Benefits and delivery risks for bus infrastructure schemes
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An important note for the reader

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Contents

Executive summary

Introduction

This research assesses the benefits and risks of bus infrastructure in New Zealand. It considers three specific types of infrastructure: bus stops, interchanges, and priority measures. The goal of the research is to provide a succinct appraisal framework to guide the development and implementation of bus infrastructure. At a policy level, we anticipate this appraisal framework can be used to feed into future iterations of the *Economic evaluation manual* (EEM) and *Guidelines for public transport infrastructure and facilities* (GPTIF), and used alongside the business case approach of the NZ Transport Agency (the Transport Agency), adapted from the Treasury's better business case guidelines (BBCG). In terms of practical outcomes, the research is anticipated to both encourage and inform appropriate investment in bus infrastructure.

In New Zealand, the planning, design and delivery of bus services and infrastructure involves the three tiers of government organisations, specifically 1) the Transport Agency, which is responsible for national transport planning and allocation of national transport funds (also responsible for state highways); 2) regional councils, which are generally responsible for coordinating the planning and management of the public transport network and services across an urban area(s); and 3) local councils – which are responsible for managing local roads, including bus infrastructure, within the road corridor.

In addition to these government organisations, there is a large number of stakeholders and affected parties involved in the planning, design and delivery of bus services and infrastructure. Stakeholders range from bus operators, who are contracted by regional councils to provide services, through to public transport users themselves, as well as households and businesses who might be impacted by bus infrastructure (eg property owners). Different stakeholders have unique perspectives and interests that need to be taken into account when considering individual bus infrastructure projects.

Regulatory processes

As a part of this project, we reviewed existing regulatory processes pertaining to the delivery of bus infrastructure. Our review has led us to conclude there is room to improve the legislative and policy processes pertaining to bus infrastructure.

More specifically, there are opportunities to integrate the Resource Management Act 1991 (RMA) planning process, as embodied in regional policy statements (RPS) and district plans, with public transport planning processes, as embodied in the regional public transport plan (RPTP). Many RPS and district plans, for example, are silent on precisely how they will enable/support the development of public transport infrastructure and services. One potential improvement would be to include in district plans more permissive zoning overlays that reduce the resource consent requirements for developing bus infrastructure in locations the RPTP identifies as being of strategic importance to the public transport network.

Another potential regulatory improvement would be to streamline public consultation processes around the establishment of shelters at bus stops. The Local Government Act 2002 (LGA) and the RMA currently specify separate public consultation processes for the establishment of transport shelters at bus stops. We recommend the Transport Agency work with other central government departments to progress legislative amendments to the LGA to remove reference to public consultation for the establishment of transport shelters.

Literature review

An extensive literature review found there are two general appraisal methods in use for assessing the impacts of public transport infrastructure projects:

1 *A primarily economic-focused approach*, based on social cost-benefit analysis (SCBA), which monetises the economic benefits and costs of proposed investments, and/or

2 *A multi-faceted approach*, based on multi-criteria analysis (MCA) which usually involves scoring of performance against multiple criteria and then calculating a weighted total performance score.

The SCBA framework appears most useful in situations where the main scheme impacts can be expressed in monetary/economic terms and when comparing broadly similar options. In contrast, the MCA framework appears to be more useful in situations where investment has multiple objectives, and where the distributional impacts (on different parties) of bus infrastructure are of relevance. In such situations it may be difficult to express impacts in monetary/economic terms. The combined and complementary application of both SCBA and MCA approaches is likely to provide the most complete framework for understanding the full range, extent and incidence of bus infrastructure impacts.

Our review noted limited research into the distributional impacts of bus infrastructure schemes; we recommend the Transport Agency undertake further research in this area.

A literature review of publications focused on risk found that bus infrastructure projects are often subject to a number of unique risks not often associated with investment in other types of transport infrastructure. These risks tend to vary spatially, eg a project in a city centre environment vs a provincial centre, and temporally, eg negative impacts during construction give way to positive benefits being realised. Some risks, eg public perception of the need for the project, may also potentially diminish as their cumulative, integrated network-wide benefits become more apparent to stakeholders.

Identifying ‘typical’ risks for different sized bus-based public transport projects earlier in the project lifecycle, and developing simple methods for addressing these risks present will help avoid known pitfalls of bus infrastructure schemes and ultimately allow such projects to be delivered more efficiently.

Proposed appraisal framework

Based on our literature review, we propose a new appraisal framework to be used by decision makers when considering bus infrastructure projects. The proposed appraisal framework incorporates five key types of information:

1 *Key factor data.* This section includes the basic data that should be included in any analysis. Key variables include number of passengers using the facility, total patronage at facility and private vehicle use. These key attributes will enable a high-level impact assessment for any proposed project.

2 *Economic and financial impacts.* This section focuses on quantifiable data with regards to travel time savings, transfer time savings, accessibility, benefits to new and existing users, and benefits to road users. This data can be quantified using the provided worksheet.

3 *Social and environment impacts.* As these are often difficult to quantify, we suggest using a qualitative scale (ranging from – to ++) to assess impacts. The indicators used in this category include access to services, simplicity of the network, safety and security, emissions and townscape/landscape.

4 *Other local area impacts.* As local area impacts are also qualitative in nature, we recommend they are assessed on a – to ++ scale. These indicators include the amenity impacts on neighbours, local land use impacts, impacts on property access or car parking and the impacts of the project on the local retail sector. Local area impacts feed directly into ‘process and implementation risks’.

5 *Process and implementation risks.* We recommend a qualitative risk assessment is undertaken that outlines the expected risks and analyses the potential impacts these risks will have. Potential risks can

be categorised into specific areas, including organisational/political risk, stakeholder/public risk, business case risk, planning/consenting risk, implementation risk and operational risk.

Not all of the above indicators will be applicable to all bus infrastructure projects.

At the core of the framework is an 'appraisal summary table' (AST), which summarises the relevant benefits of bus infrastructure schemes and risks to project delivery. The proposed AST includes procedures for assessing economic and financial impacts. These procedures cover a larger range of impacts than the existing EEM's 'simplified procedures'.

Our proposed appraisal framework was applied to several case study projects identified by the Project Steering Group (PSG); this included two bus priority projects and three bus stop/interchange projects. The case studies enabled us to 1) assess and refine the proposed appraisal method; 2) highlight situations in which benefits/risks might arise; and 3) expose difficulties in data collection or quantification.

We found most of New Zealand's current policies governing investment in bus infrastructure focus largely on ex-ante (before) *appraisal*, rather than ex-post (after) *evaluation*. We recommend the Transport Agency and approved organisations 1) record a wider range of data to ascertain whether the goals of the project are met and 2) apply thorough and consistent ex-post evaluation processes, such as AST developed in this research.

The Transport Agency and approved organisations could partner to apply and refine the appraisal framework developed in this research. This would provide insight into its relative merits for a wider range of bus infrastructure projects. In terms of wider applications, the opportunity exists for the CBA elements of the appraisal framework to inform, and potentially be informed by, future iterations of the EEM.

Conclusions and recommendations

Our primary conclusions and recommendations are summarised below:

- **Regulatory processes.** The opportunity exists to further integrate and streamline regulatory processes pertaining to the delivery of bus infrastructure. In particular, we recommend RPS and district plans are amended to include permissive zoning overlays for the development of bus infrastructure in those locations the RPTP identifies as being of strategic importance. We also recommend LGA procedures relating to public consultation on the establishment of transport shelters be removed, with such consultation instead governed solely by RMA processes.
- **Literature review.** The combined and complementary application of both SCBA and MCA approaches is likely to provide the most complete framework for understanding the full range, extent and incidence of bus infrastructure impacts. We recommend the Transport Agency undertake further research in the issue of distributional impacts of bus infrastructure schemes.
- **Proposed appraisal framework**:
    - Application of the proposed appraisal framework to case studies demonstrated it was 'fit-for-purpose' insofar as it summarises the benefits of bus infrastructure schemes and risks to project delivery.
    - We recommend the proposed appraisal framework be adopted and applied to future bus infrastructure schemes, subject to further testing/trialling by the Transport Agency and approved organisations, either for individual schemes or groups of schemes.
    - We recommend appropriate aspects of the appraisal framework, methodology and associated guidance be incorporated in future revisions to EEM and/or (as most appropriate) the development of GPTIF.
    - We recommend the framework is considered for use in ex-post evaluation of the impacts of larger schemes. Such evaluations help validate assumptions and modelling methods.

Abstract

This research evaluates existing policy and planning practices, both in New Zealand and overseas, and identifies a framework for appraising and evaluating the benefits and costs of bus-based infrastructure (bus stops and shelters, bus interchanges and bus priority) and the risks to successful project delivery. It suggests a combination of multi-criteria analysis and cost-benefit analysis can provide local authorities with useful tools for assessing proposed projects. At the heart of this appraisal method is the appraisal summary table (AST), which gives a summarised overview of the expected benefits, costs and risks relating to a project. The AST provides procedures suitable for both ex-ante and ex-post evaluation, and integrates risk management considerations into project appraisal from the outset. The proposed framework would usefully inform future revisions of the *Economic evaluation manual* and *Guidelines for public transport infrastructure and facilities*. Sustained application and refinement of the framework should ensure more systematic recording of the quantitative and qualitative benefits and risks of public transport infrastructure projects.

1 Introduction

1.1 Project objectives and scope

This report provides information on the benefits of investing in bus infrastructure schemes and the risks to project delivery. More specifically, the scope of the research project included:

1. Develop a framework for identifying and assessing the benefits of bus infrastructure schemes and assessing the risks to successful project delivery.
2. Apply the framework to five case studies to test the proposed assessment framework and highlight some of the benefits and risks of bus infrastructure schemes.
3. Provide information on the benefits and risks of bus infrastructure schemes to inform:
   a. revisions by the NZ Transport Agency (the Transport Agency) of the *Economic evaluation manual* (EEM), and
   b. development of a new national *Guidelines for public transport infrastructure and facilities* (GPTIF).
4. Provide information to assist regional and local authorities successfully implement bus infrastructure schemes in New Zealand.

We note the research did not consider specific policy or design requirements, eg type/spacing of bus stops. In other words, we focused on the benefits/risks of bus infrastructure schemes that flowed from earlier policy/design decisions on, for example, network and infrastructure design. We did, however, discuss the ways in which policy/design decisions impacted on benefits and risks for the case studies we considered.

1.2 Types of bus infrastructure covered

The types of bus infrastructure schemes covered by this study are set out in table 1.1.

Table 1.1 Types of bus infrastructure covered by this study

Type of scheme	Corridor
Bus stops and shelters	These are the main means of access to public transport services, and can range from basic stops with just a sign through to ‘premium’ stops with shelter and other amenities.
Bus interchanges (including multi-modal)	Bus interchanges, are essentially ‘super’ stops where multiple public transport services (and other modes) come together to enable transfers between services (and modes). The type and scale of bus interchanges can vary from intermediate or premium stops[1] catering for multiple public transport services to large multi-modal interchanges.
Bus priority measures	There are a large variety of different bus priority measures[2]. The impact and types of benefits of the various bus priority measures generally does not vary significantly, with the primary benefits being faster travel times for public transport users. This often comes at the expense of parking and travel times for other road users.

We note there is some overlap between bus stops/shelters and interchanges, insofar as some ‘bus interchanges’ are formed through a series of on-street bus stops. In this case, we suggest the stops are considered as a ‘package of infrastructure’, rather than assessed separately.

[1] Bus interchanges will generally at least provide a minimum level of shelter, for people waiting between services, which might also be provided at an intermediate or premium bus stop.

[2] While we focus on bus lanes, the purpose of almost all priority measures is to reduce journey times for public transport users and therefore the range of benefits considered is largely the same, irrespective of the type of scheme.

1.3 Network and scale considerations

What is the role of infrastructure in a wider public transport system? On a simple level, public transport infrastructure simply 'enables' and 'supports' services. For this reason, we suggest discussions on bus infrastructure always need to be grounded in an appreciation of its ability, or otherwise, to support effective and efficient public transport services and, more specifically, the passengers they carry.

A bus lane along a busy arterial road, for example, would have little benefit without a corresponding bus service. Furthermore, to be economically beneficial, the bus service would need to provide sufficient benefits to public transport users to offset disbenefits of that road space not being available for other uses, whether that be for pedestrians, parking, or general traffic movement.

In carrying out this study the focus was on the needs of smaller to medium-sized infrastructure schemes where full procedures under the Transport Agency's EEM may not be appropriate or necessary. This approach was adopted for the following reasons:

- These are the most common bus infrastructure projects in New Zealand, but are not explicitly covered in the EEM and in many instances no formal evaluation is undertaken due to the sheer number and relatively small scale of these projects.
- There is little guidance on appropriate proportionality of analysis for bus infrastructure schemes, which are generally part of a wider network investment. As a result, individual bus infrastructure decisions are often made on an ad-hoc, project-by-project and/or stop-by-stop basis, rather than as a package of service and infrastructure changes.
- Larger schemes require a detailed economic appraisal, including a detailed demand assessment, the requirements for which are already covered by the EEM and/or other literature.

It is important to recognise that while individual schemes may be relatively low cost, when considered as part of the wider network infrastructure investment, the potential benefits (and costs) can be substantial. For example, decisions around individual bus stops are relatively unimportant, but optimisation of all bus stops along a route can greatly improve effectiveness, while incurring significant costs.

Hence where possible in this report we emphasise the need for an integrated planning approach, whereby individual infrastructure projects are always considered in the light of wider strategic considerations.

1.4 Report structure

The rest of this report is structured as follows:

- Chapter 2 discusses bus infrastructure in New Zealand.
- Chapter 3 presents the results of our local and international literature review.
- Chapter 4 outlines our proposed framework for the assessment of benefits and risks.
- Chapter 5 applies our proposed framework to a selection of relevant case studies.
- Chapter 6 summarises considerations in applying the proposed framework.
- Chapter 7 presents our conclusions and recommendations.

To finish, we provide a bibliography and detailed appendices.

A public transport infrastructure pro-forma spreadsheet to accompany appendix F is provided separately at www.nzta.govt.nz/resources/research/reports/561.

2 Bus infrastructure planning in New Zealand

2.1 Introduction

This chapter provides an overview of bus infrastructure planning in New Zealand, including current roles and responsibilities, regulatory requirements and project life-cycle considerations. The role of regional public transport plans and bus infrastructure guidelines, including national guidelines (currently under development by the Transport Agency) are also covered. We make recommendations on potential changes to current practices where necessary.

2.2 Roles and responsibilities

The following sub-sections discuss the 1) role of government organisations; 2) stakeholders and affected parties; and 3) decision-making requirements.

2.2.1 Role of government organisations

In New Zealand, we observe three tiers of government organisation involved in the planning, design and delivery of public transport services and infrastructure (the role of other groups, including public transport operators, is discussed in the section on stakeholders and affected parties). The general roles and responsibilities of these government organisations can be summarised as follows[3]:

- The Transport Agency is responsible for national transport planning and allocation of national transport funds (also responsible for state highways)
- Regional councils are generally responsible for coordinating the planning and management of the public transport network and services across an urban area(s).
- Local councils are responsible for managing local roads, including bus infrastructure, within the road corridor

The Transport Agency funds approximately half the cost of bus infrastructure, with regional and local councils required to prepare regional land transport plans and apply for funding their transport activities. The EEM sets out the Transport Agency requirements for project assessment (refer chapter 3).

Regional councils are responsible for planning the public transport network and procuring services. To do this they must first prepare a regional public transport plan (RPTP) setting out how public transport will be delivered in their region. Regional councils are expected to have to work closely with local authorities and the Transport Agency to ensure the provision of bus infrastructure, which is generally located within the road corridor. Regional councils can provide bus infrastructure themselves where they own the land or where agreed to by the local council[4].

As noted, local councils are generally responsible for the bus infrastructure and must work closely with regional councils to ensure the necessary infrastructure is provided for public transport services. This is particularly important for bus stops and shelters, where local councils are required by legislation to follow

[3] Local and regional council responsibilities are combined in Auckland and a number of other 'unitary' authorities, eg Gisborne. In Auckland's case, Auckland Transport is a separate organisation responsible for transport in the region.

[4] Local councils can assign some responsibilities to regional councils. For example, Wellington Regional Council now manages the renewal and maintenance of most bus shelters across most of the region, except Wellington city.

a particular process that includes consultation with neighbours and take account of traffic regulations etc. This is discussed further in section 2.3 on regulatory requirements.

In several areas of New Zealand there is a move towards local government amalgamation, which involves merging regional and local council responsibilities. This has already taken place in Auckland and provides an opportunity to more closely integrate the planning and delivery of public transport services and infrastructure. It may also provide wider benefits from integrating public transport infrastructure and service delivery with land use and parking policies.

2.2.2 Stakeholders and affected parties

There are a large number of stakeholders and affected parties involved in the planning, design and delivery of public transport services and infrastructure in New Zealand. Stakeholders range from private operators who are contracted by regional councils to provide and/or manage public transport services to individuals who use public transport services, or property owners and tenants who might be impacted by the development of public transport infrastructure, eg through the loss of on-street car-parking.

When assessing the benefits and risks of investing in public transport infrastructure, it is useful to first consider different stakeholders and how they are affected. Table 2.1 identifies a number of stakeholder groups and affected parties and provides examples of likely concerns and impacts. The areas of concern/impact are particularly important when assessing project risks.

Table 2.1 Stakeholders and affected parties impacted by bus infrastructure

Stakeholder group	Examples of concerns/impacts
Existing passengers	• Access to services • Amenities provided
Potential passengers	• Access to services • Amenities provided • Impact on current travel mode
Other road users	• Travel time • Operating costs • Road safety
Residential land owners/tenants	• Access to properties • Impact on local amenity
Commercial land owners/tenants	• Impact on access • Impact on parking • Impact on local amenity • Impact on retail spend • Impact on property values
Wider community	• Amenity • Value for money
Bus operators	• Operating costs/driver hours • Speed and ease of access • Perception of service
Local government	• Community objectives • Value for money
Central government	• Value for money

We suggest there may be value in the Transport Agency and approved organisations collaborating on further research into specific concerns/impacts raised by different stakeholders.

2.2.3 Integrated decision-making

This research project considered the benefits and risks of investment in public transport infrastructure, much of which is contingent on an integrated decision-making process.

The risk of fragmented decision-making has recently reduced, with RPTPs now required to address the link between public transport services and infrastructure. Nevertheless there is still room for greater clarity and improved links between government organisations involved in the various parts of the public transport system. The need for a continued focus on integration arises largely due to the split between regional and local council responsibilities (and priorities).

In particular, we note the ongoing tendency for local councils to advocate for better public transport services, while actively pursuing parking policies – such as minimum parking requirements and free public parking – that actively undermine public transport uptake. Urban settings characterised by abundant, cheap parking are unlikely to support effective or efficient public transport. In this situation, regional councils are somewhat justified in pushing back on proposals for service improvements, which are likely to require large operating subsidies and drag down overall cost recovery.

We note that in some locales, the move towards local government amalgamation, which involves merging regional and local council responsibilities should assist in this regard. This has already occurred in Auckland and provides an opportunity to more closely link planning and delivery of public transport services with not only the bus infrastructure that is required for efficient operation of these services, but also parking policies that are likely to support public transport's effectiveness.

In summary, we suggest a need for integrated public transport decision-making in two key dimensions: 1) integration between public transport services and infrastructure and 2) integration between the provision of public transport and supportive land use and parking settings. While we are heartened by recent progress across both these dimensions, we are of the option that further improvements are possible.

2.3 Regulatory requirements and processes

The regulatory requirements applying to bus infrastructure are the same for most regional and local councils in New Zealand, although the application of mechanisms varies (eg different district plan requirements and traffic bylaws).

Table 2.2 provides a summary of the legislative requirements for bus infrastructure schemes and the relevance of each requirement to 1) bus stops and shelters; 2) bus interchanges; and 3) bus priority measures. Two aspects, specifically regional public transport plans and bus infrastructure guidelines, are discussed in further detail below.

As a result of our review, we suggest the opportunity exists to improve current regulatory requirements and processes in two key ways.

First, our review identified the opportunity to align Resource Management Act 1991 (RMA) and Land Transport Management Act 2003 (LTMA) planning processes as they relate to public transport infrastructure and services. Many regional policy statements (RPS) and district plans provide little detail on precisely how they enable/support the provision of public transport services and infrastructure. For this reason, we recommend the Transport Agency and the Ministry for the Environment (MfE) collaborate on guidance for regional and local authorities on how to improve alignment between the RPS, district plans and the RPTP. One potential innovation would be to include relatively permissive public transport zoning overlays for the development of bus infrastructure schemes in certain locations and corridors, particularly major interchanges and priority measures. These locations could be identified by the RPTP as being of strategic importance and subsequently reflected in the RPS and district plans.

Second, we see the opportunity to greatly streamline public consultation processes applying to the installation of bus shelters. Currently these shelters are subject to specific consultative procedures under the Local Government Act 2002 (LGA), while also being subject to the general requirements of the RMA. The relatively ambiguous and onerous nature of LGA procedures introduces large inefficiencies into the process for installing bus shelters, which imposes direct costs on councils and delays, or even stymies, improvements to the public transport system. We consider the RMA provides adequately for public consultation on such issues and recommend the Transport Agency and the Ministry of Transport (MoT) progress an amendment to the LGA deleting section 339.

Table 2.2 Summary of New Zealand legislation applicable to bus infrastructure projects (or schemes)

Legislations	Legislative instruments	Type of infrastructure[(a)]			Comments
		S	I	P	
Land Transport Act 1998	Traffic bylaws	√	√x	√	Traffic bylaws (or rules) are set by road controlling authorities (ie local councils) to manage the transport network. In most cases these bylaws require specific approval for bus stops and priority measures, although this can be delegated to council officers. Bus interchanges would generally only be affected by traffic bylaws to the extent to which they are located within the road corridor. Bus infrastructure guidelines are used to help meet the legislative requirements (refer section 2.3.2)
Local Government Act 2002 (LGA)	Section 339 (bus shelters)	√	X	X	The erection of bus shelters within the road corridor triggers section 339 which imposes additional consultation obligations on the road controlling authority (local council). This requirement does not apply to bus interchanges (unless within the road corridor) or to bus priority measures. Bus infrastructure guidelines are used to help meet the legislative requirements (refer section 2.3.2)
Resource Management Act 1991 (RMA)	Regional policy statement (RPS)	√	√	√	The RPS covers regionally significant issues around the management of natural and physical resources, and can include objectives for public transport that support bus infrastructure, particularly bus interchanges and bus priority measures.
	District plan	√x	√	√	The district plan governs the types of activities that can be undertaken in different parts of a city or district. Bus infrastructure, particularly interchanges can trigger the need for resource consent depending on district plan rules. Bus stops and shelters can also trigger the need for a resource consent, although usually only in limited situations. For example, in Auckland consent is only required where the bus stop affects heritage sites and/or scheduled trees.
Land Transport Management Act 2003 (LTMA)	Regional public transport plans (RPTP)	√	√	√	The RPTP is relevant to all public transport infrastructure and is discussed in section 2.3.1. The next generation of RPTPs is required to provide more detail on the infrastructure required to support bus services than previous generations.

Legislations	Legislative instruments	Type of infrastructure[a]			Comments
		S	I	P	
	Regional land transport plans	√	√	√	These set out the funding available for transport activities in the region, and must also identify any significant projects. In most cases funding for bus infrastructure is included as part of the wider funding programme rather than individually identified (eg bus stops and shelters programme, bus priority programme).

Key: S=Bus stops and shelters, I=Bus interchanges, P=Bus priority measures, √=Yes, x=No, √x=Sometimes

Further details on some of the more relevant planning requirements are discussed in the following sub-sections.

2.3.1 Regional public transport plans

Regional councils are required by legislation to prepare RPTPs which set out objectives and policies for public transport and describe the services that are intended to be provided in the region. Recent changes to the LTMA require regional and local councils to work in 'partnership and collaboration' to deliver public transport services and infrastructure (refer LTMA ss115 and 117) [5].

The Transport Agency has also prepared guidelines for regional councils to follow when preparing RPTPs. The guidelines specifically address the need to align services and infrastructure planning, stating that (NZ Transport Agency 2013a, section 7.4):

> *… In their role, [local councils] need to manage a number of issues including:*
>
> - *competing demand for access to the infrastructure (cars as well as PT services)*
> - *ownership, control, management and maintenance*
> - *resource and building consents*
> - *road design and implementation of traffic management measures*
> - *provision of land and access ways to bus stops*
> - *their investment and investment priority in the regional land transport programme (NB: Now "regional land transport plan")*
> - *consultation requirements which may result in supporting or conflicting with regional council's objectives*
>
> *… The Transport Agency recommends the RPTP should:*
>
> - *identify high level principles for infrastructure requirements, particularly bus stops and transfer points*
> - *set out the basis (eg roles and responsibilities) for collaborative working with territorial authorities to ensure timely provision of infrastructure*
> - *include a clear description or map of significant assets/activities. This should include any physical asset owned by the regional council such as interchanges, exchanges or station infrastructure, metro rail rolling stock and a clear statement of what public transport support such as real time information and call centres is provided*
> - *include information or cross references to other documents (eg territorial authority asset management or long term plans) about the provision and maintenance of*

[5] There have been significant changes to the legislation governing RPTPs, but consideration of this was outside the scope of this study.

> *infrastructure as appropriate, including any staging of the provision of infrastructure needed for the development of services. This should address any shared responsibilities (financial and non-financial) between the regional council and the [local council].*

Public transport plans are prepared by regional councils and cannot bind other parties, such as local councils, but can require specific information to be provided by territorial authorities for planning purposes. This is a particularly important consideration for bus infrastructure because, as set out above, it is primarily the responsibility of local councils[6].

2.3.2 Local and national bus infrastructure guidelines

While there is no regulatory requirement for bus infrastructure guidelines, over the last decade many local councils in New Zealand have developed bus infrastructure policy and design guidelines to assist in meeting the regulatory requirements. Examples include Auckland Regional Transport Authority (2009); Auckland Transport (2013b); Manukau City Council (2004); for example: Palmerston North City Council (2008); Queenstown Lakes District Council (2008); Tauranga City Council (2010)[7].

The existing guidelines have tended to focus on how bus infrastructure can be designed in a way that is attractive to potential users, with some limited consideration of operational efficiency. They generally cover bus stop spacing, types of bus stops, shelters and amenities, maintenance requirements. The more comprehensive guidelines also consider how bus infrastructure can be designed to complement land use, networks and urban design.

The identification of benefits and requirements for the assessment of bus infrastructure schemes is one area that is not well covered by guidelines. Most guidelines include processes and procedures for implementing bus stop/shelters, with two examples given in appendix A, but few identify the range of benefits of bus infrastructure, let alone how it is to be assessed. This is likely because regional councils are responsible for the planning and design of the public transport network, with local councils then required to follow certain regulatory and policy processes to fund and implement bus stops and shelters.

We have identified evidence that local councils have shared (or copied) guidelines from each other with some very clear commonalities. This makes sense as the issues and regulatory requirements are largely the same throughout the country, a fact that has recently been picked up by the Transport Agency which is now developing national *Guidelines for public transport infrastructure and facilities* (GPTIF). We would make the following recommendations for the national guidelines:

- The guidelines should utilise and build on the existing bus infrastructure guidelines which have been developed by local councils across New Zealand over the last few years.
- The guidelines should make it clear that the purpose of infrastructure is to enable and support public transport services. Infrastructure does this in three key ways, specifically 1) improving the value existing passengers attached to the service; 2) attracting new passengers to use the services; and 3) improving the efficiency with which services are able to operate. The third point is particularly salient and requires that planners have an understanding of public transport services and operations.

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[6] This is not so much the case in Auckland where public transport and local roading responsibilities are now the responsibility of Auckland Transport, as a result of local government amalgamation. The issue remains though for any infrastructure within state highway corridors as this is managed by the Transport Agency.

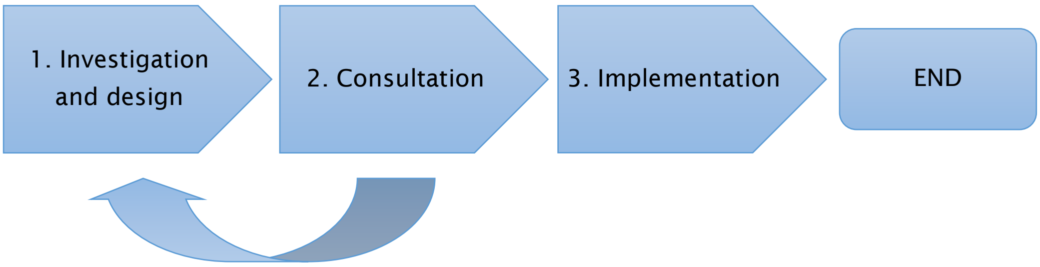
[7] These guidelines include interchange design guidelines recently developed by Auckland Transport and which appear to be the first guidelines specific to transport interchange design in New Zealand (Auckland Transport 2013b).

- The guidelines should identify how the benefits and risks of investment in bus infrastructure schemes can be identified and quantified. The guidelines should provide clear links to economic evaluation procedures in the EEM and Transport Agency business case requirements for various types of infrastructure.
- The guidelines should clearly identify how various stakeholders are likely to be affected by bus infrastructure schemes to ensure impacts are identified and addressed as early as possible.

2.4 Project life-cycle considerations

The planning, design and implementation of bus infrastructure schemes in New Zealand generally follows a typical project life cycle set out in figure 2.1. The figure identifies three stages in the project life cycle, with a feedback loop between stage 1 (investigation and design) and stage 2 (consultation). Current processes often involve multiple iterations between stages 1 and 2.

Figure 2.1 Typical bus infrastructure scheme project life cycle



While the process is relatively consistent across the various types of bus infrastructure scheme, the relevant legislation varies. Table 2.3 shows how, for each type of bus infrastructure, the main legislative requirements align with the stages of the project lifecycle. Considerations are as follows:

1. **Investigation and design** – This stage needs to consider the RPTP, as well as RPS and district plan requirements. The RPTP should identify the links between infrastructure and services and identify the main infrastructure requirements, basically the infrastructure needs to be shown to support the objective, policies and services described in the RPTP. The RPS and district plan must also be considered to identify any requirements that must be met, and can also be used to support the need for the bus infrastructure investment.
2. **Consultation** – The requirements of this stage will depend on whether there are any rules triggered by the RPS or district plan requiring resource consent (or plan change), in which case there may be specific consultation requirements. In the case of bus shelters, there are additional specific requirements for consultation with neighbours that must be followed. In all cases, affected parties and neighbours will generally be consulted in accordance with council policies.
3. **Implementation** – This stage is generally where the traffic bylaws come in and must be passed for most bus infrastructure (except bus interchanges outside the road reserve).

The following sections provide further detail on the requirements specific to the types of bus infrastructure scheme considered by this research project.

Table 2.3 Relevant legislation applying to stages of the general project process for types of bus infrastructure

<table>
<tr><th rowspan="2">Type of infrastructure</th><th colspan="3">Project stage and relevant legislation</th></tr>
<tr><th>1. Investigation and design</th><th>2. Consultation</th><th>3. Implementation</th></tr>
<tr><td>Bus stops and shelters</td><td rowspan="3">RPTP
RPS
District plan</td><td>District plan
LGA section 339</td><td>Traffic bylaws</td></tr>
<tr><td>Bus interchanges</td><td rowspan="2">District plan</td><td>District plan
Traffic bylaws</td></tr>
<tr><td>Bus priority measures</td><td>Traffic bylaws</td></tr>
</table>

2.4.1 Bus stops and shelters

The implementation procedures for bus stops and shelters follow a generally similar process throughout New Zealand. As discussed above, several councils have developed bus stop guidelines to assist with the process. These guidelines typically cover:

- **Renewals** – This involves replacing like with like, ie upgrading an existing bus shelter/seat with a new one in exactly the same location.
- **New stops** – These can range from simple road markings and a bus stop sign through to new shelters and footpaths/stairs/ramps etc.
- **Improvements** – These include any changes to existing bus stops including new road markings or remarking, hard stands, seating, new shelters and better accessibility such as stairs and ramps. This can also include bus stop relocations.
- **Removals** – This can relate to a whole bus stop or just a shelter.

The sheer number of bus stop related schemes suggests that more efficient policy processes would likely result in relatively large benefits. A case study example of the required process, using Auckland's bus stop and shelter capital works and renewals programme, is provided in appendix B.

We note a particular anomaly in regards to the establishment of bus shelters, with S.339 of the LGA setting out very prescriptive consultation requirements for individual bus shelters, as described in appendix A. We believe the strategic importance of good quality bus stop infrastructure calls into question the relevance of S.339. The original intent of the section appears to have been to ensure transport shelters would not block or impede access ways or create any safety issues. However, this is always considered at the investigation and design stage by technical experts. It therefore seems excessive to introduce an additional check into this process on top of normal RMA processes.

Furthermore, the timeframes identified in S.339 are difficult to comply with and the wording is ambiguous. This ambiguity means that people have an opportunity during a hearing to raise their own biases and perceptions around bus shelters as legitimate reasons for opposing their installation. For example it is common to hear that bus shelters will generate crime, encourage loitering, and/or result in litter and other anti-social behaviour. As far as we know there is in general little robust evidence to substantiate these concerns. Nonetheless the current process creates opportunities for disaffected members of the public to use these concerns as a means to delay the process of implementing small bus stop projects. S.339 of the LGA has not been amended since it was included in the 1979 amendment and we suggest, in light of the RMA, it is now outdated.

For this reason we recommend that S.339 'Transport shelters' be repealed and removed from the LGA on the grounds that it is no longer relevant. Alternatively it could be re-drafted to dictate the grounds on which objections can be raised. Terminology such as 'the owner of any land frontage of which is likely to be injuriously affected by the erection of the shelter' should be removed, because it presumes the installation of the shelter has negative impacts. Consideration should also be given to replacing the hearing process with a written process that is less time consuming and easier to organise.

2.4.2 Bus interchanges

Bus interchanges typically involve the development of facilities to accommodate buses and their passengers. This includes buses travelling through and/or terminating at the facility. Terminating buses often require additional facilities, such as driver restrooms, turn-around facilities and layover space.

Bus interchanges can range from a simple on-street facility with basic amenities to a large dedicated multi-modal interchange. The requirements around the former are largely the same as for bus stops and shelters, but there are additional requirements for larger interchange schemes. In most cases larger interchange schemes will not be located entirely within the road reserve and will likely trigger additional consenting requirements due to rules in the applicable planning documents (largely district plans).

Once land has been purchased for an interchange and the investigation, design and consultation stages have been completed, the road controlling authority (usually the local council) will typically designate the site for transport and issue a notice of requirement (NoR) to change the zoning to road reserve or special purpose. The normal traffic bylaws process will then apply to establishing and enforcing no parking, bus stops, time restrictions and speed limits.

Given that public transport relies on an integrated network of infrastructure and services, we would expect the objectives of the RPS to lend high-level support to the development of bus infrastructure. For example, the Proposed Auckland Unitary Plan (PAUP), (equivalent of a district plan elsewhere in New Zealand) makes specific mention of the importance of new and improved public transport infrastructure that aligns with and supports urban growth objectives, such as higher-density mixed-use development around specified nodes and corridors. Such 'up zoning' is arguably the area where district plans can most clearly align with the future development of public transport interchanges.

However, public transport interchanges are distinct from the other types of infrastructure considered in this study, namely bus priority measures and stops. The latter are often (but not always) added as upgrades to the existing road infrastructure within the existing road corridor. In most cases this will be on land already designated as road reserve, which is controlled and managed by local authorities. In some rare cases third party land needs to be acquired – usually under the Public Works Act. In contrast, bus interchanges often require land outside of the road reserve. As such the applicable district plan zoning and associated controls may or may not trigger a need for resource consents under the RMA.

The key issue here is whether or not district plans put in place sufficiently permissive policies to support the development of bus interchanges and thereby 'give effect to' what – in our experience – are higher-level objectives and policies that support the development of public transport interchanges. For example, when one digs deeper into the mechanisms of the PAUP, we find some areas of ambiguity. This ambiguity means bus interchanges may trigger a need for resource consents through a range of potentially unintended factors.

The next generation of district plans and RPTPs provides an opportunity for regional and local councils in New Zealand to improve the efficiency of the processes that apply to bus interchanges. Part 5 of the LTMA also sets out matters that regional councils must take into account when preparing a RPTP. Typically, the next generation of RPTPs will identify the location of key interchanges, which tend to emerge logically from the underlying urban form and structure of the network.

We recommend regional and local councils work to ensure that public transport interchanges are identified in the RPTP and also subsequently reflected in relevant district plan provisions. This could be by way of applying a permissive zoning overlay to general locations where the need for an interchange has been identified. Such zoning overlays would be a way for regional and local councils to align district plan rules with the strategic need for interchanges that is identified in the RPS and particularly the RPTP.

2.4.3 Bus priority measures

With regards to bus priority measures, the land required is usually already zoned as road reserve. As such the implementation stage requires that the appropriate traffic bylaws are passed by council.

Bus priority measures established within the road reserve will be subject to standard consultation processes. Regional and/or local councils are required to undertake extensive engagement and consultation with those affected by changes to their property access and on-street parking. There will generally be wider public consultation prior to the implementation of such schemes, as they impact on all road users including the wider driving population.

We did not identify any major opportunities to improve the policy processes governing the implementation of bus priority measures.

3 Literature review

3.1 Introduction

As part of this project, we undertook an extensive review of New Zealand and international literature and practice on a range of topics relevant to bus stops, interchanges and priority measures. We focused on research that could inform and assist in the development of an appropriate assessment framework and methodology for assessing (ex-ante) potential improvements to bus infrastructure in New Zealand, and managing the risks to their successful implementation.

In overview, the scope of our review of appraisal and risk approaches was as follows:

- It covered the three types of infrastructure that are the focus of this project, ie bus stops and shelters, bus interchanges and bus priority measures.
- It was concerned principally with identification of types of benefits from such infrastructure, and methods for the quantification of these benefits. As part of this, we covered methods for assessing travel demand impacts, which form a key input to the quantification of benefits. We also sought out literature specific to retail impacts of bus infrastructure.
- Our primary focus was on appraisal (ex-ante) methods rather than evaluation (ex-post) methods of demand and benefit assessment. However, we were interested in ex-ante appraisal methods that lend themselves to ex-post evaluations.
- We recognise explicitly infrastructure does not provide any significant benefits in itself, but instead provides benefits by improving 1) conditions for existing bus users; 2) attracting additional users; and 3) improving the efficiency with which services can operate. In that regard, any assessment framework/methodology relating to infrastructure needs to consider the impacts of infrastructure on the attractiveness, effectiveness and efficiency of the underlying services, in the context of specific levels and patterns of travel demand and given certain operating costs.
- The review of risk literature concentrated on risk principles and processes applicable to infrastructure schemes. As such, we focused on the implementation of risk management rather than structure, governance or foundation. The review of risk literature involved two branches of enquiry: 1) treatment of risk within bus infrastructure guidelines; and 2) literature specific to the management of risk.

Our review involved 70+ publications, principally from New Zealand, Australia and the UK, with lesser numbers of studies from the USA, Canada, European Union countries and Japan. Approximately 50 of the publications reviewed were found to include some material of relevance to the project. Appendix D provides a summary of the most relevant literature items reviewed.

This chapter discusses the following:

- New Zealand assessment procedures and consideration of benefits – summarises coverage of relevant EEM procedures, to provide a 'base' against which alternative approaches/methods for assessing the project types of interest may be compared
- an international review of appraisal approaches, compared with New Zealand procedures
- literature relating to impacts of bus infrastructure on the retail sector
- risk management approaches.

3.2 New Zealand assessment procedures and consideration of benefits

Current New Zealand (ex-ante) appraisal procedures for public transport projects (and for roading and other transport project types) are covered in the EEM (NZ Transport Agency 2013b). These procedures are based on a cost-benefit analysis (CBA) framework within a wider multi-criteria (MCA) framework. The EEM focus is on comparing national economic benefits and costs to derive economic decision criteria of benefit-cost ratio (BCR) and net present value (NPV), among others.

The EEM procedures do not address the distributional aspects of any economic costs and benefits covered, ie effects on different parties, in different areas. Nor do they address non-economic benefits and costs, such as localised effects on retail trade. A previous research study (Wallis et al 2013) identified parameters that are potentially relevant to public transport initiatives. These parameters are set out in appendix D. The table in the appendix identifies which parameters are included in the EEM and which in other comparable economic evaluation procedures in Australia, the UK and the USA.

In relation to the economic parameters included in/excluded from the EEM, our summary findings are as follows:

- **Public transport user benefits**. The EEM covers all (with minor exceptions and caveats) the 'standard' parameters that would be expected, with monetised unit values provided.
- **Road traffic system aspects**. The EEM also covers all standard parameters on this aspect, with monetised unit values.
- **Environmental impacts**. The EEM covers parameters for all environmental aspects likely to be significantly affected by the types of infrastructure investment relevant to this project, with monetised unit values in some cases.
- **Transport demand management factors**. Under this heading, the EEM covers health benefits (which are potentially relevant to public transport initiatives) and impacts on car ownership (unlikely to be significant in the context of this project, but may be relevant for larger schemes).
- **Wider economic impacts**. The EEM covers agglomeration benefits but not some of the other aspects now covered in UK procedures. Nor does it cover option/non-use benefits or economic impacts relating to transport-induced land-use changes. However, it may be argued that the impacts excluded are likely to be secondary (or insignificant) to the types of initiatives considered in this project.

So, our conclusion is that the current EEM covers all economic benefit aspects that are likely to be material to the economic appraisal (on an aggregate national basis) of public transport initiatives of the types addressed in this project. The parameters for most of these aspects are monetised in the EEM.

We also note the EEM covers initiatives delivering operating savings, albeit by way of capital investment. Such operational savings are likely to be especially relevant when considering the effects of bus priority schemes and bus interchanges, but also bus stop schemes where the changes being proposed are sufficiently significant to impact on the efficiency of bus operations. We do not consider these costs in detail as they are relatively straightforward to quantify under existing EEM processes, but their importance is demonstrated in our case studies in chapter 5, specifically around the New Lynn interchange.

For the current research, it is also of relevance that the EEM does not attempt to address distributional (incidence) impacts, ie the separate effects of public transport initiatives on the different parties affected. Thus it is not concerned with any localised effects on retail trade, whereby particular traders may be disadvantaged by a public transport initiative, with others correspondingly benefiting (and total retail trade being essentially unaffected). Nor does the EEM address any flow-on effects of public transport (or other transport) initiatives. For example, while a public transport initiative may differentially affect land values in some areas over others, the EEM does not estimate these effects – as they are a manifestation of accessibility changes (already covered through assessment of travel time changes) rather than a separate/additional economic efficiency effect.

In summary, the EEM provides a relatively comprehensive coverage of ‘conventional’ transport economic benefits (and disbenefits) of potential public transport initiatives, suitable for national economic (ex-ante) appraisal; but it does not (and is not intended to) address distributional and flow-on impacts. Nor is the EEM intended to cover (ex-post) project evaluation procedures.

3.3 International review of appraisal approaches

As noted above, we reviewed over 50 relevant publications, covering approaches/methodologies for the (ex-ante) appraisal of public transport infrastructure initiatives in general and of the three types of bus infrastructure specific to this project (bus stops and shelters, bus interchanges and bus priority measures).

In general, the literature on approaches to the appraisal of public transport infrastructure schemes tends to focus on one of two broad approaches:

1 A primarily economic-focused approach, based on CBA

2 A multi-faceted approach, based on MCA, usually involving the scoring of performance against multiple criteria, followed by calculation of a weighted sum performance score.

The New Zealand appraisal approach has for the last 20 to 30 years focused primarily on the first approach (CBA), using the detailed procedures set out in the EEM. Through the inclusion of assessment criteria on strategic fit and effectiveness, and through recent adoption of the NZ Transport Agency Business Case Approach, New Zealand has moved some way towards the second approach, adopting more of a multi-criteria approach, while still retaining a CBA appraisal.

In most respects, the New Zealand procedures have been evolving along similar lines to the evolution of UK (DfT) procedures over recent years (DfT 2014). The DfT procedures now involve: 1) a ‘five case’ approach[8]; 2) an assessment of potential options against local and national policy objectives; 3) a social CBA; and 4) an environmental impact assessment. All impacts are then drawn together into an appraisal summary table (AST).

