 respectively.
- In the Beca 2004 evaluation it was assumed that bus patronage (and associated benefits) would grow by 36% between 2001 and 2011. In fact the growth has been much higher than that at 81% (with reference to the CBD cordon based ARTA analysis).

Table 3: Summary of Modal Effects

SH1 SB AM Peak Only	Prior 2005 (3)	Actual 2009 (3)
Cars	14,749	14,482
Car Pass	3,093	4,055
Total Car Users	*17,822*	*18,537*
PT Users	5,096	7,444
PT Mode Share	**22.2%**	**28.7%**

Safety Effects

Road safety related social costs (derived from the CAS system, with 5 years pre introduction of NEX services 2001-2005 and 5 years post-implementation data 2006-2010 for the SH1 and associated junctions between Albany and the Harbour Bridge) were found to have reduced in absolute terms as follows:

Road Safety – Annual Social Cost

	Prior	Actual	Project area change	Sub-regional change	Regional change	*Comment*
Northern Busway	$15.5m	$14.3	-3%	-12%	-9%	*The reduction in social cost is similar to project forecasts but lower than sub-regional or regional trends.*

- A small reduction in the social cost of crashes on SH1 is indicated in early localised safety monitoring (CAS before and after analysis) as a result of project implementation.
- Forecast annual project related benefits at $0.5m were similar to actual savings of $0.6m.
- It should be noted that there are likely to have been a number of interventions and changes in corridor conditions over the pre and post-implementation review period.
- Comparison of project area change in social cost with regional and sub-regional changes in social cost (over the same period) indicates that potential safety benefits have not been fully realised in the implementation of the project.

A detailed comparison of project safety Impacts and background changes in social cost is shown below:

		PROJECT			SUB-REGIONAL SHs (urban central and urban north NZTA zones)			REGIONAL SHs (Auckland Region)			NATIONAL SHs		
		Fatal and Serious	Total	Social Cost $m p.a.	Fatal and Serious	Total casualties	Social Cost $m p.a.	Fatal and Serious	Total casualties	Social Cost $m p.a.	Fatal and Serious	Total casualties	Social Cost $m p.a.
Northern Busway	Pre Annual Average	5.4	76.2	18.0	43	475	118.1	115	860	237.3	1,286	5,459	1,984.9
	Post Annual Average	3.4	82.0	17.4	32	470	104.1	100	870	216.4	1,151	5,514	1,833.1
	% Change	**-37.0%**	**7.6%**	**-3.4%**	**-23.9%**	**-1.0%**	**-11.9%**	**-13.1%**	**1.2%**	**-8.8%**	**-10.5%**	**1.0%**	**-7.6%**

- The CAS assessment shows an 8% increase in casualties but a reduced number of serious casualties and fatalities between pre and post-implementation.

VOC, Global and Local Environmental Effects

- Not known, but VOC, greenhouse gas emissions and local environmental changes are likely to be minor as these are likely to be dependent on changes in traffic conditions, which have been relatively small.

Overall economic performance

- Despite a small change in outturn cost for the busway itself, the forecast BCR of 1.2 is likely to have been bettered (to a BCR of 1.3) due to the actual performance of the project in patronage and traffic reduction terms.
- The higher forecast BCR from the original evaluation for the implementation of HOV initiatives (1.7) is unlikely to be realised.
- If current procedures (using the EEM) were applied to the project that this would result in a higher BCR range than the originally estimated range of 1.2. The table below summarises alternative evaluation approaches.

	Original Forecasts (2004 Method)	**Actual Effects / Revised Forecasts** (2004 Method for PIR purposes)	**Original Forecasts** (2011 Standard EEM Method)	**Actual Effects / Revised Forecasts** (2011 Standard EEM Method)
Benefit Cost Ratio	(Scenario A) **BCR 1.2**	(Scenario C) **BCR 1.3**	(Scenario B) **BCR 1.5**	(Scenario D) **BCR 1.8**
Comparative Index (to original BCR)	100	150	217	433

- The increase in the corridor travel capacity to access the CBD may have resulted in increased economic activity and employment effects (such as agglomeration) that are additional to the transport based economic evaluation undertaken.

