Australian Transport Council

2006

National Guidelines for Transport System Management in Australia

3 Appraisal of initiatives

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or from the Bureau of Transport and Regional Economics (BTRE)

GPO Box 501, Canberra, ACT 2601,

by phone 02 6274 6806, fax 02 6274 6816.

Feedback on the Guidelines can be forwarded to the Executive Director, BTRE on the contact details above.

Contents

TABLES

FIGURES

BOXES

Foreword

This document presents detailed information on the appraisal of initiatives under the *National Guidelines for Transport System Management in Australia* (2nd edition) endorsed by the Australian Transport Council (ATC) in November 2006. It is part of a series of five documents that comprise the Guidelines. The other documents cover an introduction, detailed framework for undertaking strategic transport planning and development, an analytical approach for urban transport proposals and background material.

I gratefully acknowledge the contributions made by committee members towards this very significant piece of work. All of the members have given generously of their time and competencies, over an extended period of time, to make the Guidelines a comprehensive and user-friendly manual that will assist all jurisdictions in the complex business of transport system planning and management. In particular, I acknowledge the significant contribution of the Chair of the Committee, Dr Anthony Ockwell who directed and managed the project throughout its entire process. A list of members is presented elsewhere in this publication.

The Guidelines support transport decision-making and serve as a national standard for planning and developing transport systems. They are a key component of processes to develop and/or appraise transport proposals that are submitted for government funding. Potential users of the Guidelines include governments, private firms or individuals, industry bodies and consultants.

The Guidelines have been endorsed by all Australian jurisdictions. They were developed collaboratively over several years by representatives from all levels of government in Australia through the Standing Committee on Transport (SCOT), in consultation with SCOT modal groups (Austroads, Australian Passenger Transport Group, SCOT Rail Group). The Guidelines have been endorsed by ATC and the Council of Australian Governments (COAG).

This is the second edition of the Guidelines. It is an expanded and revised edition that reflects directions from SCOT, ATC and COAG as well as feedback from users. The revision has focused on making the material more cohesive, accessible and user-friendly, while maintaining rigour. These improvements will help to facilitate the widespread adoption of the Guidelines that has been specified by COAG.

The terms assessment, appraisal and evaluation are often used interchangeably in practice to mean the determination of the overall merits and impacts of an initiative. In the Guidelines they are used as follows:

- *Assessment*: A generic term referring to quantitative and qualitative analysis of data to produce information to aid decision-making.
- *Appraisal*: The process of determining the impacts and overall merit of a proposed initiative, including the presentation of relevant information for consideration by the decision-maker.
- *Evaluation*: The specific process of reviewing the outcomes and performance of an initiative after it has been implemented.

The current focus of the Guidelines is land transport—road, rail and inter-modal. There is scope to further broaden the Guidelines to cover other modes and transport issues in the future.

It is envisaged that the experiences of users who apply the Guidelines will continue to provide useful insights into areas requiring further improvement. The Guidelines should therefore be seen as an evolving set of procedures and practices. The agencies involved in the development of the Guidelines welcome feedback that will contribute to the process of revision and improvement.

Michael J Taylor
Chair
Standing Committee on Transport
December 2006

Committee members for 2nd edition

AUSTRALIAN GOVERNMENT	
Anthony Ockwell (Chair)	Department of Transport and Regional Services
Mark Harvey	Bureau of Transport and Regional Economics
Kym Starr	Department of Transport and Regional Services
Caroline Evans	Bureau of Transport and Regional Economics (until December 2005)

STATE AND TERRITORY GOVERNMENTS		
Peter Tisato	Department for Transport, Energy and Infrastructure	South Australia
Russell Fisher	Department of Main Roads	Queensland
Jon Krause	Department of Main Roads	
Renny Phipps	Queensland Transport	
Rhonda Daniels	Department of Planning	New South Wales
Julieta Legaspi	Roads and Traffic Authority	
Fotios Spiridonos	Department of Infrastructure	Victoria
Andrew Trembath	Department of Infrastructure	
Ed McGeehan	VicRoads	
Steven Phillips	Department for Planning and Infrastructure	Western Australia
Philip Petersen	Department of Infrastructure, Energy and Resources	Tasmania
Michael Hogan	Department of Infrastructure, Energy and Resources	
Greg Scott	Department of Planning and Infrastructure	Northern Territory

NEW ZEALAND GOVERNMENT	
Simon Whiteley	Land Transport New Zealand
Ian Melsom	Land Transport New Zealand

AUSTRALIAN CAPITAL TERRITORY & AUSTRALIAN LOCAL GOVERNMENT

The Australian Capital Territory, Department of Urban Services and the Australian Local Government Association were consulted throughout the development of the Guidelines.