In the more specific context of ‘smaller’ public transport infrastructure schemes, attention should be given to the UK Jacobs Consulting report (2011). This was commissioned to develop improved economic appraisal procedures for ‘smaller’ public transport schemes in the following categories: bus quality corridors (including priority measures), bus interchanges/stations, bus service and vehicle quality enhancements, bus real-time information, and bus and rail park-and-ride. The simplified appraisal framework (SAF) developed in this study (comprising a methodology together with software) was designed to be consistent with existing UK economic appraisal procedures (WebTAG), but to also provide additional guidance (parameter values and relationships) on the estimation of demand impacts and their translation into benefit terms. The SAF is designed for (inter-alia) ex-ante appraisal of bus interchanges and bus priority measures. It would appear likely that the SAF software could be adapted, relatively easily, to be compatible with EEM procedures. The demand relationships could also be adjusted based on New Zealand evidence.

[8] The five-case approach is at the heart of the New Zealand Treasury better business cases framework, which in turn is the basis of the Transport Agency business case approach.

Some of the literature adopts a purely-MCA approach. A leading example of this is the paper by Bitzios et al (2009), which is concerned with the post-evaluation of Brisbane's South East Busway. The adoption of this approach was born out of earlier attempts to post-evaluate the impacts of the busway within a CBA framework; it was felt that this framework did not adequately reflect the impacts experienced by the range of different stakeholders, and hence an alternative (MCA) approach was examined. The evaluation criteria and associated indicators used in this approach were:

- **Transport attractiveness**: customer satisfaction with busway services
- **Public transport performance**: travel times with/without the busway; public transport patronage growth in catchment areas; peak period relative travel times of the busway vs car; peak period public transport travel times on the busway relative to other city corridors; accessibility by transport within the corridor.
- **Economic**: cost savings for operators; the economic value of peak period travel time savings; cost per person trip for busway infrastructure relative to south eastern freeway infrastructure.
- **Transport system**: impact of the busway on road congestion levels in the corridor; traffic crashes in the corridor; the number of peak period vehicle trips removed from the corridor road network.
- **Environment**: peak period CO2 emissions per person trip on the busway relative to comparable rates per private vehicle trip.

While this approach was developed and applied in a post-evaluation context, it would appear it could be adapted for ex-ante appraisal purposes.

3.4 Application of appraisal approaches

A recent research project (Wallis et al 2013) reviewed alternative approaches adopted internationally for the appraisal of transport (particularly public transport) projects and assessed the most appropriate approach for application to public transport projects in New Zealand. It concluded that:

> *A multi-criteria analysis framework is most appropriate for overall project appraisal of transport projects in New Zealand.*
>
> *Within this overall framework, social cost-benefit analysis, supported by cost-effectiveness analysis, is the most appropriate approach to economic appraisal.*

The 2013 research focused primarily on methods for the appraisal of public transport service-oriented schemes, particularly those of a smaller scale; whereas the current research was focused on infrastructure-oriented schemes. We reviewed the relevance of the Wallis et al report conclusions and concluded that they are similarly applicable to infrastructure-oriented projects. We would note here that:

- The MCA framework is particularly appropriate for projects with multiple objectives, and where the distributional impacts (on different parties) are of particular decision-making importance, and where it is not possible to express some of the more significant impacts in monetary/economic terms.
- The social cost-benefit analysis (SCBA or CBA) framework is most powerful for situations where the main scheme impacts can be expressed in monetary/economic terms and when comparing a range of options of a broadly similar type to address a specific problem.
- In many cases, the combined and complementary application of both approaches provides the most useful framework to understand the full range, extent and incidence of scheme impacts.

In the UK, Department for Transport appraisal procedures include the use of an AST to provide a summary of scheme impacts for transport (DfT 2014, p11):

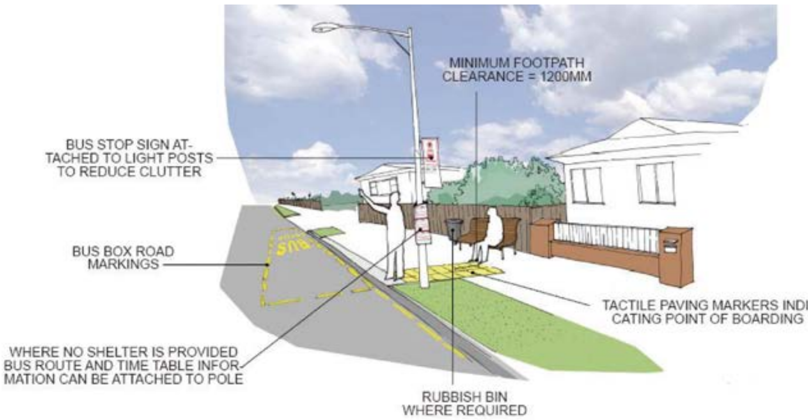
> *… transparency in the presentation of conclusions and recommendations to decision-makers and key stakeholders is as important as the analysis itself … the Appraisal Summary Table has been designed to enable intervention promoters to summarise the results of their analyses and communicate to decision-makers/assessors the key economic, environmental, social and distributional consequences of the proposed intervention. Hence, the AST is a key output of the transport appraisal process.*

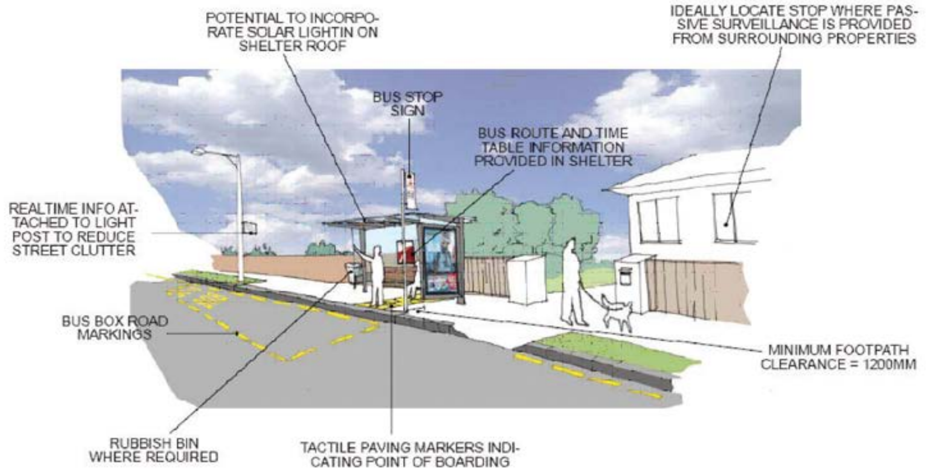
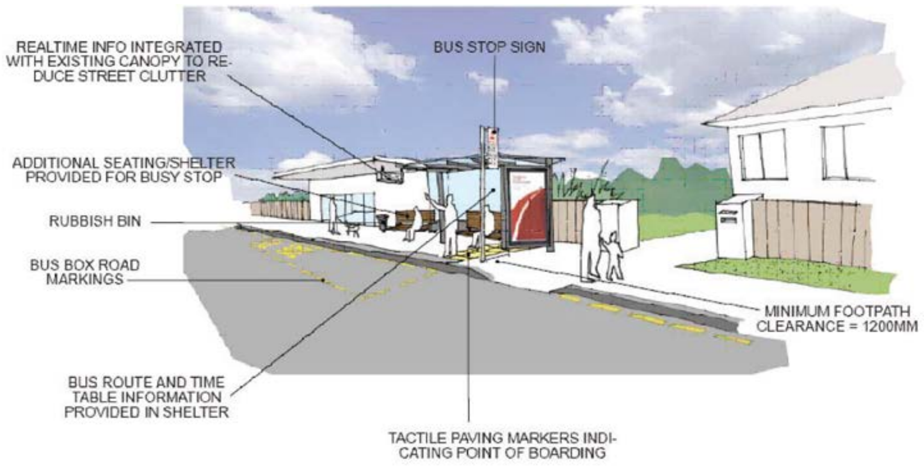
We consider this to be an approach that, with some modification, can be used to summarise the benefits and risks for bus infrastructure schemes in New Zealand. While this approach is not inconsistent with the Transport Agency's current CBA process, our approach adopts aspects specifically relevant to bus infrastructure. Our proposed approach is set out in the next chapter, while the application of these appraisal approaches for different types of bus infrastructure is considered in the following sub-sections.

3.4.1 Bus stops and shelters

There appears to be minimal literature specific to the appraisal of bus stop and shelter benefits. We believe this is because the provision of these facilities is largely determined by a set of standards, rather than each such facility being subject to individual appraisal. A common approach is to identify bus stop categories for which standards are then defined as illustrated in figure 3.1.

Figure 3.1 Bus stop and shelter categories (sourced from Auckland Regional Transport Authority 2009)

Regular stop	

<table>
<tr><td>Intermediate stop</td><td>
</td></tr>
<tr><td>Premium stop</td><td>
</td></tr>
</table>

It is probable that in most cases the standards themselves were originally set by a process that involved little or no economic input. We have however identified from the literature three components that would ideally be considered in an appraisal of bus stop and shelter facilities, these are: 1) stop spacing and location; 2) stop quality features; and 3) local area impacts. The impacts associated with these components are set out in table 3.1, which would ideally be considered in an economic appraisal of bus stop and shelters.

Table 3.1 Components of bus stops

Component	Impact	Comments
Stop spacing and location	Access (walking distance/catchment)	Covers access to and from bus stops and interchanges; referred to as accessibility in some guidelines
	Connectivity	Accessible walking routes to and from bus stops
	Operational impacts	Time taken to enter/exit bus stop and number of passengers boarding needs to be balanced against more stops providing better access
Stop quality features	Accessibility	Features related to the accessibility of bus stops for people with disabilities, rather than the access distance above
	Information	Provision of information at the bus stop

Component	Impact	Comments
	Safety and security	Includes safety features include lighting and visibility considerations
	Furniture and shelter	Seats, shelters etc provided at the stop
	Other enhancements	Generally for premium stops, includes drinking fountains, solar panels, recycling bins
	Arrangement type	Design of stop, eg indented bay
Local area impacts	Property access	The impact of the stop on access to nearby properties
	Amenity impacts on neighbours	Impact on neighbour amenities such as views and quality of environment
	Surrounding land use impacts	Consideration of the location of bus stops is important, whether a residential neighbourhood or main arterial road or city shopping street
	Commercial/retail impacts	The impact of the bus stop on nearby commercial/retail activities

3.4.2 Bus interchanges

The literature specific to bus interchanges (and multi-modal interchanges) is, like the generic literature noted above, balanced between the use of CBA approaches and MCA approaches. MCA approaches may be seen as particularly appropriate for such initiatives, given that they involve a wide range of impacts on a considerable number of affected groups (eg regular/occasional public transport passengers, public transport operators, local retail investors and traders, facility funders and managers).

For example, Transport for NSW (TfNSW) economic appraisal guidelines (TfNSW 2012) adopt an MCA approach for (ex-ante) appraisal of interchange projects, commenting that 'the qualitative scoring has been adopted because of variability of the projects and because the market is yet to provide a satisfactory measure of economic value specific for bus-rail interchanges'. The TfNSW appraisal framework involves six 'transportation' factors (accessibility, safety impacts, wider economic impacts, sustainable level of service, environment and integration) and four 'planning' factors (economy, funding options, land use policy, project readiness/deliverability). Under each factor, a set of sub-factors and scores is given. Of the overall maximum score, 70% and 30% is allocated to transportation and planning factors respectively.

Rather similar to TfNSW, Transport for London (TfL) also adopts an MCA approach (TfL 2009), but notes that this is designed to complement, rather than replace, the standard UK NATA/WebTAG appraisal methodology. The MCA criteria are set out under four themes as follows:

- efficiency: operations movement (within facility), movement (wider interchange zone), sustainability
- usability: accessibility, safety/accident prevention, personal security, protected environment
- understanding: legibility, permeability, way-finding, service information
- quality: perception, built design quality, urban realm sense of place.

Auckland Transport (2013b) also identifies a range of attributes, which can be equated to the TfL themes as follows:

- efficiency: operations
- usability: accessibility, security, visibility, shelter
- understanding: visibility, service information
- quality: facilities.

The frameworks above are used both in the planning/design stage of new or improved interchange facilities and for assessing the quality of an existing facility. The MCA evaluation is based on a simple 'traffic light' scoring system: each criterion is scored as green (all aspects have been addressed), amber (some have been addressed) or red (few if any have been addressed).

3.4.3 Bus priority measures

The specific literature on bus priority measures largely follows along similar lines to the generic literature summarised above. For bus priority measures, most of the appraisal literature focuses on the use of CBA methodologies, with the main benefit categories being: base public transport user impacts (travel time and reliability); mode switcher benefits; impacts on road users and road system (travel times, vehicle operating costs, crashes, local/global environmental effects); public transport fare revenue changes; and public transport operating cost changes.

There is also an impact on parking and commercial/retail. A number of software packages (generally Microsoft Excel-based) are available to assist in the appraisal process for a range of bus priority measures (eg refer Public Transport Authority of Western Australia 2011). Few examples were identified of the application of MCA frameworks for the (ex-ante) appraisal of bus priority measures.

3.5 Review of retail impacts

As part of this research, we reviewed the contribution of public transport users to retail activity, which is considered to be an important distributional impact of bus infrastructure schemes.

Much of the research we reviewed concluded that non-car users do make a considerable and often under-estimated contribution to retail spending. Nevertheless, there is little specific information relevant to smaller bus infrastructure schemes, such as bus stops and shelters.

In general, we were surprised at the paucity of research into the retail sector impacts of bus infrastructure, especially given that the adverse retail sector impacts of bus infrastructure proposals are often a major reason advanced by those who oppose such schemes. We suspect there would a larger body of evidence if the literature review was widened to other transport projects, including pedestrian mall developments.

Our review of the literature did note the following New Zealand-based research into retail sector impacts:

- Wallis and Bolland (2008) discuss the retail impacts of bus priority schemes in Auckland, specifically on Dominion and Mt Eden Roads. Analysis suggests that the schemes had little detectable impact on retail activity in the affected areas.
- Donovan et al (2011) analysed how retail expenditure varied between visitors to Sylvia Park, a major suburban retail centre in Auckland. While car and train users were found to spend more on average than bus users, the latter contributed the highest net revenue (on a per person basis) given the relatively low costs they imposed on the centre.
- Auckland Council (2012) provides a relatively comprehensive post-evaluation of the effects of developing shared spaces on Fort Street in central Auckland. While shared spaces are not directly related to bus infrastructure, both types of projects have similar impacts on vehicles, especially insofar as the removal of car-parking is concerned. The results of this post-evaluation suggest the development of the shared space on Fort Street contributed to higher pedestrian counts, fewer vehicles, reduced vehicle speeds and higher levels of retail spending.
- Hazledine et al (2013) consider the contribution of public transport economic productivity. The researchers suggest that public transport improvements can enhance productivity by lowering overall

commuting costs and freeing up car-parking, thereby realising agglomeration economies – especially in dense city centres. It is reasonable to hypothesise that some of the productivity and income gains associated with these agglomeration economies are subsequently reinvested into increased levels of retail spending in surrounding areas.

- Fleming et al (2013) found that non-car users contributed 40% of total retail spend. Trade generated by passing vehicles was found to generate less than 30% of total retail spend. Surveys showed retailers consistently over-estimated the relative importance of car-parking to shoppers' choice of retail destination. This finding is supported by anecdotal international evidence.

Finally, we note the UK Commission for Integrated Transport produced a report titled *Sustainable transport choices and the retail sector* (Commissioner for Integrated Transport 2006), which made the following salient findings:

- Public transport users do not spend significantly less than car users in towns and city centres.
- The shoppers' travel has very little effect on how much they spend, with income level being a more significant determinant.
- People who do not travel by car are more likely to support their local town centre, city centres and local shops, visiting them more frequently than car users.

Further information on the literature we reviewed is provided in appendix E2, which also includes comments on each study's relevance to the research. The retail impacts of bus infrastructure is likely to be a fruitful area of further research, and one which will benefit greatly from the wider availability of detailed electronic transaction data. To this end, we understand Auckland Transport (AT) is currently undertaking research into the retail expenditure patterns of bus users in Henderson.

3.6 Review of risk management literature

Our review of risk literature concentrated on risk principles and processes applicable to bus infrastructure schemes. As such, we focused on the **implementation of risk management** rather than structure, governance or foundation. Individual organisations that may end up using the risk management framework identified through this research will likely have their own existing structures and governance of risk, within which any risk management framework for bus infrastructure schemes will need to fit. The review of risk literature involved two branches of enquiry:

1 Treatment of risk within bus infrastructure guidelines

2 Literature specific to the management of risk.

These are discussed below, followed by a summary of our key findings from the risk literature. A more detailed summary of selected references is provided in appendix E.3.

3.6.1 Treatment of risk within bus infrastructure guidelines

The following bus infrastructure guidelines were reviewed:

- *Bus stop infrastructure guidelines* (Auckland Regional Transport Authority 2009)
- *Guidelines for the development of public transport interchange facilities* (NSW Ministry of Transport 2008)
- *Public transport infrastructure manual* (TransLink Transit Authority 2012)
- *HiTrans Best practice guide 2 public transport – planning the network* (HiTrans 2005)

We found very little specific reference to risk within the reviewed bus infrastructure guidelines. All of the guidelines step through the design considerations and pieces of infrastructure necessary to deliver a best practice (or minimum acceptable) bus facilities. However, generally there is little commentary about the wider risk factors that could impact on delivering project objectives.

Although specific risks are dependent on variables like location and size of the project, the core risk (eg political opposition or insufficient operational budget) will remain constant. With that in mind there would appear to be some benefit in providing a risk framework as part of infrastructure guidelines to assist those planning, designing or funding bus infrastructure.

3.6.2 Literature specific to the management of risk

The following risk literature was reviewed:

- *NZ Transport Agency risk management framework 2010–20*13 (NZ Transport Agency 2010b)
- *Minimum standard Z/44 – risk management* (NZ Transport Agency 2013c)
- *Project risk management handbook addressing uncertainty, threats and opportunities in projects* (Auckland Transport 2012)
- *Project risk management - guidance for WSDOT projects* (Washington State Department of Transport 2013)
- Other concepts (level of risk, response to risk).

3.6.3 Key findings

It would be fair to say that risks associated with project construction are extremely well understood and documented. There are many good examples of risk evaluation matrices available for use. These generally follow the framework established in the ISO 31000:2009 international standard. In most cases this document is the source of the risk management 'DNA' and, as such, its core principles tend to be reflected in more specific risk management frameworks.

While there are a number of definitions of risk, the prevailing definition taken from the ISO31000:2009 standard is '**effect of uncertainty on objectives**'. Uncertainty is a neutral term and does not have a negative or positive bias. In this way the definition moves risk (and more specifically the management of risk) away from a purely negative basis, ie 'chance or probability of loss', to a system that could accommodate both positive and negative uncertainty. This is an important factor to carry forward into a framework for risk relating to public transport projects, especially where unexpected success may cause projects to become 'victims of their own successes'. There are numerous local examples of bus infrastructure projects where high patronage has highlighted operational and passenger constraints.

The risk principle of '**scalability**' is particularly relevant to bus infrastructure. The wide range of projects and urban contexts means it is important to have a flexible approach to risk identification and mitigation. We caution against spending undue time examining risk on small projects or unlikely/low-impact risks on large projects. Variation occurs mainly in how risks are ranked and actioned. There is little value to be added to risk identification and mitigation at this end of the project lifecycle. There is however scope to develop a useful risk framework for bus-based public transport infrastructure to manage risk in the earlier phases of a project; strategy, investigation and design.

Bus infrastructure projects are often subject to a number of risks that a private vehicle-based project may not be. These risks will vary between location (eg a bus project in Auckland/Wellington city centre vs a provincial town centre) and over time with some risks (eg public perception of the project being a waste of money) potentially diminishing as more successful public transport projects are delivered.

There are a number of excellent bus infrastructure guideline documents from New Zealand and internationally. The infrastructural elements are well covered within documents reviewed above, which provide clear guidance on the 'what' question (ie 'what facility should we be providing?'). However, based on the documents reviewed there does not appear to be particularly useful information on the 'how'.

Indeed, 'how' projects are identified, planned, designed, funded, consulted on, delivered, operated and monitored is as important as providing the correct infrastructure. A best practice, high-quality piece of bus infrastructure perfect for the location is of no use if it fails to be delivered due to risk factors like political opposition or poor description of benefits.

Identifying a range of 'typical' risks for bus infrastructure projects earlier in the project lifecycle and developing a simple method for addressing the risks present will help project managers avoid known pitfalls of bus schemes and ultimately allow projects to be delivered more efficiently.

3.7 Implications for assessment framework

The implications of the above literature for the development of a framework for assessing benefits and risks to success project delivery are:

- A MCA framework is appropriate, as most bus infrastructure schemes have objectives and distributional impacts (on different parties) that cannot all be expressed in monetary/economic terms (eg impacts on property access). Many of these distributional impacts are associated with subsequent risks, eg removal of on-street car-parking.
- A SCBA or CBA framework is appropriate for those impacts that can be expressed in monetary/economic terms and when comparing a range of options of a broadly similar type to address a specific problem.
- Therefore, the combined and complementary application of both MCA and CBA approaches provides the most useful framework to understand the full range, extent and incidence of scheme impacts.
- It is also important to identify and manage the scale and nature of risks throughout the project, to ensure successful project delivery.
- An AST approach can help ensure a transparent process by helping communicate to decision-makers the range of impacts associated with a scheme.

A CBA assessment within a wider multi-criteria framework is the base of the current appraisal procedures in New Zealand. The next chapter sets out a proposed framework for assessing benefits and risks to successful project delivery. This covers a wider range of benefits and risks to successful project delivery than is included in current procedures.

4 Proposed framework for assessing benefits and risks to successful project delivery

4.1 Introduction

This chapter sets out a proposed framework for identifying and assessing the benefits of bus infrastructure schemes and assessing the risks to successful project delivery. At the core of the framework is an AST which is designed to provide a succinct summary of 1) the relevant benefits of bus infrastructure schemes and 2) potential risks to project delivery.

In New Zealand, all new projects moving forward will go through a business case process in order to be approved by the Transport Agency for funding. The process, which requires increasingly more detailed assessments, starts with a strategic case before moving into a more detailed programme business case, preliminary and detailed (project) business cases and eventually implementation. The typical project life-cycle for bus infrastructure schemes in New Zealand is similar with projects progressing from investigation and design to consultation and implementation, with a feedback loop from consultation back to investigation and design.

The AST can also be applied with increasingly more robust assessment as a project progresses through the business case stages. The following sections describe the proposed AST methodology and set out how it might be applied as projects progress through the business case stages and the project life-cycle.

4.2 Appraisal summary table

The AST is designed to provide a succinct summary of the relevant benefits of bus infrastructure schemes and risks to implementation in a form that is readily understood by decision makers. This includes identifying, describing and quantifying all significant social, economic and environmental impacts, including distributional impacts such as those on retailers and other property owners/tenants.

The proposed AST concept is based on the AST requirements for transport projects in the UK but has been developed for specific application to bus infrastructure schemes in New Zealand. The proposed AST identifies benefits and risks under the following categories (which are discussed further in section 4.3):

- key factor data
- economic and financial impacts
- social and environment impacts
- other local area impacts
- process and implementation risks.

The economic and financial impacts are monetised and calculated using a pro-forma spreadsheet (available at www.nzta.govt.nz/resources/research/reports/561), whereas other impacts are assessed in either a quantitative or qualitative sense, depending on the information available and type and scale of the scheme. The proposed AST essentially comprises a SCBA analysis placed within a wider MCA setting, which is similar to current New Zealand procedures but with a wider range of impacts relevant to bus infrastructure schemes being considered[9]. In this way the AST very much builds from and extends existing planning processes in a way that is more useful to bus infrastructure.

The proposed AST is set out in table 4.1, with further discussion below on the assessment and quantification of benefits and risks. We note that while the economic/financial impacts are combined to provide a CBA we have not made any attempt to aggregate or apply weightings to the other impacts as this will vary depending on decision-maker requirements.

Table 4.1 Proposed appraisal summary table for bus infrastructure schemes

			Page 1
Scheme name:	[ ]	Infrastructure scheme type:	[ ]
Brief description:	[ ]	Business case stage:	[ ]
		Assessor name:	[ ]
Problem definition /opportunity	[ ]	Assessment date:	[ ]
Category		**Assessment of relevant measures**	**Summary of impact**
A. Key factor data			
Patronage impacts		Total patronage on routes/stops affected by proposed infrastructure scheme	[#,###]
Service impacts		Number of vehicles using the proposed infrastructure	[#,###]
Private vehicle trips		Number of two-way trips per day	[#,###]
Other		Other relevant information	[#,###]
B. Economic/financial impacts			
B1. Benefits			
PT existing user benefits	In-vehicle time	[Brief comment on impact/significance]	[$#.## pa]
	Access time	[Brief comment on impact/significance]	[$#.## pa]
	Wait/transfer time	[Brief comment on impact/significance]	[$#.## pa]
	Frequency benefits	[Brief comment on impact/significance]	[$#.## pa]
	Reliability benefits	[Brief comment on impact/significance]	[$#.## pa]
	Infrastructure quality	[Brief comment on impact/significance]	[$#.## pa]
	Subtotal		**[$#.## pa]**
PT new user benefits		[Brief comment on impact/significance]	[$#.## pa]
Road user benefits		[Brief comment on impact/significance]	[$#.## pa]
Total annualised economic benefits			**[$#.## pa]**
B2. Costs			
Capital costs (public sector)		[Brief comment on impact/significance]	[$#.##]
Recurrent costs (public sector)		[Brief comment on impact/significance]	[$#.## pa]
Total annualised costs			**[$#.## pa]**
B3. Cost-benefit assessment			
Net present value (NPV)		[Brief comment on what value shows]	[$#.##]
Benefit-cost ratio (BCR(G))		[Brief comment on what value shows]	[#.#]

[9] Current procedures consider strategic fit, effectiveness and efficiency.

			Page 2
Category		**Assessment of relevant measures**	**Summary of impact**
C. Social/environmental impacts			
Access to services	Catchment area / connectivity	[Summary of assessment with quantitative results (where possible) or qualitative assessment with 5-point scale]	[# or +/- scale]
	Accessibility (for people with disabilities)	[As above]	[# or +/- scale]
Simplicity	Simplicity/legibility	[As above]	[# or +/- scale]
Safety and security	Safety and accidence prevention	[As above]	[# or +/- scale]
	Personal security	[As above]	[# or +/- scale]
Emissions	Noise	[As above]	[# or +/- scale]
	Local air quality	[As above]	[# or +/- scale]
Townscape /landscape	Sense of place Urban realm	[As above]	[# or +/- scale]
	Severance	[As above]	[# or +/- scale]
D. Other local area impacts			
Amenity impacts on neighbours		[Summary of assessment with quantitative results (where possible) or qualitative assessment with 5-point scale]	[# or +/- scale]
Local land use impacts		[As above]	[# or +/- scale]
Property access/car parking		[As above]	[# or +/- scale]
Commercial/retail impacts		[As above]	[# or +/- scale]
E. Process/implementation risks			
Organisational/political		[Summary of assessment with quantitative results (where possible) or qualitative assessment with 5-point scale]	[# or +/- scale]
Stakeholder/public		[As above]	[# or +/- scale]
Business case		[As above]	[# or +/- scale]
Planning/ consenting		[As above]	[# or +/- scale]
Implementation		[As above]	[# or +/- scale]
Operational		[As above]	[# or +/- scale]

4.3 Benefit and risk categories

The header section of the AST includes basic information about the scheme, including the type of scheme (eg bus stop, interchange or bus priority) and business case stage. It also includes the problem definition /opportunity statement which has to be developed during the early strategic assessment stages of a business case.

The proposed AST then include the following benefit and risk categories:

- key factor data
- economic and financial impacts

- social and environment impacts
- other local area impacts
- process and implementation risks.

We now provide further detail on each of these categories, including a description of the benefits and risks included in each and how the assessment should be undertaken as part of the proposed AST framework.

4.3.1 Key factor data (A)

The key factor data section of the AST is intended to provide a brief summary of key characteristics of the proposed scheme. Table 4.2 provides further discussion on the key factor data.

Table 4.2 Key factor data – summary and assessment notes

Category	Assessment of relevant measures	Comments
A. Key factor data		
Patronage impacts	Total patronage on routes/stops affected by proposed infrastructure	This measure shows the total patronage affected by the infrastructure. For bus priority schemes this could be analysed at the level of individual bus routes. In contrast, for bus stop and interchange schemes the number of boardings/alightings is a more valuable metric. For new bus stops, the patronage potential can be analysed using trip generation rates from existing bus stops served by similar routes, multiplied by the catchment of the stop. Benefits from improved interchange facilities will mostly be experienced by passengers using the interchange, especially those who are boarding and/or transferring. It is important to quantify the number of transfers, boardings and alightings at the existing facility and to estimate the impact of the improved interchange on these numbers. Some schemes might combine an interchange upgrade with a network redesign, in which case the number of transfers can be expected to increase – which in turn will amplify the benefits of the interchange.
Service impacts	Number of buses using the infrastructure	The number of buses using the facility or priority scheme is important for understanding the scale of potential operational benefits.
Private vehicle trips	Number of two-way trips per day	Some projects, especially bus priority measures, may have negative impacts on journey times for private vehicle drivers. While tolerance of these impacts is a strategic decision, it is important the disbenefits are quantified wherever possible.
Other	Other relevant information	Any number of additional relevant key factor measures can be added to the proposed AST as appropriate.

4.3.2 Economic/financial impacts (B)

The proposed AST assessment of economic and financial impacts is based on a CBA, with economic and financial impacts defined as follows:

- **Economic impacts** – these cover 1) the 'national resource' items commonly included in CBA appraisals; 2) items conventionally counted as 'costs' (eg infrastructure capital costs, public transport operating costs) and 3) those counted as user 'benefits' (eg positive changes in travel times, travel quality factors etc as experienced by transport system users).

- **Financial impacts** – these cover a sub-set of the economic impacts, specifically those (incremental) costs that are funded from public sources (national taxes, regional rates etc).

The bus infrastructure schemes covered in this project are typically intended to reduce the 'generalised costs' of public transport use and hence attract additional public transport users. A proportion of these additional users are typically attracted from driving their cars for the trip in question, and hence some degree of 'decongestion' will result, producing time savings (and reliability improvements) for remaining car users. The additional public transport travel may result (principally at peak periods) in the need to increase the public transport service capacity, which is likely to require increased public funding; or alternatively, if capacity is not increased, will result in more crowded conditions for public transport passengers (thus reducing their travel quality, or increasing their 'generalised costs' for the trip).

We have developed procedures for assessing the economic and financial impacts of bus infrastructure schemes, including calculating NPV and BCR metrics. The procedures are based on two spreadsheet templates (pro-forma), the first of which is used to calculate the benefits and costs of bus stops and shelters and bus interchanges, and the second for bus priority measures. Further details on the procedures and associated pro-forma, including assumptions and application, are provided in appendix F.

The procedures are used to calculate economic and financial impacts, which are then summarised in the proposed AST. An overview of these impacts and relevant considerations is provided in table 4.3.

Table 4.3 Economic/financial impact – summary and assessment notes

Category		**Comments**
B. Economic/financial impacts		
B1. Benefits		
Public transport existing user benefits	In-vehicle time	Benefits associated with any changes to the amount of time that passengers are on the bus. The change is travel time can be quantified as travel time savings. This measure can be assessed using existing and future time tables. Combined with patronage and travel time values, a dollar figure can be calculated and attributed to the infrastructure investment.
	Access time	Locating or relocating bus stops impacts on the distance that people have to walk to access a bus service. Stops can be located to minimise the average walking time required, which can be measured as the weighted average distance from addresses within the stop/route catchment area.
	Wait/transfer time	Upgrading bus stop/interchange improves the wait/transfer experience for passengers by reducing the value attached to time spent at the facility.
	Frequency benefits	Higher service frequency will reduce travel time for existing customers as average wait time duration will be reduced.
	Reliability benefits	Improved reliability benefits existing passengers by effectively reducing the time allowed for a particular trip. Reliability benefits are only considered for bus priority measures, but for these schemes they can comprise a substantial proportion of user benefits.
	Infrastructure quality	High-quality infrastructure is valued by passengers and can be assessed using a rating scale with dollar values assigned based on stated and revealed preference surveys.
	Subtotal	**[$#.## pa]**

Category	Comments
B. Economic/financial impacts	
B1. Benefits	
Public transport new user benefits	If the above-mentioned benefits result in increased patronage, the new passengers will have a perceived benefit (otherwise they would not switch). In economic terms, the perceived benefits per new user are calculated as half the unit benefits to existing passengers (the rule of a half) ex-ante, the number of new users is estimated based on the forecast change in 'generalised costs' of travel for the existing users. Ex-post monitoring should be undertaken to identify the patronage changes.
Road user benefits	A proportion of users attracted to the improved public transport services would previously have made the trip as car drivers; and hence their switching will marginally reduce car traffic volumes and (at peak periods) associated congestion levels. The extent of 'decongestion' will depend on the extent of traffic reduction (after allowing for some 'induced traffic' effect) and the initial degree of congestion. 'Decongestion' benefits will comprise principally time savings to motorists, with secondary components being operating cost savings, crash savings (or possibly increases), global emissions (CO2) reductions and local environmental impacts (noise, particulates etc).
Total annualised benefits	**[$#.## pa]**
B2. Costs	
Capital costs (public sector)	This item includes: 1) land costs (opportunity cost basis); 2) planning, design, consenting etc costs; and 3) construction costs.
Recurrent costs (public sector)	Higher bus patronage can in some instances increase public transport operating costs, particularly at peak times when additional capacity would be required. These additional costs would be offset (in whole or part) by increased fare revenues.
Total annualised costs	**[$#.## pa]**
B3. Cost-benefit assessment	
Net present value (NPV)	**[$#.##]**
Benefit-cost ratio (BCR(G))	**[$#.##]**

Notes: (a) Fare payments represent a 'transfer' between users and operators (or regional councils), and hence their net effect on a national economic appraisal is zero. However, for a BCR (G) calculation (as here), there are counted as a net disbenefit to users (in the BCR numerator) and a net saving to public costs (in the BCR denominator).

4.3.2.1 Scheme type considerations

The economic/appraisal assessment above is applicable to all the bus infrastructure scheme types considered. There are, however, some differences between the scheme types. Table 4.4 highlights the critical inputs to the economic/financial appraisal for each of the three scheme types: these do not cover all the inputs required from the scheme analyst, but cover those inputs that are most critical to the overall scheme economic/financial performance.

Under the 'bus stops and stop facilities' scheme type, we have developed two separate appraisal methods, each with a separate set of inputs: one relates to the enhancement of facilities at an existing stop (eg provision of seat, shelter, real-time information (RTI)); the other to stop relocation or addition/removal decisions.

Table 4.4 Economic/financial – inputs by scheme type

<table>
<tr><th colspan="2">Scheme type</th><th>Key appraisal inputs</th></tr>
<tr><td colspan="2">Bus/multi-modal interchanges</td><td>• Changes in travel times (origin-destination) for passengers using (or affected by) the new/enhanced facility
• Any changes in public transport user transfer requirements, including transfer walk and wait time savings
• Any changes in user perceived (generalised) time, including comfort, convenience etc effects, associated with use of the interchange
• Scheme capital costs (land and construction)
• Scheme direct operating and maintenance costs (eg additional staffing at interchange, interchange maintenance etc)
• Impact on public transport operating costs (resulting from changed routings, changed schedules, terminus layover time etc) – costs dependent principally on changes in bus hours in operation, and partly/wholly offset by changes in fare revenues.</td></tr>
<tr><td rowspan="2">Bus stops and stop facilities:</td><td>Enhancement of stop facilities</td><td>• Number of passengers boarding at the stop
• Frequency of services using the stop
• Stop enhancement measures proposed (eg seat, shelter, lighting, RTI)
• Capital costs of enhancement measures</td></tr>
<tr><td>Stop relocation or addition/ removal</td><td>• Number of boarding/alighting passengers affected by proposals
• Average change in walking distance for passengers affected
• Number of passengers on the bus travelling past the stop(s) affected
• Proportion of buses stopping at the affected stop.</td></tr>
<tr><td colspan="2">Bus priority measures</td><td>• Changes in average travel times in corridor in question (by time period/direction) for buses and general traffic
• Number of bus passengers benefiting from these bus travel time reductions
• Number of cars affected by any travel time changes for general traffic
• Scheme capital costs (land and construction)
• Impact on public transport operating costs (dependent principally on the number of bus trips affected and the average time saving per bus trip).</td></tr>
</table>

4.3.2.2 Project scale considerations

The economic/financial impact assessment procedures have been developed with smaller scale projects in mind, while also being applicable to larger scale projects. The main difference will be that large scale projects will need to go through a more extensive and rigorous process to confirm the assumptions and demand impacts.

We also note that not all indicators will be relevant at all project scales, for example the impact of smaller bus stop projects on travel time will be minimal.

4.3.3 Social/environmental impacts (C)

Table 4.5 provides details on the proposed assessment basis under the 'social and environmental' impacts heading. For each sub-category, it provides notes on the proposed assessment basis. We provide the following additional comments:

- For most of the environmental/social categories covered in the table, the impacts of the scheme types under consideration are likely to be very small or negligible. To the extent that any adverse impacts might be more substantial, these would typically be addressed at the planning/design stage, either through checking for conformity with standards/guidelines, or through specific scheme audits (eg safety audits).

- Arguably, the two access sub-categories (A1, A2) are likely to be most significant (usually with favourable impacts); while most of the environmental impact categories (C-F) will generally be insignificant.
- A number of other potential 'social/environmental' impacts have not been included in the table, as our prior judgement was that they would not be significant for the scheme types being considered. These impacts include health/fitness benefits, agglomeration benefits and option/non-use benefits.

Table 4.5 Social/environmental impacts – summary and assessment notes

Category		Assessment of relevant measures
C. Social/environmental impacts		
Access to services	Catchment area/ connectivity	Mostly relevant for bus stop projects. Includes an assessment of number of dwellings within walking distance of existing and proposed bus stops. Where possible, this should be quantified. If not possible, display on a 5-point scale.
	Accessibility (for people with disabilities)	Assess any changes through an accessibility audit of any proposed changes (refer O'Fallon 2010); and then ensure that any significant deficiencies identified are addressed prior to scheme finalisation.
Simplicity	Simplicity/legibility	In some cases, particularly where bus routes are being adjusted, legibility of the network or simplicity of a bus journey can be improved. This can generate a benefit, which can be assessed on a 5-point scale.
Safety and security	Safety and crash prevention	Ensure that 'larger' schemes are subject to a safety audit at the planning/design stage, with remedial action as appropriate; for 'smaller' schemes, ensure that they comply with any relevant standards.
	Personal security	Assess the impact of the proposed changes against Crime Prevention Through Environmental Design (CPTED) principles, compared with a do-minimum scenario. Can be displayed on a 5-point scale.
Emissions	Noise	Where applicable, an assessment of the effects of the scheme on noise should be taken into account. Noise impacts are considered minimal for most bus infrastructure projects.
	Local air quality	Larger bus interchange projects generally have an effect on local air quality. Where appropriate, this should be assessed against a 5-point scale. For many bus infrastructure projects, this would not be relevant.
Town-scape/ landscape	Sense of place/ Urban realm	Some bus infrastructure projects, in particular bus interchanges, can have an impact on the urban realm. While this will be difficult to quantify, there may be a comparative difference between different options and the do-min scenario. These can be assessed on a 5-point scale.
	Severance	As with all mobility-related infrastructure, bus priority measures and to a lesser extent interchanges and stops can cause severance to the urban form, particularly when land acquisition and road widening is required. For bus stops and interchanges, pedestrian accessibility and crossings are a factor that can be assessed. This factor needs to be assessed on a 5-point scale.

4.3.3.1 Scheme type considerations

Table 4.6 sets out a number of considerations specific to each of the bus infrastructure scheme types reviewed.

Table 4.6 Social/environmental impacts – inputs by scheme type

Scheme type		Primary social/environmental impacts
Bus stops and shelters		For bus stops, the 'access to services' and 'safety and security' categories are likely to be the most relevant. We suggest impacts on safety and crash prevention, and personal security in particular, as well as the emissions and townscape/landscape categories are adequately addressed by a number of existing guidelines, some of which are listed in table 4.5.
Bus interchanges	Access to services	Interchanges typically aim to improve access by providing a well-sited and well-designed facility through which passengers can access services. Typically there is a tension between operational efficiency, ie the ease with which bus services enter/exit the facility, which tends to increase the physical footprint and associated costs and catchment, ie the density of surrounding activities. Achieving operationally efficient interchanges can require large physical footprints, which can in turn be challenging and costly in denser locations that are most accessible to passengers.
	Legibility, simplicity	More highly visible bus interchanges will enhance the profile of public transport and increase the legibility of the bus network and simplicity of transfers.
	Safety and security	By concentrating services and passengers, interchanges can often warrant a higher level of investment in facilities for passenger safety and security. Such facilities could include a physical presence, eg kiosk attendant and/or security guard, or CCTV technologies. Passive surveillance is often higher at interchanges as well.
	Emissions	Interchanges will typically increase emissions within the immediate environs, while decreasing them elsewhere. Appropriate siting, choice of materials, and landscaping can help to minimise the degree to which passengers and adjacent land use activities are exposed to emissions.
	Townscape/landscape	Our AST identifies two primary issues to consider, specifically urban place impacts and severance. These issues are comprehensively addressed in other documents. We note, however, severance issues around an interchange will not only adversely affect surrounding land use activities, but also tend to undermine the catchment of the facility. Hence we recommend pedestrian severance around bus interchanges is minimised as much as possible.
Bus priority measures	Access to services	This is typically not relevant to bus priority measures.
	Legibility, simplicity	Large scale bus priority measures will enhance the visibility of the public transport network and increase the legibility of the bus network. For smaller priority projects this is less relevant
	Safety and security	Bus priority measures should consider the ease with which pedestrians can cross. As most public transport journeys happen in both directions, almost all passengers will have to cross the road at least once on their inbound/outbound journey. Safety of cyclists and parked vehicles may also be relevant in certain urban contexts
	Townscape/landscape	The physical parameters (eg speed profile and associated geometric dimensions) of bus priority measures should respond to the urban context in which they sit. In denser urban contexts, this may require a lower speed profile with reduce geometric dimensions

4.3.4 Other local area impacts (D)

Local area impacts are summarised in the following table, along with additional notes to guide their assessment. We note these impacts are typically distributional in nature and hence highlighting them here can help to identify relevant issues that should be considered for more detailed investigation as part of the risk framework, which is considered in more detail in subsequent sections.

Table 4.7 Other local area impacts- summary and assessment notes

Category	Assessment of relevant measures	Scheme type considerations
D. Other local area impacts		
Amenity impacts on neighbours	This category covers any objective or subjective (dis)benefits as perceived by residents or businesses in the direct vicinity of the scheme. Potential (perceived) negative effects include noise, litter and graffiti. This assessment should be rated on a 5-point scale where possible.	Most likely to be an issue for bus stop relocations and/or additional stops
Local land use impacts	Any impacts on local land-uses, including social infrastructure like schools or community centres are covered by this category. For larger scale interchange projects, this value can be significant, as the proposed interchange will attract growth and development to the surrounding area. For smaller scale projects, these criteria should be assessed on a 5-point scale.	Most likely to be an issue for bus stops and interchanges. For peak-hour bus priority lanes, the presence of schools may require an earlier start to the PM peak.
Property access/car parking	All three types of schemes have a potential impact on parking and property access. Bus stops usually compete with on-street parking for kerb space. Interchanges, whether on-street or off-street usually include the removal of parking to some extent. Bus priority infrastructure can have a significant impact on on-street parking availability. These impacts need to be assessed, either quantitatively or on a 5-point scale.	Most likely to be an issue for bus priority schemes and bus stops. Adopting demand responsive pricing policies to manage on-street parking provides councils with tools to maintain occupancy at appropriate levels (typically ~85%).
Commercial/ retail impacts	Bus infrastructure schemes can have both positive and negative impacts on surrounding retail. A bus stop or interchange can (greatly) improve the number of pedestrians in an area. Bus priority measures on the other hand can increase severance and vehicle speeds through an area, which might negatively affect retail.	Most likely to be perceived as greatest for schemes that restrict parking and/or impact pedestrian movement but can also be applicable to areas where vehicle speeds will be impacted due to the scheme.

4.3.5 Process/implementation risks (E)

The risk management framework provides a means for identifying and assessing risks specific to successful implementation of bus infrastructure schemes.