TABLE 5: IMPACT SUMMARY – NORTHERN BUSWAY		
Aspect	**Impacts relative to Base/'Do Minimum' Forecasts**	**Impacts relative to Scheme Forecasts**
1. Capital costs	• $220.5m outturn construction cost • Part of a package of measures to provide bus stations, park and ride facilities and introduce service changes. • The busway-only element of the project was funded at a FAR of 100% as a state highway project.	• c. +5% ($10.5m) more than pre-construction estimate of $210m.
2. Travel Demand	• Bus patronage demand has grown substantially by 46%. This is greater than would have been anticipated in the absence of the busway. • Traffic demand in terms of vehicle volumes has fallen by 2% post-implementation (between 2005 and 2009) and there has been an increase in car occupancies (from 1.2 to 1.3).	• Actual changes in bus patronage and traffic demand are similar to forecast.

3. Travel times	• Significant 36% reduction in bus travel times. • Relatively small 6% increase in road travel times.	• Forecast reduction in travel times.
4. Safety	• The social cost of crashes has reduced (by an average of $0.6m pa). • The total number of casualties have increased slightly (from 76 p.a. to 82 p.a.) post-implementation although there has been a reduction in crash severity.	• Safety improvements are generally consistent with forecasts.
5. Vehicle operating costs and environmental impacts	• Marginal VOC, GHG and other environmental effects likely to be small due to changes in general traffic conditions also being small.	• Generally consistent with forecasts
6. Overall economic performance	• The BCR has been achieved due to the outturn cost increase (compared with the original evaluation) being balanced by the bus user benefits being greater than expected.	• The main forecast benefit is for time savings (77%) made up by a combination of traffic reduction and bus user benefits. From the evidence available the traffic benefits are similar to forecast and the bus user benefits are greater than expected.

A4.10 Conclusions

- The project has achieved its aims of significantly increasing public transport patronage and mode share.
- The project has contributed to an increased number of people (+13.4%) accessing the CBD by a combination of public transport and private vehicles, during the am peak period.
- The early evaluation for this project was problematic, partly because economic evaluation procedures at the time had not been fully developed for application to major public transport projects. Consequently, for funding evaluation purposes at the time it was necessary to adopt a number of non-standard approaches and assumptions.
- The original forecast BCR of 1.2 has more than been achieved in terms of the evaluation method employed at the time of funding approval. This because costs have remained close to the funding approval estimates and forecast public transport benefits (in the early post-implementation period) have been achieved resulting in a revised out-turn BCR, using the original PEM/ATR methodology for strict PIR purposes, of 1.3.
- The position concerning travel time benefits to general traffic is less clear, as traffic volumes have reduced in absolute terms, but travel times in the immediate post-implementation period appear to have increased slightly due to the effect of unrelated road works.
- If current economic evaluation procedures with respect to public transport (EEM 2011) were applied, then this would have produced a higher BCR of between 1.5 and 1.8.

A4.11 References

REF	AUTHOR	TITLE	DATE	SOURCE
1	ARTA	Auckland Transport Plan	2009	
2	ARTA	Results of After Study: Constellation and Albany Stations	2007	
3	ARTA	Northern Busway Stations Survey	2006	
4	Auckland Council	Annual Cordon Surveys	2006 - 2010	
5	Auckland Transport	Busway Demand Trends and Forecasts (v4)	2011	*Spreadsheet Data Analysis*
6	Auckland Transport	Key Performance Indicators (KPI) Report	2011	
7	Beca	NSB Economic Evaluation Update	2004	*Report for Transit NZ*
8	NSCC	Project Web Site	2011	
9	NZTA	Congestion Index (CGI) surveys	2006-2010	
10	NZTA	Northern Busway Web Site Description.	2011	*http://www.nzta.govt.nz/network/projects/project.html?ID=15*
11	NZTA	State Highway Traffic Data Booklet Data, 2004-2009	2009	
12	NZTA	Traffic Volumes Monthly Report	2010	
13	NZTA	CAS Data	2011	
14	NZTA	Transport Investment (TI) Online	2011	
15	Parsons Brinkerhoff	Additional Waitemata Harbour Crossing Network Plan: Passenger Transport	2010	
16	Smith M, et al.	Auckland: The North Shore Busway Evaluation	2002	
17	NCHRP	Cost benefit Analysis of Converting a Lane for Rapid Transit, Phase ii Evaluation and Methodology,	2011	*21st ASATCTRB*
18	NZTA	Six Major Projects Review, North Shore Busway Annex	2004	*Transfund Board Paper*
19	Wallis I	PT Option and Non-Use Values	2011	*Draft Research Report for NZTA*
20	Wallis I	Auckland PT Performance Benchmark Study	2011	*Report for Auckland Council*

A4 Appendix- Implementation History

Northern Busway: Calendar of Events:

2003:

Northern Busway construction commences.

2005:

July – new North Shore services commenced, including increased level of suburban express services.

New service design implemented to provide for servicing of busway stations (when completed).