1 Appraisal process and methodology

At a glance

- Volume 3 of the Guidelines sets out a methodology for appraising proposed transport initiatives that contribute to multiple government objectives.
- The objectives should be derived in Phase 1 of the Framework as described in Volume 2 of the Guidelines.
- The methodology features a Strategic Merit Test (SMT) to assess how well the initiatives fit with the government's objectives, rapid and detailed appraisals (including the use of benefit–cost analysis (BCA), an optional adjusted BCA, completion of an Appraisal Summary Table (AST) and a Business Case that brings together, in a single document, the results of the SMT, BCA, AST and other analyses (financial, environmental and social).
- The SMT template includes an Objective Impact Table that formalises thinking about the strategic fit of an initiative.
- Rapid appraisal is intended to be a cost-effective way of gauging whether an initiative is likely to pass a detailed appraisal.
- The methodology for a rapid appraisal is the same as for a detailed appraisal, but with lower expectations about comprehensiveness and accuracy.
- The adjusted BCA technique is a formal and transparent way to use a set of weightings of objectives that are different from the implicit weightings in standard BCA.
- Non-monetised benefits and costs can be presented to decision-makers for consideration alongside monetised (BCA) results using the AST.
- For small-scale initiatives, the detailed BCA step can be omitted.

1.1 Overview

Volume 1 of the Guidelines introduced the three-stage appraisal process adopted in the Guidelines. The three stages, interpreted as three filters (see Figure 4 in Volume 1), consist of:

- the SMT
- rapid appraisal, and
- detailed appraisal.

The three-stage process uses the following tools:

- BCA
- an optional technique called 'adjusted BCA', and
- the AST concept.

BCA is a long-standing appraisal tool with a primary focus on monetised impacts, and plays a central role here. Adjusted BCA is an extension of BCA, involving an adjustment to BCA results to better reflect the relative importance the decision-maker may place on different objectives. The AST is a particular format for presentation of the impacts of an initiative in which both monetised and non-monetised impacts are presented side-by-side, on an equal basis, to assess overall net benefit, or net value. Presenting both monetised and non-monetised impact information is critical in the appraisal of transport initiatives (see background discussion in Section 5.3 in Volume 2).

The above elements, together with risk assessments and other specialised activities, provide the basis for developing a business case to advise the decision-maker of an initiative's contribution to a jurisdiction's multiple objectives, policies and strategies, and the initiative's impacts and overall merit.

Initiatives should generally be subjected to the same appraisal process. The level of detail will vary with the size and complexity of each initiative—smaller, less complex proposals often will not proceed to the stage of detailed appraisal (see Section 1.7). The level of detail in appraisal may also vary between infrastructure and non-infrastructure initiatives.

1.1.1 Role and structure of Volume 3

The role of this volume of the Guidelines is to explain the appraisal process in more detail, providing instructions for how practitioners can implement the process and methodology. The volume is divided into two parts:

- Part 1 describes the appraisal process and methodology, covering the SMT, BCA and adjusted BCA, the AST and Business Case development. Appendix A provides a template for the SMT and rapid BCA. The template can serve as a first draft of a Business Case.
- Part 2, together with material in Volume 5, is largely a BCA manual, applicable to road, rail and inter-modal initiatives—both modal infrastructure and non-infrastructure proposals, including proposals that improve the management of existing transport infrastructure. Guidance for financial analyses is also provided to ensure consistency between economic and financial appraisals.

1.1.2 Desirable attributes of the methodology

Establishing a level playing field for appraising initiatives, including across modes, is an important principle underlying the appraisal methodology set out in Volume 3. For reasons of efficiency and equity, decisions regarding funding of initiatives should be based on appraisals that are consistent in methodology and assumptions. Estimates of benefits and costs need to be realistic and comprehensive.

Appraisal of initiatives is not costless. The appraisal methodology is designed to screen out, at an early stage, initiatives that are unlikely to succeed and to ensure smaller initiatives are subjected to a simpler assessment process.

Given funding constraints, governments also look for ways to make better use of existing infrastructure and for solutions that ensure all modes are used to their maximum advantage. The appraisal methodology therefore has to be sufficiently flexible to apply to non-infrastructure proposals as well as infrastructure proposals.

The guiding principles behind the methodology in Volume 3 are that, as far as practical, the methodology is:

- able to identify an initiative's contribution to specified objectives
- cost-effective
- defensible, comprehensive, transparent, rigorous
- consistent across initiatives, and
- able to compare different types of initiatives, including different modes.