Our proposed risk management framework tries to raise awareness of risks and bring a scalable risk analysis into existing project processes. Based on our review of the literature, we have developed a proposed risk management approach that, when used in conjunction with the above economic assessment framework, provides a practical framework for bus infrastructure (and other public transport) schemes in New Zealand. We have developed this framework with a mind to incorporating it within existing planning processes and/or best practice guidelines.

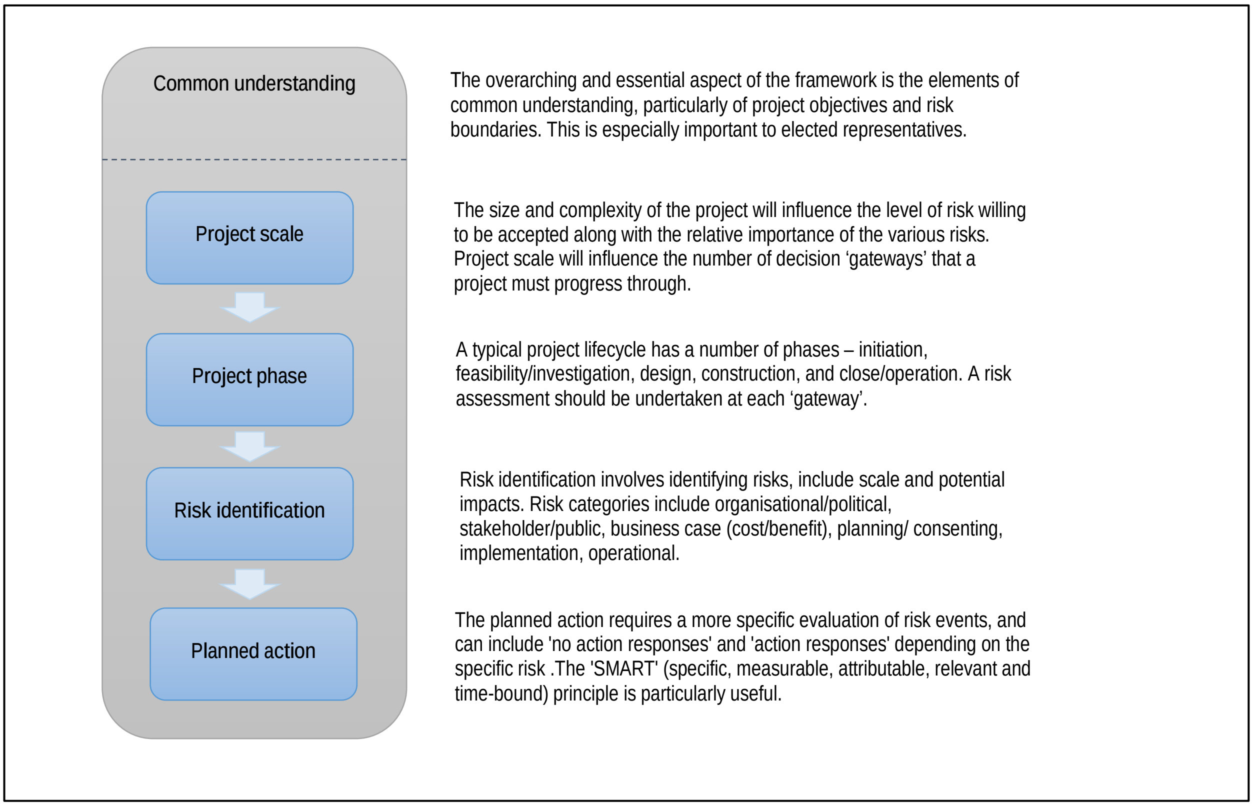
Most importantly, bus infrastructure schemes are considered 'alternative transport' (to roading schemes) in current parlance. This term often carries the perception of benefiting only a minority of the population (ie those who currently use or would consider using public transport). This issue is exacerbated by the fact that many people making decisions on bus infrastructure are relatively unlikely to use buses regularly themselves. Hence, the key risk facing many bus infrastructure projects in New Zealand is simply that many decision makers struggle to identify with the people who will benefit from the infrastructure.

For this reason, risks posed to bus infrastructure and other public transport project cycles are often more frequent and more serious when compared with projects that derive most of their benefit from improvements to private vehicle trips.

Our review of risk literature identified a gap in practitioner guides around identification and planning for risk. Risk frameworks tend to focus on construction and the associated time and budget issues. In terms of bus infrastructure, most of the risk exists earlier in the project lifecycle and is generally not explicitly addressed. This can often lead to delays in delivering projects (ie delays in benefit realisation) and impacts on decisions on infrastructure type, location and design – potentially reducing benefits realised.

Broadly, our proposed risk management framework follows the process identified in figure 4.1. The components of the framework are described further below.

Figure 4.1 Outline of proposed risk management framework for bus infrastructure schemes



These individual elements are discussed in more detail in the following sub-sections.

4.3.5.1 Common understanding

The overarching and essential aspect of the framework is the elements of common understanding, particularly of project objectives and risk boundaries as set out in table 4.8.

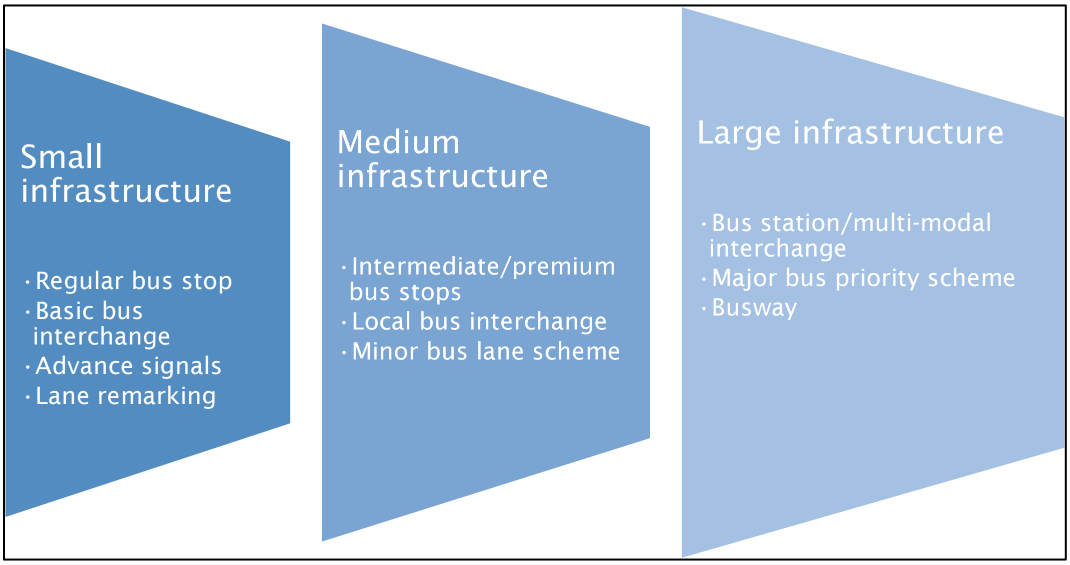
Table 4.8 Elements of common understanding

Element	Description
Project objectives	All projects need to be based on addressing an existing or future problem, or improving an existing situation. The project objectives are the agreed way to measure success in addressing these and deliver the project benefits. Project objectives need to be clearly stated at the outset and at each project stage they need to be checked against. In terms of bus infrastructure, the need for changes/improvements is often not well understood by people who are not regular users of bus services. Hence objectives need to be caged in terms that decision makers and stakeholders can relate to, eg travel-time, or carefully explained. This is particularly important for interchange and stop improvements, which essentially improve passengers' wait-time experience – which is something that people who usually drive are often not familiar with.
Risk boundaries	There needs to be an understanding at the outset of the project – and probably reviewed as the project progresses – of the level of risk acceptable. Either too much or insufficient focus on risk will slow the project and create wastage of time and money. These risk boundaries will be influenced by the scale and complexity of the project.

4.3.5.2 Project scale

The size and complexity of the project will influence the level of risk willing to be accepted along with the relative importance of the various risks. Project scale will influence the number of decision 'gateways' that a project must progress through. For bus infrastructure there are logically three groupings for project scale as set out in figure 4.2. Types of bus infrastructure are also covered in chapter 2.

Figure 4.2 Project scale guideline for bus infrastructure schemes



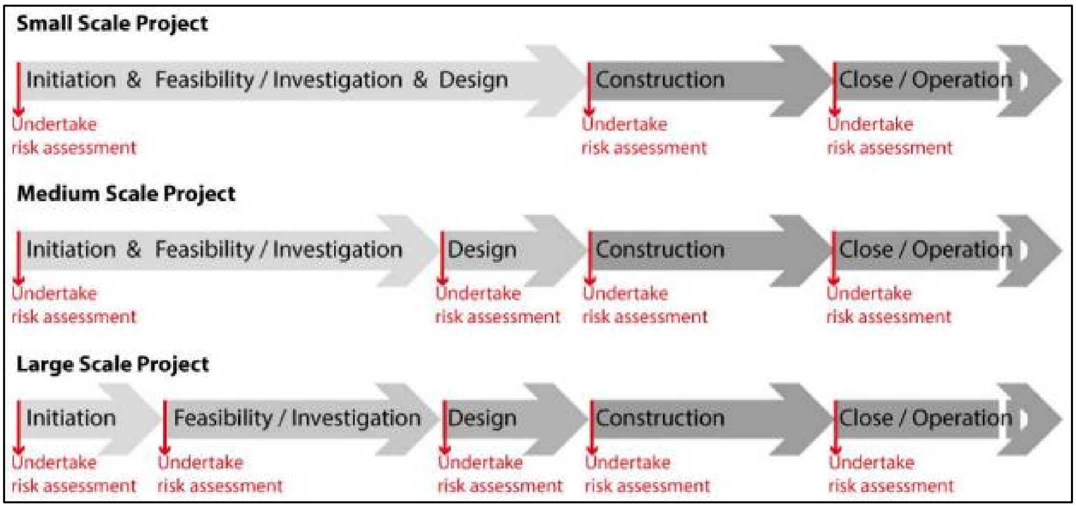
4.3.5.3 Project phase

A typical project lifecycle has a number of phases: initiation, feasibility/investigation, design, construction, and close/operation. A risk assessment should be undertaken at each 'gateway'.

The typical project lifecycle is broken down into the process shown in figure 4.3. There is a gateway between each phase where the project will be assessed for benefits, costs and achieving the objectives. It is also a logical point to check against existing risks and add any newly identified risks.

The gateways between the phases will depend on the scale of the project. For a simple basic bus stop, initiation, feasibility, investigation and design may all occur concurrently. In this way the risk assessment process is automatically scaled to the size of the project.

Figure 4.3 Typical project lifecycle by scale



4.3.5.4 Risk identification

Risk identification involves identifying risks, include scale and potential impacts. Based on our collective experience we suggest risk categories for bus infrastructure projects can broadly be grouped as follows:

- organisational/political
- stakeholder/public
- business case (cost/benefit)
- planning/consenting
- implementation
- operational

Each risk or grouping of risks will impact on the ability to deliver on the key objectives of the project, which in turn will impact on delivering benefits. It is important to recognise the key risks before and during the project. A sample of key risks is provided in table 4.9[10].

Table 4.9 Sample of key risks to public transport projects

Risk area	Key risk	Scale	Comment
Organisational/ political	Local board unaware of project	S	Can cause delay. Local board input can help to refine concepts for public consultation
	Senior managers unclear of project objectives	M, L	Miscommunication of objectives and benefits can cause delay and harm organisational reputation
	Project becomes politicised for reasons outside of the project (ie “party politics”)	S, M, L	Awareness of politicised issues will indicate where focus is required to ensure a clear and robust case for decisions.

[10] This risk framework is intended to ultimately provide a risk checklist for practitioners as a starting point for risk assessment. Given the complexity of risk by project and location the list will not cover everything, but will intended to provide a catalyst for consideration of risk

Risk area	Key risk	Scale	Comment
	Project delivered by one arm of government for another without proper engagement	S, M, L	Public transport engineering and operations are often split into separate teams within regional/local councils. Creates risk of poor project outcomes if the ultimate 'end user' of the asset (operations) is not involved during design.
	Long or complicated process for delivering simple infrastructure	S	Inefficient process for delivering small parts of a network (eg creating or moving bus stops) may put practitioners off starting projects and prevent efficiencies and benefits being achieved.
	Poor policy direction	S, M, L	Good clear policy, particularly statutory policy, will make delivering benefits through public transport projects quicker and easier, eg major public transport network changes often benefit from pre-agreed policies on coverage and expenditure.
Stakeholder/ public	Vocal opponent or group 'drowning out' majority approval	S, M, L	Organisations and politicians are averse to negative publicity. Clear objectives and a robust reason for a project are essential when dealing with the 'squeaky wheel'.
	Poor understanding of project objectives	S, M, L	Miscommunication of objectives and benefits can cause delay and harm organisational reputation.
	Fundamental stakeholder objection	M, L	Often bus infrastructures are opposed by stakeholders simply because 'they involve buses'. In this case it is very difficult for projects that increase bus volumes in a particular area to proceed unless they have adequate support from senior management.
	Insufficient consultation	S, M, L	Inadequate consultation with affected parties may cause unexpected delays to programme. For larger projects this may occur later in the process (ie during consenting)
	Key stakeholder not identified	M, L	Delay to the process can be caused depending on when the stakeholder is identified.
Business case (cost/benefit)	Bias in the tools for measuring benefits	M, L	Public transport projects are at a disadvantage for traditional business case evaluation. Some of the true benefits of more significant public transport projects, eg effects on reliability, agglomeration economies, socio-economic inclusion and urban form, are relatively complex and difficult to quantify – hence they are often excluded from appraisals.
	Poor communication of project objectives	M, L	Project objectives and benefits are intertwined so it is important the primary benefits are clearly stated and can be measured.
	Benefits delayed by staging	L	Large projects can have funding risks which can see projects staged. In some instances the real benefit of a public transport project (eg a busway) will not be released until it is completed. Breaking it into pieces may impact on benefit realisation, and public perceptions of the value of the investment.

Risk area	Key risk	Scale	Comment
	Poor cost estimate information early in the project	M, L	Failure to recognise components required to deliver the project (eg land for addressing effects) can threaten the viability of the project.
Planning/ consenting	Poor communication of project objectives	M, L	NoR or consenting processes will benefit from an ability to clearly state project objectives.
	Assessment of alternatives	M, L	It is necessary to have a clear assessment of all alternatives for controversial projects. The larger the project the greater the focus needs to be on this. Documentation of evaluation is critical.
Implementation	Risks during construction or delivery of the proposal are much more location and project specific and are not well covered with a generic sample list or checklist. There are many documents existing that focus on risk during this phase.		
Operational	No monitoring of operations before or after implementation.	M, L	As more focus is placed on measurable benefits it is important for a good monitoring and post-evaluation regime to be put in place. This provides feedback to other projects and improves understanding of benefits and risks
	Infrastructure not fit for purpose and has negative impact on operation	M, L	Ongoing operational inefficiencies can create significant costs over time. Inefficiency in delivered infrastructure (intentional or otherwise) may constrain future budgets.
	Operational budget not secured, inefficient use of infrastructure	L	Consideration of operation budgets is required during planning for significant infrastructure to ensure predicted benefits can be delivered.

4.3.5.5 Planned action

Once the risks are broadly identified, it is important to specifically define a risk event. The planned action requires a more specific analysis of risk events, and can include 'no action responses' and 'action responses' depending on the specific risk .The SMART (specific, measurable, attributable, relevant, time-bound) principle is particularly useful.

For significant projects the risk action plan would need to cover:

- risk description – including risk title, cause/hazard, effect
- risk categorisation – risk owner, phase/type
- analysis – probability (%), cost, time, reputation, safety
- rating – score
- treatment – mitigation (pro-active – before risk impacts), contingency (reactive – if risk impacts), action priority.

There are a number of pro-forma type spreadsheets available for the identification and assessment of risks using the SMART principles. These range from simple to complex with the complexity required varying depending on size of the project.

5 Case studies

5.1 Background

In this chapter we present the results of five case studies. The purpose of the case studies was to:

- provide a focus for the development, testing and fine tuning of the appraisal methodology
- demonstrate to potential users of the methodology how it would work in practice on a range of projects in a range of urban contexts, especially in light of potential data issues
- provide indicative appraisals of the five cases examined, (from which it might be possible to make some generalisations about the potential performance of other infrastructure projects).

In regard to this last point, our case study appraisals are not definitive. Instead, they are more reasonably viewed as indicative appraisals based on the limited information that was available.

Case studies were selected in consultation with the Steering Group and were chosen to cover a range of bus infrastructure projects, with a variety of budgets and in a variety of urban settings. The case studies are summarised in the table below, along with their locations, modes involved, status, date of implementation and approximate cost.

Table 5.1 Case studies identified for further investigation

#	Name	Region	Modes	Status	Date	Value (nom.)
Major case studies						
1	Dominion Rd bus lanes	Auckland	Bus	Implemented	1998	Unknown
			Bus	Programmed	2014	$50.0m
2	New Lynn interchange	Auckland	Bus, rail	Implemented	2010	$15.4m
3	Manners Mall busway (bus lanes)	Wellington	Bus	Implemented	2010	$11.0m
Minor case studies						
4	Otara bus interchange	Auckland	Bus	Implemented	2013	$2.1m
5	Tauranga downtown bus interchange	Tauranga	Bus	Implemented	2010	$0.78m

Our appraisals are based on the available data, which is drawn from both ex-ante and ex-post analyses. Where information was not available, we have estimated values for costs and benefits. In estimating these benefits we noted considerable inconsistency in the level of information that was available for each case study. While the larger projects usually include some sort of ex-post analysis, this was not the case for the smaller schemes. For some schemes, no quantitative ex-ante analysis was available.

Based on our experience preparing these case studies we recommend the Transport Agency require more comprehensive and consistent information from AOs on the (expected) costs and benefits of proposed bus infrastructure schemes. Only with such information can detailed and comparable post-evaluation analyses of bus infrastructure be undertaken. The AST identifies several key indicators for which data is relatively easy to collect and are subsequently very useful in assessing the benefits of a proposed scheme.

For each case study we also identify risks, and discuss (where possible) how these were identified and managed. We caution that many risks (especially those of a political nature) tend to be addressed on a day-to-day basis by the project manager and are consequently not reflected in official documentation.

We note that one of the key considerations of this research project was the ‘distributional’ impacts of bus infrastructure schemes across stakeholders and affected parties. Local retail trade, for example, may be affected by bus priority measures. These impacts can be negative, due to increased severance or removal of parking, or positive, where more foot traffic is expected because of improvements to the public transport network. While such distributional impacts are distinct from changes in overall economic welfare – and therefore not relevant to the EEM – they are often relevant to regional and local decision makers and stakeholders. Data on the nature of these impacts can be used to manage risks and build consensus with stakeholders on individual bus infrastructure projects.

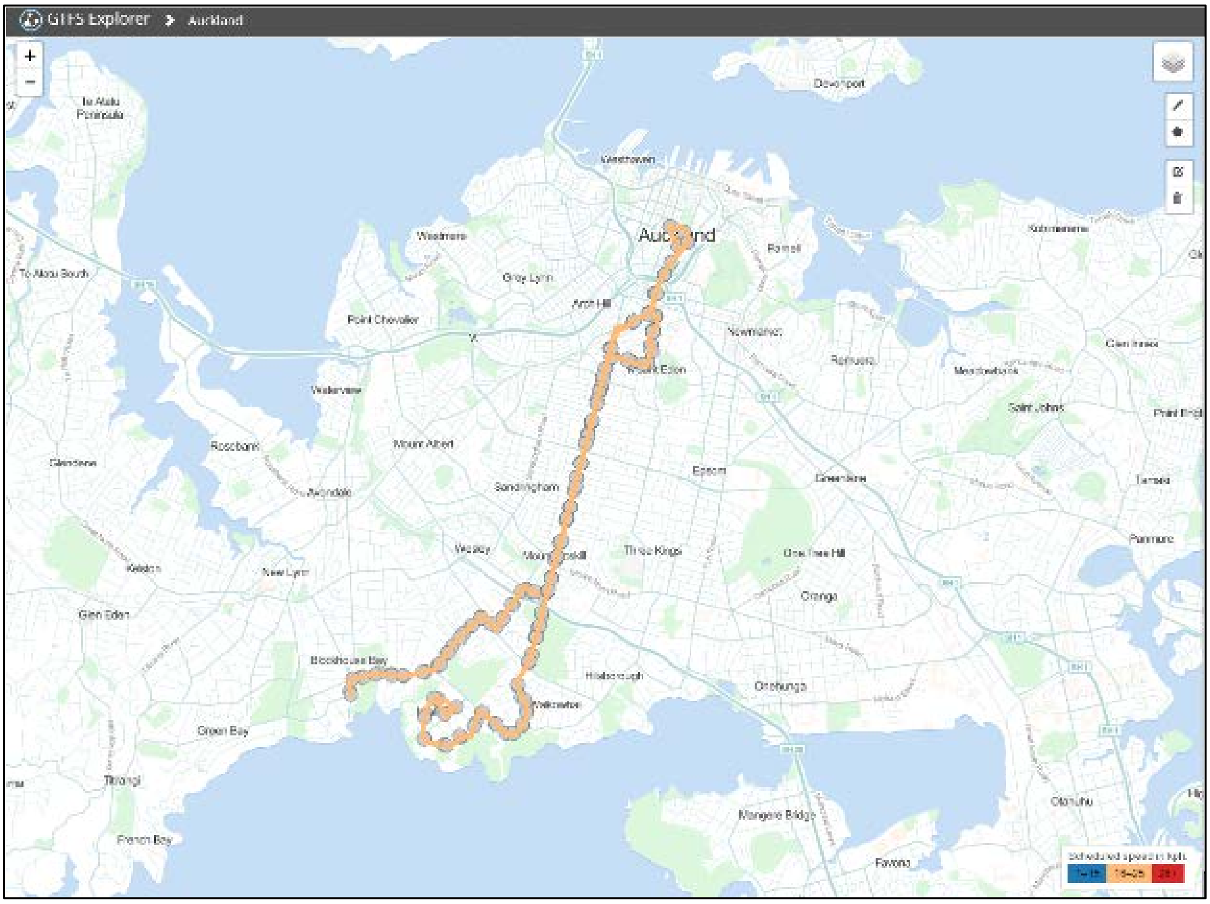
Finally, for each of the case studies, the AST was used to identify the key benefits of the project. For each of the major case studies an economic evaluation was undertaken to quantify the benefits of the respective project. In each of the minor case studies, where less quantitative data was available, the cost or benefit in the overall assessment impact was usually estimated on a scale of 1 to 3 dollar signs; the general impacts or risks were assessed on a scale of three minuses to three plusses.

5.2 Case study 1: Dominion Rd bus lanes

5.2.1 Background

Dominion Road is an urban arterial located in Auckland’s central isthmus. The figure below shows the two main Dominion Road services (routes 258 and 267) and their associated stops (both inbound and outbound). These routes connect dense and mixed-use suburbs to the city centre via Symonds Street.

Figure 5.1 Bus routes on Dominion Road



Dominion Road is a 1–2 lane road with a five-day bi-directional annual average daily traffic (AADT) of approximately 26,000 vehicles per day[11] and high levels of side friction caused by adjacent land use activities. This results in high traffic congestion, which in turn compromises bus speeds. At the same time, bus services operating in the Dominion Road corridor are subject to extremely high levels of demand, so that most services operate commercially, ie without public subsidy.

5.2.2 Problem definition

In the late 1990s, traffic congestion on Dominion Road was hindering efforts to improve bus reliability and further increase patronage on the main route through the Auckland isthmus. With bus numbers expected to grow significantly, bus priority measures were required to ensure efficient and reliable bus services.

5.2.3 Scheme description

The Dominion Road bus only lanes were implemented by Auckland City Council in 1998. The project converted existing peak-hour clearways into peak-hour bus lanes. The bus lanes stopped short of major intersections to minimise impacts on private vehicles. While no cost information is available, we expect the bus lanes were delivered at a relatively low cost, as they required no changes to kerb lines or road width.

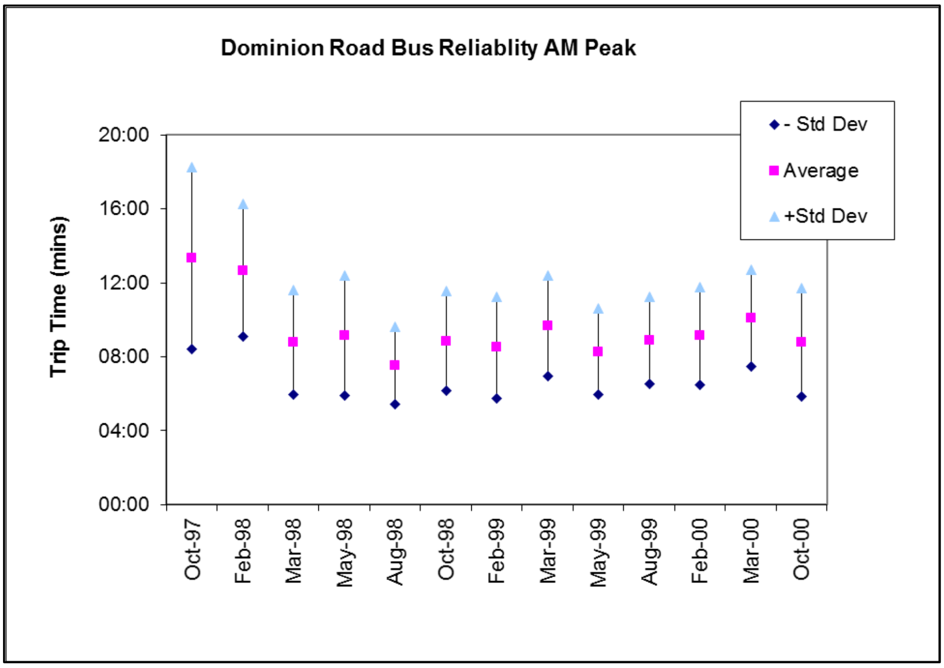
Figure 5.2 Dominion Road bus lanes (www.nzchinese.com)

5.2.4 Transport impacts

The impacts of the bus lanes scheme on bus travel times and reliability has been studied following the implementation of the northbound bus lanes on Dominion Road in early 1998, as illustrated in figure 5.3.

[11] www.aucklandtransport.govt.nz/improving-transport/maintenance/Road/Pages/Traffic-Counts.aspx

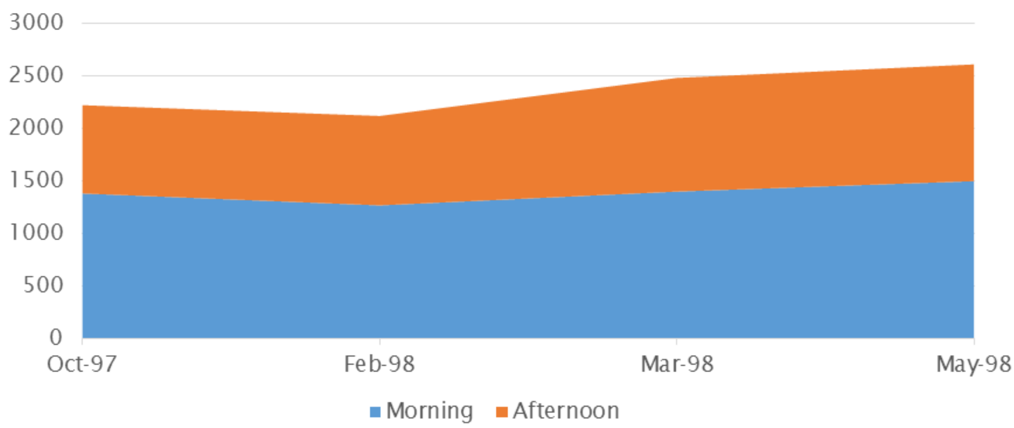
Figure 5.3 Bus travel time reliability along Dominion Road



The data shows the average travel-time for city-bound trips in the AM peak decreasing from circa 13 minutes to 8 minutes following implementation of the bus lanes. Variability in bus travel-times (ie the inverse of reliability) also decreased, with the standard deviation reducing from 4 minutes 15 seconds to 2 minutes 39 seconds.

The Auckland Regional Authority monitored patronage shortly before and after the bus lanes were implemented. This data shows an increase in patronage of about 18% in the morning peak and 31% in the afternoon peak.

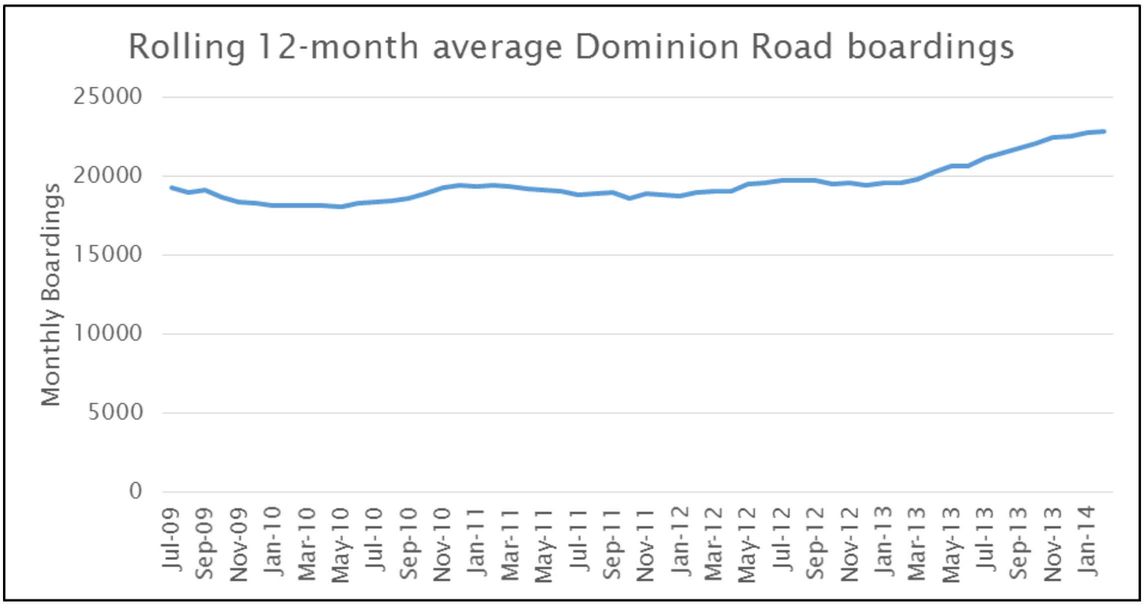
Figure 5.4 Number of boardings on Dominion Road (in AM and PM peak)



This initial patronage growth was followed by ongoing service enhancements, eg higher frequencies. Today, Dominion Road remains one of the busiest bus corridors in New Zealand, with services carrying well over two million boardings pa (approximately 4% of Auckland's total annual public transport patronage)[12]. Figure 5.5 shows passenger number growth between 2009 and 2014.

[12] Patronage data sourced from Auckland Transport.

Figure 5.5 Dominion Road daily bus boardings (12-month rolling average)



An average of 1,732 boardings were recorded in the AM peak in March 2014[13], which represents growth of approximately 20% since the post construction survey in May 1998. Vehicle traffic during the same time period reduced from approximately 2,600 vehicles inbound in the morning peak to approximately 2,430, which equates to a reduction of about 7%.

AT has developed further proposals for improved bus infrastructure on Dominion Road, which will see bus lanes extended through intersections. At the same time, AT has proposed to consolidate bus stop locations and upgrade the general streetscape. At the time of writing of this report, the Dominion Road upgrade project is awaiting start of construction in 2014.

The sustained shift in mode split in favour of public transport associated with the 1998 scheme has created a case for further investment in bus infrastructure. Indeed, the implementation of relatively cost-effective bus priority infrastructure as part of the original project can be considered to have laid the foundation for the more comprehensive bus infrastructure upgrades that are currently being progressed.

Table 5.2 outlines the performance targets for Dominion Road following construction of the extended bus lanes in 2014. This shows measurable indicators through which the impacts of the proposed scheme (once implemented) can be evaluated.

[13] Letter from AT to the Transport Agency, 11 September 2013: Proposed performance measurements: Dominion Road

Table 5.2 Key performance indicators for Dominion Road

Indicator	2013 baseline	2021 Target	2031 Target	2041 Target
1 Bus travel time[2]	11:03 minutes inbound 11:34 minutes outbound	10 minutes inbound 10 minutes outbound	10 minutes inbound 10 minutes outbound	10 minutes inbound 10 minutes outbound
2 Bus boardings[3]	1,457 persons per 2 hours AM peak.	2,429	3,074	3,270
3 Cyclist numbers on parallel cycle routes[4]	22 cyclists per day average as surveyed 4 and 9 July 2013	66	110	154
4 Crash statistics[5]	4.18 crashes per km for the 2008 to 2012 five year period	3.55	3.55	3.55
5 All vehicles [6]	2,490 vehicles per 2 hours AM peak inbound	2,103	2,156	2,209
6 Total person movements	4,445 per two hour AM peak inbound	4,952	5,661	5,920

Note 2: travel time drops on completion of project and holds constant. Note 3: bus boardings increase per CRL model due to more services, faster speeds, more passengers and use of double decker buses. Note 4: cyclist numbers double on completion of project then increase at 10% pa. Note 5: 15% reduction in crash stats. Then hold constant. Note 6: ART3 scenario 1 per AT Transport Modelling Leader.

5.2.5 Appraisal summary table

The AST for Dominion Road is set out in table 5.3 (Note: the completed pro-forma worksheet for the economic/financial assessment is set out in appendix H). Wherever possible, the data used in the AST was derived from information collected by the former Auckland City Council (1998). Alternatively, where actual data was unavailable then we estimated values.

Table 5.3 Case study 1: Dominion Road bus lanes appraisal summary table

			Page 1
Scheme name:	**[Dominion Road bus lanes]**	**Infrastructure scheme type:**	**[Bus lanes]**
Brief description:	[The project consisted of the conversion of existing peak-hour clearways into peak-hour bus lanes. The bus lanes were stopped short of the intersections to minimise disruption for private vehicles and to ensure the impact of the bus lanes on the capacity of the intersections was curtailed. Because no road widening was required, these works will have been delivered at a relatively low cost]	Business case stage: Assessor name:	[Monitoring] [ ]

Problem definition/ opportunity	[Traffic congestion on Dominion Road was hindering efforts to improve bus reliability and suppressing patronage growth. With bus numbers expected to grow, priority measures were required to ensure efficient and reliable operation of the bus network]	Assessment date:	[ ]

Category		Assessment of relevant measures	Summary of impact
A. Key factor data			
Total patronage		Total patronage on routes serviced by proposed infrastructure scheme	6,000
Facility utilisation		1,440 trips per two-hour AM peak period	1,440[a]
Private vehicle trips		1,740 trips per two-hour AM peak period	1,740[a]
Other		n/a	n/a
B. Economic/financial impacts			
B1. Benefits			
Public transport existing user benefits	In-vehicle time	Reduced by five minutes (b)	$601,000
	Access time		n/a
	Wait/transfer time		n/a
	Frequency benefits		$6,200
	Reliability benefits	Standard deviation reduced from 7:56 to 5:51m	Refer IVT above
	Infrastructure quality		n/a
	Subtotal		**$607,200**
Public transport new user benefits		18% increase in AM, 31% in PM peak period[b]	$16,000
Road user benefits			$0
Total annualised benefits			**$622,800**
B2. Costs			
Capital costs (public sector)		Estimated cost of $3m	$261,600
Recurrent costs (public sector)		Includes PT expenses and maintenance	-$157,000
Total annualised costs			**$104,000**
B3. Cost-benefit assessment			
Net present value (NPV)		Benefits mainly accrue to existing users	**$518,800**
Benefit-cost ratio (BCR(G))		Relatively cost effective scheme with large benefits	***6.0***
C. Social/environmental impacts			
Access to services	Catchment area/ connectivity	Larger catchment due to increased public transport quality[c]	+
	Accessibility (for people with disabilities)	[As above]	[# or +/- scale]
Simplicity	Simplicity/legibility	Bus lanes improve legibility/visibility of bus routes[c]	+
Safety and security	Safety and accidence prevention	Improved cyclist safety as buses now do not have to weave in and out of traffic lanes frequently.	+
	Personal security	[#]	[# or +/- scale]
Emissions	Noise	[#]	[# or +/- scale]

	Local air quality	[#]	[# or +/- scale]
Townscape /landscape	Sense of place Urban realm	[#]	[# or +/- scale]
	Severance	[#]	[# or +/- scale]
D. Other local area impacts			
Amenity impacts on neighbours		[Summary of assessment with quantitative results (where possible) or qualitative assessment with 5-point scale]	[# or +/- scale]
Local land use impacts		Improved accessibility of local shops	+
Property access / car parking		No change, as existing clearways had limited parking	0
Commercial/retail impacts		[As above]	[# or +/- scale]
E. Process/implementation risks			
Organisational/political		Some risk as this was the first project to implement bus lanes in Auckland region.	-
Stakeholder/public		Some risk in public consultation as project was about removing car capacity in favour of bus lanes. First bus lane to be implemented.	-
Business case		Some risk surrounding the evidence for the requirement and benefits. Impacts not entirely known.	-
Planning/ consenting		Implementing bus lanes was a new process for many within the organisation.	-
Implementation		Few risks as it involved changing existing clearway to bus lane. No extra removal of parking required.	-
Operational		Impacts, particularly on general traffic needed to be assessed carefully. Small negative impact on vehicle travel time.	-

5.2.6 Risk assessment

Through the case study the Dominion Road bus lane project has provided insights into risk identification and realisation that can usefully be applied to other projects going forward.

Table 5.4 Case study 1: Dominion Road interchange risk summary table

Risk area	Finding	Application
Political	As the first major bus lanes to be constructed in New Zealand, the original Dominion Road bus lane project was associated with considerable political risks. This risk was partly mitigated by a significant amount of ex-ante research and significant post implementation surveying. Bus travel times, patronage, private vehicle travel times and volumes were all recorded before and after implementation. The monitoring showed a significant positive impact of the implementation of the bus lane.	Comprehensive monitoring - Essential for promoting and sharing success and learning from deficiencies. Applicable to most medium to large scale bus based infrastructure projects. Particularly in locations where bus facilities are less common.
Managing expectations	Bus priority measures can have significant long-term effects. While the Dominion Road bus lanes had a short-term effect on bus travel times and reliability, they also enabled a wider shift towards public transport that otherwise would not have otherwise occurred – thereby justifying subsequent investment.	Applicable to most medium to large-scale bus-based infrastructure projects. Particularly in locations where bus facilities are less common.

Risk area	Finding	Application
Operational importance	Improved bus reliability and travel time impacts on operation cost and ultimately the frequency of buses. Improved frequency along with reliability will have long-term effects on patronage. These changes have to be taken into account when economically assessing bus priority measures.	Applicable to all large-scale bus-based infrastructure projects.
Financial risk	The financial risk related to this project was relatively low. No road widening was required for the project, as existing clearways could be converted to accommodate the new bus lanes. Capital works required involved painting of bus lane road markings and signage.	Limited application to risk assessment going forward. However, good example of an 'easy win' where paint and signs can have a significant impact on bus reliability and contribute to patronage increases.

5.2.7 Conclusions

Medium-scale bus priority measures have the potential to deliver significant benefits in the short and long term. The Dominion Road bus lanes improved bus travel times and reliability and catalysed a significant shift towards public transport. Reasonably robust data has enabled the schemes benefits to be quantified, and demonstrated to be significant. This experience should be held up so as to alleviate opposition to bus priority measures, especially when based on perceived disbenefits to drivers – which in busy bus corridors seem likely to be outweighed by the benefits to bus passengers.

5.3 Case study 2: New Lynn interchange

5.3.1 Background

The New Lynn bus interchange was opened in 2010 at a total cost of $15.4m. The bus interchange was seen as an integral part of a new $120 million transit-oriented development designed to support the re-development of New Lynn as a sub-regional centre, as recommended by the Auckland Regional Growth Strategy 2010. The bus interchange was developed on the site of the previous interchange, adjacent to the New Lynn town centre and associated mall.

New Lynn interchange sits at a strategic point in the wider sub-regional public transport network. Approximately 825 buses stop somewhere in the vicinity of the interchange in an average weekday, with a peak bus stopping volume of more than one bus per minute. The bus interchange also provides access to the adjacent train station for travel further afield and to the shopping centre – mall and mainstreet.

The following sub-section discusses the impacts of the New Lynn interchange in more detail.

5.3.2 Problem definition

The previous New Lynn interchange provided relatively low levels of amenity for pedestrians in general and for bus passengers in particular. For this reason, the design of the new bus interchange focused on creating a highly amenable environment with strong connections to the adjacent rail station and nearby land uses, including a major mall. New Lynn was undergoing significant redevelopment following adaptation of the New Lynn 2010 strategy by the Waitakere City Council. The transit-oriented development (TOD) scheme relied heavily on public transport to support the town centre. The existing train tracks were trenched and a new railway station was constructed. To improve the public transport user experience and ensure a safe and convenient transfer between bus and train and bus and town centre, a new bus interchange was required that also integrated with the redevelopment of the town centre and train station.

5.3.3 Scheme description

Key features of the New Lynn interchange include:

- The interchange was designed to integrate with and support a wider re-development strategy for the town centre, including improved rail infrastructure and services.
- The interchange incorporated high-quality design as a means to countering negative public perceptions.
- The quality of the interchange has subsequently enabled (after a three to five year lag) AT to realise major operational efficiencies in the wider public transport network.
- The cost of the interchange, as well as its integration with a major rail project, created large and complex risks, especially in regard to securing funding.

5.3.4 Transport impacts

AT's post-implementation review (PIR) provides an overview of what the project achieved. It states that 'the purpose of this PIR report is to (a) outline how well the New Lynn Package has delivered its expected benefits, (b) identify and explain any variation between expected and actual (observed) benefits and costs, and (c) identify lessons learned and/or good practice that can be used to improve the delivery of similar projects in the future. The PIR identifies the key benefits and achievements of the package as:

- The overall project (including TOD stages 1 and 2 and rail station) was delivered for $120m, $40m below budget.
- It has won a number of prestige engineering and architectural awards, including the ACENZ Award of Excellence 2011 and the NZEE Supreme Award for New Zealand Engineering Excellence 2012 for the New Lynn Rail Trench and New Lynn Rail Station.
- Rail use in 2012 is ahead of the 2016 planned target (ie boarding is up by 60%).
- Improvements in travel times (planned versus actual) are shown along Clark Street and Great North Road, in particular during the AM and peak time periods.
- A reduction in the number of crashes along Clark Street from Rankin to Portage is evident, reducing from eight in 2010 to three in 2011.

Bus patronage in 2012 was below the 2016 planned target. This was to be expected as integrated ticketing had only recently been implemented and structural changes to the bus network were planned but not yet implemented.

As mentioned above, the development of New Lynn bus interchange did not deliver immediate operational efficiencies, with bus services left largely unchanged as work progressed on other parts of Auckland's public transport network, specifically integrated fares and electrification of the rail network.

The impending completion of these two major projects, however, now creates the opportunity for a major reorganisation of the bus network ('the new network', or NN). The NN proposes a move towards a more frequent and connected network, with a greater reliance on transfers between services at locations such as New Lynn. The New Lynn interchange plays a key role in enabling the NN, which will rely more heavily on transfers, particularly between bus and train.

5.3.5 Retail impacts

We analysed retail impacts of the New Lynn bus interchange in two ways: 1) we surveyed local retailers and 2) we analysed electronic transaction data.

First, we surveyed retailers close to the New Lynn bus interchange. For this survey, paper surveys and an information letter were dropped off at every retailer in the study area. These surveys were recovered later the same day. As an alternative, retailers were given the option to fill out the survey online. The response rate was relatively low, with about 10 responses recorded out of an estimated 50 retailers. Hence, results are extremely sensitive to sample size and are unlikely to be representative.

The survey focused on retailers experience before and after completion of the bus interchange. Questions asked covered the trend in business turnover pre- and post-construction, change in travel patterns for staff, council communications during the construction phase and the impact on foot traffic. We noted the following responses to our survey:

- Five of the 10 businesses surveyed were operating before construction began on the bus interchange. None of these businesses expected the bus interchange to impact negatively on their business, but three businesses noted a loss of business during construction. One business saw an increase in public transport usage by their staff.
- Communications by the council were generally well received. Most people were happy with the frequency and effectiveness of the communication.
- Retailers in the survey area on average expect 71% of their customers to arrive by car and only 11% to arrive by public transport.
- With regards to the overall impact of the bus interchange, three businesses found it to have a negative impact on business, two found it to be positive, three did not know.
- Interestingly, seven out of nine businesses considered the close proximity of their business to the interchange a benefit to their business in the future.