November – Albany and Constellation Stations open.

Suburban expresses and local services north of Constellation rerouted to serve Stations.

Northern Express dedicated service from Albany (some trips commence Massey University Albany) to Britomart commences.

Express services use motorway shoulder from Constellation Station south.

2006:

February – Northern Express peak frequency increases to 10 minutes weekdays to cope with demand.

2007:

February – Northern Express peak frequency increased to 7.5 minutes. Northern Express services commence and terminate at Albany Station, deleting the Massey University connection.

2008:

February – Full busway opens with stations at Sunnynook, Smales Farm and Akoranga.

Northern Express frequency increased to 5 minutes at peak.

Suburban express services south of Constellation rerouted to include Smales farm and Akoranga Stations (excluding Onewa Rd and Northcote/Marlborough services).

Local services rerouted to include busway Stations providing greater connectivity between services.

October – Northern Express peak frequency increases to 4 minutes at peak

2009:

February – off board ticket validation facility provided at Albany Station in the morning peak and Britomart in the afternoon peak. Allows for vehicles to be boarded through both front and rear doors to reduce passenger dwell time.

October – Northern Express weekday evening frequency increased to 15 minutes.

Reduction in weekend daytime frequency from 10 to 15 minutes.

2010:

March – additional non-timetabled capacity provided on Northern Express morning peak in response to demand.

2011:

May – increase in Northern Express frequency and service span.

3 minute frequency introduced at peak times weekdays.

Weekday services commence at 5.30am

Increase in evening service span to 12.00 midnight Monday to Thursday and 3am Friday and Saturday nights.

Service History

November 2005:

Service frequency 15 minutes Monday to Sunday

Service span – M-F 0545 until 2315

Sat 0630 until 2315

Sun 0700 until 2115

Some trips commenced or continued to Massey University in Albany.

All other trips Albany Station to Britomart.

February 2006:

10 minute frequency introduced Monday to Friday only 0700 to 0800 ex Albany and 1700 to 1800 ex Britomart.

February 2007

7.5 minute frequency Monday to Friday between 0700 and 0830 ex Albany

10 minute frequency 0830 to 0900 ex Albany.

7.5 minute frequency Monday to Friday between 1700 and 1800 ex Britomart

10 minute frequency 1800 to 1830 ex Britomart.

Evening frequency reduced to 30 minutes.

Weekend frequency reduced from 10 to 15 minutes.

April 2007

Two additional trips ex Albany to provide 10 minute frequency between 0630 and 0700.

February 2008

Opening of the busway resulted in a significant increase in services levels across the North Shore.

Peak frequency on the Northern Express was increased to 5 minute frequencies at peak times (0700 to 0900 inbound and 1600 to 1830 outbound).

At this time the trips to Massey University were curtailed (this link was provided by local services).

October 2008.

By this stage peak NEX services were regularly 'crowded'.

Peak frequency increased to 4 minutes 0710 to 0755 ex Albany and 1700 to 1740 ex Britomart.

January 2009

Off board ticketing function introduced at Albany between 0700 and 0830 and at Britomart 1630 to 1800.

This service validates periodical passes only and provides boarding through both front and rear doors simultaneously. This speeds boarding and ensures that headway is maintained.

October 2009

Increased weekday evening frequency from 30 minutes to 15 minutes Monday to Friday 2000 to 2200.

May 2011

Substantial changes to Northern Express services as detailed below:

Monday to Friday:

- Service commences 5.30am ex Albany (currently 5.45am).
- Service commences 6.00am ex Britomart (currently 6.30am).
- Service frequency increase ex Albany to 5 minutes from 6.30am to 7.00am (currently 10 minutes).
- Service frequency increase ex Albany to 3 minutes 7.00am to 7.57am **School term only** (currently 4-5 minutes). During school terms frequency will operate at 5 minutes.
- Service frequency increase ex Albany to 5 minutes from 9.30am to 10.00am **School term only** (currently10 minutes).
- Service frequency increase ex Britomart to 5 minutes 3.00pm to 4.00pm (currently 10 minutes).
- Service span increase Monday to Thursday - last service 12.00am ex Britomart. Service will operate every 15 minutes to 12 midnight.

Friday and Saturday evenings:

- Increase in service span – last service 3.00 is ex Britomart.
- Friday night – 15 minute frequency until 12.00am midnight ex Britomart then every 30 minutes until 3.00am.
- Saturday night – 30 minute frequency until 3.00am ex Britomart (currently ends 11.00pm).

At various times, additional non timetabled services operated at peak times. Provision was dependent on availability.