It is important to note that while the public transport improvements were one driver in the revitalisation of New Lynn, numerous other projects have been undertaken in recent years, including street scape upgrades, development of more retail, and road realignment. All of these projects will have had an impact on foot traffic, retail expenditure and subsequently the perceptions of local retailers.

To gain more independent and comprehensive insight into retail impacts, we also collected electronic payment data (EFTPOS transactions) for all retailers in area surrounding the New Lynn interchange. This data is provided by Paymark, who handles about 75% of all electronic payment data in New Zealand. Using the data provided, the trend before and after completion of the bus interchange can be established.

The following table show the total number of transactions and volume of retail spend from one year before completion of the bus interchange to one year after. It is recognised that not all construction work had been completed one year after the completion of the bus station.

Figure 5.6 Monthly retail spending and transactions New Lynn

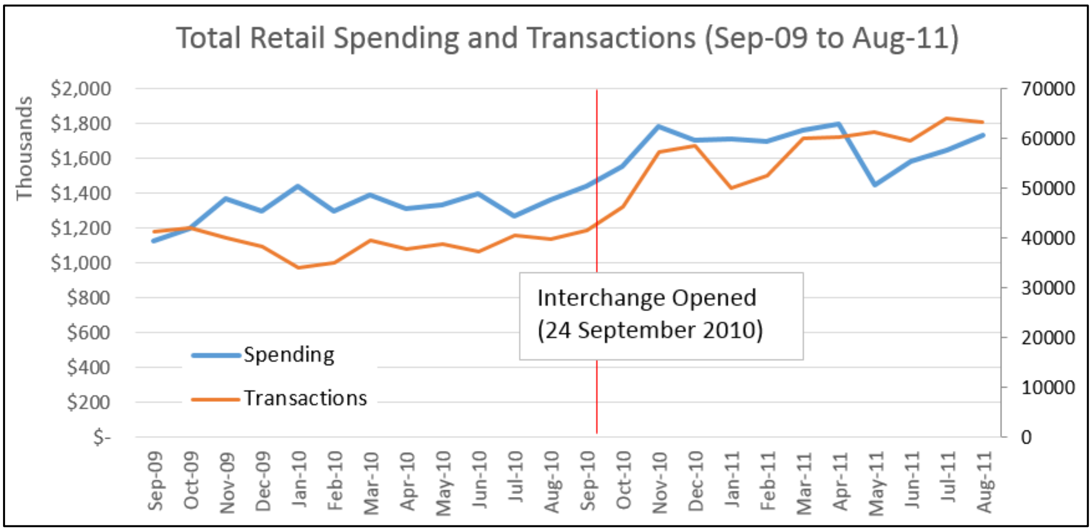


Table 5.5 Monthly retail spend New Lynn

Time period	Average monthly transactions	Average monthly spend
September 2009 – August 2010	66,224	$2,249,661
September 2010 – September 2011	96,163	$2,833,650
Increase	**+45%**	**+26%**

We find there was a large increase in both retail spend and the number of transactions following completion of the interchange. However, the number of transactions grew faster than the total spend, which indicates that the average spend per transaction has reduced. This potentially suggests a shift in the nature of retail activity towards smaller purchases.

Overall the payment data shows relatively strong growth in retail spend in the New Lynn area after completion of the bus interchange. Retail growth in the wider Auckland region was 38% in the period 2000 to 2010 (Fairgray 2011), although much of this growth was likely to be associated with the city centre and other areas which experienced sizable population increases. More detailed analyses of spatial trends in retail activity appear to be a worthwhile area of future research.

5.3.6 Appraisal summary table

The following table summarises the appraisal for the New Lynn interchange project. We note the project qualified for Transport Agency funding and was also associated with a fairly comprehensive post-implementation study. Where possible, this data has been used in the AST. Where data was not available, we have estimated inputs using the most comparable information available.

We emphasise that this evaluation is in many respects premature, insofar as not all benefits of the new bus interchange have yet been realised. More specifically, the interchange was partly constructed to facilitate a restructure of the surrounding bus network to realise operational savings. This re-structure is expected to be consulted on in mid-2014, with implementation soon thereafter.

Table 5.6 Case study 2: New Lynn interchange appraisal summary table

Page 1

Scheme name:	**[New Lynn bus interchange]**	**Infrastructure scheme type:**	**[Bus lanes]**
Brief description:	[The project consisted of upgrading the existing bus interchange at New Lynn, while parallel projects delivered a trenched railway, new railway station and new roads for general traffic]	Business case stage:	[Monitoring]
		Assessor name:	[ ]
Problem definition/ opportunity	[The New Lynn interchange is part of the transformation of New Lynn as a TOD. The interchange enables better transfers between bus and train and delivers a high quality public transport environment]	Assessment date:	[ ]

Category		**Assessment of relevant measures**	**Summary of impact**
A. Key factor data			
Total patronage		Total daily patronage on routes serviced by proposed infrastructure scheme	9,740
Facility utilisation		Number of passengers using the facility per 2-hour peak period.	2,715
Private vehicle trips		n/a	n/a
Other		n/a	n/a
B. Economic/financial impacts			
B1. Benefits			
Public transport existing user benefits	In-vehicle time	No vehicle travel time savings envisaged	n/a
	Access time	Two minutes faster access time estimated	$324,000
	Wait/transfer time	Three to four minutes faster transfer time between bus/bus and bus/train estimated	$320,000
	Frequency benefits	Small frequency benefit	$9,900
	Reliability benefits	n/a	n/a
	Infrastructure quality	Improved waiting facilities	$165,000
	Subtotal		**$819,000**
Public transport new user benefits		Approximately 290 new passengers expected	$12,600
Road user benefits		Due to decongestion	$25,000
Total annualised benefits			**$856,000**
B2. Costs			
Capital costs (public sector)		Cost of project: $12.7m	$1,107,000
Recurrent costs (public sector)		[Brief comment on impact/significance]	-$162,000
Total annualised costs			**$946,000**
B3. Cost-benefit assessment			
Net present value (NPV)			**-$89,000**
Benefit-cost ratio (BCR(G))		*Cost at this stage outweighs benefits*	**0.9**

C. Social/environmental impacts			
Access to services	Catchment area/ connectivity	Much improved connectivity between town centre and bus interchange	++
	Accessibility (for people with disabilities)	Easier access between bus and train station	++
Simplicity	Simplicity/legibility	Improved bus station visibility and legibility of services	+
Safety and security	Safety and accidence prevention	Improved pedestrian crossings, clear pedestrian visibility	$1.6m
	Personal security	Better quality facilities, better design, better safety infrastructure	+
Emissions	Noise	No impact	0
	Local air quality	No impact	0
Townscape /landscape	Sense of place Urban realm	Central public transport interchange supports sense of place in New Lynn, gives town centre a focal point	+
	Severance	Redesign of bus routes reduces severance, consolidates bus stops	+
D. Other local area impacts			
Amenity impacts on neighbours		Increased amenity, higher quality infrastructure.	+
Local land use impacts		Improved public transport accessibility allows for construction of higher density TOD on the surrounding land as part of New Lynn redevelopment plan	++
Property access / car parking		Not greatly affected. New off-street parking building located close by to mitigate any effects.	0
Commercial/retail impacts		Positive impact on retail overall, although some individual stores may have suffered a loss of trade.	+
E. Process/implementation risks			
Organisational/political		Part of a very large and complex set of projects. Complex funding mechanism.	--
Stakeholder/public		Many stakeholders, significant construction nuisance. Expansive consultation required.	-
Business case		Integrated business case for all projects involved. Agglomerated, wide spread and long term benefits from TOD can be complicated to quantify.	-
Planning/ consenting		Significant studies beforehand focusing on different design alternatives and TOD alternatives and objectives	+
Implementation		Complicated construction period with various projects at different stages. Delivered on time and within budget	+
Operational		Operational benefits not entirely realised until new bus network is implemented.	-

The data from the above mentioned AST has been used to do an economic appraisal of the project. Using the worksheet provided in appendix F, the BCR and NPV have been calculated for this project. The economic evaluation of the New Lynn Interchange resulted in a calculated BCR(G) of 0.9. The detailed calculation steps can be found in appendix H1.

The low BCR value is partly due to the fact that not all benefits of the interchange have yet been realised, which will occur following implementation of the NN. We suggest an ex-post BCR analysis of the New Lynn bus interchange is undertaken once the NN is complete and incorporates bus operating cost savings associated with operating a more connective network in this area of Auckland.

5.3.7 Risk assessment

Looking at the delivery of the New Lynn projects there are a number of areas where learning is possible from the identified risks.

Table 5.7 Case study 2: New Lynn interchange risk summary table

Risk area	Finding	Application
Integrated land use	There is significant value in ensuring a comprehensive development strategy surrounding public transport nodes. Development, scaled to the size of the project and surrounding area, will generally concentrate around nodes of frequent public transport. Allowing for this kind of development to take place can greatly enhance the value of the public transport project and contributed to increased patronage and long-term economic benefits.	Applicable to all large scale bus based infrastructure projects. Consideration at the project initiation phase.
Integrated transport	Combining a bus interchange with a train station and developing them in tandem ensures an integrated design and will add more value over delivering a bus interchange by itself.	Applicable to all large-scale bus-based infrastructure projects near other public transport modes. Consideration at the project initiation phase.
Network operation – all modes	Tailoring the bus network to suit more integrated public transport trips and enhance the benefits of the initial investment. Consideration should be given to network operation, all modes, during and after construction to ensure integrated transport and a 'sum is greater than the parts' outcome.	Applicable to all large-scale bus-based infrastructure projects. Consideration at the project initiation phase.
Community engagement/political	It can take a long time for transport benefits to materialise and can be hard to capture in a simple ex-ante evaluation. It is important to recognise these effects though, as they can have a very significant impact on patronage in the city.	Applicable to all medium to large bus infrastructure projects. Managing expectation of benefit realisation throughout the project lifecycle. Achieved through robust monitoring programme.
Effected party engagement/political	Integration of public transport and land use development can generate a more vibrant town centre with an enhanced retail sector. While not all retailers benefit equally from the changes, in fact some business owners might suffer a loss due to a change in retail type, the town centre as a whole can benefit from the increased pedestrian traffic and urban design environment.	Applicable to all medium to large bus infrastructure projects. Managing expectation of benefit realisation throughout the project lifecycle. Achieved through robust monitoring programme.
Financial	The project was delivered under budget; a positive outcome. Although capital underspend, particularly of the scale in this project ($40m under an estimate of $160m) can come with its own risks in terms of organisation cashflow. The case study and investigation did not pinpoint any particular element that enabled delivering the project under budget.	Applicable to all medium to large bus infrastructure projects. Accurate cost estimate and consistent message to political and public stakeholders.

Risk area	Finding	Application
Project partner interface (organisational)	The key risk facing this project was related to its complexity. The bus interchange upgrade was part of the revitalisation of the New Lynn town centre, which included roading upgrades, trenching of the railway line and the bus interchange. The large number of stakeholders greatly increased the complexity of the project. Kiwirail, OnTrack, ARTA, Waitakere City Council and the Transport Agency were all key stakeholders during the process	Applicable to all medium to large bus infrastructure projects with multiple project partners. Clear communication to public even though project delivered by multiple partners – public only see one project.

5.3.8 Conclusions

Some key lessons can be drawn from the New Lynn project.

The first is the value of a comprehensive development strategy surrounding major interchanges. Especially in larger cities, there is merit in enabling development to concentrate around locations where frequent public transport is available. Encouraging this kind of development by investing, for example, in urban amenity, can enhance public transport operating efficiency. Such investment will typically offset any negative retail impacts that occur during construction.

Fully realising the benefits of large-scale investment in public transport interchanges, however, requires a simultaneous commitment to improving operational efficiency of services using the interchange. In the case of New Lynn, benefits to public transport users were insufficient to achieve a BCR in excess of 1.0. Instead, the development of the interchange needed to be a catalyst for wider changes to the surrounding bus network, especially on reducing duplication between bus and rail. Such benefits are only now being realised, with delays partly linked to the absence of integrated ticketing and fares in Auckland.

New Lynn demonstrates how integrating bus interchanges can increase retail activity. These benefits, however, may not be distributed evenly between retailers.

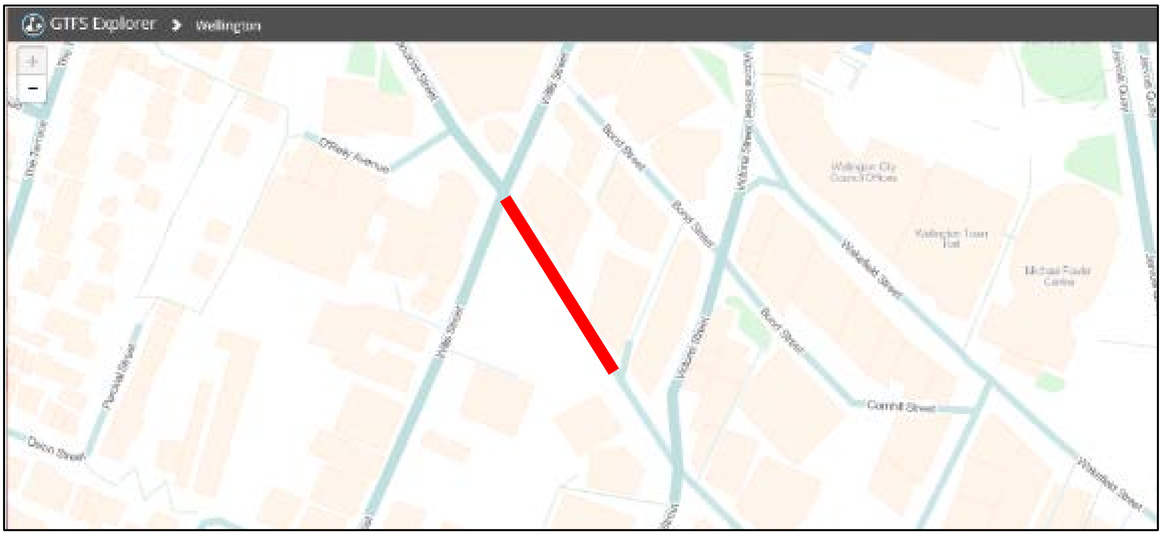
5.4 Case study 3: Manners Mall bus lanes

5.4.1 Background

Manners Mall served as a pedestrianised street in Wellington's CBD from the 1970s until 2010. The Manners Mall bus lanes project came about in 2008 when Wellington City Council received a report proposing improvements at the southern end of the Golden Mile, which was perceived to be a significant factor contributing to bus delays.

In response to this report the council determined that a comprehensive and holistic plan was required for the wider area. This considered the role of the Golden Mile within the Ngauranga to Airport Corridor Plan, and also the Greater Wellington Regional Council and bus operators. A controversial element of the project was the removal of a 120m pedestrian mall from the western end of Manners Mall, which had existed since circa 1970. This section of bus lanes is illustrated in red below.

Figure 5.7 Introduction of bus lanes to Manners Mall



To compensate for the loss of public space in Manners Mall, Wellington City Council proposed new pedestrian improvements in the wider area.

The Manners Mall bus lane scheme is a useful case study because of the risks involved in delivering projects in central city environments. The project required input from a variety of stakeholders, including bus operators, local authorities, pedestrians, retailers, drivers and public transport users. The project also required a special process under the Local Government Act 2002 to revoke the pedestrian mall status. Partly in response to these risks, there is a comprehensive series of papers evaluating the proposal, including a number of technical reports considering impacts on bus travel times and wider retail impacts.

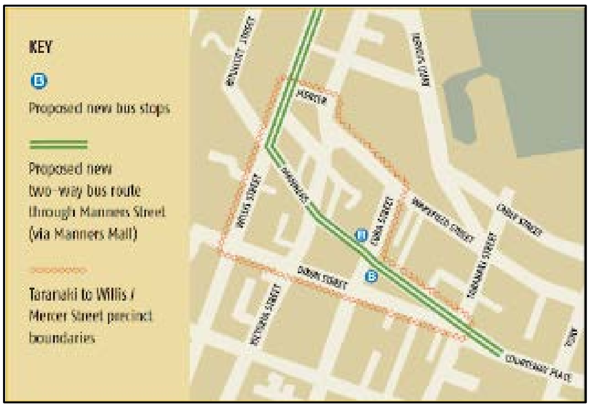
5.4.2 Problem definition

Buses in central Wellington encountered significant delays due to their circuitous routing and traffic congestion. Furthermore, the bus network lacked legibility due to the one-way bus routes around Wellington's 'Golden Mile'. By removing the pedestrian mall designation from Manners Mall, buses were able to follow a more direct route through the CBD between Willis Street and Taranaki Street. This was expected to improve bus journey times and reliability and increase bus network legibility and patronage.

5.4.3 Scheme description

The extent of the project is illustrated in figure 5.8.

Figure 5.8 Manners Mall bus lanes

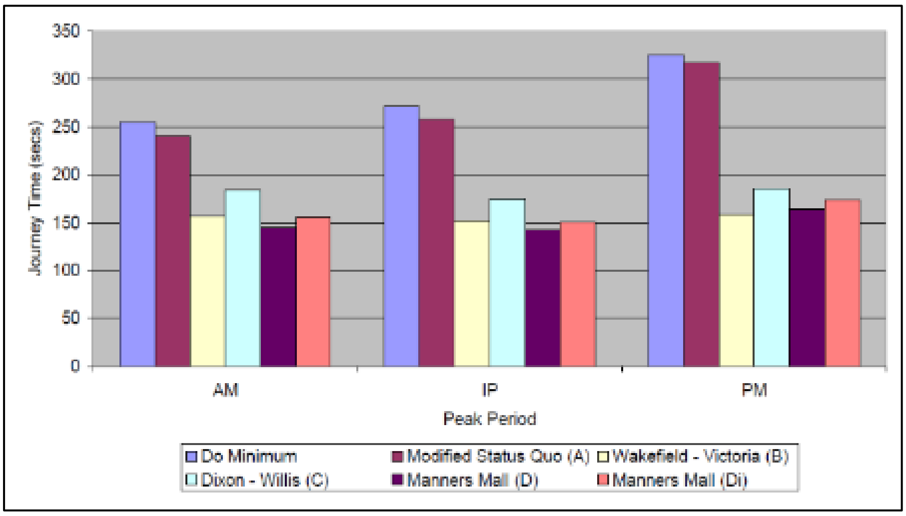


The Manners Mall bus lane scheme involved reconstructing Manners Street by establishing new bus lanes in Wellington's city centre between Willis Street and Taranaki Street; the project was completed in November 2010.[14] The project aimed to improve bus travel times and reliability along the Golden Mile and improve overall legibility.

5.4.4 Transport impacts

An ex-ante evaluation of the proposal was undertaken, which modelled the impacts of the proposal on bus travel time and reliability. Of the four different scenarios modelled, scenario D was chosen as it was associated with the most significant gains in bus travel time.

Figure 5.9 Modelled bus travel time along the Golden Mile (Opus)



An ex-post evaluation of the Manners Mall project was undertaken by the Greater Wellington Regional Council. Bus travel times between points either side of Manners Mall were evaluated before and after the Manners Mall bus lanes were implemented. The results of this analysis can be found in table 5.8.

Table 5.8 Bus travel times (minutes) before and after

Southbound	May 2010	May 2011	Change
Early AM (to 6:59)	2.5	3.4	36%
AM peak (7:00–8:59)	3.6	4.3	19%
Interpeak (9:00–13:59)	4.1	4.5	10%
PM peak (14:00–16:59)	4.7	4.9	4%
Evening (from 18:00)	3.5	4.1	17%
All day	3.9	4.4	13%
Northbound	**May 2010**	**May 2011**	**Change**
Early AM (to 6:59)	4.1	4.7	15%
AM peak (7:0–8:59)	5.5	5.4	-2%
Interpeak (9:00–13:59)	5.9	5.9	0%
PM peak (14:00–16:59)	7.7	6.6	-14%
Evening (from 18:00)	4.9	4.9	0%
All day	5.8	5.7	-2%

[14] http://wellington.govt.nz/~/media/your-council/projects/files/brochure.pdf

As can be seen from this table, travel times only increased in the southbound direction, with the most notable decreases in the PM peak northbound (14%, or 1.1 minutes). This indicates the Manners Mall bus lanes did deliver faster bus travel times in the PM peak, but not in the AM peak.

We understand the absence of benefits in the AM peak may reflect differences between the scheme that was modelled and the final design that was implemented. Specifically, the final implementation included an additional bus stop on Manners Street (which modelling assumed would be removed), while the final design included an additional pedestrian crossing on Willis Street.

5.4.5 Retail impacts

A survey was undertaken among retailers on Manners Street and retailers on the side streets, close to Manners Street. It was hand delivered to retailers, together with an information letter explaining the purpose of the research. The survey was picked up the following day to allow retailers enough time to fill it out. The retailers were also given the option to fill out the survey online.

The survey focused on retailers' experience before and after the reconstruction of Manners Street. Questions asked covered the trend in business turnover pre- and post-construction, change in travel patterns for staff, council communications during the construction phase and the impact on foot traffic. This same survey was undertaken for the New Lynn case study.

Key findings from the survey were:

- Most businesses (67%) had an increase in sales prior to the opening of the bus lanes.
- 67% expected business to decrease following the opening of the bus lanes, only 7% expected an increase.
- During construction, 87% noted the works had a negative impact on business.
- 56% reported a decline in sales post-construction of the Manners Mall bus lanes
- 56% claimed the number of pedestrians had decreased post-construction; 19% claimed there was no change; and 0% thought there was an increase.
- General opinion on the impacts of the opening of Manners Mall on retail business was quite negative. 31% considered the impact to be minimal, but 50% considered the opening of Manners Mall to buses had a negative effect on business.
- 71% considered the location of the business next to the bus lanes had a negative impact on the future of the business.

5.4.6 Electronic payment data

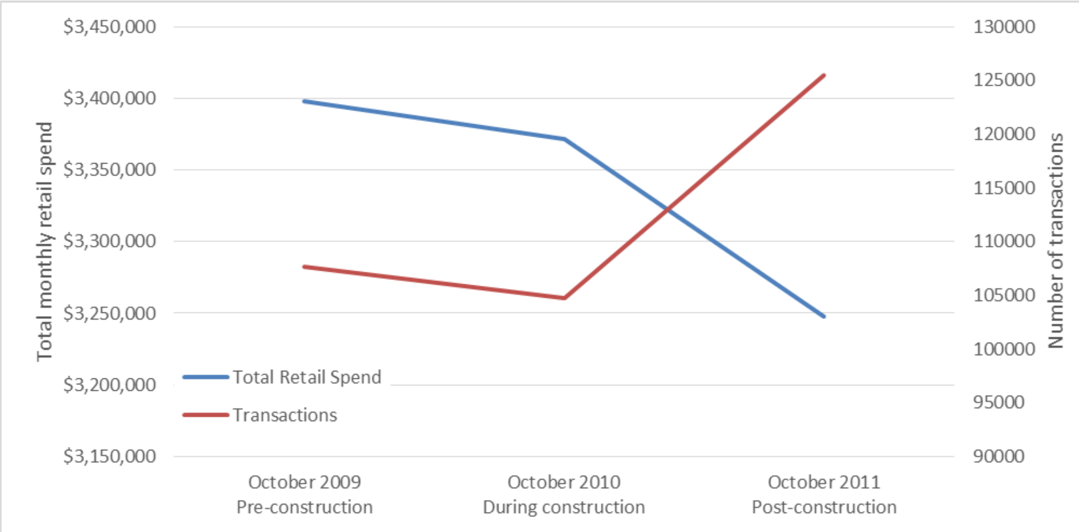
Electronic payment data was collected to analyse the impacts of the opening of Manners Mall to buses. Payment data was collected for October 2009 (prior to construction), October 2010 (during construction) and October 2011 (after completion) to assess the impacts of construction and opening. The following table shows the total spent and number of transactions per month.

Table 5.9 Changes in retail spending Manners Mall

Time period	Monthly transactions	Change (2009 = 100)	Monthly spending	Change (2009 = 100)
October 2009	107,630	100	$3,398,000	100
October 2010	104,713	97	$3,372,000	99
October 2011	125,456	117	$3,248,000	96

As can be seen in the table, the total amount spent at Manners Mall decreased by 4% when comparing the before and after data. During construction, the total amount spent decreased slightly, by 1%. The total number of transactions, however, dropped during construction, but bounced back up after completion to an increase of 17% compared with pre-construction levels. The development of retail spend and number of transactions over time is shown in figure 5.10.

Figure 5.10 Retail spending and number of transactions in Manners Mall



This data corresponds with surveys of retailers, in which respondents indicated a decrease in business following construction of the bus lanes on Manners Mall.

Comparing the Manners Mall data to region-wide retail spending shows a big discrepancy between the two. During the 12 months up until March 2010, retail spend in the Wellington region dropped by about 4.1%, but recovered in the 12 months up to December 2011, with a growth rate of 7.7% (NZ Retailers Association 2011). This growth rate is not reflected in the Manners Mall data, which shows a decline in retail spend and no recovery.

We note that retail impacts are not relevant to economic assessment from a transport investment perspective, but are part of the wider multi-criteria analysis/management of risk and an important factor for local decision makers.

5.4.7 Appraisal summary table

Post-implementation study for Manners Mall is relatively limited. Some data with regards to bus travel times has been collected, other information is gathered from the scheme assessment report.

Table 5.10 Case study 3: Manners Mall bus lanes appraisal summary table

			Page 1
Scheme name:	**[Manners Mall bus lanes]**	**Infrastructure scheme type:**	**[Bus lanes]**
Brief description:	[The project included re-opening of Manners Mall to buses by implementing two-way bus lanes through the existing pedestrian mall]	Business case stage:	[Monitoring]
		Assessor name:	[ ]
Problem definition/ opportunity	[Improvements were required to Wellington's bus network to ensure more reliable travel time and reduce delay experienced at intersections. It also simplified the bus network in Wellington CBD]	Assessment date:	[ ]

Category		**Assessment of relevant measures**	**Summary of impact**
A. Key factor data			
Total patronage		Total bus passengers per day	48,000
Facility utilisation		Total buses per day	2,020
Private vehicle trips		n/a	n/a
Other		n/a	n/a
B. Economic/financial impacts			
B1. Benefits			
Public transport existing user benefits	In-vehicle time	Vehicle travel time +0.5m NB, -0.1m SB	$300,000
	Access time		
	Wait/transfer time		
	Frequency benefits		
	Reliability benefits		
	Infrastructure quality		
	Subtotal		**$300,000**
Public transport new user benefits			$25,000
Road user benefits			$0
Total annualised benefits			**$325,000**
B2. Costs			
Capital costs (public sector)		Cost: $11.1m	$1,011,000
Recurrent costs (public sector)			-$53,000
Total annualised costs			**$1,058,000**
B3. Cost-benefit assessment			
Net present value (NPV)			**-$757,000**
Benefit-cost ratio (BCR(G))			***0.3***

C. Social/environmental impacts			
Access to services	Catchment area / connectivity	Catchment reduced in area, but services shops on Manners Mall more directly.	+
	Accessibility (for people with disabilities)	No impact	n/a
Simplicity	Simplicity/legibility	Much improved legibility of bus network with buses down central spine.	++
Safety and security	Safety and accidence prevention	Some incidents with pedestrian/bus conflicts. Requires more investigation.	--
	Personal security	Some safety issues around the pedestrian mall improved due to increased connectivity.	+
Emissions	Noise	Noise impacts on local retailers, anecdotally noticed as being quite bad.	-
	Local air quality	Reduced air quality in Manners Mall expected.	-
Townscape /landscape	Sense of place Urban realm	Less pedestrian space through removal of pedestrian mall, some of that was reinstated elsewhere.	--
	Severance	Much more severance through Manners Mall.	-
D. Other local area impacts			
Amenity impacts on neighbours		Local shops very concerned about negative impact of noise, fumes and vibrations.	--
Local land use impacts		Expected to have benefits for local land use, some change noticed with retail turning over.	0
Property access/car parking		62 extra on-street car parks constructed, easier property access for stores.	+
Commercial/retail impacts		Negative impact for local retailers with drop in retail sales following construction. -4% drop in sales.	--
E. Process/implementation risks			
Organisational/political		High-profile project, needed a lot of political consensus.	-
Stakeholder/public		Public was opposed to removing the pedestrian mall status. Mitigation in the shared space at lower Cuba Street tried to address this issue.	-
Business case		Modelling of expected outcomes did not provide an accurate prediction. Actual outcomes significantly worse than model predicted.	--
Planning/ consenting		Special legislative process required to revoke pedestrian mall status. Had not been used before.	--
Implementation		Local shop owners experienced a lot of nuisance during construction.	-
Operational		Expected travel time savings not quite achieved.	--

In terms of the BCR, we understand the project was positioned as an urban design project and a significant proportion of the costs were for urban design elements, including changes to Lower Cuba Street. As we have included all of the capital costs in our BCR calculation, our appraisal is likely to overstate the true costs. A more detailed assessment would seek to split the costs attributable to bus priority measures from the wider urban design and pedestrian improvements that were implemented as part of the project.

5.4.8 Risk assessment

The Manners Mall project is an interesting case study for risk, with many of the identified risks being realised during the course of the project. These risks are summarised in the table below.

Table 5.11 Case study 3: Manners Mall risk summary table

Risk Area	Finding	Application
Political	Opening of Manners Mall to buses was a high-profile project for the Wellington City Council. There was a lot of public interest, as the projet involved removing a pedestrian-only area from Wellington's CBD. There were inherent safety and economic risks in delivering the project.	Applicable to some medium to large-scale bus-based infrastructure projects, particularly in central CBD areas where pedestrian movement and commercial activity are high.
Effected party engagement/monitoring	Integration of public transport and land use development can generate a more vibrant town centre with an enhanced retail sector. However there is significant perceived risk by local businesses. Many of the retailers along Manners Mall were sceptical about the project and its impact on trade during, but also after the construction period. Many citizens were equally concerned about the loss of public open space. This risk was partly mitigated by including a redesign of Lower Cuba Street into the project, including a new shared space.	Applicable to all medium to large bus infrastructure projects. Managing expectation of negative impacts during construction and benefit realisation throughout the project lifecycle. Achieved through robust monitoring programme.
Procedural	Specific to Manners Mall project, the project faced a risk from a special procedure under the LGA. This was a new procedure that required special legislation and had not been done before in New Zealand.	Applicable to all bus infrastructure projects. Consider all legislation relating to not only building but also operating buses when completed.
Operation and benefit realisation	The ex-post evaluation indicates that not all expected benefits have been achieved. Bus travel times have reduced for some time periods, but on average it appears that they have actually increased. Another risk was the change in bus routing and required relocation of bus stops.	Applicable to all medium to large-scale bus-based infrastructure projects. Understanding why benefits were not realised. Good monitoring essential to capture all potential benefit – even those not originally anticipated.
Financial	At a capital cost of about $11m, the project carried some financial risk. While the planning phase took longer than expected, the actual delivery of the project was in line with the schedule and budget.	Applicable to all medium to large bus infrastructure projects.

5.4.9 Conclusions

Opening Manners Mall to buses was a significant project for the Wellington City Council, as the existing pedestrian mall had strong support from the community. In this context, the plan to re-route buses through the mall was met with resistance.

The impacts of the project do not align with the business case, largely because the predicted travel time benefits were not fully realised. This is largely attributable to design changes, such as retention of a bus stop and the installation of an additional pedestrian crossing. For some time periods and routes, travel times have increased. This suggests minor operational decisions, such as the number and location of bus stops and pedestrian crossings, are a risk to bus priority measures.

Prior to construction of the bus lanes, local retailers had significant concerns regarding the changes to Manners Mall and how the introduction of buses on the street would impact on their business. The council's expectation was that more buses would deliver more people to go shopping. Retail data shows total retail turnover in the area dropped by about 4% post-implementation, while the wider region experienced growth. Anecdotal evidence suggests that there is a significant change in retail type, which could indicate that over time the retail sector may recover as the area adapts to the change.

5.5 Case study 4: Tauranga bus interchange

5.5.1 Background

Over the last 10–15 years Tauranga's public transport network has experienced significant patronage growth. This growth has been supported by rapid population growth, as well as increased regional support for public transport services. Regional investment has focused on creating a simple all-day network operating at regular headways. Tauranga operates a simple fare system, which consists of a flat integrated fare that is valid for journeys across the whole network. The public transport system supports connections between services, especially at key locations such as the city and Bayfair.

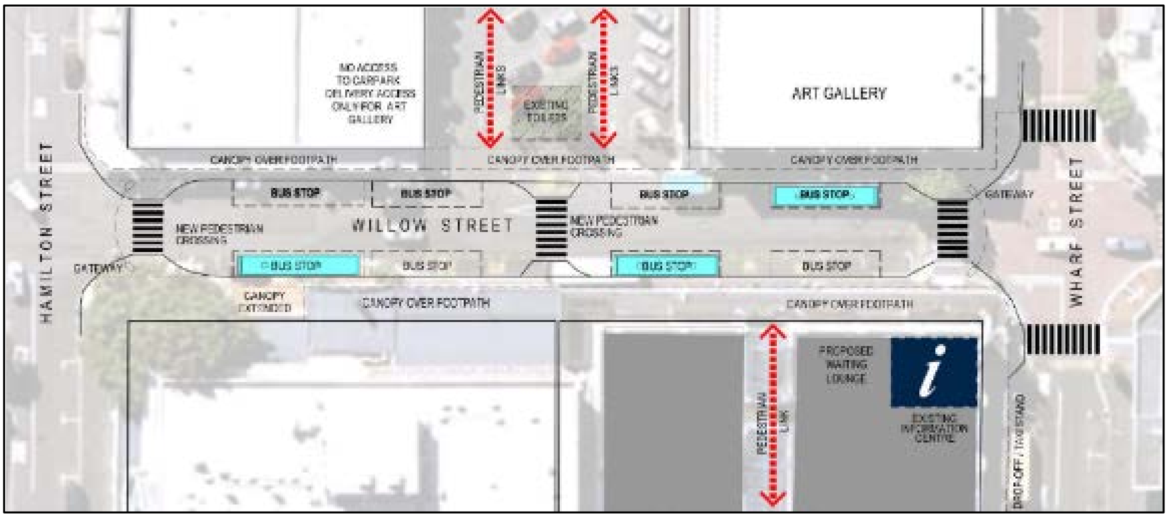
5.5.2 Problem definition

Tauranga's central city bus station was previously located on-street (Wharf Street) in Central Tauranga and catered for both local and inter-regional bus services. Growth in patronage and vehicle volumes meant that buses were increasingly overflowing into Willow Street and Durham Street. As frequencies increased, the number of passengers connecting between services was also expected to grow. The existing interchange was also illegible for passengers, lacked weather protection and had insufficient waiting areas. For these reasons, a new central bus interchange was needed to cater for future growth and meet passenger needs.

5.5.3 Scheme description

Following extensive public consultation and technical analysis, Willow Street was considered the more appropriate option. The proposed bus interchange is shown in figure 5.11.

Figure 5.11 New Tauranga bus interchange



The new Tauranga bus interchange opened in 2010. As an on-street facility it deals with 500 bus departures and up to approximately 3,200 passenger movements per day.[15] Key attributes of the Tauranga bus interchange that lend themselves to being a case study include:

- It focused on providing a cost-effective on-street interchange solution in close proximity to a number of key civic amenities, such as the library and art gallery.
- Passenger pick-up/drop-off was provided for separately from vehicle layover. Vehicles requiring layover of more than 10 minutes were routed around the corner, where they would wait before circling the (small) block to begin their run.
- The proposal to develop a downtown bus interchange encountered significant community opposition from local retailers who were concerned with the negative effects of losing car-parking and amenity effects, such as air quality and visuals.
- Community engagement was managed via a thorough consultation process that was undertaken in accordance with the LGA. This resulted in the production of a comprehensive public consultation document[16] and a realistic simulation video of the proposed interchange.
- The project was implemented for a total out-turn cost of only $750,000. This included the costs of establishing bus stops/shelters and minor changes to the street.

5.5.4 Transport impacts

Ex-ante evaluation that we know of so far includes several reports commissioned by the Tauranga City Council:

- *Investigation into a transport centre for Tauranga* (Booz Allen Hamilton 2004)
- *Tauranga transport centre site investigation* (Parsons Brinckerhoff 2005)
- *Tauranga transport centre stage 2* (Parsons Brinckerhoff 2006)
- *Tauranga bus network review* (Beca 2009)
- *Tauranga city centre strategy* (Tauranga City Council 2007).

[15] Personal communication with Emlyn Hatch, Tauranga City Council.

[16] http://content.tauranga.govt.nz/meetings/2009/September/AGEN%20Council%2029.9.09%20-%20DC294-c.pdf

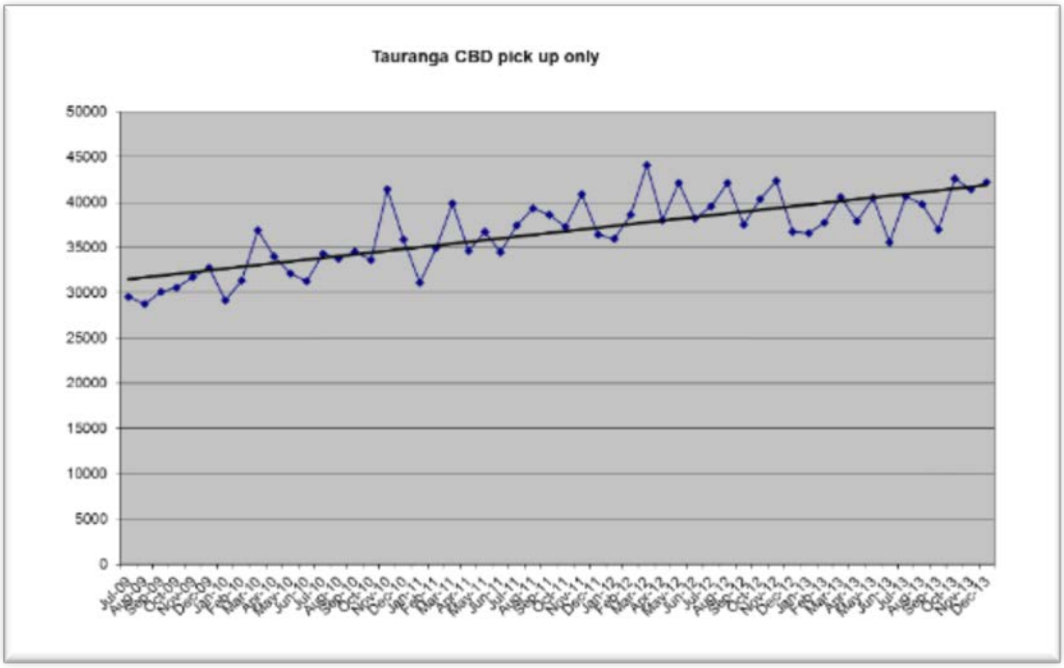
While each of these studies addresses the site location and benefits thereof, very little quantitative evidence is found of these benefits. Each evaluation is mostly qualitative by nature and reflects little on capacity or impacts of the new location of the bus station on bus reliability or expected passenger numbers.

Project costs were calculated at $750,000 (note: later increased to $780,000). With benefits of $3,569,540 the project had a BCR of 4.75 and was eligible for Transport Agency funding.

Little post-evaluation data is available for this project. Data gathered by the Bay of Plenty District Council is limited to the total number of boardings in Tauranga's CBD. As can be seen in figure 5.12, the number of boardings at the CBD interchange has not been significantly affected by the relocation of the interchange. The passenger numbers for Tauranga CBD jumped in the month after opening of the interchange (October 2010), but quickly recovered to normal growth levels.

The patronage growth anticipated in the Tauranga Annual Plan is 10% per annum. The observed change in passenger boardings in Tauranga CBD and throughout the network does not meet this growth level, with growth reducing to 2.8% in the 12 months to December 2013. This, however, may reflect local economic activity rather than the performance of the bus interchange per se. The number of boardings is currently approximately 20% higher than before the opening of the new bus station.

Figure 5.12 Tauranga CBD boardings since July 2009



The Bay of Plenty Regional Council also runs a yearly bus satisfaction survey amongst residents, which suggests a high level of satisfaction with the route changes in Tauranga. At the same time, it shows a significant increase in the percentage of people who use the bus at least once a month. The survey also indicates that 49% of the respondents have increased their bus usage in the past 12 months. As a reason for the increase in bus travel, 35% answered that it was more convenient than the car, 15% answered that it was more frequent than a year ago. Of the people who reduced their bus usage in the last 12 months (14%), six people stated their reason for doing so was a change in routing, or a relocated bus stop.

Figure 5.13 Tauranga bus network

5.5.5 Appraisal summary table

The Tauranga CBD bus interchange project has not had the same level of post-implementation research as the New Lynn interchange. This assessment will rely for a large part on qualitative data.

Table 5.12 Case study 4: Tauranga interchange appraisal summary table

			Page 1
Scheme name:	**[Tauranga CBD bus interchange]**	**Infrastructure scheme type:**	**[Interchange]**
Brief description:	[The project consisted of the relocation of the existing bus interchange to a new on-street facility, improving bus capacity and waiting facilities for passengers.]	Business case stage:	[Monitoring]
		Assessor name:	[ ]
Problem definition /opportunity	[Future growth in bus frequency and patronage could not be accommodated within the existing bus interchange. New interchange required to accomplish future patronage targets.]	Assessment date:	[ ]

Category	**Assessment of relevant measures**	**Summary of impact**
A. Key factor data		
Total patronage	Total daily patronage on routes serviced by proposed infrastructure scheme (estimated).	9,000
Facility utilisation	Number of passengers using the facility per 2-hour peak period (estimated).	3,000
Private vehicle trips	n/a	n/a
Other	n/a	n/a

B. Economic/financial impacts			
B1. Benefits			
Public transport existing user benefits	In-vehicle time	No vehicle travel time savings envisaged.	n/a
	Access time	1 minute faster access time estimated.	$195,000
	Wait/transfer time	1 to 2 minute transfer time benefits estimated due to better bus routing.	$254,000
	Frequency benefits	Small frequency benefit.	$4,100
	Reliability benefits	n/a	n/a
	Infrastructure quality	Improved waiting facilities.	$143,000
	Subtotal		**$595,000**
Public transport new user benefits		Approximately 200 new passengers expected.	$6,500
Road user benefits		Due to decongestion.	$31,000
Total annualised benefits			**$633,000**
B2. Costs			
Capital costs (public sector)		Cost of project: $780,000.	$68,000
Recurrent costs (public sector)		[Brief comment on impact/significance]	-$16,000
Total annualised costs			**$52,000**
B3. Cost-benefit assessment			
Net present value (NPV)			**$580,000**
Benefit-cost ratio (BCR(G))		Very high BCR.	***12.1***
C. Social/environmental impacts			
Access to services	Catchment area/ connectivity	Relatively similar to existing catchment.	0
	Accessibility (for people with disabilities)	No change.	0
Simplicity	Simplicity/legibility	Rerouting bus routes and realigning stops will improve legibility.	+
Safety and security	Safety and accidence prevention	Improved pedestrian crossings improve pedestrian safety.	+
	Personal security	Passive surveillance is available around the site.	+
Emissions	Noise	No impact.	n/a
	Local air quality	No impact.	n/a
Townscape /landscape	Sense of place Urban realm	Improved bus station will create a better sense of place in Tauranga CBD.	+
	Severance	No impact.	n/a
D. Other local area impacts			
Amenity impacts on neighbours		Renewed bus station with higher amenity will have positive impact on neighbours.	+
Local land use impacts		No impact on local land use patterns.	n/a
Property access / car parking		Some car parks removed to create bus bays.	-
Commercial/retail impacts		Small impact on local retailers, impact as of yet unknown. Not measured.	n/a

E. Process/implementation risks		
Organisational/political	Small risk, considering extensive consultation and the chosen option.	+
Stakeholder/public	High level of consultation where public was allowed to vote on either of the options.	+
Business case	BCR calculated at 4.75, no ex-post evaluation done	+
Planning/ consenting	New bus stop space had to be designated. No major impacts	+
Implementation	Relatively small project, no implementation issues	0
Operational	Some operational benefits due to aggregating bus stops and routes.	+

The data from the above mentioned AST was used to do an economic appraisal of the project. Using the worksheet provided in appendix F, the BCR and NPV have been calculated for this project. The required information was collected from Bay of Plenty bus timetables and the AST. The economic evaluation of the Tauranga Interchange resulted in a calculated BCR(G) of 12.1. The detailed calculation steps can be found in appendix B.3.

5.5.6 Risk management

Table 5.13 Case study 4: Tauranga interchange risk summary table

Risk area	Finding	Application
Stakeholder engagement	There was a lot of local interest in the new bus interchange in Tauranga. A significant round of public consultation was organised, backed up by a large advertising campaign. The consultation period specifically focused on involving young people and gave the public a clear choice between the two options – an on-street Willow Street option or an off-street Durham Street option.	Applicable to all medium-large bus based infrastructure projects. Public engagement reducing negative publicity risk and raising awareness of the project.
Operational importance	The choice of location for the bus interchange greatly influenced the future development of the bus network in Tauranga. Following the decision to construct an on-road bus interchange on Willow Street, the bus network was adjusted to enable all CBD buses to stop there.	Applicable to all large-scale bus-based infrastructure projects. Consideration at the project initiation phase.
Benefits realisation	While it was expected the network and infrastructure changes would trigger a large increase in patronage in Tauranga CBD, the figures show that growth was steady before and after the construction of the interchange. As the bus interchange has not generated the extra patronage predicted in the ex-ante evaluation yet, future analysis should focus on that.	Applicable to all medium to large-scale bus-based infrastructure projects. Understanding why benefits were not realised. Good monitoring essential to capture all potential benefit – even those not originally anticipated.
Financial	By opting for the on-street interchange option, the financial risk was greatly reduced as the total capital cost was $780,000 instead of the expected $3m for the off-street option. The council still may need to invest further in an off-street facility though, pending future bus patronage growth.	Applicable to all medium to large-scale bus-based infrastructure projects. Value for money important to political and public acceptance.

5.5.7 Conclusions

Lessons learned from the Tauranga bus interchange include the benefits of extensive consultation. Based on research by Beca, the council opted for the low risk on-street bus interchange. This was in line with public submissions. The ex-ante evaluation was largely based on qualitative data. Only expected patronage growth and some decongestion benefits were included in the BCR calculations. While this is a very simplified assessment method, it is recommended that future bus projects at least include an analysis of the number of boardings, alightings and transfers at any bus interchange to be able to assess the true impact of the improvements.

5.6 Case study 5: Otara interchange upgrade

5.6.1 Background context

Otara is a suburb in the south east of Auckland. The area has a very multi-cultural population. The Otara Interchange upgrade project is an upgrade for a medium sized bus interchange with approximately 3,000 daily passengers.

5.6.2 Problem definition

The project was undertaken following an assessment by Manukau City Council (MCC) of existing infrastructure. The interchange prior to the upgrade is shown in figure 5.14. The bus shelter in place at the time was considered inadequate and repairing it was not a viable option.

Figure 5.14 Otara bus interchange prior to upgrade

At the same time MCC's Property Department expressed an interest in upgrading the existing public toilets next to the interchange. The council's Economic Development arm was also interested in an overall upgrade of the area to improve pedestrian amenity and support economic development there. Following this assessment, it was decided to investigate options for a wider redevelopment of the area. This resulted in a plan that improved the bus interchange, the pedestrian accessibility, the public toilets and the general amenity of the area and neighbouring square.

5.6.3 Scheme description

The bus interchange upgrade involved replacing the existing shelters, redeveloping the adjoining public square and making it a more user friendly space and replacing the existing public toilets. The public space was to function as a community gathering place, with benefits beyond public transport.

Funding was sourced from three areas within Council: 1) transport; 2) properties; and 3) Business Improvement District (BID). MCC used Transport Agency funding to undertake neighbourhood accessibility plan (NAP), but Central Government's funding priorities subsequently changed and the recommendations of the NAP were not likely to be funded. MCC determined that external Transport Agency funding was unlikely given current climate and appraisal processes. Following this, the decision was made to upgrade the bus interchange but leave services unchanged, reducing the capital costs. Total cost for the project was approximately $2.1 million dollars, with the final result shown in figure 5.15.

Figure 5.15 Otara interchange after the upgrade

5.6.4 Transport impacts

The economic benefits of the project have not been assessed. Nonetheless, the public response to the project has been positive. During peak hours, the interchange is serviced by up to 27 buses an hour. The total number of buses servicing the Otara interchange has not changed significantly following the upgrade of the interchange, although it will do so following the implementation of AT's new network. With regards to patronage, there is no reliable data available before the upgrade took place. There is some HOP card data available after the upgrade, although the data is limited to NZ Bus services. Nonetheless the HOP data suggests that patronage has increased to more than 5,400 boardings per day in March 2013 and that the Otara interchange is increasingly well used.

5.6.5 Appraisal summary table

The Otara interchange upgrade was accepted based on strategic fit and the state of the existing interchange. No Transport Agency funding was required so no comprehensive appraisal was undertaken. Most of these factors are qualitative in nature.

Table 5.14 Case study 5: Otara interchange appraisal summary table

			Page 1
Scheme name:	**[Otara bus interchange]**	**Infrastructure scheme type:**	**[Interchange]**
Brief description:	[The project included a bus interchange and shelter upgrade, reconstruction of the public plaza and public toilet facilities.]	Business case stage:	[Monitoring]
		Assessor name:	[ ]
Problem definition /opportunity	[The opportunity arose to upgrade the existing facilities, public space and bus interchange at the same time as existing facilities were]	Assessment date:	[ ]

Category		**Assessment of relevant measures**	**Summary of impact**
A. Key factor data			
Total patronage		Total daily patronage on routes serviced by proposed infrastructure scheme (estimated).	6,000
Facility utilisation		Number of passengers using the facility per 2-hour peak period (estimated).	2,900
Private vehicle trips		n/a	n/a
Other		n/a	n/a
B. Economic/financial impacts			
B1. Benefits			
Public transport existing user benefits	In-vehicle time	No vehicle travel time savings envisaged.	n/a
	Access time	No change in access time.	$0
	Wait/transfer time	No change in transfer time.	$0
	Frequency benefits	No change in frequency.	$0
	Reliability benefits	No reliability improvement.	$0
	Infrastructure quality	Greatly improved waiting facilities.	$147,000
	Subtotal		**$147,000**
Public transport new user benefits		No new users included in assessment as unknown patronage at station at this point	$0
Road user benefits		n/a	$0
Total annualised benefits			**$147,000**
B2. Costs			
Capital costs (public sector)		Cost of project: $1,050,000	$110,000
Recurrent costs (public sector)		[Brief comment on impact/significance]	-$7,000
Total annualised costs			**$103,000**
B3. Cost-benefit assessment			
Net present value (NPV)			**$44,000**
Benefit-cost ratio (BCR(G))			***1.4***
C. Social/environmental impacts			
Access to services	Catchment area/ connectivity	Slightly improved catchment through better environment	+
	Accessibility (for people with disabilities)	No impact	n/a

Simplicity	Simplicity/legibility	No impact	n/a
Safety and security	Safety and accidence prevention	No impact	n/a
	Personal security	Higher amenity bus stop generates better safety environment	+
Emissions	Noise	No impact	n/a
	Local air quality	No impact	n/a
Townscape /landscape	Sense of place Urban realm	Design of interchange tailored to local heritage and culture, much improved sense of place	++
	Severance	No impact	n/a
D. Other local area impacts			
Amenity impacts on neighbours		Renewed bus station with higher amenity will have positive impact on neighbouring properties.	+
Local land use impacts		No impact on local land use patterns.	n/a
Property access/car parking		Opportunity to create new access to neighbouring property at new public plaza, unfortunately not achieved.	0
Commercial/retail impacts		No impact on local retail.	n/a
E. Process/implementation risks			
Organisational/political		Transition period during amalgamation of councils proved an organisational risk. Several different departments working together and funding in tandem.	-
Stakeholder/public		High level of public engagement to ensure a sense of ownership with the community.	+
Business case		No Transport Agency funding required so no official economic appraisal undertaken.	0
Planning/ consenting		No major impacts as mostly upgrade of existing facilities.	0
Implementation		Relatively small project, no implementation issues.	0
Operational		Some operational benefits due to aggregating bus stops and routes.	+

The data from the above mentioned AST has been used to do an economic assessment of the project. Using the worksheet provided in appendix F, the BCR and NPV have been calculated for this project. The required information was collected using Auckland Transport's southern bus guide, GTFS Explorer software developed by MRCagney and the AST. The economic evaluation of the Otara interchange resulted in a calculated BCR(G) of 1.4. The detailed calculation steps can be found in appendix H5.

5.6.6 Risk management

There is limited data from this case study relating to risks; however, there were a number of interesting observations that are applicable.

Table 5.15 Case study 5: Otara interchange risk summary table

Risk area	Finding	Application
Political	The project itself was initiated by various departments in the council (MCC at the time) and ultimately gained political support. This enabled significant support across council and budget for the project was sourced from a number of departments.	Applicable to all bus-based infrastructure projects. While high-level political support can fast-track a project, this cannot override the need to understand the benefits and costs and implications on the network.
Effected party engagement/monitoring	One of the key risks regarding the redevelopment of the Otara interchange was community engagement. It was considered very important to engage the community at an early stage to reduce the risk of vandalism and improve the sense of ownership of the place among the local community. This was achieved through communicating with the local board, iwi and neighbouring Manukau Institute of Technology at an early stage. Community open days were organised and a letter drop amongst local residents was done. A local artist was commissioned to design the artwork surrounding the shelters, which enforces the sense of identity and uniqueness of the location.	Applicable to all medium to large bus infrastructure projects. Communication of the project and including input from surrounding business can have a significant impact on the facilities ultimate success.
Monitoring	With regards to the ex-ante and ex-post analysis, the project was accepted on strategic grounds. This means very little data collection was undertaken to underwrite the decision.	Applicable to all bus infrastructure projects. Consider all legislation relating to not only building but also operating buses when completed.
Operational information (during construction)	The bus network operation was not changed after construction of the new interchange. During construction, the bus station was affected, but this could be mitigated by implementing temporary bus stops close by. Local stakeholders and bus companies were kept up to date throughout the process to minimise disruption.	Applicable to all bus based infrastructure projects. Important to remember existing users and have a clear communication strategy to inform of change.
Financial	Dealing with several departments within the council posed a risk with regards to funding. It was decided not to apply for Transport Agency funding because of the varied set of objectives for the project. This meant the different departments of council had to cooperate to fund the project. An extra complicating factor was the looming amalgamation of councils into the Auckland Council. This required a continuation of the work throughout the reorganisation and reallocation of funds.	Applicable to all medium to large bus infrastructure projects.

5.6.7 Conclusions

Key recommendations and conclusions from the Otara bus interchange upgrade include the opportunities for added value from a coordinated upgrade project. Coordinating efforts led to a much increased solution, not solely based on the bus interchange but addressing various issues around the public space in the area. The benefits of this approach have not been quantified, this is a recommendation for future projects, as any quantified results would be beneficial for justification of similar projects.

This need for data is also highlighted in the bus interchange part of the project. Very little data was available to analyse the effects of the upgrade with respect to patronage. Some data suggests a significant increase in the years following the upgrade, but this data is not well documented.

5.7 Summary of case studies

Table 5.16 summarises our case studies under following key headings:

- problem definition
- impacts (transport and economic)
- key risks.

Table 5.16 Summary of case study appraisals

#	Name	Problem definition	Impacts		Project risks
			Transport	BCR	
1	Dominion Rd bus lanes	Bus priority measures required to maintain efficiency.	Average travel-time and variability decreased by circa 5/2 minutes respectively. Patronage increased 18% and 31% in AM/PM peaks respectively.	6.0	Political risks from impacts on vehicle travel times and parking.
2	New Lynn interchange	Existing interchange had low levels of amenity that detracted from strategic plans for town centre.	Improvements in travel time in surrounding streets, as well as a reduction in recorded crashes. Rail patronage is up 60% and ahead of forecast, although bus patronage is behind forecast. The latter likely reflects delays in transitioning to a more frequent and connected network.	0.9	Operating efficiencies unable to be realised due to dependencies on other projects, eg electrification and HOP.
3	Manners Mall bus lanes	Buses delayed due to circuitous routing and traffic congestion. Also reduced legibility.	Travel times reduced in the northbound direction in the PM peak (14%, or 1.1 minutes), but not in the AM peak. May reflect differences between the scheme and the final design that was implemented.	0.3	Large political risks and benefits not fully realised due to subsequent design changes.
4	Tauranga bus interchange	Existing interchange unable to handle growth, illegible for passengers, and lacked adequate shelter.	Patronage in Tauranga city centre is approximately 20% higher than before opening of the new bus interchange. Resident surveys show high levels of satisfaction with route changes in Tauranga, as well as a significant increase in percentage of people who use the bus at least once a month.	12	Political and stakeholder risks required careful engagement. Low levels of bus use reduced support for change.
5	Otara bus interchange	Existing bus considered inadequate in context of wider town centre improvements.	Benefits mainly limited to existing bus passengers, with only peripheral transport impacts, eg improved visibility for pedestrians. Changes to surrounding network may result in more passengers connecting between services at Otara.	1.4	Durability of the facility was a key risk; required careful attention to design and engagement.

6 Application considerations

6.1 Introduction

In this chapter we summarise the main conclusions from the case studies presented in the previous section and recommend ways in which the proposed framework might influence future iterations of the EEM, the *Guidelines for public transport infrastructure and facilities* and the business case processes. We also discuss how this research can assist local authorities in decision making around (generally smaller) public transport infrastructure projects.

6.2 Lessons from our case studies

6.2.1 Benefits identification

Our investigation of five case studies suggests New Zealand public transport projects focus on ex-ante evaluation. Little ex-post evaluation is undertaken, particularly in the smaller projects (Otara, Tauranga). Larger projects like New Lynn, Manners Mall and Dominion Road have been subject to some post-implementation evaluation, but this is relatively scattered and inconsistent, insofar as it tends to consider separate aspects of the project and not the project as a whole.

For the smaller projects, Otara and Tauranga, the current ex-post evaluations focus largely on the consultation side of the project. Factors like bus patronage, bus travel time, impacts on general traffic are generally not assessed, even though these are 1) the primary benefits of such schemes and 2) able to be objectively and independently measured. Public opinion on the changes was well documented, but cannot easily be transferred to an economic analysis. Meanwhile, the lack of consistent post-evaluation reduces the information available to inform public consultation on future projects. Instead, success of a project is generally defined by an absence of complaints or accidents following the upgrade, rather than its implications for the efficiency and effectiveness of the bus network.

Dominion Road and Manners Mall are projects with more clearly quantified benefits. Dominion Road has demonstrable benefits; Manners Mall less so – primarily because predicted improvements in bus travel-times do not appear to have materialised. In terms of interchanges, the Tauranga downtown interchange is a clear winner in terms of cost-effectiveness: Its low cost and high patronage impacts demonstrate that improved bus infrastructure has a role to play even in smaller provincial cities. In terms of the Otara interchange, we find it was marginally positive from a public transport perspective and will have had wider (unquantified) positive effects for the town centre.

Finally, the New Lynn interchange is the most expensive project we considered. We note the upgrade was part of a wider area redevelopment plan and as such the benefits of the interchange itself are not clearly distinguished from the redevelopment of New Lynn. Analysis of retail spending (see section 6.2.4) shows a clear increase in expenditure following completion of the interchange, and associated development of medium and high-density housing in the immediate environs. From an economic perspective, we find marginal benefits from the interchange in its current form. This suggests a need for investment in bus interchanges to be linked to services changes, where the latter delivers additional operational efficiencies.

6.2.2 Evaluation methods

The assessment framework proposed in chapter 1 delivers a good overview of the benefits and risks. For the historic projects, it has not been possible to quantify every item in the table, as current practice does not require significant ex-post evaluations to take place. The proposed framework also focuses on different areas and outcomes, but relevant data from these projects has not been collected and has proven difficult to attain.

To properly test the proposed framework, a more current project should undertake an ex-ante and ex-post evaluation using the framework. Using a current project will enable a good test of the evaluation criteria and highlight any difficulties in data collection or benefit quantification. The proposed Dominion Road upgrade (2014) could serve as a good test case as there has been extensive data collection undertaken for this project. We note the proposed upgrade has a much greater focus on streetscape improvements. Hence, we suggest a comprehensive analysis of retail expenditure patterns before and after the upgrade is warranted, as well as the standard appraisal of transport user benefits.

6.2.3 Risk management

From the case studies, it becomes clear that public opinion is considered the key risk to be managed in public transport infrastructure projects. In particular, the smaller public transport projects like the Tauranga interchange and the Otara interchange have a strong focus on consultation and community engagement. These projects focus less on public transport network performance, particularly in post-implementation analysis. Some of these projects are accepted based on strategic goals, rather than on economic, quantifiable, benefits.

Larger projects like Manners Mall, Dominion Road and New Lynn have a stronger evidence base when it comes to public transport network performance. The original 1998 Dominion Road bus lanes had a fairly comprehensive post-implementation analysis, which focused on public transport performance and impacts on private vehicle travel time. This can be explained by the fact that this was the first bus lane project in New Zealand and there was a lot of interest in how it performed.

In the case of the Otara interchange upgrade, institutional changes were one of the key risks to be mitigated. The Manukau City Council was going through an amalgamation into Auckland Council. The project team had to ensure continuity throughout this process. At the same time, the nature of the project required cooperation of different departments within council and different sources of funding.

6.2.4 Retail impacts

From the case studies it is obvious that the impacts of retail must be well considered in the planning and consultation phase of the project. Our research shows that public transport projects can have significant impacts on local retail, both positive and negative – especially during construction. The impacts on retail in New Lynn are positive with a significant increase in retail spending growth after construction of the interchange. In Wellington on the other hand, the retail spend in Manners Mall has reduced, while the rest of the region showed growth. This indicates concerns raised by the retail sector prior to the project were valid, although more analysis is needed to assess the extent of how the changes in retail type have impacted on total spend. It is recommended future public transport infrastructure projects analyse electronic payment data at fine spatial scales to monitor the impacts on the retail sector.

6.3 Proposed framework application considerations

This section incorporates our learnings from the case studies and builds on the earlier discussion of application of the proposed AST and business case considerations discussed in chapter 1 by looking at potential application of the proposed framework by the Transport Agency and regional and local councils. The following areas are covered:

- economic appraisal and evaluation
- national infrastructure guidelines
- Transport Agency's better business case requirements
- other information for local authorities.

6.3.1 Economic appraisal and evaluation

The proposed framework sets out an approach for identifying and assessing the benefits of bus infrastructure schemes, using a procedure that covers a wider range of impacts than the current EEM procedures. The proposed AST, for example, includes procedures for appraising economic and financial impacts (refer appendix F) and can be applied to schemes of varying scales.[17]

We believe the current EEM does not address all of the potential benefits associated with bus infrastructure schemes. Incorporating several key benefits quantified in the proposed appraisal framework will improve the quantitative appraisal of both bus infrastructure schemes and bus services.

Moreover, while the EEM is useful for generating BCRs, it does not incorporate many factors that can be easily quantified and can be useful in the decision-making process. The inclusion of the proposed AST, and in particular the proposed procedures for assessing economic and financial impacts, greatly widens the scope and applicability of the EEM for assessing bus infrastructure schemes.

Finally, the proposed AST is relatively flexible insofar as it is compatible with both (ex-ante) scheme appraisal and (ex post) scheme evaluation.

Ex ante appraisal can be used throughout the planning life-cycle and stages of business case development, with increasingly detailed assessments and testing of assumptions possible as more information comes to light throughout the process.

Following implementation, ex-post evaluations can be used to identify the scale and distribution of relevant impacts and give some measure (qualitative, ranking/rating, numerical or monetary measures) of the extent of each impact and how this compares to the ex-ante appraisal.

Applying essentially the same process ex-ante and ex-post will enable more effective comparisons and may highlight where risks to benefit realisation are under-estimated in the planning stages. In turn, this may help inform the design of future schemes and/or improve the accuracy of ex-ante appraisals.

6.3.2 National infrastructure guidelines

The Transport Agency has been developing national infrastructure guidelines *Guidelines for public transport infrastructure and facilities*. The first draft of these guidelines was released by the Transport Agency in June 2014.

The guidelines state that they draw extensively on the guidelines currently used in Auckland but at this stage focus on principles and standards for bus stops only. As discussed in chapter 2, we identifed a number of guidelines developed by regional and local councils and recommend that these provide a good basis for the national guidelines.

The proposed AST set out in chapter 4 provides a summary of the relevant benefits and risks to successful project delivery and quantification of these. The national infrastructure guidelines would benefit from including a summary of benefits and risks and also identifying which are relevant for different

[17] The main difference with larger-scale schemes is that the inputs and assumptions would need to be subject to a more extensive processes, such as surveys and/or transport modelling, to ensure a robust assessment.

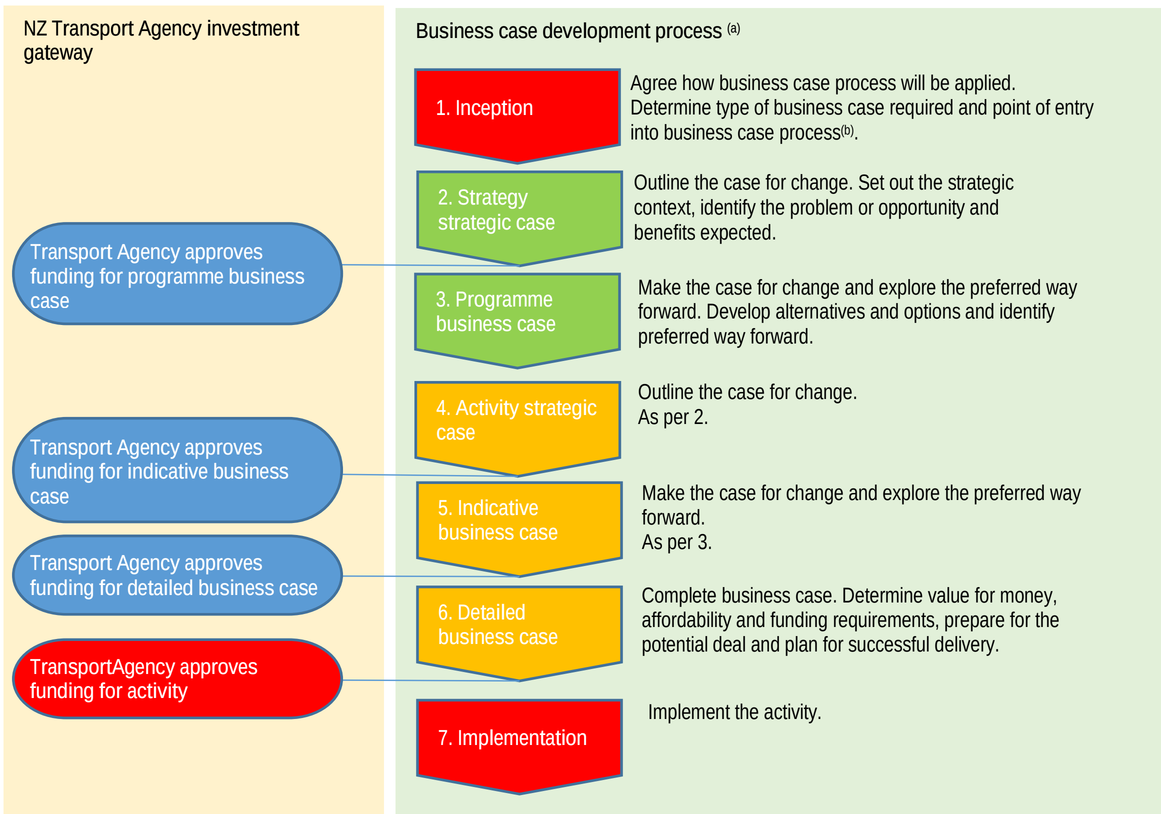
infrastructure schemes (eg bus stops and shelters, bus interchanges and bus priority). Guidance in the infrastructure guidelines should be closely linked to the economic assessment procedures in EEM. This is particularly import to help determine what information is necessary, based on the type and scale of a project to determine the level of analysis appropriate. The case studies have shown that this can be quite a challenge, particularly when trying to carry out ex-post evaluations and necessary data/information has not be recorded.

The national infrastructure guidelines would also benefit from some detail on the decision-making processes required to be followed and planning requirements. They should also set out an appropriate risk management framework as proposed in this research with the risks identified and managed through the project life cycle and business case process.

6.3.3 Transport Agency business case requirements

The Transport Agency requires regional and local councils to follow its business case processes when applying for funding for bus infrastructure schemes (and other transport schemes), as shown below.

Figure 6.1 Phases of the business case approach



(a) Adapted from the Transport Agency's Planning & Investment Knowledgebase – Planning to project delivery process (1 August 2013) and Treasury's *Better business cases* quick reference guide (August 2012).
(b) The entry point may be step 2, 3 or 4 depending on prior work. The entry point will generally be step 2 unless there is an existing Transport Agency approved strategy (enter at step 3) or programme (enter at step 4).

A key consideration when looking to apply the business case process to bus infrastructure schemes is to ensure that the process is suitable for the type and scale of the proposed scheme. It is important to ensure an efficient assessment process and not repeat analysis (eg for each stage of business cases) where there is little additional benefit.

During the business case process, assumptions will need to be tested and potentially re-evaluated but the proportionality of analysis and process is important. It would make little sense to follow the full business case process for a single bus stop or shelter costing less than $10,000 but it would be appropriate for a large-scale bus interchange costing many millions of dollars.

On the other hand, an ongoing annual programme of bus stop upgrades may well benefit from the business case approach. Packaging up ongoing minor capital improvements can bring the benefits of more rigorous and consistent investigation and design, planning, appraisal and risk assessment – without unduly delaying (and sometimes even expediting) implementation.

We would recommend guidelines are provided on the appropriate proportionality of analysis during the stages of the Transport Agency business case processes for the various types and scales of bus infrastructure scheme and also the public transport services that utilise the infrastructure facilities.

The remainder of this section covers how the AST might be applied as a scheme progresses through the project life-cycle and business case stages. The Transport Agency business case development process is summarised in table 6.1 and is required for most public transport schemes in New Zealand.

In table 6.1 we reconcile the better business case development process with several stages in the development of bus infrastructure projects.

Table 6.1 Relating phases of the business case approach to stages in bus infrastructure projects

Development process	Infrastructure	Planning	Appraisal	Risk assessment
Inception	Required step for all infrastructure types	Pre-assessment of planning requirements		Define project scale and appropriate level of assessment.
Strategic case		How proposal aligns with the relevant council and Transport Agency strategic planning documents, ie visions and aims.	No formal appraisal required, business case investment logic mapping process used	Clear articulation of problems and/or opportunities to ensure 1) common understanding of the project objectives; 2) risk boundaries; and 3) risks to the project achieving the identified objectives.
Programme business case	Bus stop and shelters are network infrastructure with each item generally small scale cost and risk, and should only need to be considered at the programme business case level. Bus interchanges and priority measures should be considered within the programme business case, before proceeding to	Identify any resource and building consent requirements. These could be as minor, eg working within the drip-line of a tree, through to major, eg relocation of services. While the actual planning applications would not be undertaken until the pre-implementation stage it is crucial to identify key planning	Proposed AST can be completed at a high level with standard assumptions and estimation of impact. We note that bus stops are likely to be determined based on access and catchment considerations and impacts on various parties rather than on a BCR calculation.	Important to determine what level of consultation is required and who to consult with as that will dictate some of the timeframes in the business case.

Development process	Infrastructure	Planning	Appraisal	Risk assessment
	more detailed assessment if required.	issues as soon as possible because this is a key risk.		
Activity strategic case	For bus stops and bus priority measures, this can consider the role the changes play in improving the efficiency of a specific corridor. For bus interchanges, this probably should refer to wider network and land use developments.			The risk assessment should be updated when a preferred option is selected. The increased detail will allow refinement of risks. The updated risk assessment will contribute to planning for delivery (eg timing and process) and funding application.
Indicative business case	Not required for small bus stops and shelters. Required for most bus interchanges and priority measures.	Specific details of any planning requirements need to be finalised.	Proposed AST analysis completed with relevant assumptions	
Detailed business case	Not required for small bus stops and shelters. Required for most bus interchanges and priority measures.	Aspects will need to be confirmed for each type of bus infrastructure scheme	Assumptions should be tested and revised as appropriate and proposed AST analysis updated.	Risk assessment should be updated to contribute to a full understanding of their potential impacts on benefits and costs.
Implementation	Monitor impacts	Check the project is/was installed as proposed.	Monitoring the benefits, costs and proposed AST can enable ex-ante/ex-post comparisons.	Review success of risk assessment to improve understanding for similar projects.

6.3.4 Information for local authorities

The proposed AST framework provides a useful approach to identifying and assessing the benefits of bus infrastructure schemes and the risks to successful project implementation. We believe the approach set out in this research paper would improve the reporting of bus infrastructure scheme benefits to decision makers. We have not attempted to weight the different information set out in the proposed AST in order to identify preferred schemes or options but the proposed framework could easily be used in that fashion.

By using the proposed appraisal framework, local authorities can assess a project's economic, quantified benefits while at the same time assessing the qualitative impacts of the project, including local area impacts and impacts on retail. Including this data in a structured way will help local authorities assess different options against each other and will help identify potential risks to the project at an early stage.

As shown in the case studies, many smaller public transport infrastructure projects are accepted mainly on strategic grounds. The quantified part of ex-ante evaluations is usually limited to a cost calculation and in some cases a limited BCR. Other benefit indicators are qualitative of nature and the effects of the project on these indicators are not evaluated afterwards. Ex-post evaluations usually focus on the outcomes of public consultation and not on the actual quantified benefits relating to the project. The Excel pro-forma used in this paper provides a simple and quick approach to identify the economic and financial impacts of proposed bus infrastructure schemes and is more ‘complete’ than current EEM simplified procedures (SP9/10).

7 Conclusions and recommendations

Our conclusions and recommendations are set out in table 7.1 (reference is made to specific sections in the report for further details).

Table 7.1 Summary of conclusions and recommendations

Work area	Conclusions	Recommendations
A. Develop a framework for identifying bus infrastructure scheme (BIS) benefits and delivery risks	**Roles and responsibilities** for BIS have generally been fragmented, in large part due to the split of functions between regional and local authorities. This problem has been reduced/removed in Auckland, and may be further reduced in other areas in the event of local government amalgamation	
	Infrastructure guidelines. The Transport Agency's *Guidelines for public transport, infrastructure and facilities* (GPTIF) could provide a significant step forward in terms of providing a set of national guidelines that 1) can largely replace existing regional/local guidelines; 2) will be aligned with the Transport Agency's business case approach; and 3) can incorporate procedures for assessing the benefits and risks associated with BIS.	We recommend the further development of the GPTIF, ensuring that it will cover these requirements [2.4.2].
	Regional policy processes. Currently many regional policy statements and district plans do not address how BIS will be provided for or facilitated.	We recommend greater emphasis on aligning the strategic intent of the RPS and district plans with the RPTP. One possibility would be the inclusion in district plans of relatively permissive zoning overlays to allow development of BIS in strategic locations identified in the RPTP [2.4.3]. Specific recommendations are made relating to 1) amending the LGA in regard to procedures relating to bus shelters [2.4.4]; and 2) regional/local councils ensuring that public transport interchange requirements are identified in the PTP and then reflected in relevant district plans [2.4.5].
	Benefit assessment framework. An appropriate (ex ante) framework, based on an appraisal summary table (AST) has been developed to identify and summarise the range of potential impacts from BIS [table 4.1]. The framework covers impacts under four groups—economic/financial, social/environmental, local impacts, process/implementation risks.	Subject to further testing/trialling by the Transport Agency and approved organisations, we recommend this framework be adopted at the planning stage of future BIS. The framework also has potential for use in ex-post evaluation of scheme impacts. Such evaluations would be extremely useful for validating assumptions and modelling methods.
	Economic/financial impacts. These form one group in the AST. Detailed procedures have been defined for ex-ante economic appraisal of schemes. These procedures are consistent with EEM (in terms of parameter values) and also include short-cut demand assessment components.	Subject to further testing/trialling, we recommend the economic and financial procedures developed be incorporated into EEM for small/medium-scale infrastructure schemes.

Work area	Conclusions	Recommendations
B. Undertake case studies to examine and test the proposed BIS assessment framework	Five case studies were undertaken, covering both interchanges and priority projects. Bus/multimodal interchanges (New Lynn, Otara, Tauranga), bus priority schemes (Dominion Road, Manners Mall). Scheme capital costs ranged from minimal ($100,000) to c$50 million. The case studies involved a review of the available ex-ante and ex-post evidence on scheme impacts. In addition, we undertook new surveys of retailers in the vicinity of the New Lynn and Manners Mall schemes. Generally, we were able to source information for most items in our proposed AST, although much of this was qualitative only. The task of completing our economic/financial template was problematic in most cases: ex-ante economic appraisals existed for only one of the schemes, ex-post economic appraisals for none of them.	We recommend that in future: 1) Ex-ante appraisals consistent with the proposed AST and economic/financial appraisal templates be undertaken for all significant schemes, either at an individual scheme level (larger schemes) or for a group (programme) of similar (smaller) schemes. 2) Ex-post appraisals be undertaken for larger schemes and a selection of smaller schemes, again using the AST and economic/financial templates (subject to any modifications that may be required for ex-post application).
C. Provide information on BIS benefits and risks to inform 1) future revisions to EEM; 2) development of GPTIF	The proposed appraisal framework covers all benefits and risks considered potentially significant for bus infrastructure schemes [Ch 4, in particular tables 4.1 – 4.5]. The case studies to illustrate these impacts for particular schemes [Ch 5].	We recommend that appropriate aspects of the appraisal framework, methodology and associated guidance be incorporated in future revisions to EEM and/or (as most appropriate) the development of GPTIF.
D. Provide information to assist regional/local authorities to implement BIS	Information to assist authorities in developing, implementing and monitoring BIS is provided through the proposed appraisal framework/methodology, including appraisal of process/ implementation risks [Ch 4]. Further information on implementation considerations is also provided [Ch 6].	Recommendations on this topic are covered above.

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Appendix A: Example bus stop/shelter processes

Figure A.1 Bus stop/shelter process flowchart from Palmerston North (Palmerston North City Council 2008)

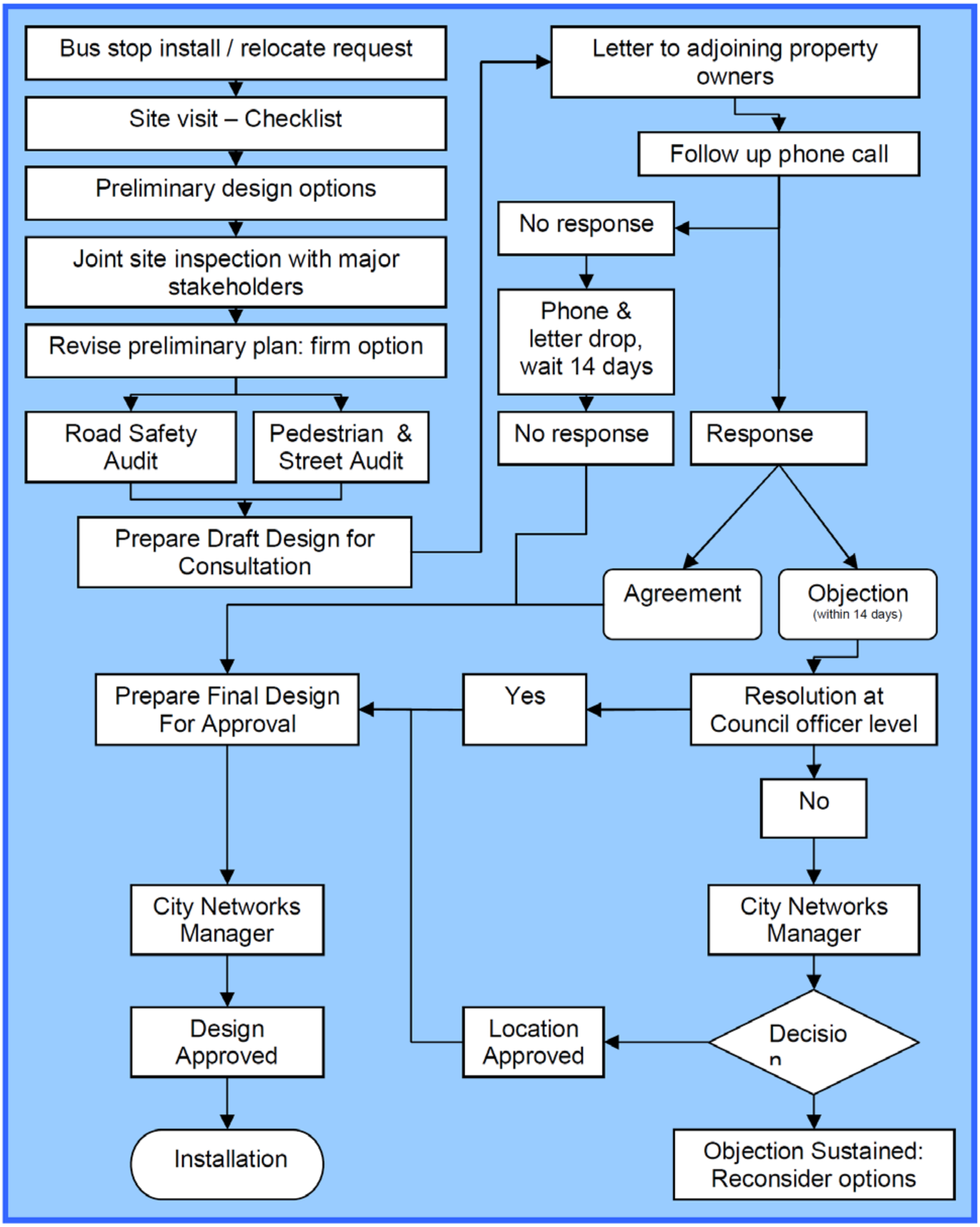
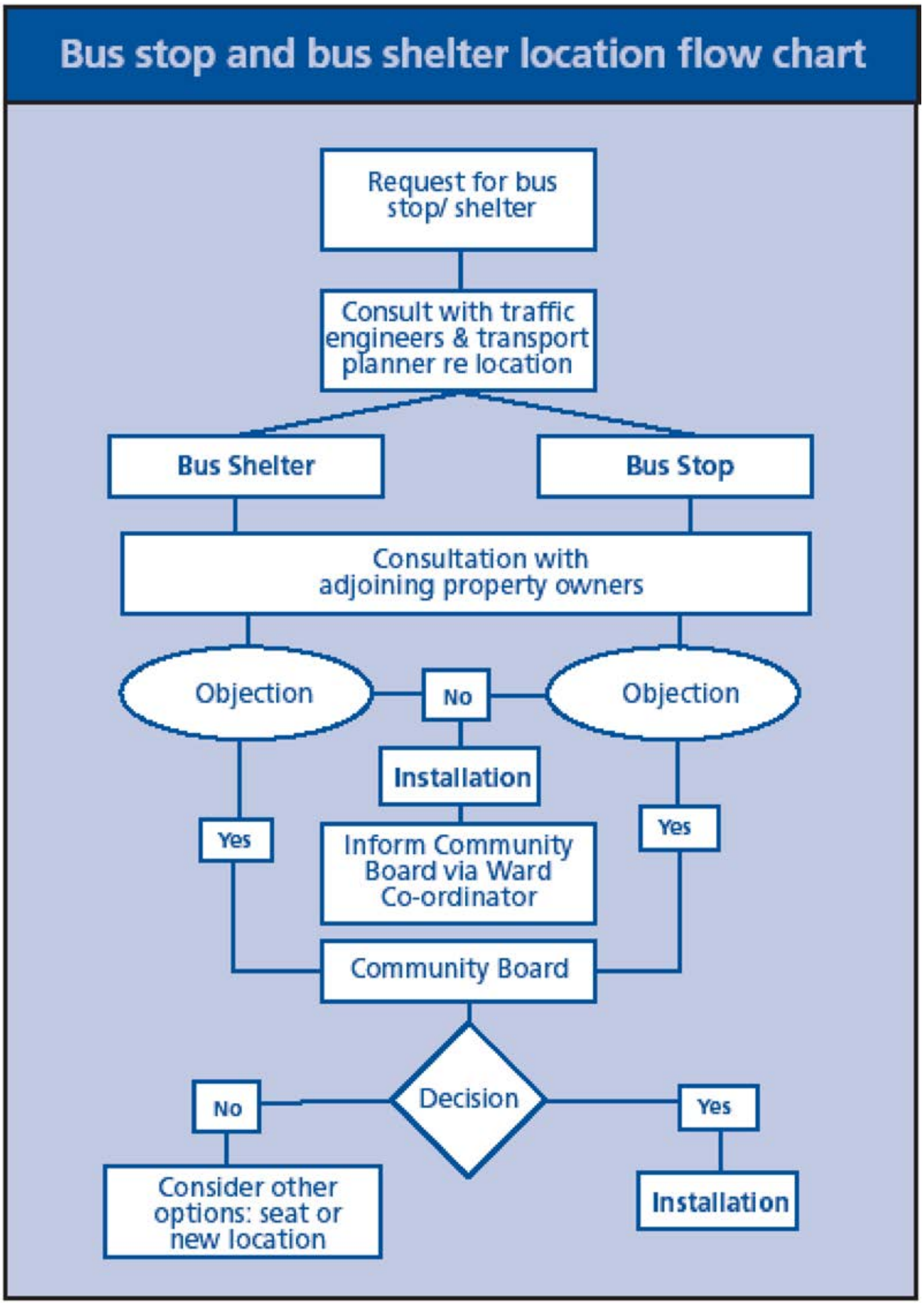


Figure A.2 Bus stop/shelter process flowchart from Manukau City Council (now part of Auckland Council) (Manukau City Council 2004)



A1 References

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Appendix B: Consultation requirements for bus shelters (section 339 of the LGA)

This appendix provides an overview of section 339 of the Local Government Act 2002 (LGA), pertaining to consultation requirements for bus shelters within the road reserve. There have been numerous amendments to the LGA since its inception in 1974. The LGA 2002, section 82 outlines the 'Principles of Consultation'. These principles form the basis for best practice during the consultation processes. Except for the general principles identified under section 82 of the LGA there is only one specific aspect of bus stop infrastructure that is singled out, the installation of bus shelters under 'Section 339 Transport Shelters'. This section, included below, was drafted as part of the inclusion of Part 21 (comprising sections 315 to 361) inserted on 1 April 1979, by section 2 Local Government Amendment Act 1978 (1978 No 43).

> *Section 339 Transport shelters*
>
> *The council may erect on the footpath of any road a shelter for use by intending public-transport passengers or taxi passengers provided that no such shelter may be erected so as to unreasonably prevent access to any land having a frontage to the road.*
>
> *The council shall give notice in writing of its proposal to erect any shelter under this section to the occupier and, if he is not also the owner, to the owner of any land the frontage of which is likely to be injuriously affected by the erection of the shelter, and shall not proceed with the erection of the shelter until after the expiration of the time for objecting against the proposal or, in the event of an objection, until after the objection has been determined.*
>
> *Within 14 days after the service of the notice, the occupier or owner, as the case may be, may object in writing to the council against the proposal.*
>
> *Where any person objects to the proposal in accordance with subsection (3), the council shall appoint a day for considering the objection and shall give notice to the objector of the time when and place where the objection is to be heard. Any such time shall be not earlier than 7 days after the date on which the notice of objection was received at the office of the council.*
>
> *The council shall, at the time and place stated in the notice referred to in subsection (4), consider the objection, and after hearing any submissions made by or on behalf of the objector, may either dismiss the objection or decide not to proceed with the proposal or make such modifications to the proposal to which the objection relates as it thinks fit. The hearing of any such objection may be adjourned from time to time and from place to place.*
>
> *Where there are more objectors than 1, the council shall, as far as practicable, hear all objections together and give each objector an opportunity of considering and being heard in respect of all other objections.*
>
> *No resolution under this section shall be passed until the council has considered all the objections of which notice has been given in accordance with this section.*

Councils have developed different processes for dealing with section 339 of the LGA. Prior to the formation of Auckland Council and AT, for example, the various different councils in Auckland had widely different approaches to the implementation of section 339. In some cases it was not enacted while in others hearings were held at Community Board meetings for anyone objecting to the proposal. As a result of the RPTP roll out in Auckland a greater focus has been put on improving bus stop infrastructure.

Appendix C: Case study of Auckland's bus stop programme

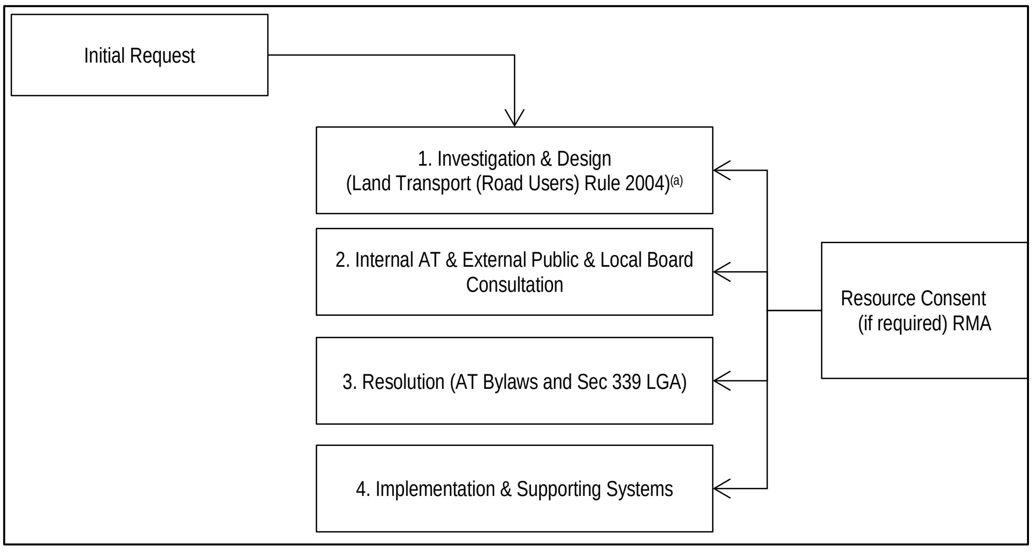
In Auckland, small-scale bus stop projects are managed by Auckland Transport (AT), as the road controlling authority (ie equivalent to local councils in the rest of New Zealand), under what is known as the 'Bus Stop and Shelter Capital Works and Renewals Programme' (the Programme).

This Programme encompasses all the planned bus stop and shelter work in the Auckland region. In the past the Programme has be quite reactive as it was primarily based on customer requests. The Auckland Regional Public Transport Plan 2012 (RPTP) has led to the Programme becoming much more proactive in implementing changes to the region's physical public transport infrastructure.

The process to implement the Programme has undergone several changes and is intentionally a very linear process with each stage needing to be completed before the next one can be moved on to. This is to ensure each bus infrastructure project is supported internally and does not clash with any other projects before going out to the public for consultation. Figure B.1 summarises the steps in the Auckland process, which are likely to be comparable to those of other councils' programmes around New Zealand. Typically the internal and external consultation processes take the longest and have the greatest element of uncertainty.

The Auckland 'Traffic Bylaw 2012' is used to legalise bus stop/shelter projects through a resolutions process (step 3). This process involves completing the appropriate resolution report template and plan including relevant legal precedents to clearly identify any changes to road markings, parking restrictions, time restrictions etc. The report and plan go through a multi-layered review process culminating in a meeting of the Traffic Control Committee (TCC) for final approval. There is also a 'delegated authority' process for projects that involve installing a bus shelter at an existing bus stop. This process means that the report can be signed off by a manager with the relevant delegated authority rather than go to the full TCC. However, this process is only possible if there are no objections to the bus shelter (otherwise section 339 of the LGA applies). This delegated process is more commonly used in other parts of the country for bus stops in general.

Figure C.1 Bus stop project process followed by Auckland Transport



Notes: (a) The Land Transport (Road User) Rule 2004 stipulates certain requirements under sections 6.8 and 6.9 such as a bus stop should not be installed within 1m of a driveway or 6m of an intersection unless this can be justified by the road controlling authority.

The shortest time required to install a basic pair of bus stops in Auckland is three to four months. More complex projects, such as those that affect different properties, change restrictions etc, can take longer – especially if changes to the original design are proposed, which can trigger re-consultation of affected parties (sometimes even if they did not provide any feedback originally). If the changes to the design are only minor, eg moving a bus stop a metre or two, then only those parties that provided feedback originally are advised of the changes.

Bus stop/shelter projects are some of the most difficult projects to quantify in terms of timeframes. This is because they often challenge traditional concepts of how the road corridor should be used and also evoke emotional responses from the public. A breakdown of the general process outlined above, along with estimated timeframes is provided in table C.1. These are only guidelines as the time required can vary greatly depending on the complexity of the project and the consultation process.

Table C.1 Summary of process for bus stop projects

Stage	Timeframes	Task
Investigation and design	2–3 weeks to 1–2 months depending on scale, ie standard upgrade versus full route review	Desktop review
		Site visit
		Sourcing and reviewing 'beforeUdig' information
		Identifying if resource consent information required
		Drafting initial design sketch
		Discussing design with public transport before finalising design
		CAD design
Resource consent (if required)	1–2 months	Commissioning planner to do the work, arranging contract etc
		Pre-application plans, site meetings etc
		Assisting with consent submission
		Council consent review process
Consultation	1–2 weeks	Preparation of letters and consultation plans
	2–4 weeks	Internal consultation
	1 month	Local board consultation
	2 weeks	Affected properties consultation
	1 month	Responses to feedback/objections
Bylaw process	1 month	Preparation of report and plans
		Review process
		Getting all signatures on the report
		Attending TCC meeting
Implementation and supporting systems	1–6 months depending on contractor	Arranging physical work with contractors
		Construction plans (if required)
		Informing customer services, bus companies etc

Appendix D: Comparison of benefit parameters in various appraisal procedures

The following table is taken from appendix C of *NZ Transport Agency research report 533* 'Economic appraisal of public transport service enhancements' (Wallis et al 2013). Note: Recent updates to the EEM and UK WebTAG procedures are not included in the table although in both cases the updates have not changed the underlying considerations.

Table D.1 Comparison of benefit parameters

Aspect of methodology		Economic appraisal procedure[a]					
		EEM	Aust. NGTSM	Aust. TfNSW	UK WebTAG	UK TfL	US 'new starts'
Public transport user benefit parameters							
Value of in-vehicle time (IVT)	IVT (standard values)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
Journey time attributes	Access time • walk time (access/egress) • car access • public transport access[b]	✓(M)[f] × ×	✓(M) × ×	✓(M) ✓(M) ✓(M)	✓(M) - -	✓(M) - -	x x x
	Headway (service interval)[c]	✓(M)	✓(M)	✓(M)	✓(M)[i]	✓(M)	x
	Seat availability/crowding	✓(M)	✓(M)	✓(M)[h]	✓(M)[i]	✓(M)	x
	Interchange (transfer penalty and wait time)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
	Reliability of travel time[d]	✓(M)	✓(M)	✓(M)	✓(N)	✓(M)	x
	Mode-specific factors[e]	×	✓(M)	×	–	–	x
	Pre-journey/ticketing	x	x	x	x	✓(M)	x
Quality attributes	Vehicle features	✓(M)	✓(M)	✓(M)	✓(M)[j]	✓(M)	x
	Stop/station features	✓(M)[g]	✓(M)	✓(M)	✓(M)[j]	✓(M)	x
Provision for 'simplified procedures'							
Provision for simplified procedures		✓	✓[m]	x	x	x	✓
Benefit parameters included[k]	Public transport user benefits	✓(M)[l]	×	×	×	x	✓(N)
	Road user benefits	✓(M)	✓(M)[n]	×	×	x	✓(N)
Other benefit parameters[o]							
Road traffic system (de-congestion) benefits	Travel time savings	✓(M)	✓(M)	✓(M)	✓(M)	x	x
	Vehicle operating cost savings	✓(M)	✓(M)	✓(M)	✓(M)	x	x
	Accident cost savings	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)
	Parking cost savings	✓(M)	–	–	✓(M)	x	✓(N)
Environmental factors	Noise	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	x
	Vibration	✓(N)	×	×	×	×	×
	Water quality	✓(N)	✓(M)	✓(M)	✓(N)	✓(N)	×

Aspect of methodology		**Economic appraisal procedure**[a]					
		EEM	**Aust. NGTSM**	**Aust. TfNSW**	**UK WebTAG**	**UK TfL**	**US 'new starts'**
	Special areas	✓(N)	×	×	✓(N)	✓(N)	×
	Ecological impacts	✓(N)	✓(M)	✓(M)	✓(N)	✓(N)	×
	Biodiversity	–	–	–	✓(N)	✓(N)	×
	Landscape	–	–	–	✓(N)	✓(N)	×
	Townscape	–	–	–	✓(N)	✓(N)	×
	Visual impacts	✓(N)	×	×	×	×	×
	Community severance	✓(M)	✓(M)	✓(M)	✓(N)	✓(N)	×
	Overshadowing	✓(N)	×	×	×	×	×
	Isolation	✓(N)	×	×	×	×	×
	Vehicle emissions (local)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)
	Vehicle emissions (global)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)	✓(M)
	Upstream/downstream costs[p]	×	×	✓(M)	×	×	✓(M)
	Journey ambience	–	–	–	✓(N)	×	×
	Accessibility	–	–	–	✓(N)	✓(?)	×
	Personal affordability	–	–	–	✓(N)	×	×
TDM factors	Health benefits	✓(M)	–[q]	✓(M)	✓(N)	✓(N)	–
	Reduced car ownership	×	✓(M)	×	×	×	×
Wider economic benefits	Population and employment	–	–	–	–	–	✓(N)
	Agglomeration benefits	✓(M)	×	×	✓(N)	✓(N)	×
	Output change in imperfectly competitive markets	–	–	–	✓(N)	✓(N)	–
	Labour supply impacts	–	–	–	✓(N)	✓(N)	–
	Move to more or less productive jobs	–	–	–	✓(N)	✓(N)	–
	Economic development effects	–	–	–	–	–	✓(N)
	Option and non-use values	×	×	×	✓(N)	✓(N)	×
National strategic factors	Security of access	✓(M)	×	×	×	×	×
	Investment option values	✓(M)	×	×	×	×	×

Notes:

Key: ✓ (M) = monetised parameter; ✓ (N) = non-monetised parameter; – = unclear/inconclusive; × = not covered

[a] EEM (NZ Transport Agency 2010), Aust. NGTSM (ATC 2006), Aust. TfNSW (Transport for NSW 2012), UK WebTAG (DfT 2011), UK TfL (TfL 2008), US 'new starts' (Federal Transit Administration (US) 2013)

[b] Public transport access time (eg bus/ferry access to rail) is considered a 'transfer' and covered under 'interchange' in most procedures.

[c] Headway (service interval) is often referred to as the expected wait time at a stop or station.

[d] Reliability of travel time includes unexpected wait time at stop or station and unexpected IVT (eg delay due to congestion).

[e] Mode-specific factors are also known as alternative specific constants.

[f] EEM is unclear as to treatment of walk access.

(g) EEM provides parameters for bus stop and station features only (ie excludes rail).

(h) TfNSW seat availability/crowding parameters provided for rail only.

(i) WebTAG headway (service interval) and seat availability/crowding parameters provided for rail only.

(j) WebTAG quality attributes are provided for rail, it is unclear if any apply to other modes.

(k) The review of procedures included consideration as to whether any specific 'public transport user benefits' and/or 'road user benefits' were identified for inclusion in 'simplified procedures'.

(l) EEM provides for 'public transport user benefits' when appraising existing public transport services but not when appraising new services.

(m) Aust. NGTSM includes 'rapid appraisal' and 'detailed appraisal' in the decision-making process.

(n) Aust. NGTSM includes procedures for calculation of decongestion benefits.

(o) Parameters not considered further as they primarily relate to roads and therefore are more appropriately considered as part of any review of roading activities.

(p) Refers to indirect costs of transport including energy generation, vehicle production and maintenance and infrastructure construction and maintenance (Transport for NSW 2012).

(q) Considers disbenefit for less walking/cycling.

D1 References

Australian Transport Council (ATC) (2006) *National guidelines for transport system management in Australia*. Canberra: Australian Transport Council.

Department for Transport (2014) *Transport analysis guidance – guidance for the senior responsible officer*. Accessed 24 August 2014. www.gov.uk/transport-analysis-guidance-webtag

Federal Transit Administration (US) (2013) *Proposed new starts and small starts policy guidance*. Accessed 24 August 2014. www.fta.dot.gov/documents/NewStartsPolicyGuidance.pdf

NZ Transport Agency (2010a) *Economic evaluation manual* (volume 1).

Transport for London (TfL) (2008) *Business case development manual*. London: Transport for London.

Transport for NSW (2012) *Principles and guidelines for economic appraisal of transport investment and initiatives* (draft). Sydney, Australia.

Wallis, I, A Lawrence and N Douglas (2013) Economic appraisal of public transport service enhancements. *NZ Transport Agency research report 533*.

Appendix E: Summary of literature reviewed

E1 Appraisal approaches (bus infrastructure)

E1.1 Bus stops and shelters

Please see chapter 8 'References' in the main part of the report for bibliographic details of the works referenced in this appendix.

Reference	Key points	Consultant comments
(Texas Transportation Institute et al 1996)	• This report (for the USA TRB Transit Cooperative Research Program) provides guidelines for the location and design of bus stops, for use principally by transit agencies. Only a small part of a long report is concerned with the need for and location of stops. • It states that: 'As the first point of contact between the passenger and the transit service, the bus stop is a critical element in a transit system's overall goal of providing timely, safe and convenient transportation.' It further notes that universal concerns of both transit users and transit service providers, which are influenced by bus stop location and design decisions, include: transit system performance; traffic flow; safety; and security. • In determining the need for (and location of) a bus stop, transit agencies need to consider the following: 1) transit agency policy (eg regarding route types, stop installation guidelines); 2) equity aspects (eg equity in level of service among different segments of the community; demographic and social economic considerations); and 3) accessibility aspects (to the stop, to amenities, at the stop). • Other important factors in determining the need/location for a bus stop include: • trip generation/land use – how many potential bus passengers? • walking distance – how far do passengers have to walk? • boardings and alightings – how many passengers are getting on and off? • dwell time – how long does the bus dwell at the stop? • travel time – how long is the trip from the origin to the rider's destination? • transfer potential – how many routes serve this stop? The report does not address any economic issues relating to bus stop location and spacing, nor mention any economic rationale that may underpin the setting of standards for bus stop spacing/location or facilities.	While this report may be relevant to other aspects of this project, it does not contain any useful material relating to the economics of bus stop spacing/ location, including on the setting of standards for these aspects.

E1.2 Bus interchanges

Reference	Key points	Consultant comments
(Transport for NSW 2012)	• The TfNSW *Economic appraisal manual for transport initiativ*es includes a section specific to the appraisal procedures developed for interchanges (funded through the NSW parking space levy fund). • This section comments as follows in relation to the economic benefits of interchange projects: *Improving bus-rail interchange is often an integral part of wider*	This manual, which is applied to transport projects in NSW, provides arguably the best example available (certainly in this part of the world) of the

Reference	Key points	Consultant comments
	local strategies to bring about economic regeneration, or improve environmental quality. *The following wider economic benefits are anticipated from the implementation of the Interchange program:* • *Development of brownfield sites, coupled with a reduction in the generalised cost of commuting by public transport, leading to higher employment levels in regeneration areas;* • *The presence of good transport links at a site can often be commercially attractive for potential developers.* • *Wider availability of transport alternatives coupled with a reduction in commuting times & increasing the number of productive hours in a working day;* • *Reliability benefits which will produce most benefits for commuters; improve links between business centres;* *Environmental benefits – enhanced interchanges and seamless travel attract current and potential future car users into public transport (park and ride opportunities). By encouraging mode shift from private car to public transport, the program will contribute towards: removing cars from the road, reducing the energy consumption of transport; reducing rate of traffic growth, minimising congestion; and achieve a switch to less fuel intensive transport.;* • An MCA approach is specified for (ex-ante) appraisal of interchange projects, focused on an AST along the lines of that used in the UK (NATA/WebTAG). It comments that 'The qualitative scoring has been adopted because of variability of the projects and because the market is yet to provide a satisfactory measure of economic value specific for bus-rail interchanges.' 'The AST provides the information needed to make a judgement about the overall value for money of the option or options in achieving the Government's objectives. Providing the information in this way enables a consistent view to be taken about the value of projects. The AST does not automatically provide a mechanistic way of estimating value for money, but summarises the effects in each area so that decision makers have a clearer and more transparent basis on which to make a judgement.' • The appraisal framework involves six 'transportation' factors (accessibility, safety impacts, wider economic impacts, sustainable level of service, environment, integration) and four 'planning' factors (economy, funding options, land use policy, project readiness/ deliverability). Under each factor, a set of sub-factors and related scores is given. 70% of the overall maximum score is allocated to the transportation factors, 30% to the planning factors. • Scoring of each interchange proposal (as defined in the scoping studies) on each attribute is undertaken by a panel of four staff, who then agree on a common score or adopt an averaged score. This score is then divided by the project cost to give a relative effectiveness: cost ratio. An XL tool is available to facilitate this process	multi-criteria analysis (MCA) approach to ex-ante evaluation of interchanges (typically, in the NSW context, these are bus-rail interchanges, but this is not a limitation of the method). If an MCA approach is to be adopted for inter-changes in New Zealand, it could well be appropriate to start with the NSW AST list of factors and scores, apply this to a few case studies, and then adjust in the light of this experience. We have some reservations about consistency between the NSW factors and scoring methodology, and the methodology of then dividing by project capital costs to derive an effectiveness: cost ratio.
(NSW Auditor-General 2007)	• This performance audit report examines how well Sydney's system of public transport interchanges promotes the increased use of public transport. It focuses particularly on the critical role of TfNSW. • The report was critical of TfNSW performance in assessing the effectiveness of Sydney's public transport interchanges and potential	Most of the audit report criticisms of the NSW procedures/processes for interchange evaluation are probably similarly

Reference	Key points	Consultant comments
	improvements to them, in the following aspects: - lack of interchange performance objectives and measures of effectiveness - lack of finalisation/adoption of practice notes on interchange planning and design - lack of an evaluation process framework (using benefit: cost or other methods) to establish the impacts of interchanges on the public transport market - lack of ongoing monitoring of interchange usage and of before/after studies. It appears that many of the criticisms made in the audit report are no longer relevant, as a result of the TfNSW adoption of new (ex ante) appraisal procedures (Refer TfNSW 2012, above)	applicable in New Zealand – one of the purposes of this project is to ameliorate this situation. As noted, much of the content of the audit report is probably no longer relevant, and TfNSW (2012) is of great interest for this project.
(Wedderburn 2013)	• This Transport Agency research report (RR537) focused on improved cost-benefit methodologies for analysing the economic benefits of encouraging/integrating walking and cycling as access modes to public transport services. It included development of a spreadsheet-based evaluation tool, which can be applied to a single bus stop or a major multi-modal interchange. • The report focuses on methods for estimating economic benefits from improved walking/cycling access and facilities, given a specified change in access mode shares (which may be estimated with guidance from existing access mode share data in New Zealand). • The benefit estimation scope and methodology is essentially consistent with that given in EEM. Mention is also made of some other potential benefit categories which are not quantified in EEM. • The report does not cover changes in public transport interchange quality and their economic benefits (apart from aspects directly related to walking/cycling access and facilities).	This report is of little direct relevance to the present project, given its primary focus on walking/cycling access and facilities for public transport stops and interchanges. It does not cover the more general benefits of improving public transport interchanges and how they should be assessed for public transport, its users and public transport-car users.
(HiTrans 2005)	• The HiTrans guide notes that 'the key role of transfers and interchange points must be recognised' in planning the networks, but says very little on interchange planning, design and evaluation aspects. • The guide states that: 'Transfer is an inescapable feature of the majority of possible journeys that can be made through the public transport network. Consequently, how interchanges are designed and presented, and the processes through which passenger expectations are moulded and satisfied, is at the heart of the overall strategy of improving the public transport offer.' • Key benefits from the systematic improvements of interchanges are stated to be: - 'Reductions in disutility from reducing unpleasantness of individual interchange experiences of existing users. - Reduced journey times from rerouting where previously interchanges discouraged use. - Fulfilling a necessary condition to make possible an increase in public transport mode share. - Reduced pressure on crowded radial sections. - Increased flexibility for operators and planners to offer a mix of public transport modes to suit local circumstances.'	This 'best practice' guide seems to add nothing more than other literature sources on interchange planning and evaluation.

Reference	Key points	Consultant comments
(Buchanan and Nevell 1999)	• Project for UITP, involving questionnaire survey of major public transport operators internationally (97 responses) to investigate policies relating to purpose-built interchanges and their desirable design features. • Identified that improvements could be achieved through four approaches: - improved design and organisation within the physical confines of the interchange facility - improved sub-modes that feed into the existing interchange facility - improved locations for interchange with the existing transport system - improved total transport systems which reduce the need for interchange. • Main difficulties in interchanging that have to be overcome related to: - the loss of time - inconvenience as a result of long walkways and steps - the danger of missing connections. • The main barriers to easy/convenient interchange are: - poor layout involving long walks, stairs, crossing busy roads, etc - uncoordinated timetables, low frequencies and unreliable services - lack of through ticketing - competition and unclear responsibilities - lack of understandable, relevant information - poor quality design and maintenance. • The views of public transport coordinators were that key ingredients of good interchange are: - services that are reliable/punctual, high frequency, high capacity and with good connections between services, involving short walking distances - through ticketing - availability of staff and enquiry facilities - availability of car parking, with low or zero charges. • Passenger priorities for interchange improvements included: - more telephones, better protection from the weather, toilets, a clean litter-free environment, better and more understandable passenger information, and better personal security. • Desirable features of bus/bus interchanges in town centres (involving modest expenditures) would appear to include: - more and better weather protection - grouping of stops by destination served - instantly readable and relevant information - minimum service levels - faster boarding times.	Paper provides a useful checklist of 1) barriers to be overcome, and 2) desirable features, relating to bus interchanges and their facilities. Ideally any assessment methodology would place values on such features, based on user preferences etc.
(Ubbels et al 2013)	• Paper provides results from the EU City-HUB project relating to the key determinants of successful interchanges. It includes a state-of-the-art overview of improvement elements defining interchange quality, based on results from other EU research projects, case studies, policy documents and stakeholder interviews.	The paper provides information on important features of interchanges on the perspectives of the major stakeholder groups (users, operators,

Reference	Key points	Consultant comments
	• A crucial aspect is understanding user (existing/potential) requirements. Important aspects that affect user travel behaviour are perceived time and costs, travel time, reliability, convenience, comfort, security and accessibility. • Measures that would enhance the quality of interchange for users relate to intermodal integration (eg secure cycle stands), passenger services (eg integrated ticketing, availability of shops) and design aspects (eg short distances between transport modes). To a significant extent, different user groups (eg regular users, occasional users, people with disabilities) have different priorities. • From the operator perspective, issues relate to service coordination, integrated facilities (eg ticketing) and ongoing operation/maintenance. Arrangements for consultation/cooperation between stakeholders are required, including effective management/administration arrangements. • From the policy maker/government perspective, often modally based policies tend to have the effect of reducing the importance of interchanges (eg under the UK 'deregulated' bus model).	government policymakers). These can contribute to defining a check list of features, on which values would (desirably) be placed for use in the assessment of interchange options.
(Morris and Pope 2006)	• Paper reporting on a UK-based consultancy project into barriers to public transport use and means of overcoming them, with particular reference to urban transport interchanges (the aspect where the greatest barriers are perceived that discourage/prohibit public transport contemplation and use). • Project involved extensive market research in East Lancashire, including: in depth household interviews, focus groups, and a mystery travel survey. The research investigated all travel related areas consideration, including not only the journey itself but also the decision-making process involved prior to making the journey and even deeper decision-making fundamentals (such as cultural and political grounding). • Perceived barriers to public transport use were categorised under a number of common themes: time, cost, accessibility, personal safety, and familiarity. Barriers under each theme could arise during three distinct phases of the journey process, ie underlying factors, in planning a journey, and in undertaking the journey. • The significance of these barriers for individuals is highly dependent on the traveller profile and the type of journey in question. Traveller profiles may be categorised by car availability and age group/gender/ disabilities/ employment situation. • Much of the paper focuses on how to reduce the barriers to interchange through improved information. Another, related focus was on improved/simplified network design, so that the required information could be simplified. It was suggested that a 'core network' should be defined to connect all the principal urban centres in the study area, the inter-urban bus and rail connections: local services would then be co-ordinated with this core network at key interchange locations. • The paper concludes that, to achieve substantial increases in patronage, public transport journeys need to be designed and marketed as a 'seamless' whole: as well as infrastructure improvements, this will require major improvements in terms of information and marketing approaches.	The area covered by the research (essentially the Manchester conurbation) as a more complex public transport system (metropolitan train services, mostly deregulated bus services) than occurs in New Zealand (with possible exceptions in Auckland). The New Zealand task of providing appropriate information and marketing at interchanges should thus be significantly easier than in Manchester (and should be assisted by moves to simplify networks in Auckland in particular). While the paper has little to say on the wider assessment of interchanges, it does highlight the importance of good information and marketing for interchange facilities and zones.

<table>
<tr><th>Reference</th><th>Key points</th><th>Consultant comments</th></tr>
<tr><td>(Pienaar 1998)</td><td>This paper (summarised from a PhD thesis) sets out a methodology and provides a case study for the (ex-ante) economic evaluation of public transport terminals/interchanges in a South African context.
The paper uses a ‘conventional’ economic methodology. Benefits from interchange investments comprise: facility O&M costs; public transport operating cost changes; changes in interchange user (base/new) travel costs; and changes in road user time and costs where traffic conditions are influenced by the facility.
To assess interchange user costs with/without the new facility, a ‘standard’ user generalised travel cost formulation is used (excluding fares) (eg refer ATC 2006). This incorporates in-vehicle travel time, waiting time, walking time, transfer time, each multiplied by perceived time factors. Factors for time spent at the facility are varied according to its quality, in three categories: well-designed, sheltered and functions effectively; partially sheltered and functioning moderately; badly designed, and sheltered and functioning poorly. [This approach to allowing for interchange quality in economic evaluation would appear to have merits – it is not incorporated into RR533 (Wallis et al 2013).]
The paper discusses non-transport economic benefits, and concludes that: 1) any increases in commercial activities resulting from the interchange facility and its use are transfers of activity from other locations, hence not regarded as economic benefits; and 2) any rents received from commercial activities renting space in the terminal comprise a financial benefit, but should not be included as an economic benefit in the evaluation.</td><td>While this paper offers a ‘conventional’ approach to the (ex-ante) economic appraisal of public transport interchanges etc, it includes a few novel points on detailed methodology. In particular, it suggests varying factors be applied to time spent at interchanges according to broad assessments of interchange ‘quality’.</td></tr>
<tr><td>(Transport for London 2009)</td><td>TfL design and evaluation framework for use in optimising interchange design and operation and assessing performance of existing/proposed interchange zones. Framework is designed to complement the standard UK NATA approach and associated WebTAG methodology.
The framework can emphasise different aspects of interchange than those covered in NATA/WebTAG. For example, it can capture perceptions of different stakeholders (users, operators etc). The framework is intended to 1) highlight key considerations during the design and planning stages of new/improved interchange facilities or zones; and 2) provide a set of criteria against which the quality of an existing or planned interchange zone can be assessed.
The principles (criteria) are set out under four themes as follows:
- efficiency: operations movement (within facility), movement (wider interchange zone), sustainability
- usability: accessibility, safety/accident prevention, personal security, protected environment
- understanding: legibility, permeability, way-finding, service information
- quality: perception, built design quality, urban realm sense of place.
When the framework is used to evaluate an existing interchange facility, the evaluation is based on a simple ‘traffic light’ scoring system: each principle/criterion is scored as green (all aspects have been addressed), amber (some have been addressed) or red (few if any have been addressed).</td><td>This framework appears to have been applied successfully by TfL over recent years, and is amenable to both ex-ante and ex post applications.
The principles/criteria comprise factors that should be addressed in interchange planning, although the present framework does not attempt to evaluate performance in terms of monetary values.
Arguably the framework is more useful for ex-post evaluation than ex-ante appraisal, although it could be of value for either/both situations.</td></tr>
</table>

Reference	Key points	Consultant comments
(Auckland Transport 2013a)	• The Auckland RPTP defines four categories of interchange (major, intermediate, minor, neighbourhood connection). It then specifies key features that should be incorporated into any new or upgraded interchange facilities (eg toilets, kiosk ticket machines, help points cycle storage, maps and timetables, RTI). • The RPTP also states that 'AT has developed detailed guidelines for the development of public transport interchanges'.	The AKL RPTP does not itself provide any information on approaches to assessing the range of benefits that might be achieved with appropriate interchange facilities and design. This is covered more in the interchange design guidelines (refer New Zealand practice review where discussed further)

E1.3 Bus priority measures

Reference	Key points	Consultant comments
(Tsamboulas 2006)	• Provides a methodology for the (ex-ante) appraisal of the implementation of exclusive bus lanes. Methodology is based on the use of translocation models to estimate demand effects, followed by an economic evaluation based on 'standard' CBA approach/methodology. • The demand modelling work derives estimates of the following variables for both the existing and the option situations: traffic volumes per lane, passenger volumes, traveller (car/public transport) travel times, traveller costs, public transport operator costs, other transport operator costs, vehicle operational costs, driver time and costs, energy impacts, environmental impacts. • All these impacts are then brought together in the economic appraisal. The principal benefit components are changes in: 1) trip maker travel time and cost impacts (all modes, both in vehicle and public transport waiting times); 2) travel cost impacts for modal switchers (principally car to public transport); 3) change in public transport operator revenues; 4) external costs (including energy consumption, noise and atmospheric pollution). • Economic-based indicators (eg NPV, BCR) are then derived, for consideration by decision-makers.	The paper outlines a fairly standard application of CBA for such situations. It does not appear to offer any significant new insights in the context of the present project.
(Public Transport Authority (PTA) of Western Australia 2004)	• This document sets out design principles and planning guidelines, including (ex-ante) economic evaluation procedures, for bus priority measures in Western Australia (Perth). • It includes description of a Project Prioritisation & Evaluation Model (PPEM) developed by PTA for the economic evaluation of 1) a range of bus priority options being considered for a particular location; and 2) competing projects in different locations, so as to achieve maximum value for money. PPEM may be applied to physical infrastructure projects or service developments, for discrete sites, continuous routes, individual corridors or wider networks. • The model includes nine components, covering: project evaluation framework; project/intervention type; assessment parameters, project benefit imports, bus operating cost inputs, project capital costs, economic performance (BCR etc), sensitivity tests, externalities (non-quantifiable, including environmental impacts, impacts on community and local government stakeholders etc).	PPEM appears to be a fairly 'standard' (ex ante) economic appraisal model for public transport/transport demand management projects of this type. Unlike some such models, it appears that any demand effects (eg extent of modal switching) have to be assessed outside the model and provided as inputs. It appears likely that, if requested, PTA would be

<table>
<tr><th>Reference</th><th>Key points</th><th>Consultant comments</th></tr>
<tr><td></td><td>Table E.1 Types of bus priority measures
<table>
<tr><th>Technology</th><th>Corridor</th><th>Point</th></tr>
<tr><td>• Active signal priority (transit signal priority/pre-emption, phase compensation, priority green and ‘B’ lights, advanced priority phase linking)
• Dynamic scheduling
• Real-time information
• Smartcard ticketing
• Passive signal priority (transit signal timing, priority movement detection, green priority weighting, reduced cycle time)
• On board GPS/ transponder</td><td>• Transit mall
• Bus priority lanes (non-exclusive lanes, semi-exclusive lanes, exclusion lanes (bus rapid transit (BRT), contraflow lanes)</td><td>• Bus gate/sump busters
• Freeway access ramps
• Bus undertaking at stops
• Queue jumping provisions (short transit lanes, queue relocation bus lanes, bus advance area, intersection bypass lane)
• Turning movement ban exemption
• Hook turn provision
• Bus plug
• Transit mall
• Kerb extensions/ bus bulbs</td></tr>
</table></td><td>willing to provide a copy of the model (Excel-based) for use in New Zealand, at least on a trial basis.</td></tr>
<tr><td>(Currie et al 2007)</td><td>• This paper outlines ‘a new approach to evaluating on-road public transport priority projects, balancing the demand for limited road space’.
• It appears that the primary ‘new’ aspect in the methodology is the use of a dynamic traffic micro-simulation model to estimate travel time and reliability for both bus and car users with/without the priority measure which is the subject of the (ex-ante) evaluation. A generalised cost elasticity/diversion rate methodology is used to estimate changes in public transport demand and hence in car travel demand.
• The economic appraisal component of the methodology is largely ‘conventional’, and comprises the following main components: 1) base case public transport user impacts- travel time, reliability; 2) base case road user impacts- travel time, reliability: 3) mode switcher and related impacts- mode switcher travel time benefits, road congestion-related impacts (travel times, vehicle operating costs (VOC), accidents, environmental impacts), fare revenue impacts; and 4) public transport operator impacts (bus hours, peak vehicle requirements (PVR)). Economic performance measures (NPV, BCR etc) are then derived.</td><td>The approach adopted in this paper largely follows conventional CBA methodology for such projects. Apart from the use of micro-simulation to assess travel time impacts (both car and bus modes), the other feature worth noting for the current project may be the method for estimating reliability benefits.</td></tr>
<tr><td>(Takeshita et al 2007)</td><td>• Paper provides an ex post evaluation of the BRT system (involving median bus lanes) implemented in Nagoya city (1985). The results demonstrate the effectiveness of the system in terms of 1) higher bus operating speeds/reduced travel times and greater reliability; 2) higher bus patronage; and 3) no reduction in overall corridor capacity (in terms of total person throughput).</td><td>Paper is of some relevance in showing the various effects of bus priority measures and the parties affected.</td></tr>
</table>

Reference	Key points	Consultant comments
	• Paper includes a flowchart showing the mechanisms by which the various features of the BRT system come together to produce impacts on bus users, bus service providers, car users, the general population and the city economy (the latter in terms of land prices and locational decisions).	
(Auckland Transport 2011)	• This paper provides criteria adopted by AT for the application of bus/transit lanes in Auckland. • It specifies six criteria for situations where bus/transit lanes may be appropriate: (A) alignment with strategic transport plans; (B) consideration of specific characteristics of the route; (C) road safety considerations; (D) travel time or level of service; (E) corridor productivity or efficiency; and (F) person trips (per lane). The last three (quantitative) criteria in particular are the major factors influencing decisions between bus priority lanes or T2/T3 lanes.	The paper may be of some relevance for this project. There is no mention of any direct economic appraisal component for (ex-ante) assessment of bus priority measures. It appears that the six standards-based criteria presented are intended as substitutes/ proxies for an economic appraisal.
(Wallis and Bolland 2008)	• This report provides an (ex-ante) economic appraisal of the proposed (2008) Wellington City Bus Priority Plan. • The economic appraisal methodology adopted was fairly 'conventional'. One exception is the estimation of benefits from improved bus reliability (which are commonly seen as one of the major benefit components for bus priority measures): these were estimated as a proportion of (average) travel time benefits, based on some more detailed case studies undertaken in the UK. • Other aspects of the report that may be relevant to this project include: 1) review of UK (ex-post) evidence on the impacts of bus priority programmes; 2) review of evidence on impacts of Auckland City bus lane programme (1998–2003); and 3) summary of evidence on the impacts of the Dominion Road/Mt Eden Road bus priority measures on pedestrians and the business sector (results of monitoring surveys in 1999).	Both the review of impacts of the Auckland City BP programme, and the evidence on the local impacts of the Dominion Road/Mt Eden Road schemes, may be of relevance to the proposed case studies. As far as we are aware, the survey evidence on the impacts of the Dominion Road/Mt Eden Road schemes on local pedestrian movements and the business sector is the only evidence for such schemes in New Zealand.
(Currie and Sarvi 2012)	• This paper reports on a 'new model for secondary benefits of transit priority'. • It provides useful (new) contributions in three main areas, from review of international and local experience with busway/bus priority measures: - bus patronage growth in the corridor as a function of bus travel time reductions - proportion of new bus passengers who previously made the trip as car drivers, as a function of bus travel time (TT) reductions - reduction in PVR (hence bus fleet size requirements), as a function of bus TT reductions. • The paper concludes that the 'secondary' benefits of bus priority measures (including mode switching effects and operator cost savings) are likely to be significantly greater than suggested in some previous works, and that these 'secondary' benefits may well exceed the primary benefits of bus user travel time savings.	The paper provides a useful contribution to making improved estimates of the full range of significant impacts of bus priority measures (unfortunately, it largely excludes reliability benefits). It should therefore be useful in developing improved economic appraisal methods relating to bus priority initiatives.
(Ang-Olson and Mahendra 2011)	• This research digest (prepared for the USA TRB/NCHRP) summarises the results of a methodology/evaluation phase for 'cost benefit analysis of converting a lane for bus rapid transit'.	This research appears to contribute little of use for the current project.

Reference	Key points	Consultant comments
	• The research project essentially adopted a conventional CBA approach to assessing benefits. • It also discusses potential treatment of the following 'indirect' benefits: - savings in parking costs for drivers who switch from car to the new BRT service and/or reduction in the need to provide parking in the CBD - improvements in the journey reliability that would accrue to BRT riders - savings in operating costs for the transit agency due to the higher efficiency of the BRT service - Land development impacts, involving a change in the use and value of properties located near the new BRT corridor - economic impacts from enhanced accessibility to employment. • It states that these 'indirect' benefits have not been quantified for the BRT project because 1) 'it will be difficult to isolate the impacts of the BRT project alone…'; and 2) the business and employment benefits are typically not included in project level analyses, since they are assumed to be transfers from other regions or from parts of the same region'.	In terms of its treatment of what it calls 'indirect' benefits, we would agree with its rationale for dismissing items (D) and (E) as transfers. We are surprised at its dismissal of items (A), (B) and (C) as too 'difficult to isolate': we would normally include these, as real economic impacts, in any economic appraisal of such schemes.
(Fleming et al 2013)	• This Transport Agency research project investigated the economic impacts of transport and road space reallocation in shopping areas located in central cities and along major transport corridors in New Zealand. It focused on three research questions: 1) gaining understanding of the retail spending of transport users, to derive data on average $ spend per user by primary mode of transport: 2) identifying the road space allocation and design elements important to retailers and shoppers: and 3) developing a compendium of case studies. • A total of 1,744 shopper surveys and 144 retail surveys were completed form nine shopping centres (in central city locations and along arterial corridors) in Auckland, Christchurch and Wellington. It was found that sustainable transport users accounted for 40% of the total retail spend in these shopping areas. • A key difference between the retailer and shopper groups in the survey was the importance of parking. The retailers consider parking as the most important design feature to attract shoppers. However, the evidence from the shoppers is that the majority indicated they would be willing to forgo parking in shopping centres, to ensure they had a safe and attractive shopping experience. • One argument put forward for the provision of on-road parking outside shops, especially in arterial shopping areas, is that 'passing by trade' is less likely to stop if parking is not readily available outside the shops. The results of this research showed that the majority of people who shopped in arterial shopping areas in New Zealand intended to visit the area anyway, with passing trade accounting for less than 30% of all purchases. • Early consultation with the local community and key stakeholders, presenting the findings of such research, is seen as more likely to result in the development of a successful project with community backing. The report recommended that when further research is undertaken, additional data is collected and tailored to the needs of the specific study. This would include undertaking parking surveys to understand the use of on and off-street parking in the area, as part of the economic surveys.	This is a useful report for the current project, in terms of providing evidence on retail spend patterns in New Zealand cities, and on attitudes of shopper and retailer groups on the role of public transport and other sustainable modes, and on the importance of parking availability and price issues.

E2 Retail impacts

Reference	Summary
(Donovan et al 2011)	This study considered transport and land use outcomes at Sylvia Park, Auckland. A key conclusion was that while non-car users constituted only a small proportion of total visitors to Sylvia Park (8.8%), they contributed a disproportionate amount of revenue given the relatively low transport costs that they impose on the private sector, both in the form of upfront infrastructure and ongoing operating costs. This study provides detailed analysis of the expenditure patterns of bus users at Sylvia Park. When compared with other modes, bus passengers were found to be the most profitable – due to the relatively low costs that they impose and the moderate levels of expenditure that they generate per person. This study is considered to be of moderate relevance to our research.
Williamson et al 2012)	The purpose of this study (*NZ Transport Agency research report RR479*) was to develop methodologies to quantify the economic productivity and land use impacts of transformational or structural transport investments over time. The study analysed how the revealed preferences for locational choices could inform the assessment of the productivity and land use effects of transformational/structural transport investment. The researchers note that 'economic theory predicts a positive relationship between improved accessibility and increased productivity, and between increased productivity and increased land (or property) values'. RR479 is primarily concerned with how to predict the impacts of 'transformational' transport investments. In contrast, our research is primarily concerned with the economic impacts of small to moderate bus infrastructure improvements. In most cases, we would not expect significant impacts on the locational decisions of firms and households. For this reason we suggest this study is of low relevance to our research.
(Hazledine et al 2013)	The objective of this research project was to *'*quantify the contribution of public transport to economic productivity*'*, above and beyond what might be considered in conventional economic appraisal processes, such as those contained in the EEM. To answer this question the researchers chose to adopt and extend a model developed in Venables (2007), where all the productivity 'action' comes from agglomeration economies generated in city centres, or other nodes of concentrated employment. The study adapted Venables' model in three ways: First, it modelled directly the implications for congestion and travel speeds of mode shifts induced by the public transport innovation, with capability built in to handle a variety of types of innovation, including changes in fares, service levels, and performance. Second, it allowed for change in land use within the CBD, specifically the consequent change in demand for and supply of car parking. Third, the model was implemented in an accessible and replicable spreadsheet format. The relevance of the Hazledine study to this project is expected to be dependent on the relative size of the case studies that are considered. The largest case study considered by Hazledine is the Central Connector, which cost $26 million project and was found to generate additional productivity benefits in the order of 22% of the conventional economic benefits. This is at the upper end of the case studies considered in our research.
(Fleming et al 2013)	This study looked at 'the economic impact of transport choice and road space allocation on retail activity in shopping areas located in central cities and along major road corridors in New Zealand cities.*'* Three key research areas were considered: 1) Relevant research/case studies on road space allocation; 2) The economic impact of users by transport mode in New Zealand shopping areas; and 3) How road space allocation/street design influences use of shopping areas. The study found that non-car users contributed 40% of the total retail spend in an area, which was lower than that predicted by retailers surveyed by the researchers. This was somewhat at odds with the case study evidence from overseas. The implications for this project is that where bus infrastructure reduces roadway capacity

Reference	Summary
	and/or parking capacity, then there may be an associated negative impact on the retail spend of car-users. Off-setting this impact, however, is increased spend from non-car users. The balance of effects will depend on the relative size of the impacts on users of different modes.
(Wallis et al 2013)	Ian Wallis Associates recently completed this research project, which looked at procedures and methods for the economic appraisal of public transport projects in the New Zealand context. The focus of the project was public transport service enhancements but the appraisal approaches considered are also applicable to public transport infrastructure projects. The study reviewed project appraisal procedures from New Zealand (EEM), Australia (National Guidelines for Transport System Management) and the UK (WebTAG). It included consideration of the range of benefits within each of the various procedures. The study made recommendations for how appraisal procedures might be applied to public transport service improvements in New Zealand. Three potential levels of analysis were identified (detailed, rapid or simple) with the appropriate level of analysis depending on the three factors: type of project, cost and risk profile of the project and stage of assessment within the decision-making process. This framework provides a good starting point for the consideration of public transport infrastructure projects and aligns well with the NZ Transport Agency Business Case Approach framework. It will be used as the starting point for our research, as it identifies a range of benefits and appraisal procedures that are relevant to this project.
(Auckland Council 2012)	Auckland Council prepared this evaluation of the impacts of the Fort Street shared space on a range of economic outcomes. Construction on the Fort Street shared space was undertaken in three stages, beginning in 2011 and continuing for just under two years. A before/after photo of the Fort Street shared space is shown in figure E.1. The development of the shared space was found to have the following key impacts: • Pedestrian count volumes increased by over 50%. • Surveys of users found 91% were highly complementary of the shared space. • Vehicle count volumes decreased from 6,150 to 4,700 vpd. • Average vehicle speeds reduced by 5–9km/h. • Total retail spending activity in the general Fort Street area increased 22% following the end of construction, and almost 400% in the directly affected area. While the Fort Street shared space is primarily a pedestrian improvement, we suggest that the evaluation undertaken by Auckland Council is highly relevant to our research. This relevance arises because the primary effects of the shared space on vehicles, namely fewer passing vehicles and reduced parking supply, are similar to the effects of many bus priority projects. This raises the potential for bus priority measures to integrate with general pedestrian improvements so as to support retail activity in affected areas. In this way, the development of bus priority measures can act as a catalyst for enhanced mobility (for bus users) and accessibility (for pedestrians).

Reference	Summary
	Figure E.1 Before and after photo of Fort Street shared space 
(Jones Lang LaSalle 2008)	This study was undertaken by Jones Lang LaSalle (JLL) for Wellington City Council, as part of the investigation into the opening of Manners Mall to buses. It provided qualitative discussion of how the reintroduction of buses to Manners Mall (and associated changes to nearby streets, such as Willis Street might impact on outcomes for pedestrians, bus users, and car drivers. This discussion was grounded in an analysis of trends in retail rents, vacancy rates, and pedestrian counts. The study is of only minor relevance to our research. While hypothetical relationships between foot traffic, retail spending, and rents are discussed, the study provides no basis for quantifying how a particular change in public transport accessibility might impact on retail outcomes.

E3 Risk management

E3.1 Risk within bus infrastructure guidelines

Reference	Summary
(Auckland Regional Transport Authority 2009a)	While the 2009 ARTA guidelines do not have anything specific about risk, Appendix D has a bus stop checklist that points towards dealing with many of the typical risks. It delves into aspects outside of the technical/physical including: Driver training, consultation, funding, links to other modes (cycling) projects.
(NSW Ministry of Transport 2008)	No reference to risk or risk management. The main part of the document deals with the deliverable side (ie requirements to meet objectives), but nothing specific or useful for helping avoid project pitfalls.

<table>
<tr><th>Reference</th><th>Summary</th></tr>
<tr><td>(TransLink Transit Authority 2012b)</td><td>Risk is discussed within the document but only relating to safety and personal security at facilities. There is nothing specific or useful for helping avoid non-technical/infrastructure project pitfalls.</td></tr>
<tr><td>(HiTrans 2005)</td><td>
This guideline document deals with network planning rather than infrastructure and does deal with risk. Generally messages around risk are linked to economic factors, however chapter 4 which covers ‘Methods and tools for assessment of solutions’ includes a table looking at factors to be dealt with in the business case appraisal and risk management is listed as an objective, specifically table E.1.
It is interesting that risk is identified in the HiTrans network planning document, but not in the infrastructure document. Looking at the language there seems to be a greater focus on risk due to greater private sector investment in the network planning element.
Table E.2 Summary of factors to be dealt with in the business case appraisal for the Edinburgh transport initiative
<table>
<tr><th>Objective</th><th>Global measures</th><th>Data</th></tr>
<tr><td>Economic efficiency</td><td>Journey time savings
Journey time reliability
Operating costs
Capital costs
Charges
Taxation impact</td><td>Transport modelling
Transport modelling
Systems development
Systems development
Transport modelling
Financial, transport modelling</td></tr>
<tr><td>Local economy</td><td>Employment changes
Spatial economic impacts</td><td>Economic model
Economic model</td></tr>
<tr><td>Environment</td><td>Air quality, greenhouse gases
Pedestrian environment
Visual intrusion
Loss of green space
Noise</td><td>Transport modelling
Qualitative
Qualitative
Project definitions
Transport modelling</td></tr>
<tr><td>Safety</td><td>Personal injury road accidents
Personal security</td><td>Transport modelling
Qualitative</td></tr>
<tr><td>Accessibility</td><td>Accessibility measures
Severance</td><td>GIS/transport modelling
Scheme assessment</td></tr>
<tr><td>Integration</td><td>Transport user convenience
Effect on slow modes
Integration with land use planning</td><td>Qualitative
Transport mode
Transport modelling, qualitative</td></tr>
<tr><td>Social inclusion</td><td>Effect on income groups
Accessibility of deprived groups
Regeneration</td><td>GIS
GIS/transport modelling
Land use modelling/qualitative</td></tr>
<tr><td>Health</td><td>Physical fitness/life expectancy</td><td>Qualitative</td></tr>
<tr><td>Risk management</td><td>Acceptance – public and political
Technology and operational risks
Financial risk
Statutory risk</td><td>Consultation
Expert advice
Financial model
Qualitative</td></tr>
<tr><td>Financial framework</td><td>Charging revenue
Investment cost profile
‘Non-productive’ costs (interest etc)</td><td>Transport modelling
Scheme timing and cost profiles
Financial model</td></tr>
</table>
</td></tr>
</table>

E3.2 Literature specific to management of risk

<table>
<tr><th>Reference</th><th>Summary</th></tr>
<tr><td>(NZ Transport Agency 2010b)</td><td>
Like most risk management framework documents the Transport Agency framework is based on the 31000:2009 ISO standard. It adopts the neutral definition of risk ‘effect of uncertainty on objectives’ which allows for identification of risks with positive outcomes.
The applicability of information in this framework is considered high as the Transport Agency, along with local authorities are likely to be the end user of the findings of this research paper. Listed below are the key components of the document that relate to the bus-based public transport risk framework we will produce.
Context of risk – external vs internal
The table below summarises the Transport Agency’s separation of risks into those inside and outside the Transport Agency’s direct control (NZ Transport Agency 2010b, chapter E1, pp7–9). Each will need to be acknowledged, if not interrogated as part of risk assessment.
Table E.3 Risk context
<table>
<tr><th>External (outside organisations control)</th><th>Internal (inside organisations control)</th></tr>
<tr><td>Social</td><td>Governance and structure</td></tr>
<tr><td>Political</td><td>Objectives</td></tr>
<tr><td>Cultural</td><td>Policies and procedures</td></tr>
<tr><td>Legal and regulatory</td><td>Resources</td></tr>
<tr><td>By-laws</td><td>Information systems</td></tr>
<tr><td>Financial</td><td>Culture</td></tr>
<tr><td>Technological</td><td>Contractual relationships</td></tr>
<tr><td>Economic</td><td>Capability</td></tr>
<tr><td>Natural environment</td><td>Organisation factors</td></tr>
<tr><td>Competitors</td><td></td></tr>
<tr><td>International</td><td></td></tr>
<tr><td>External stakeholders</td><td></td></tr>
</table>
Components of risk management process
Again, the Transport Agency has borrowed from ISO 31000 with the ‘7Rs and 4Ts’ of risk management process (NZ Transport Agency 2010b, chapter F2, p15).

Recognition or identification of risks
Ranking or evaluation of risks
Responding to risks:

tolerate
treat
transfer
terminate

Resourcing controls
Reaction planning
Reporting and monitoring risk performance
Reviewing risk management effectiveness

The other component identified is for opportunity risk, an additional option to exploit the risk.
</td></tr>
<tr><td>(NZ Transport Agency 2013c)</td><td>Linked to the Transport Agency’s Risk management framework 2010 – 2013 is the Minimum standard Z/44 – risk management. The Z standard series outlines the requirements the Transport Agency has for projects it undertakes or funds. It has a number of useful diagrams and process outlines that are applicable to a potential risk framework for bus-based public transport.</td></tr>
</table>

Reference	Summary
	The two figures below are from the Z/44 standard and relate to the Transport Agency's Highway Network Operations (HNO) projects. HNO is the delivery arm of the Transport Agency. The diagrams set out how to action and measure different risks and opportunities. Of particular importance is the language used and how it translates to required action. When looking to develop a risk framework specifically for bus-based public transport it is important to understand the terminology used by the Transport Agency, which will likely play some role in the project – as client or funder – and the weight or power the term has. When developing a new purpose-built risk framework it will be important to match terms like 'high threat' with those in this document to avoid confusion.

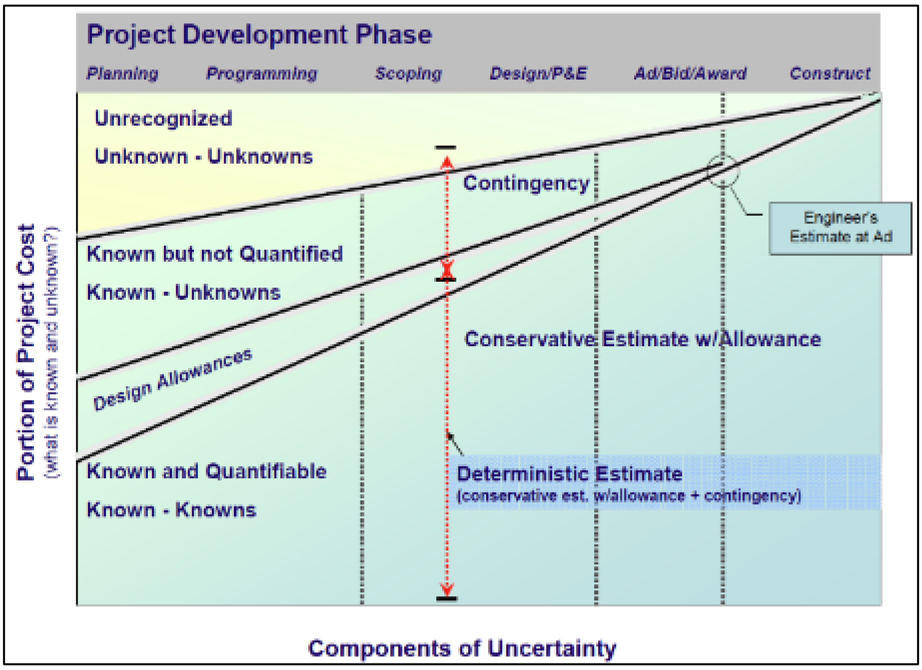
Figure E.2 Risk and response – NZ Transport Agency projects

HNO Risk Level				
Threat Level	Action	Notification of new risk or risk where the Threat/ Opportunity level has increased	Reporting	Opportunity Level
Extreme Threat	Maintain record in risk register, determine requirement for treatment, thereafter implement, manage and monitor as appropriate.	Notify NZTA Client within 1 working day or immediately if urgent response is required. NZTA Client to evaluate risk for escalation.	As per contract reporting requirements	Extreme Opportunity
High Threat				High Opportunity
Moderate Threat		Notify NZTA Client within 5 working days or immediately if urgent response is required. NZTA Client to evaluate risk for escalation.		Moderate Opportunity
Low Threat	Maintain record in risk register, risk may be Parked without requirement for treatment, requires ongoing monitoring.	Notify Line Manager within 5 working days.		Low Opportunity

Figure E.3 Risk probability – Transport Agency projects

	HNO Threat Probability Rating				
	Very Low	Low	Medium	High	Very High
Likelihood (applicable to Capital Projects)	≤10%	>10% - 30%	>30% - 50%	>50% - 70%	>70%
Frequency (applicable to M&O contracts)	Less than once in 10 years	At least once in a period of >6 - 10 years	At least once in a period of >2 - 6 years	At least once in a period of >1 - 2 years	At least once in a period of 12 months

Reference	Summary
(Auckland Transport 2012)	The Project Management Services department of Auckland Transport (AT) has produced a comprehensive handbook on the managing of risk across a project's lifecycle. The fact that it interrogates risk early in a project (eg project planning and investigation), which makes this particularly useful for developing a bus-based public transport risk framework.

Reference	Summary
	Figure E.4 illustrates that the earlier you are in the project lifecycle the greater the chance of unrecognised cost implications. Simply put these are the things 'you don't know that you don't know'. As such it is not possible to identify or plan for them. This highlights that while cost risks are certainly important to recognise there are likely other risks equally important in the early stages of project development. A useful definition of the objective of project risk management is provided on page 9 of the document: *The project risk management process helps project sponsors and project teams make informed decision regarding alternative approaches to achieving their objectives…* It is important to: a) understand the objectives of your project, and b) that there will be different approaches to achieve those outcomes. Focusing on outcomes rather than infrastructure earlier in the project will allow flexibility and greater likelihood of successful delivery.
	Figure E.4 Evolution of project knowledge through project development (Auckland Transport 2012, p6) 
	Likelihood and consequence Creating a matrix from risk likelihood (probability) and consequence (impact) is currently the favoured method of ranking risks. The figures below, taken from pages 22, 24, and 25 of Auckland Transport (2012) illustrate how each element (likelihood and consequence) can be ranked in order to develop an overall risk score. While the scale of the metric may change (eg likelihood could be in months rather than years) the basic principle will remain the same when measuring risks at any point of the project lifecycle.

Reference	Summary
	Table E.4 Ranking of risk likelihood (taken from Auckland Transport 2012)

Ranking	Likelihood of risk event	Likelihood expressed as a %	Likelihood expressed in terms of frequency
5	Very high	>75%	May occur this year
4	High	50–75%	May occur in next 2 years
3	Medium	20–50%	May occur in next 2–5 years
2	Low	2–20%	May occur once in 5–20 years
1	Very low	<5%	May occur once in 20 years

Table E.5 Ranking of risk consequence – evaluation the impact of a threat on project objectives (taken from Auckland Transport 2012)

	Impact				
Constraint	Very low	Low	Medium	High	Very High
Time	Insignificant schedule slippage	Delivery plan milestone delay within 3 months	Delivery plan milestone delay of 3 months	Delivery plan milestone delay of more than 3 months	Delivery plan milestone delay outside fiscal year
Cost	Insignificant cost increase	<5% cost increase	5–10% cost increase	10–20% cost increase	>20% cost increase
Scope	Scope decrease is barely noticeable	Changes in project limits or features with <5% cost increase	Changes in project limits or features with 5–10% cost increase	Sponsor does not agree that scope meets the purpose and need	Scope does not meeting purpose and need
Quality	Quality degradation barely noticeable	No safety issues – C, O, M deficiencies approved by project team	No safety issues – C, O, M deficiencies require management approval	Quality may be made acceptable through mitigation or agreement (eg fact sheet)	Quality does not meeting one or all the following: C, O, M
Stakeholder perception	Negligible number of negative stakeholder perceptions	Limited number of negative, but manageable stakeholder perceptions	Small number of negative stakeholder perceptions requiring a coordinated response	Significant number of negative stakeholder perceptions requiring a managed response	Large number of negative stakeholder perceptions requiring a managed response

Note: C = constructability, O = operability, M = maintainability

Reference | **Summary**

Figure E.5 Likelihood and consequent matrices

Option 1: PxI Matrix for Significant Focus on High and Very High Impacts (Non-linear Impact Scoring)

Probability	Threats				
5	5	10	20	40	80
4	4	8	16	32	64
3	3	6	12	24	48
2	2	4	8	16	32
1	1	2	4	8	16
	1	2	4	8	16
	Impact on Selected Objective				

Option 2: PxI Matrix for Moderate Focus on High and Very High Impacts (Linear Impact Scoring)

Probability	Threats				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	Impact on Selected Objective				

(Washington State Department of Transport 2013)

The Washington State Department of Transport project risk guidance document has a number of practical explanations for different parts of risk management. The document itself clearly influenced the Auckland Transport Project Risk Management Handbook as a number of the diagrams have be taken from here.

Simplified process

Most useful, outside that already covered above, is a simple process for working with risks (chapter 2, pages 2-1 to 2-3). The steps are summarised below and will likely form the structure of any bus-based public transport risk framework.

1 Establish common understanding

  a Project objectives

  In order to fully understand and assess the risks that our projects are exposed to we must first insure that there is a mutual understanding of the project under evaluation. This means that when we embark to meaningfully and deliberately focus on the risks and uncertainties our project will face, we must first be able to define the project in terms of scope, schedule and estimate…

  b Risk boundaries

  State the assumptions for risk identification and analysis and delineate thresholds for risks. For example a project team may want to describe all cost risks below $100,000 as minor and all schedule risks less than 2 weeks as minor thereby not spending inordinate amounts of time on those risks and allowing them to focus on more significant risks (assumptions and thresholds for risk assessment will be influenced by the size and complexity of the project, project environment, and the owners' tolerance for risk).

2 Information gathering - brainstorming, lessons learned database (this could be one possibly to include in the risk framework)

3 Identification (ie number each risk for ease of tracking)

4 Categorise and scale (ie threat or opportunity)

5 Date and phase of risk (eg design, construction)

6 Describe risk event – be SMART (specific, measurable, attributable, relevant, time-bound)

7 Risk trigger

  Risks rarely just suddenly occur; usually there is some warning of imminent threat or opportunity.

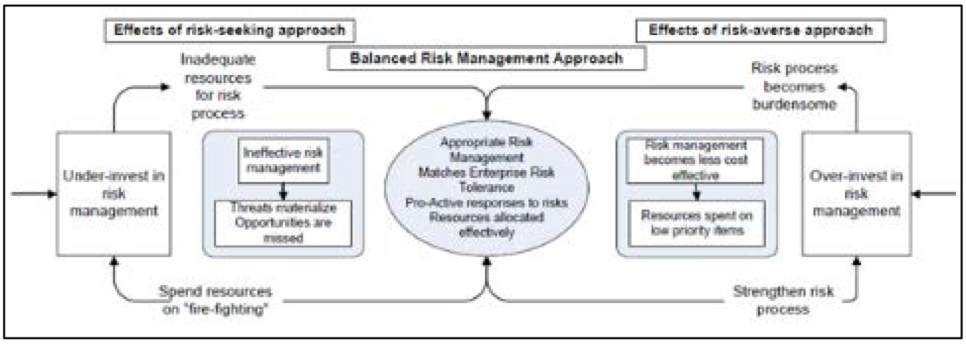
8 Potential response

Risk tolerance

Risk tolerance is explained simply in this document. Figure E.6 shows the spectrum of risk management from under investment to over investment and the impacts this has on the project. A version of this diagram is also used in the Auckland Transport document.

<table>
<tr><th>Reference</th><th>Summary</th></tr>
<tr><td></td><td>

Figure E.6 Risk tolerance (taken from Washington State Department of Transport 2013)



</td></tr>
</table>

E3.3 Other concepts

<table>
<tr><th>Concept</th><th>Description</th></tr>
<tr><td>Level of risk</td><td>

As identified above it is important to categorise risk by their potential impact. The Otago University Risk Management Framework (University of Otago 2011) separates risk into three organisational categories:

1. Corporate risk – potential impact on the ability of the university to deliver its objectives
2. Divisional risk – potential impact on the divisions objectives
3. Cost centre risk – inhibit the achievement of aims for a cost centre.

A similar categorisation could be used to help rank the risks associated with bus infrastructure schemes. Understanding the scale of the risk will help define the level of reporting required (eg a whole organisation reputation vs a single person's reputation).

</td></tr>
<tr><td>Response to risk</td><td>

Following the principles within the ISO 31000 standard, response to risk can be considered 'internal control' (HM Treasury 2004). Internal control will generally consist of:

- tolerating the risk
- treating the risk in an appropriate way to constrain the risk to an acceptable level or actively taking advantage, regarding the uncertainty as an opportunity to gain a benefit
- transferring the risk
- terminating the activity giving rise to the risk

Quoting (HM Treasury 2004, chapter 1.4):

> *The level of risk remaining after internal control has been exercised (the "residual risk") is the exposure in respect of that risk, and should be acceptable and justifiable – it should be within the risk appetite.*

</td></tr>
</table>

Appendix F: Economic appraisal methodology and procedures (pro-forma template)

F1 Overview

This appendix sets out our methodology for assessing the economic benefits and costs of providing public transport service improvements. Three types of improvement are considered:

- bus priority measures
- interchanges
- bus stops.

Economic benefits include:

- benefits to existing bus passengers from some or all of reduced travel times, greater reliability and improved facilities
- benefits to new users who currently travel by car or another public transport service and who change mode or service or who travel more frequently to take advantage of the improved service
- benefits to existing public transport users from increased frequency
- time savings for the bus operator from priority measures or enhanced interchange arrangements
- benefits to road users who suffer less congestion as a result of some drivers switching to bus.

Against this there are additional costs including:

- the opportunity cost of any land required and the development and any ongoing maintenance costs of new facilities
- the additional operating cost of the public transport service to serve the new facilities or to carry more passengers
- delays to road users resulting from any reduction in road capacity.

Finally, when we calculate the perceived user benefit, the user perceives the fare as a cost. Adding this back (since it is a transfer payment not an economic cost) and setting it against the additional operating cost for carrying new passengers, gives a net revenue that can either be treated as a producer surplus if it would accrue to the operator or as a reduction in subsidy if it would accrue to the funding agency.

These effects are considered in the following sections.

F2 Existing and new bus users

F2.1 Bus priority

For bus priority schemes, the benefits to existing bus users are straightforward: they benefit from the reduction in (average) travel time.

There is also normally an improvement in service reliability and this benefits users by reducing the time they need to allow for the journey. Based on international research, this has been assessed (probably conservatively) as 25% of the time saving benefits (Wallis and Bolland 2008).

The benefits to existing bus users are monetised by multiplying the time savings by the value of commuter travel time. (For bus priority schemes, it is assumed that benefits occur only in peak periods, thus the use of commuter time values is appropriate.) The derivation of the values of time savings is discussed in section F2.5.

F2.2 Transport interchange

The effect on existing public transport users depends on whether they currently transfer, travel through the interchange or their journey terminates. In general the benefits to transferring travellers will be positive. Boarding and alighting passengers may also benefit from improved facilities, but 'through' passengers will not usually benefit and may suffer delays if the running time or the dwell time is increased to provide for connecting passengers.

The spreadsheet delivered in conjunction with this research report[18] assumes the benefits and disbenefits from improved facilities are as perceived rather than necessarily actual time savings. While there may be actual time differences, the primary effects are often 'comfort and convenience' for which user perception is a better guide to how the changes are actually valued. This means that in general the analyst will need to use survey results to estimate the benefits. Data will be required on:

- % passengers who 1) travel through, 2) board/alight, and 3) transfer
- perceived benefits to passengers who 1) travel through, 2) board/alight and 3) transfer.

It is also useful to subdivide these benefits into in-vehicle time (IVT) savings, walking/waiting time savings and comfort/convenience (perceived) benefits. These 'benefits' may be positive or negative. The net 'generalised' travel time benefit is calculated as a weighted sum of the perceived benefit components. If the net generalised travel time increases, the project will not be beneficial to users.

The benefit to existing bus users is monetised by multiplying the time savings by the value of commuter travel time for peak users and the value of 'other' time for interpeak users.

F2.3 Estimating the number of new passengers

The number of new bus users was estimated from the perceived (generalised) time savings using demand elasticities drawn from the international literature; default elasticities of demand with respect to generalised time were estimated at (-)0.6 for peak periods, (-) 0.9 for off-peak periods.

It is also important to know the source of the new passengers – whether from car driver, car passenger, or other public transport mode. The relevant 'diversion' factors were also based on international experience, together with local survey results. The prior mode proportions of the new public transport passengers were taken as the following: car driver 5% (all periods); car passenger 10% peak, 5% off-peak; other public transport services 15% (all periods); other (walk, cycle, taxi) 30% peak, 20% off-peak; no (similar) previous trip 40% peak, 55% off-peak (ATC 2006, vol 4.1).

New users are assessed to benefit by half the benefit to existing users. The factor of a half may be too big a discount if commuters are switching between broadly substitutable options. If the options are close substitutes, then at equilibrium in the 'before' situation the perceived costs to the marginal user will be the same by bus and by the former mode, and switching modes will result in a benefit equal to the full cost saving.

[18] The spreadsheet is available at www.nzta.govt.nz/resources/research/reports/561

F2.4 The Mohring effect

Increases in public transport patronage are likely to result in some combination of operator economies of scale (where marginal operator cost is less than average cost) and user economies of scale (where marginal user cost is less than average user cost). This section addresses user economies. The impact on the operator is discussed in the next section.

To the extent that increases in patronage result in increases in service levels and frequencies, existing passengers will benefit from reductions in bus waiting times. This is a 'user economy of scale', also known as the 'Mohring effect'. (It is the opposite of what occurs on the road system, where increases in demand for travel result in increases in waiting time (congestion) for existing users.)

The Booz Allen Hamilton (BAH 2004) report showed that, subject to specified assumptions, the benefit to existing passengers of increased service levels (resulting in reduced waiting times) is equal to 1) that part of the waiting time function that is variable with the headway times; 2) the unit value of the waiting time savings. It also showed that a wide range of unit benefit values may result from this benefit formulation, with values varying in direct proportion to:

- initial headway
- service: patronage 'gearing ratio'
- wait time: headway factor
- unit value of time savings.

Following BAH (2004) we have calculated benefit as a function of the headway as:

*benefit = (0.3*headway*VTTS) * (change in passengers * gearing ratio)* (Equation F.1)

where the gearing ratio is the variability of service frequency with patronage. This ratio may vary from 0 (patronage changes have no effect on frequency), typically in off-peak periods, to 1.0 (frequencies are fully adjusted to maintain a target load factor), commonly in peak periods. In the spreadsheet, the gearing ratio can be entered by the user. It affects both the user benefits and the operating costs.

F2.5 Value of travel time savings: in-vehicle time

The time values (VTTS) used to calculate the benefits to public transport users from time savings are taken directly from the EEM, updated to mid-2013 values. In accordance with current practice, 'equity' values – which do not vary by mode – are used. The values used for IVT are shown in table F.1.

Table F.1 Travel time values (for economic appraisal purposes)

Trip purpose	Base value of time (2002$/h)	Value adjusted to mid-2013$/h
In-work travel	23.85	33.39
Commuting to/from work	7.80	10.92
Other non-work travel	6.90	9.66

Source EEM, table A4.1b. Factor 1.40 to adjust from 2002 to 2013 values (EEM table 12.2).

It is assumed that peak public transport users are commuting to/from work and that off-peak public transport users are travelling for 'other' non-work travel purposes.

F2.6 Value of travel time savings: walking and waiting time

It has been normal in the past to multiply the IVT by factors of 1.4 and 2.0 to reflect the perceived cost of walking to and waiting for public transport services. Table A4.1a in the EEM gives a walking (pedestrian) value of 1.4 x the seated public transport value, so we assume this also applies to evaluation values for walking time relative to ‘standard’ IVT, and also that the standard value of 2.0 should continue to apply to waiting time. The spreadsheet allows the factors (if any) to be varied by the user.

F3 Public transport operator impacts

There are two potential impacts on public transport operators – operating cost savings or increases, and the costs and revenues associated with additional passengers

F3.1 Operating costs

Bus priority lanes typically reduce running times and potentially peak bus requirements. On the bus priority spreadsheet, the user enters the running time before and after the introduction of the lane.

The requirement to serve an interchange point on a timetabled basis may add time and distance to the bus journey. Changes in running time may also affect the peak bus requirement. The interchange spreadsheet allows times and distances to be entered as an average time and distance per service.

Previous work undertaken for the Ministry of Transport (BAH 2004) in consultation with AT (previously Auckland Regional Council) and Greater Wellington Regional Council staff investigated marginal public transport operating costs (on an economic basis) for Auckland bus and Auckland/Wellington rail in some detail. That work is highly appropriate for the present requirements, as it included estimates of marginal costs per (incremental) passenger on bus services at peak periods. Rather than attempt to replicate the previous work in detail, we have updated the previous estimates for Auckland bus services to current (2013) prices, by applying a factor of 1.46, which represents the approximate movement in the current Transport Agency bus cost index over the period 2001/02 to September 2013.

The resultant unit costs are summarised in table F.2. It should be noted that these estimates include an annualised capital charge for the additional buses required to provide the additional peak period capacity; these capital charges are typically around half of the total peak period marginal costs.

Table F.2 Bus operating variable costs

Operating costs	Bus
Cost per service hour ($)	30.36
Cost per service km ($)	1.21
Cost per vehicle ($pa)	56,582

Source: BAH (2004) updated to mid-2013 prices (factor 1.46)

F3.2 Additional passengers

The effect on the public transport service subsidy of additional passengers is calculated by estimating the incremental revenue and incremental cost per person. Revenue is simply the fare, taking account of common discounts (and removing GST). The cost is calculated as the current variable cost per passenger multiplied by the value input by the user as the variability of service frequency with patronage.

As before, the cost estimates use the unit variable costs from table F.2. Even if the cost is higher than the revenue, we still call this a producer surplus to keep the terminology consistent with economic convention.

F3.3 Competing service impacts

Some of the observed new passengers may have transferred between routes. The net impact on a service that loses patronage is the converse of the services impacts discussed in the previous section. It is assumed that the numbers who change route will be small and therefore only the net increase in passengers is considered. If it is likely that services will be significantly and differentially affected, this section of the spreadsheet may be expanded to cover each service explicitly.

F4 Road (de)congestion impacts

F4.1 Overview

A vehicle travelling in congested conditions imposes a cost (externality) on all other vehicles. Additional demand causes travel times to increase for all vehicles. It can be shown mathematically that if the road is operating at capacity, the cost (in vehicle minutes) imposed by an extra vehicle is just equal to its travel time. More generally, it can be shown that the externality is proportional to the difference between the actual travel time and the free-flow travel time. The constant of proportionality will depend on the characteristics of the network. Both an Akçelik function (used in the Auckland and Wellington transport models) and a Bureau of Public Roads function with the power term coefficient equal to 4.0 provide a good fit to Auckland motorway and Wellington state highway data. This indicates that using a constant of proportionality of 4.0 with the Bureau of Public Roads function should reasonably represent the impact of demand on vehicle running times.

In the bus priority spreadsheet, the calculation is made in two steps – first an elasticity (which measures the percentage change in travel times resulting from a 1% change in demand and reflects the degree of congestion) is calculated based on the difference between the peak and the free-flow travel time in the priority corridor, and then the externality is calculated by multiplying the elasticity by the peak travel time. The two step calculation enables the elasticity to be compared with values obtained from transport models (such as SATURN), and with internationally reported values. When using the spreadsheet, the user can accept the estimate of the elasticity from the travel times or over-write it with an estimate from model runs or international comparisons.

In the case of a bus interchange, there is no single route for which travel times can be obtained and used. In this case an elasticity is entered directly into the spreadsheet.

In both cases, the calculations use the relationship:

$$\textit{Externality} = \textit{elasticity} * \textit{travel time} \qquad \text{(Equation F.2)}$$

F4.2 Bus priority

There are two possible effects from the introduction of a bus priority lane. First of all, if provision of the lane reduces the capacity of the road for other vehicles, their travel time could be expected to increase. If the percentage reduction in capacity is p, the new travel time would be

$$t_{new} = t_{free} + (t_{old} - t_{free})/(1\text{-}p)^4 \qquad \text{(Equation F.3)}$$

The increase in time would affect all remaining road users (except bus passengers).

However offsetting this is the second effect whereby each ex-car commuter switching to bus 'saves' congestion costs equal to the travel time elasticity multiplied by the congested travel time. The difference between the time increase from the capacity reduction and the time decrease due to people switching gives the net impact of the priority lane.

The net impact of the reduced capacity and mode switching will depend on the degree of substitutability between car and bus on the project road. Car and bus can range from being direct substitutes (transferring to the project bus route is a reasonable option for a significant proportion of car users[19]) to being totally independent (car users on the project road are not travelling to or from the locations served by the project bus route). Where they are close substitutes, any reduction in bus running times will attract car drivers from the remaining lanes, and will continue to do so until the level of congestion on the remaining lanes has reduced to the point that the relative times by the two modes are restored. Hence if car and bus are substitutes, the net impact of the bus priority would be expected to be a switch of users from car to bus and a net reduction in car travel times in the corridor. If there is little scope for substitution the car times will depend purely on any change in effective capacity on the road.

At equilibrium, we would expect to see the immediate impact on the project road dissipated across the road network. Thus considering only the road network effects, at equilibrium we would expect the observed effect on the project road to be less than the calculated effect. Typically one might expect the change in travel time on the project road to be about half the calculated value (an Ashley factor of 0.5). If this is not the case (or the effects are in different directions) the spreadsheet displays a 'check' flag. The likely reasons for this are that either the change in road capacity or the amount of mode switching (or both) have been incorrectly estimated.

The spreadsheet can be used in either a predictive (pre-implementation) or an evaluation (post-implementation) mode. In the pre-implementation mode, the calculated impact is compared with the expected 'observed' change in travel time, but the calculated time is used in the calculation of benefits. In the post-implementation mode, the observed travel time is given greater weight. The calculated effect should be larger than the observed effect and represents the network benefits, whereas considering the observed travel time would only count benefits in the corridor. The CBA uses the calculated time but only if it is in the expected range – which is numerically more than the observed time but less than twice the observed time.

F4.3 Public transport interchange

In the case of a public transport interchange, there is only the impact from the mode change. Each ex-car commuter switching to bus 'saves' congestion costs equal to the elasticity multiplied by the car travel time. For the interchange analysis, a single average elasticity is entered and the former car travel time is assumed to be 0.7 times the average bus travel time. If there are significant differences in the degree of congestion between corridors served by the interchange, a more sophisticated analysis akin to that used for bus priority may be warranted.

F4.4 Value of travel time savings: other road users

The net effect of changes to the public transport service on other vehicles discussed above is calculated in vehicle minutes, so needs to be multiplied by a value of travel time savings for average motorists during the morning and afternoon peaks to give a monetary value. The composite value of time reflects the

[19] In other words, at least some people use public transport out of choice. This was probably not the case in Auckland up until the 1980s but is now increasingly true.

average vehicle occupancy and the proportion of vehicle passengers that are commuting or travelling on business.

The EEM methodology estimates travel time benefits as the sum of three components:

- base travel time benefits
- travel time benefits (incremental) in congested conditions
- travel time benefits (incremental) in unreliable conditions.

We cover each of these in turn.

1 EEM (2013, table A4.3) gives base values of time for all vehicles of $15.13 per hour (2002 prices). This figure can be derived from table F.1 above by assuming a mix of work, commuter and other travel and average vehicle occupancies[20].

2 EEM (2013, A4.4) states: 'For all bottleneck delay, the maximum increment for congestion from table A4.1 or table A4.3 should be added to the base value of travel time'. The value given in EEM table A4.3 is $3.88. Since the circumstances being analysed are generally congested, we have used this as the average incremental value for valuing time savings in congested conditions.

3 EEM (2013, A4.5) provides a set of procedures for estimating the benefits from improvements in trip time reliability: these procedures relate reliability in large measure to the V/C ratios on the links and intersections traversed. The procedures are relatively complex to apply, and would require running a detailed traffic model. Instead, we have taken a short-cut approach, based on experience from more detailed studies where the incremental value of reliability benefits has been derived as a proportion of the base travel time benefits. We were advised that, typically, the incremental reliability unit value is in the range 5%–8% of the base travel time unit value[21]. We have therefore applied a proportion of 6.5% in this case.

The above figures are in 2002$/vehicle hour. To adjust values to July 2013$, we apply an escalation factor of 1.40 (EEM table 12.2).

The result of the above is that the value of time savings for other vehicles in peak periods is $20.86/vehicle hour (2013 prices), as shown in table F.3.

F4.5 Other impacts

F4.5.1 Impact on vehicle operating costs

Previous work has examined the relationship between changes in travel time costs and changes in vehicle operating costs (VOC) (both on a ¢/km basis) at different average speeds, based on EEM travel time and VOC unit values (BAH 2003, appendix F).

Over the range of speeds examined in that work, it was found that the change in VOC was 5.5%–6.0% of the change in travel time costs (for the driver). On this basis, we assume that the VOC component of any decongestion benefits is 6% additional to the driver travel -time component[22].

This 6% estimate applies to the base value plus incremental congestion value of time, at 2002 prices, consistent with the method used for the original Booz Allen Hamilton (2003) estimate.

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[20] Working backwards from the A4.3 figure, it appears that the assumption is 23% business travel and a vehicle occupancy of 1.31.

[21] Advice (personal communication) from Andrew Murray (Beca) 15 April 2011.

[22] A figure of 7% was used in the STCC study.

F4.5.2 Impact on environmental costs

Greenhouse gas emissions (GHG)

Reductions in congestion will tend to result in reductions in fuel consumption and hence in GHG emissions. We provide an order-of-magnitude assessment of this effect, as follows:

- Carbon emissions are valued at approximately 4.5% of total VOC, at 2008 prices (EEM 2013, A9.6/A9.7).
- The fuel cost component accounts for c 50% of total VOC (EEM 2013, A9.7).
- At the margin (for changes in travel speed), we would expect that most of any VOC change relates to changes in fuel consumption. Hence, at the margin, changes in carbon emissions are likely to be valued at around 9% of any changes in VOC.

We therefore apply this 9% proportion to estimate the unit value of changes in carbon emissions from the unit changes in VOC estimated above.

Local environmental impacts

No attempt has been made to value the changes in any local environmental impacts associated with the changes in traffic speeds between the base situation and the option situation.

Such local impacts might include noise, air quality and water quality. Previous research (eg BAH 2003) suggests that any marginal changes in these costs through changes in average traffic speeds of the extent under consideration in this study would be very small (relative to the other cost items that have been valued).

F4.5.3 Impact on safety (crash) costs

Reductions in congestion are likely to result in some marginal increase in crash costs, for a given traffic volume (VKT) on the network. UK research indicates that this effect is likely to be quite significant; in urban conditions, crash rates appear to rise quite sharply with reduced levels of congestion, and the proportion of crashes that are fatal or serious also rises (BAH 2003, appendix C).

At this stage a detailed methodology has not been developed to estimate the magnitude of the crash disbenefits (or benefits) associated with public transport infrastructure options (relative to the base case). However, a 'back of the envelope' assessment is as follows:

- Average social costs of road crashes in the Auckland urban area over the five-year (calendar) period 2006–2010 were $768 million pa ($2010) – based on Crash Analysis System (CAS) data analyses.
- The proportion of this total related to the peak periods (defined as 7am – 9am and 4pm – 6pm, seven days/week) was 27.3%, ie $209.7 million pa – based on further CAS analyses.
- Deducting the Saturday/Sunday peak periods (assuming the crash costs at these periods are two-thirds of the peak figure per weekday) gives a factor of 0.79, leaving a cost of $166 million pa for the weekday peak periods.
- We assume this cost would increase in direct proportion to average speed if congestion were reduced. Hence, a 1% increase in average speed over the whole AKL road network would increase crash costs by 1%, ie by $1.7 million pa on the AKL peak figure of $166 million pa.
- The total AM peak (2006) travel time on the AKL road network is estimated at 150,000 hours per peak period (Wallis and Lupton 2013, table 4.1), which equates (* 500) to 75 million vehicle hours per year (peak periods only).

- Thus a 1% increase in average speeds, or 1% reduction in vehicle hours (total c 75 million hours pa) is estimated to result in an increase in crash costs of $1.7 million pa. Hence the average increase in crash costs per vehicle hour saved is 1.7/0.75 = $2.27/vehicle hour.[23]

This estimated figure represents disbenefits from higher operating speeds. While these are significant, they are less than 10% of the benefit items (table F.3).

F4.6 Valuation of decongestion benefits: summary

Based on the analyses in the preceding sections, table F.3 provides our estimates of unit benefit values for those cost items on which values have been placed. It is seen that (in $/vehicle hour, at July 2013 prices):

- the overall unit benefit value is $30.08/vehicle hour
- the travel time component, including its congestion and reliability components, totals $27.98/ vehicle hour, about 93% of the total
- these unit benefits are partially offset by a disbenefit relating to increases in crash costs, estimated at $2.27/vehicle hour, and resulting in an overall net benefit estimate of $27.81/vehicle hour. However, note that this unit crash cost figure should be regarded as indicative only
- the net figure of $27.81/vehicle hour is to be applied to the estimated total change in vehicle hours (excluding mode switchers) between the base situation and the public transport infrastructure option to derive our estimate of the 'decongestion' benefits to 'base' road users.

Table F.3 Summary of road user unit ('decongestion') benefit values

Item	Base date	Unit value @ base date ($/veh hr)	Factor to July 2013[a]	Unit value @ July 2010 ($/veh hr)
Travel time savings				
• Base value	July 2002	15.13	1.40	21.18
• Congestion increment	July 2002	3.88	1.40	5.43
• Reliability increment	July 2002	0.98[b]	1.40	1.37
Sub total	July 2002	19.99	1.40	27.98
Vehicle operating costs	July 2002	1.14[c]	1.70	1.94
Environmental costs				0.16[d]
Total[d]				30.08
Disbenefits: Crash costs				-2.27
Net 'decongestion' benefits				27.81

Notes:

[a] Taken from EEM (2013) vol 1, appendix A12.3.

[b] Taken as 6.5% of base travel time value (refer section B2.3).

[c] Taken as 6% of travel time savings (base + congestion increment) value.

[d] Taken as 8% of the vehicle operating costs change

[e] Excluding crash costs

[23] This estimate relates to 2006–2010 crash statistics in $2010. We assume that it applies unchanged to more recent statistics in $2013 on the assumption that the effects of reducing crash rates will offset the increases in unit costs per crash.

F5 Annualisation and performance statistics

F5.1 Daily analysis periods to annual factors

The public transport subsidy and congestion benefits are calculated for a typical period during a typical weekday – morning peak, both peaks combined, off-peak periods. We have multiplied them by an appropriate annualisation factor to give an annualised figure. The factors used are shown in table F.4.

Table F.4 Benefit annualisation factors

From single peak period to both peaks annually	500
From both peak periods combined to both peaks annually	250
From weekday off-peak (10 hrs) to all off-peak (incl weekends) annually	310

Source: Consultant estimates

F5.2 Performance statistics

Economic performance measures are presented in the form of average annual values. No attempt has been made to estimate a traffic growth rate or differential impacts over time. This makes the performance measures easy to calculate and understand. The resulting BCRs will be conservative when compared with any analysis that assumes traffic growth. If a project is expected to have an irregular cost or benefit profile, the spreadsheet could be adapted to give a conventional present value analysis.

The initial capital costs are converted to an annualised value by using the Excel PMT (annuity payments) function, with a discount rate of 6% and a residual value equal to the input land value. The resulting sum is taken over 20 years (as the default asset life), but this may be varied by the user.

The net annualised value (NAV) is calculated as the sum of the annual benefits minus the annual recurrent costs and minus the annualised capital cost. A NAV greater than zero indicates a project that is worthwhile at a 6% discount rate (ie the discounted benefits exceed the discounted costs).

Since there is an ongoing cost to government issue rather than a capital funding issue, we have calculated the BCR to government(s), BCR(G), rather than the national BCR, BCR(N). The BCR(G) measures the benefit generated per dollar of government spending (capital and recurrent, by all levels of government) over the life of the project (with all figures reduced to an annualised first-year basis in this case)..

In most projects, there will be an impact on operator revenues and costs. The net impact is referred to as a producer surplus. The treatment of the producer surplus affects the size of the BCR(G), but does not affect the NAV. The appropriate treatment of the producer surplus depends on the form of contract. If the operator's contract is net, and there is no adjustment to subsidies, then the producer surplus will accrue to the operator. In this case, from an economic perspective the surplus should be included in the benefits (the BCR numerator). If the financial impact of the changes accrues to the funding agency, then the producer surplus should be deducted from the agency cost (the BCR denominator); this will be the usual situation under the PTOM contracting model.[24] The spreadsheet allows for these two options. If the contract effect is not either of these (eg a gross contract where the revenue accrues to the agency but the costs to the operator) the spreadsheet should be adjusted explicitly. In no case should the funding arrangement affect the NAV.

[24] PTOM (Public Transport Operating Model) is the planning, procurement and business development framework developed by MoT with the Transport Agency for public transport services throughout New Zealand.

F6 References

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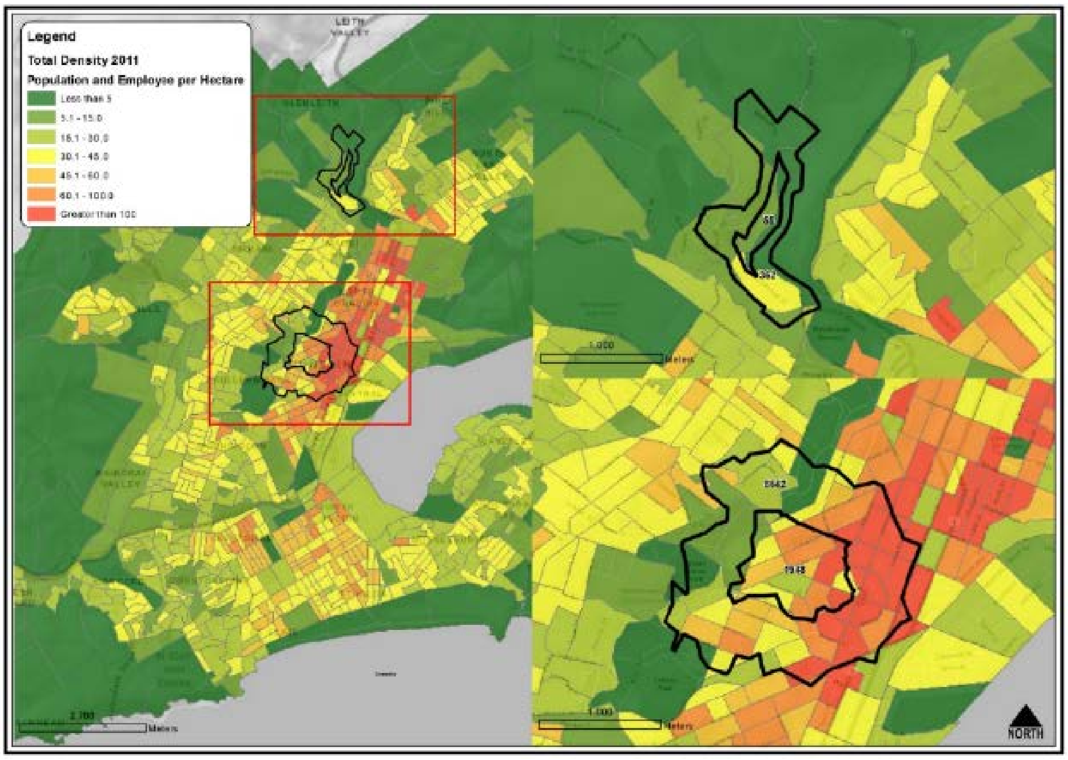
Appendix G: Bus stop coverage calculations

Understanding bus stop impacts usually starts from an understanding of coverage. In general, it is the coverage of a bus stop (and to a lesser degree its location within a route) that defines its usefulness.

Analyses of coverage typically seek to quantify the access in terms of the number of people and/or jobs that lie within a certain geographical area. The extent of this area, in turn, is typically defined as the distance most people are prepared to walk to access public transport. While many coverage analyses use a fixed distance of 400m–600m, research typically suggests the distance people are prepared to walk actually varies based on the quality of service (eg the range of routes available and the frequencies at which they operate) and stop attributes (eg offline/online, passenger facilities). Demographic and topographic variables are also important, although rarely incorporated into coverage analyses. We suggest there is merit in regional and local councils undertaking research into the distance people are prepared to walk to access public transport, and factors affecting how this distance varies.

Once an appropriate walk distance has been defined, one can calculate the coverage of each stop on a route and/or in a network using GIS. Two points are relevant here: First, coverage is defined exclusively in the sense that it should not overlap with adjacent stops. Second, coverage is defined by the underlying pedestrian network, which may differ from the road network. The interaction between stop catchment, walk distance and pedestrian links is illustrated in the figure below, which compares the catchment of two stops in Dunedin. The northernmost stop is located in a relatively impermeable part of the city in an area with low prevailing land use densities. In contrast, the southernmost stop is located in a relatively permeable part of the city centre, which has relatively high land use densities. Using GIS, we estimated the coverage of the southernmost stop to be more than 20 times greater than the coverage of the northernmost stop, as measured by the number of jobs and residents within a fixed radius.

Figure G.1 Illustrating stop coverage (employment plus population)



Stop coverage is important because it tends to define the accessibility of the underlying public transport services. In our professional experience, all too often bus stops are not located in locations where their coverage is maximised, primarily because of opposition from adjacent landowners who perceive they are adversely impacted in some way. We suggest the weight given to these opponents by elected representatives and public staff is tempered by an awareness that poorly located bus stops will tend to generate less patronage, and by extension increase the subsidies required to deliver public transport services.

G1 Establishing/removing stops on an existing route

We now consider the issue of whether to establish a new stop on an existing bus route. In our professional experience this issue arises relatively frequently in practice, where members of the community request a new stop is established and/or an existing stop is removed.

The primary trade-off that arises when considering issues of bus stop spacing relates to the tension between *coverage* and *speed*. Installing a new stop will typically increase the catchment of a route while simultaneously increasing bus travel times, and vice versa in situations where a stop is being removed. We suggest empirical analysis of this trade-off can inform regional and local government decision making on whether stops should be established/removed. More specifically, we suggest an additional bus stop should be established in situations where the patronage generated from the new coverage exceeds the patronage lost from increased travel times. This patronage criteria is elaborated on in more detail in the following set of equations:

$$Establish\ stop\ if\ \Delta\ Patronage > 0 \quad \text{(Equation G.1)}$$

$$Where{:}\ \Delta\ Patronage = Patronage_{Stop} - Patronage_{Travel\ time}\ and$$

$$Patronage_{Stop} = Additional\ coverage\ x\ Trip\ generation\ rate\ and$$

$$Patronage_{Travel\ time} = Patronage_{Before}\left[\left(\frac{Travel\ time_{After}}{Travel\ time_{Before}}\right)^{\varepsilon} - 1\right] \quad \text{(Equation G.2)}$$

Turning first to the patronage that is lost from the additional travel time, we propose it is calculated using a standard elasticity function which considers the change in travel times before and after the new stop is established. We emphasise that when we say 'travel time' we are here defining it from the perspective of passengers, rather than buses – even if the two are naturally related (as shall be discussed below).

The calculation of passenger travel times before and particularly after a new stop is established, however, is not a trivial matter. Travel times before the new stop is established can be calculated using tag on/off data, where it is available (currently Auckland and Wellington). In places where passenger tag off data is not available, then average travel times, eg sourced from the New Zealand Household Travel Survey and/or other passenger surveys, may be used instead.

Travel times after the new stop is established, however, depends on the number of passengers who are on buses and in turn the likelihood these services will subsequently need to stop to pick-up/drop-off passengers. The potential number of passengers affected (PPA) by the new stop is defined by the loadings on services approaching the stop, which can be calculated as follows:

$$PPA = Loadings = \sum_{i \in V}\left(\sum_{j \in S} Boardings_j - Alightings_j\right) \quad \text{(Equation G.3)}$$

Where:

- V is the number of bus trips travelling past the new stop
- S is the number of bus stops upstream of the new stop
- $Boardings$ is the number of passengers boarding at stops upstream of the new stop
- $Alightings$ is the number of passengers alighting at stops upstream of the new stop.

Of course, not all of these bus services will actually need to use the stop. Instead, passengers will only incur delays if the vehicle they are travelling on is required to stop at the new stop in order to pick-up and/or drop-off passengers.

We suggest the probability a bus is required to stop at the new stop is best modelled empirically using data from other stops in the network. We could expect this probability to be a function of loadings before a stop and coverage of that stop (to capture the demand for alightings), as well as patronage at the stop (to capture the demand for boardings). Estimation of such a vehicle-stop probability model is beyond the scope of this report; for our purposes we simply denote the probability of buses needing to stop as follows:

$$Pr\left[Dwell_{Stop}\right] = f\left(Loadings_{Stop},\ Catchment_{Stop}, Patronage_{Stop}\right) \quad \text{(Equation G.4)}$$

This probability of stopping can then be multiplied by the PPA (defined above), and finally multiplied by the average dwell time per vehicle (usually around one minute) to estimate the additional time we would expect passengers to incur as a result of the new stop being established, ie

$$\Delta\, Travel\ time = PPA \times Pr\left[Dwell_{Stop}\right] \times Average\ dwell\ time \quad \text{(Equation G.5)}$$

The increase in travel time can then be added to the travel time before the new stop was established and subsequently used as an input into equation G.2.

Finally, we have suggested the patronage generated by a new stop is estimated as a function of the coverage of the stop and a trip generation rate (defined as public transport trips per square metre of developed area that is covered). The latter can be derived based on empirical data from other stops on the network and might take the form of multi-variate regression models that predict boardings and alightings for each stop as a function of prevailing land use characteristics.

Once these parameters have been estimated then the question of whether to establish a new stop (or remove an existing stop) can be informed by an empirical understanding of the net patronage effects.

G2 Stop spacing

Having discussed issues relating to stop coverage and adding/removing stops to existing routes, the final issue we consider here is related to stop spacing. This issue is independent from previous sections in that it pertains to the location of multiple stops on contiguous public transport corridors. The term ‘stop spacing’ is usually used to describe the distance between two consecutive stops. Spacing stops further apart will increase walk time, but also reduce the total number of stops and thereby increase in-vehicle speeds. The tension between walk-time and in vehicle-time is similar to that discussed above.

In practice, average stop spacing varies from up to 1km–2km on bus rapid transit (BRT) corridors, such as the Northern Busway, to effectively zero on so-called ‘hail and ride’ services (which can stop wherever they are flagged down by passengers). The optimal stop spacing is thus largely dependent on service frequency: the higher the frequency, the father apart stops should be spaced on the corridor. In the context of a system with increasing patronage (and hence service levels) there will be a general tendency for stop spacing to increase over time. We note, for example, stop spacing in European cities is typically longer than in North American cities. This likely reflects the latters' high demands/service levels.

While optimal stop spacing is context dependent, we suggest the following general process is used to determine stop spacing (note: this process presumes 1) the corridor already supports public transport services and stops and 2) continuous development exists along the corridor):

1 Identify 'anchor' stops at the end points of the corridor. These are the locations between which services will operate as a contiguous corridor.

2 Identify 'major' stops along the corridor. These are the key activity centres along the corridor where a well-located bus stop is considered to be strategically important.

3 For each segment of the corridor:

    a For existing stops on the corridor, map 1) boardings; 2) coverage (eg total density); and 3) distance between stops. Map how loadings along the corridor vary.

    b Presume one of the 1) weakest and/or 2) most poorly located stops is to be removed. Re-assign demands associated with this stop to adjacent stops based on walk distance.

    c Calculate benefits of removing stop using the processing discussed in the previous section. If removing the stop is found to have:

        i A net positive impact on patronage, then consider re-arranging existing stops to minimise loss of coverage. Repeat from step 3a.

        ii A net negative impact on patronage, then consider whether any other stops might potentially be removed and/or shifted to improve their coverage.

    d Once 3ii is completed, then proceed to next segment.

We note at there may be situations where parallel corridors interact, or compete, with each other. In these cases, passengers may be able to choose between corridors. For this reason it may be useful to optimise stop spacing for each corridor and then consider how the stop catchments interact. In some situations it may be possible to 'offset' stops on each corridor so as to minimise the degree to which they compete with each other (which is equivalent to maximising coverage).

Finally, we emphasise analyses of stop spacing should be undertaken only once a detailed network study has been undertaken. This study would look to establish alignments and frequencies for key routes. These are in turn key inputs into stop spacing analyses.

Appendix H: Case study completed economic assessment pro-forma

H1 Dominion Road bus lanes

BUS PRIORITY case studies: input requirements/pro forma			Note: lanes in each direction evaluated separately	
			Case study Dominion road	
Corridor data			**AM inbound**	**PM outbound**
	Route length	km	10.0	10.0
	Free -flow time (car)	min	15	15
	Before travel time (TT) by car (average over peak)	min	20	20
	Before TT by bus (average over peak)	min	25	25
	After TT by bus with transit lane (ave)	min	21	23.5
	After TT by car travel with transit lane (ave)	min	20.5	19.5
	Estimated % reduction in capacity for other vehicles		5%	5%
Service data	Length of peak period	hrs	2	2
	# bus trips in corridor in peak (peak direction)	#	80	80
	Average headway (all routes)	min	1.5	1.5
	Number of city destinations/origins	#	1	1
	Peak bus requirement	#	40	40
	Average load per trip	#	24	24
	Average fare	$	3.4	3.4
	Before passengers per peak period (1 direction)	#	1920	1920
Capital costs	Land value (opportunity cost)	$000	0	0
	Construction costs	$000	2500	2500
	Planning/overheads/contingencies etc	$000	500	500
	Total capital costs	$000	3000	3000
Operating costs	Annual operating and maintenance costs (approx)	$000pa	50	50
Bus demand impacts:				
Ridership impact	Saving in travel time	min	4.0	1.5
		%	16%	6%
	TT elasticity		-0.4	-0.4
	Expected new passengers		123	46
Prior mode shares of new users	Main mode changers:			
	*Car driver (all the way)	%	50%	50%

BUS PRIORITY case studies: input requirements/pro forma			Note: lanes in each direction evaluated separately	
			Case study Dominion road	
	*Car passenger (all the way)	%	20%	20%
	*Other transit routes (all the way)	%	10%	10%
	*Other (walk, cycle, taxi etc)	%	20%	20%
	*Total	%	100%	100%
Reduction in car driver trips	Reduction in car driver trips	#	**61.4**	**23.0**
Direct public transport (PT) user benefits:				
Before user time savings	Time saving per trip	min	**4.0**	**1.5**
	Annual savings	(000 hr	**32**	**12**
	TT (and reliability) savings	$000pa	437	164
Mohring effect (benefits of scale)	Variability of line haul service frequency with patronage		1	1
	Current variable component of wait time	min	0.45	0.45
	PT user benefits/passenger (economies of scale)	$	0.16	0.16
	PT user benefits/year	$000pa	4.5	1.7
Mode switcher benefits	Mode switcher benefits	$000pa	14.0	2.0
Total user benefits		$000pa	455	167
PT system impacts:				
Reduction in bus costs	Number of trips affected		80	80
	Total time saving (bus opns) per peak	min	320	120
	Reduction in peak buses		2.7	1.0
	Annual public transport op cost savings	$000pa	191.4	71.8
Cost of additional users	Net increase in PT passengers	#	**111**	**41**
	Unit marginal op cost/passenger	$	4.42	4.42
	Unit fare revenue/passenger	$	2.96	2.96
	Increase in PT costs	$000pa	**122.2**	**45.8**
	Increase in PT fares revenue	$000pa	**81.7**	**30.7**
	Increase in net PT operator costs	$000pa	40.5	15.2
Overall reduction in operator (net) cost			150.9	56.6
Road system and user impacts:	Current traffic in peak period (peak direction)	#	2000	2000
	Number of car drivers diverting	#	61	23
	TT elasticity wrt volume		*1.30*	*1.16*
Effect of reduced capacity	Increased corridor time due to capacity reduction	min	1.1	1.1
Effect of driver switching	Reduction in time due to switching	*min*	**0.9**	**0.3**
	Net increase in calculated TT	*min*	**0.3**	**0.9**
	Observed increase in corridor TT	*min*	**0.5**	**-0.5**

BUS PRIORITY case studies: input requirements/pro forma		Note: lanes in each direction evaluated separately		
			Case study Dominion road	
				check
	Is 'observed' actual or forecast?		1.0	1.0
	Equivalent network increase in TT	*min*	0.5	-0.5
	Calculated cost to other users per peak	hrs	16.7	-16.7
Total road decongestion impact	Calculated cost to other users per year	$(000)	117.4	-117.4
Summary of benefits				
PT user benefits	**Existing user benefits**	$000pa	**441**	**165**
	Mode switcher benefits	$000pa	**14**	**2**
	Total road decongestion benefits	$000pa	**-117**	**117**
Producer benefits	Include producer benefits?		**0**	**0**
	PT provider benefits	$000pa	**0**	**0**
Total	**Total benefits**	$000pa	**337.9**	**284.9**
Summary of costs	**Capital costs**	$000	**3000**	**3000**
	Capital costs--annualised	$000pa	**261.6**	**261.6**
	O&M costs	$000pa	**50**	**50**
	PT operational costs (net)	$000pa	**-151**	**-57**
	Total annualised costs	$000pa	**161**	**255**
	Benefit-cost ratio (BCR)(G)		**2.1**	**1.1**
	Net present value (NPV)		**177.2**	**29.9**
	Target BCR		**1.0**	**1.0**
	Conclusion		**pass**	**pass**

H2 New Lynn interchange

			New Lynn interchange		
			Peak	**Off-peak**	**Notes**
A0. Key factor data					
Patronage	Total passengers per day/period through facility		5430	4310	Estimated based on 30/10 people per bus
	% passengers travel through		70%	70%	Default
	% passengers boarding/alighting		20%	20%	Default
	% passengers who transfer		10%	10%	Default
	Average vehicle loading at facility		30	10	Estimated
PT services	Number of destinations served	#	9	9	From timetable
	Average services per hour (through stop/interchange)	#	45	27	From GTFS explorer
	Length of the period	hr	4	16	From GTFS explorer
	Total no. of services during period	#	180	432	

			New Lynn interchange		
			Peak	**Off-peak**	**Notes**
Route/journey time	Average bus running time (across all routes, terminus to terminus)	min	50	50	Estimated from AT timetable
	Average passenger journey time	min	30	30	Estimated
	Average passenger generalised journey time	min	45	45	
	Average saving in TT (average all routes)	min	0.00	0.00	Replacing existing facility
A1. PT user benefits (existing users)					
In-vehicle time (IVT)	Average TT savings for through passengers	IV min	0.00	0.00	
	Average TT savings per passenger	IV min	0.00	0.00	
	Total IVT benefits	$/day	0.00	0.00	
	Total benefits	$pa	0	0	
Access time	Avg walk time savings to/from facility for boarding/alighting passengers	Walk min	2.00	2.00	Estimated
	Avg walk time savings within facility for transfer passengers	Walk min	1.00	1.00	Estimated
	Average access time savings per passenger	Walk min	0.50	0.50	
	Total access time benefits	$/day	691.78	485.74	
	Total benefits	$pa	172,946	150,578	
Wait time/transfer	Avg wait time savings for boarding passengers	Wait min	0.00	0.00	No change in wait time
	Avg transfer time savings for transfer passengers	Wait min	3.00	4.00	More efficient interchange between train/bus
	Average wait time/transfer savings per passenger	Wait min	0.30	0.40	
	Total wait time/transfer benefits	$ / day	592.96	555.13	
	Total benefits	$pa	148,239	172,090	
Reliability	Not required for bus interchanges				
Frequency	Increase frequency in line with patronage?	Y/N	Y	N	
	Average frequency benefits per passenger	Hr	0.03	0.00	
	Total frequency benefits (Mohring effect)	$/day	39.55	0.00	
	Total benefits	$pa	9,886	0	
Stop quality attributes	1 Cleanliness and graffiti	Scale	Poor to Good	9	
	2 Weather protection/shelter	Scale	Avg to Good	5	

			New Lynn interchange		
			Peak	**Off-peak**	**Notes**
	3 Seating	Scale	Avg to Good	2	
	4 Schedule info on bus times	Scale	Avg to Good	2	
	5 Real time info	Scale	Poor to Good	7	
	6 Lighting	Scale	Poor to Good	4	
	Stop quality benefit for boarding passengers	$ per pass	0.29	0.29	
	Stop quality benefit for alighting passengers	$ per pass	0.00	0.07	
	Stop quality benefit for transfer passengers	$ per pass	0.29	0.29	
	Average stop quality benefit per passenger	$ per pass	0.06	0.06	
	Average stop quality benefit per passenger	IV min	0.32	0.40	
	Total infrastructure quality benefits	$ per day	314.9	278.0	
	Total benefits	$pa	78,735	86,178	
Vehicle quality	Not covered by this research project				
Average user time savings (existing users) per existing user		IV mins per day	1.62	1.90	
Average user benefit (existing users) per existing user		$ per day	0.30	0.31	
Total user benefits (existing users)		**$ per day**	**1639.22**	**1318.86**	
Total user benefits (existing users)		**$ pa**	**409,806**	**408,847**	
A2. PT user benefits (new users)					
Demand impact	Total generalised journey time	IV mins	45.0	45.0	
	Percent reduction in generalised time	%	3.6%	4.2%	
	Travel time elasticity (generalised time)	#	-0.6	-0.9	Default values used
	Calculated increase in passengers	%	2.2%	4.0%	
	Total expected new passengers	#	120.71	170.69	
	User benefit per new passenger	$ per pass	0.15	0.15	
Total user benefits (new users)		**$ per day**	**18.22**	**26.12**	
Total user benefits (new users)		**$pa**	**4,555**	**8,096**	
A3. Road user benefits (decongestion)					
Prior mode	Same (travel more often)	%	40%	55%	Default values

			New Lynn interchange		
			Peak	**Off-peak**	**Notes**
	Car driver (all the way)	%	5%	5%	Default values
	Car passenger (all the way)	%	10%	5%	Default values
	Other transit (all the way)	%	15%	15%	Default values
	Other (walk, cycle, taxi etc)	%	30%	20%	Default values
	Total	%	100%	100%	
Change in car trips	Reduction in peak car driver trips	#	6.04	n/a	
	Estimated elasticity (% speed vs % volume)	#	1.0	n/a	Default values
	Total reduction in car travel time	IV mins	211.25	n/a	
Total road user benefits (decongestion)		**$ per day**	**99.24**	**n/a**	
Total road user benefits (decongestion)		**$pa**	**24,810**	**n/a**	
A4. Capital costs (public sector)					
Capital cost	Land value (opportunity cost)	$	0	n/a	None assumed
	Construction costs	$	12,700,000	n/a	Actual cost
	Planning/overheads/contingencies etc	$	2,540,000	n/a	Default values
	Life of asset	Years	30	n/a	Changed to 30 years
Total capital costs		**$ 000**	**15,240**	**n/a**	
Total capital costs annualised		**$ 000**	**1,107**	**n/a**	
A5. Recurrent (net) costs (public sector)					
Facility O&M	Annual facility O&M costs (approx)	$pa	50,000	n/a	Default value
Bus service op costs	Increase in running time per service	IV mins	0.00	0.00	
	Increase in km per service	Km	0.00	0.00	
	Increase in bus hours per period	Hour	0.00	0.00	
	Increase in bus km per period	Km	0.00	0.00	
	Increase in peak vehicles	#	0.00	0.00	
	Total increase in costs per annum (ex pax)	$pa	0	0	
Producer benefit (new pax)	Unit marginal op cost/passenger	$	4.61	0.00	
	Increase in PT costs/ period	$	555.91	0.00	
	Unit fare revenue per passenger	$	4.5	4	Est based on timetable and fare structure
	Increase in PT fares revenue/period	$	543.20	682.75	
	Net PT operator cost increase/period	$/ period	12.70	-682.75	
	Net PT operator cost increase pa (new pax)	$pa	0	-211,652	
Total recurrent costs		**$pa**	**50,000**	**-211,652**	

		New Lynn interchange		Notes
		Peak	Off-peak	
A. Economic/financial impacts		**All figures in $000pa**		
A1. PT user benefits (existing users)				
IVT		0.0		
Access time		323.5		
Wait/transfer time		320.3		
Reliability		0.0		
Frequency		9.9		
Infrastructure quality		164.9		
Total		819	147	
A2. PT user benefits (new users)			12.7	
A3. Road user benefits			24.8	
A4. Capital costs (public sector)			1,107.2	
A5. Recurrent (net) costs (public sector)			-161.7	
A6. Total benefits/costs				
Annualised benefit			**856**	
Annualised cost			**946**	
Net annualised value			**-89**	
BCR(G)			**0.91**	

H3 Manners Street bus lanes

BUS PRIORITY case studies: input requirements/pro forma		**Note: lanes in each direction evaluated separately**			
		Case study Manners Street			Notes
Corridor data			**AM inbound**	**PM outbound**	
	Route length	km	0.3	0.3	Overwrite with actual distance
	Free -flow time (car)	min	0	0	REPLACE WITH NEW DATA
	Before TT by car (average over peak)	min	0	0	REPLACE WITH NEW DATA
	Before TT by bus (average over peak)	min	4.6	6.2	4km/h AM inbound; 3km/h PM outbound
	After TT by bus with transit lane (avg)	min	4.9	5.8	
	After TT by car travel with transit lane (avg)	min	0	0	REPLACE WITH NEW DATA
	Estimated % reduction in capacity for other vehicles		0%	0%	
Service data	Length of peak period	hrs	24	24	Time during which the priority is effective

BUS PRIORITY case studies: input requirements/pro forma		Note: lanes in each direction evaluated separately			
		Case study Manners Street			Notes
	# bus trips in corridor in peak (peak direction)	#	2,022	2,022	INPUT
	Average headway (all routes)	min	0.71	0.71	
	Number of city destinations/origins	#	2	2	For calculating the average wait time
	Peak bus requirement	#	27	31	
	Average load per trip	#	24	24	INPUT
	Average fare	$	3.4	3.4	Average fare paid per passenger
	Before passengers per peak period (1 direction)	#	48,528	48,528	
Capital costs	Land value (opportunity cost)	$000	0	0	If road widening etc required
	Construction costs	$000	11,100	0	
	Planning/overheads/ contingencies etc	$000	500	0	Default = 20% on construction costs
	Total capital costs	$000	11,600	0	
Operating costs	Annual O&M costs (approx)	$000 pa	50	50	For enforcement etc (maybe ignore)
Bus demand impacts:					
Ridership impact	Saving in TT	min	-0.3	0.4	
		%	-7%	6%	
	TT elasticity		-0.4	-0.4	**Based on RR248, medium-run estimate**
	Expected new passengers		-1266	1252	
Prior mode shares of new users	Main mode changers:				
	* Car driver (all the way)	%	50%	50%	**Refer Wallis and Bolland (2008). Also ATC 2006, vol 4.1, table 1.6.6.**
	* Car passenger (all the way)	%	20%	20%	
	* Other transit routes (all the way)	%	10%	10%	
	* Other (walk, cycle, taxi etc)	%	20%	20%	
	* Total	%	100%	100%	
Reduction in car driver trips	Reduction in car driver trips	#	-633.0	626.2	
Direct PT user benefits:					

BUS PRIORITY case studies: input requirements/pro forma		**Note: lanes in each direction evaluated separately**			
		Case study Manners Street			**Notes**
Before user time savings	Time saving per trip	min	**-0.3**	**0.4**	
	Annual savings	(000hr	**-60.66**	**80.88**	Note: annualisation factor is 250 (Notes!D79)
	TT (and reliability) savings	$000pa	-828	1104	
Mohring effect (benefits of scale)	Variability of line haul service frequency with patronage		1	1	0 = none, 1 = fully variable
	Current variable component of wait time	min	0.43	0.43	
	PT user benefits/ passenger (economies of scale)	$	0.16	0.16	
	PT user benefits/year	$000pa	-44.3	43.8	
Mode switcher benefits	Mode switcher benefits	$000pa	10.8	14.2	Rule of a half (maybe too severe)
Total user benefits		$000pa	-862	1162	
PT system impacts:					
Reduction in bus costs	Number of trips affected		2,022	2,022	
	Total time saving (bus opns) per peak	min	-606.6	808.8	
	Reduction in peak buses		-0.4	0.6	
	Annual PT op cost savings	$000pa	-100.6	134.1	
Cost of additional users	Net increase in PT passengers	#	**-1139**	**1127**	
	Unit marginal op cost/passenger	$	0.29	0.37	Bus $4.60, WGN rail $3.65, AKL Rail $5.04
	Unit fare revenue/passenger	$	2.96	2.96	
	Increase in PT costs	$000 pa	**-81.8**	**102.9**	
	Increase in PT fares revenue	$000 pa	**-842.1**	**833.1**	
	Increase in net PT operator costs	$000 pa	760.4	-730.2	
Overall reduction in operator (net) cost			-860.9	864.3	
Road system and user impacts:					
	Current traffic in peak period (peak direction)	#	0	0	
	Number of car drivers diverting	#	-633	626	

BUS PRIORITY case studies: input requirements/pro forma		**Note: lanes in each direction evaluated separately**			
		Case study Manners Street			**Notes**
	TT elasticity wrt volume		*0*	*0*	
Effect of reduced capacity	Increased corridor time due to capacity reduction	**min**	0.0	0.0	Without allowing for re-assignment etc
Effect of driver switching	Reduction in time due to switching	*min*	**0**	**0**	
	Net increase in calculated TT	*min*	**0**	**0**	
	Observed increase in corridor TT	*min*	**0.0**	**0.0**	
			0	**0**	if 'check' signs differ - check number diverting and assumed capacity reduction
	Is 'observed' actual or forecast?		**1.0**	**1.0**	1= actual, 0 = forecast
	Equivalent network increase in TT	*min*	**0**	**0**	expect |corridor| <|network| < 2* |corridor|
	Calculated cost to other users per peak	**hrs**	0	0	
Total road decongestion impact	Calculated cost to other users per year	**$(000)**	**0**	**0**	
Summary of benefits					
Public transport user benefits	**Existing user benefits**	$000 pa	**-872**	**1148**	
	Mode switcher benefits	$000 pa	**11**	**14**	
	Total road decongestion benefits	$000 pa	**0**	**0**	
Producer benefits	Include producer benefits?		**0**	**0**	1 = yes. 0 = no
	PT provider benefits	$000 pa	**0**	**0**	
Total	**Total benefits**	$000 pa	**300.6**		
Summary of costs	**Capital costs**	$000	**11,600**		
	Capital costs--annualised	$000 pa	**1,011.3**		
	O&M costs	$000 pa	**50**		
	PT op costs (net)	$000 pa	**-3**		

BUS PRIORITY case studies: input requirements/pro forma		Note: lanes in each direction evaluated separately			
		Case study Manners Street			Notes
	Total annualised costs	$000 pa	1,058		
	BCR(G)		0.3		
	NPV		-757.7		
	Target BCR		1.0		
	Conclusion		fail		Compares benefit with annualised cost

H4 Tauranga interchange

			Tauranga interchange		Notes
			Peak	Off-peak	
A0. Key factor data					
Patronage	Total passengers per day/period through facility		6000	3000	500 buses per day, occupancy of 30/10 per bus
	% passengers travel through		50%	70%	
	% passengers boarding/alighting		40%	20%	
	% passengers who transfer		10%	10%	
	Average vehicle loading at facility		30	10	
PT services	Number of destinations served	#	4	4	
	Average services per hour (through stop/interchange)	#	50	30	
	Length of the period	hr	4	10	
	Total number of services during period	#	200	300	
Route/journey time	Average bus running time (across all routes, terminus to terminus)	min	60	60	Estimated from Bay of Plenty (BOP) timetable
	Average passenger journey time	min	30	30	Half the running time
	Average passenger generalised journey time	min	45	45	
	Average saving in travel time (average all routes)	min	0.00	0.00	Reduced travel time through more efficient routing
A1. Public transport user benefits (existing users)					
In-vehicle time	Average TT savings for through passengers	IV min	0.00	0.00	
	Average TT savings per passenger	IV min	0.00	0.00	

			Tauranga interchange		Notes
			Peak	Off-peak	
	Total IVT benefits	$/day	0.00	0.00	
	Total benefits	$pa	0	0	
Access time	Avg walk time savings to/from facility for boarding/alighting passengers	Walk min	1.00	1.00	No change
	Avg walk time savings within facility for transfer passengers	Walk min	0.00	0.00	Default value
	Average access time savings per passenger	Walk min	0.40	0.20	
	Total access time benefits	$ / day	611.52	135.24	
	Total benefits	$pa	152,880	41,924	
Wait time/transfer	Avg wait time savings for boarding passengers	Wait min	1.00	1.00	Some efficiency gains
	Avg transfer time savings for transfer passengers	Wait min	1.00	2.00	Few transfers expected, but rerouting of buses results in efficiency gain
	Average wait time/transfer savings per passenger	Wait min	0.30	0.30	
	Total wait time/transfer benefits	$ / day	655.20	289.80	
	Total benefits	$pa	163,800	89,838	
Reliability	Not required for bus interchanges				
Frequency	Increase frequency in line with patronage?	Y/N	Y	N	
	Average frequency benefits per passenger	Hr	0.01	0.00	
	Total frequency benefits (Mohring effect)	$ / day	16.41	0.00	
	Total benefits	$pa	4,102	0	
Stop quality attributes	1 Cleanliness and graffiti	Scale	Avg to Good	4	
	2 Weather protection/shelter	Scale	Poor to Good	10	
	3 Seating	Scale	Poor to Good	4	
	4 Schedule info on bus times	Scale	Avg to Good	2	
	5 Real time info	Scale	Avg to Avg	0	
	6 Lighting	Scale	Avg to Good	2	
	Stop quality benefit for boarding passengers	$ per pass	0.22	0.22	
	Stop quality benefit for alighting passengers	$ per pass	0.00	0.03	
	Stop quality benefit for transfer passengers	$ per pass	0.22	0.22	

			Tauranga interchange		Notes
			Peak	Off-peak	
	Average stop quality benefit per passenger	$ per pass	0.07	0.05	
	Average stop quality benefit per passenger	IV min	0.36	0.29	
	Total infrastructure quality benefits	$ per day	396.0	141.0	
	Total benefits	$pa	99,000	43,710	
Vehicle quality	Not covered by this research project				
Average user time savings (existing users) per existing user		IV mins per day	1.52	1.17	
Average user benefit (existing users) per existing user		$ per day	0.28	0.19	
Total user benefits (existing users)		**$ per day**	**1,679.13**	**566.04**	
Total user benefits (existing users)		**$pa**	**419,782**	**175,472**	
A2. PT user benefits (new users)					
Demand impact	Total generalised journey time	IV mins	45.0	45.0	
	Percent reduction in generalised time	%	3.4%	2.6%	
	Travel elasticity (generalised time)	#	-0.6	-0.9	Default values used
	Calculated increase in passengers	%	2.1%	2.4%	
	Total expected new passengers	#	125.22	72.10	
	User benefit per new passenger	$ per pass	0.14	0.09	
Total user benefits (new users)		**$ per day**	**0.70**	**1.26**	
Total user benefits (new users)		**$ pa**	**176**	**390**	
A3. Road user benefits (decongestion)					
Prior mode	Same (travel more often)	%	40%	55%	Default values
	Car driver (all the way)	%	5%	5%	Default values
	Car passenger (all the way)	%	10%	5%	Default values
	Other transit (all the way)	%	15%	15%	Default values
	Other (walk, cycle, taxi etc)	%	30%	20%	Default values
	Total	%	100%	100%	
Change in car trips	Reduction in peak car driver trips	#	6.26	n/a	
	Estimated elasticity (% speed v % vol)	#	1.0	n/a	Default values
	Total reduction in car travel time	IV mins	262.97	n/a	
Total road user benefits (decongestion)		**$ per day**	**123.54**	**n/a**	
Total road user benefits (decongestion)		**$pa**	**30,885**	**n/a**	
A4. Capital costs (public sector)					

			Tauranga interchange		Notes
			Peak	**Off-peak**	
Capital cost	Land value (opportunity cost)	$	0	n/a	
	Construction costs	$	650,000	n/a	Expected cost (Beca 2007)
	Planning/overheads/contingencies etc	$	130,000	n/a	
	Life of asset	Years	20	n/a	Default value
Total capital costs		**$**	**780,000**	**n/a**	
Total capital costs--annualised		**$pa**	**68,004**	**n/a**	
A5. Recurrent (net) costs (public sector)					
Facility O&M	Annual facility O&M costs (approx)	$pa	20,000	n/a	Lowered from default
Bus service op costs	Increase in running time per service	IV mins	0.00	0.00	
	Increase in km per service	Km	0.00	0.00	Default value used
	Increase in bus hours per period	Hour	0.00	0.00	
	Increase in bus km per period	Km	0.00	0.00	
	Increase in peak vehicles	#	0.00	0.00	
	Total increase in costs per annum (ex pax)	$pa	0	0	
Producer benefit (new pax)	Unit marginal op cost/passenger	$	4.61	0.00	
	Increase in public transport costs/ period	$	576.69	0.00	
	Unit fare revenue per passenger	$	2.5	1.6	Estimated from BOP transport
	Increase in PT fares revenue/period	$	313.06	115.36	
	Net PT operator cost increase/period	$/ period	263.63	-115.36	
	Net PT operator cost increase pa (new pax)	$pa	0	-35,762	
Total recurrent costs		**$pa**	**20,000**	**-35,762**	
A. Economic/financial impacts			**All figures in $000pa**		
A1. PT user benefits (existing users)					
In-vehicle time			0.0		
Access time			194.8		
Wait/transfer time			253.6		
Reliability			0.0		
Frequency			4.1		
Infrastructure quality			142.7		
Total			595	147	
A2. PT user benefits (new users)				6.5	
A3. Road user benefits				30.9	

			Tauranga interchange		Notes
			Peak	Off-peak	
A4. Capital costs (public sector)				68.0	
A5. Recurrent (net) costs (public sector)				-15.8	
A6. Total benefits/costs					
Annualised benefit				**633**	
Annualised cost				**52**	
Net annualised value				**580**	
BCR(G)				**12.11**	

H5 Otara interchange

			Otara interchange		Notes
			Peak	Off-peak	
A0. Key factor data					
Patronage	Total passengers per day/period through facility		2,910	3,060	301 buses a day, 30 in peak, 15 in off peak
	% passengers travel through		70%	70%	Default value
	% passengers boarding/alighting		20%	20%	Default value
	% passengers who transfer		10%	10%	Default value
	Average vehicle loading at facility		30	15	Estimated
PT services	Number of destinations served	#	6	6	From AT Southern Guide
	Average services per hour (through stop/interchange)	#	24	14	From GTFS explorer
	Length of the period	hr	4	15	From GTFS explorer
	Total number of services during period	#	96	210	
Route/journey time	Average bus running time (across all routes, terminus to terminus)	min	50	50	From southern timetable
	Average passenger journey time	min	35	35	Estimated
	Average passenger generalised journey time	min	52.5	52.5	
	Average saving in TT (average all routes)	min	0.00	0.00	No travel time savings
A1. PT user benefits (existing users)					
In-vehicle time	Average TT savings for through passengers	IV min	0.00	0.00	
	Average TT savings per passenger	IV min	0.00	0.00	
	Total IVT benefits	$ / day	0.00	0.00	
	Total benefits	$pa	0	0	

			Otara interchange		
			Peak	**Off-peak**	**Notes**
Access time	Avg walk time savings to/from facility for boarding/alighting passengers	Walk min	0.00	0.00	No change
	Avg walk time savings within facility for transfer passengers	Walk min	0.00	0.00	Default value
	Average access time savings per passenger	Walk min	0.00	0.00	
	Total access time benefits	$/ day	0.00	0.00	
	Total benefits	$pa	0	0	
Wait time/ transfer	Avg wait time savings for boarding passengers	Wait min	0.00	0.00	No service changes
	Avg transfer time savings for transfer passengers	Wait min	0.00	0.00	No changes
	Average wait time/transfer savings per passenger	Wait min	0.00	0.00	
	Total wait time/transfer benefits	$/day	0.00	0.00	
	Total benefits	$pa	0	0	
Reliability	Not required for bus interchanges				
Frequency	Increase frequency in line with patronage?	Y/N	N	N	
	Average frequency benefits per passenger	Hr	0.00	0.00	
	Total frequency benefits (Mohring effect)	$/day	0.00	0.00	
	Total benefits	$pa	0	0	
Stop quality attributes	1 Cleanliness and graffiti	Scale	Poor to V good	11	
	2 Weather protection/shelter	Scale	Poor to Good	10	
	3 Seating	Scale	Poor to Good	4	
	4 Schedule info on bus times	Scale	Poor to Good	4	
	5 Real time info	Scale	Poor to Good	7	
	6 Lighting	Scale	Poor to Good	4	
	Stop quality benefit for boarding passengers	$ per pass	0.40	0.40	
	Stop quality benefit for alighting passengers	$ per pass	0.08	0.08	
	Stop quality benefit for transfer passengers	$ per pass	0.40	0.40	
	Average stop quality benefit per	$ per	0.09	0.09	

			Otara interchange		Notes
			Peak	Off-peak	
	passenger	pass			
	Average stop quality benefit per passenger	IV min	0.48	0.54	
	Total infrastructure quality benefits	$ per day	254.6	267.8	
	Total benefits	$pa	63,656	83,003	
Vehicle quality	Not covered by this research project				
Average user time savings (existing users) per existing user		IV mins per day	0.48	0.54	
Average user benefit (existing users) per existing user		$ per day	0.09	0.09	
Total user benefits (existing users)		**$ per day**	**254.63**	**267.75**	
Total user benefits (existing users)		**$ pa**	**63,656**	**83,003**	
A2. PT user benefits (new users)					
Demand impact	Total generalised journey time	IV mins	52.5	52.5	
	Percent reduction in generalised time	%	0.9%	1.0%	
	Travel elasticity (generalised time)	#	-0.6	-0.9	Default values used
	Calculated increase in passengers	%	0.6%	0.9%	
	Total expected new passengers	#	16.11	28.79	
	User benefit per new passenger	$ per pass	0.04	0.04	
Total user benefits (new users)		**$ per day**	**0.70**	**1.26**	
Total user benefits (new users)		**$ pa**	**176**	**390**	
A3. Road user benefits (decongestion)					
Prior mode	Same (travel more often)	%	40%	55%	Default values
	Car driver (all the way)	%	5%	5%	Default values
	Car passenger (all the way)	%	10%	5%	Default values
	Other transit (all the way)	%	15%	15%	Default values
	Other (walk, cycle, taxi etc)	%	30%	20%	Default values
	Total	%	100%	100%	
Change in car trips	Reduction in peak car driver trips	#	0.81	n/a	
	Estimated elasticity (% speed vs % volume)	#	1.0	n/a	Default values
	Total reduction in car travel time	IV mins	28.19	n/a	
Total road user benefits (decongestion)		**$ per day**	**13.24**	**n/a**	
Total road user benefits (decongestion)		**$pa**	**3,310**	**n/a**	
A4. Capital costs (public sector)					
Capital cost	Land value (opportunity cost)	$	0	n/a	

			Otara interchange		
			Peak	Off-peak	Notes
	Construction costs	$	1,050,000	n/a	Half total cost allocated to bus interchange
	Planning/overheads/contingencies etc	$	210,000	n/a	
	Life of asset	Years	20	n/a	Default value
Total capital costs		**$**	**1,260,000**	**n/a**	
Total capital costs--annualised		**$pa**	**109,853**	**n/a**	
A5. Recurrent (net) costs (public sector)					
Facility O&M	Annual facility O&M costs (approx)	$pa	20,000	n/a	Lowered from default
Bus service op costs	Increase in running time per service	IV mins	0.00	0.00	
	Increase in kms per service	Km	0.00	0.00	Default value used
	Increase in bus hours per period	Hr	0.00	0.00	
	Increase in bus km per period	Km	0.00	0.00	
	Increase in peak vehicles	#	0.00	0.00	
	Total increase in costs pa (ex pax)	$pa	0	0	
Producer benefit (new pax)	Unit marginal op cost/passenger	$	0.00	0.00	
	Increase in public transport costs/period	$	0.00	0.00	
	Unit fare revenue per passenger	$	4	3	Estimated from AT fares
	Increase in public transport fares revenue/period	$	64.43	86.38	
	Net public transport operator cost increase/period	$/ period	-64.43	-86.38	
	Net PT operator cost increase pa (new pax)	$pa	0	-26,777	
Total recurrent costs		**$pa**	**20,000**	**-26,777**	
A. Economic/financial impacts			**All figures in $000pa**		
A1. PT user benefits (existing users)					
IVT			0.0		
Access time			0.0		
Wait/transfer time			0.0		
Reliability			0.0		
Frequency			0.0		
Infrastructure quality			146.7		
Total				147	
A2. PT user benefits (new users)				0.0	
A3. Road user benefits				0.0	
A4. Capital costs (public sector)				109.9	
A5. Recurrent (net) costs (public sector)				-6.8	

		Otara interchange		
		Peak	**Off-peak**	**Notes**
A6. Total benefits/costs				
Annualised benefit			**147**	
Annualised cost			**103**	
Net annualised value			**44**	
BCR(G)			**1.42**	

Appendix I: Glossary

AADT	annual average daily traffic
AO	approved organisation
AST	appraisal summary table
AT	Auckland Transport
BIS	bus infrastructure scheme
BRT	bus rapid transport/transit
CAS	Crash Analysis System
CBA	cost-benefit analysis
CBR	cost-benefit ratio
DfT	Department for Transport (UK)
EEM	NZ Transport Agency's *Economic evaluation manual*
GC	generalised cost
GHG	greenhouse gas emissions
GPTIF	NZ Transport Agency *Guidelines for public transport infrastructure and facilities*
GTFS	General Transit Feed Specification
IVT	in-vehicle time
LTMA	Land Transport Management Act 2003
LGA	Local Government Act 2002
MCA	multi-criteria analysis
MCC	Manukau City Council
NAV	net annualised value
NN	new network
NoR	notice of requirement
NPV	net present value
PAUP	Proposed Auckland Unitary Plan
PIR	post-implementation review
PT	public transport
PVR	peak vehicle requirements
RCA	road controlling authority
RMA	Resource Management Act 1991
RPS	regional policy statement
RPTP	regional public transport plan
RTI	real-time information

SAF	simplified appraisal framework
SCBA	social cost-benefit analysis
TCC	Traffic Control Committee (Auckland)
TfL	Transport for London
TfNSW	Transport for New South Wales, Australia
TOD	transit-oriented development
Transport Agency	New Zealand Transport Agency
TT	travel time
VOC	vehicle operating costs