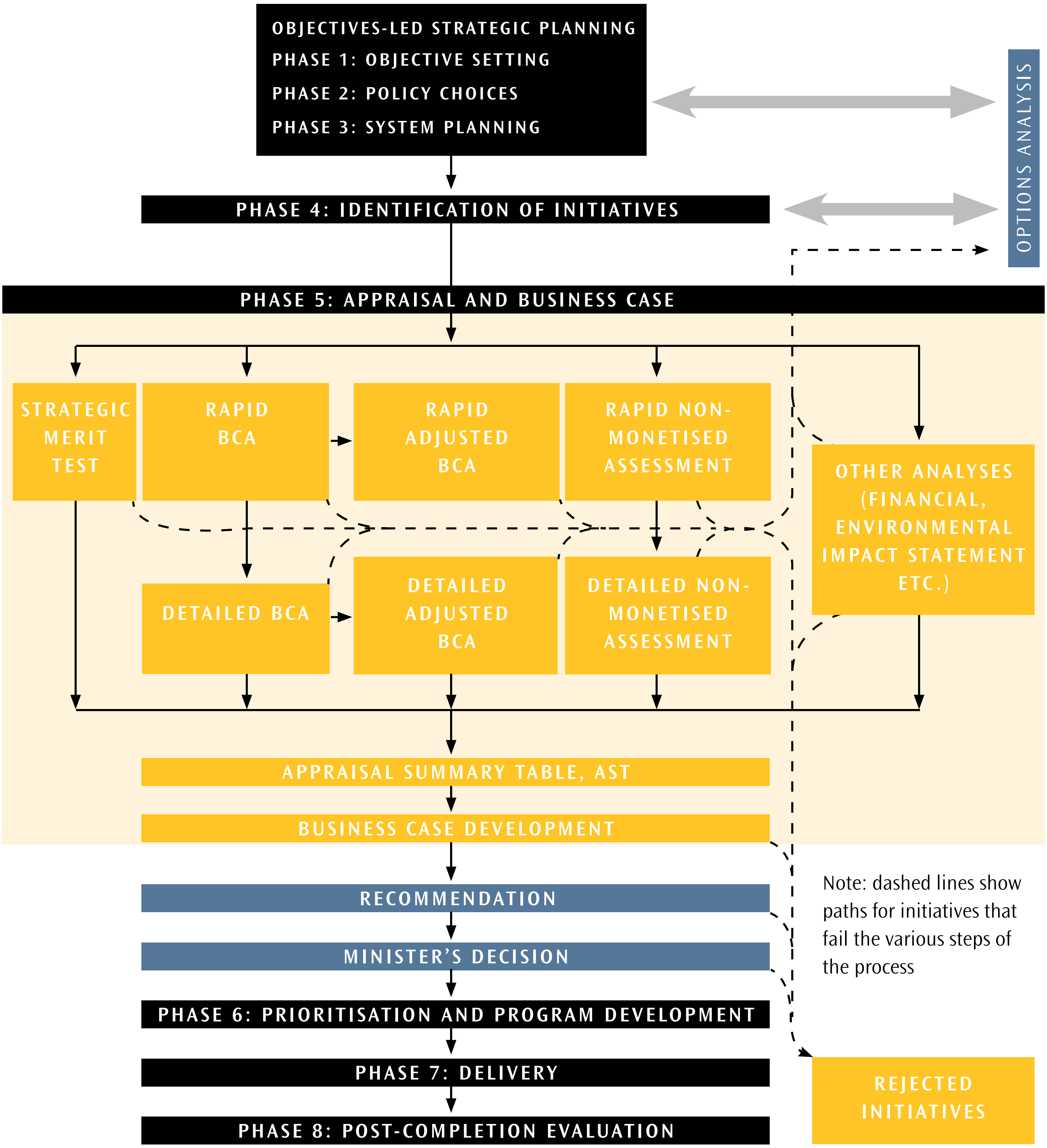
1.1.3 Overview of the methodology

Figure 1.1 shows a flowchart of how the appraisal process (Phase 5) fits together with the other phases of the Transport System Management Framework.

Throughout Volume 3, it is assumed that:

- strategic planning (Phases 1 to 3) has already been undertaken
- high-level transport system objectives have been translated into more detailed linked objectives for elements of the transport system (networks, corridors and areas, routes, links) (see Table 1 in Volume 2), from which objectives for individual initiatives can be developed, and
- Phase 4 identified a range of potential initiatives ready for appraisal.

Figure 1.1: Appraisal methodology flowchart



Phase 4 of the Framework may have included some consideration of different options. Where options are difficult to choose between, they can be retained in the proposal until more analysis has been undertaken.

SMT

The main purpose of the SMT is to assess how an initiative aligns with jurisdictional objectives, policies and strategies. The SMT is a qualitative assessment that also provides a series of checks on the feasibility of the initiative and ensures that full consideration is given to options. It should quickly eliminate initiatives that are unlikely to pass a detailed appraisal. The SMT is an efficient means of filtering initiatives before further developing and appraising the initiative or option. The documentation developed for the SMT should form the first draft of the Business Case.

Rapid appraisal

Rapid appraisal screens out initiatives that have passed the SMT, but are unlikely to pass more detailed assessment. It incorporates an indicative assessment of the main benefits and costs, without expending the resources necessary to achieve a high level of accuracy. Rapid BCA allows consideration of monetised benefits and costs. Non-monetised benefits and costs also need to be explored at an indicative level. The AST can be used to summarise both monetised and non-monetised impacts.

Rapid appraisal is intended to be a cost-effective way of gauging whether an initiative is likely to pass a detailed appraisal. It should facilitate screening large numbers of initiatives to select those with the greatest net benefits and point to information requirements for the next stage of appraisal.

The SMT and rapid appraisal may be undertaken in parallel as they support each other. Undertaking the SMT before the rapid appraisal allows a preliminary indication of an initiative's alignment with objectives, policies and strategies in qualitative terms, before appraisal resources are expended on highly detailed information and new data. On the other hand, rapid appraisal identifies, and where possible quantifies, preliminary benefits and costs. This helps to discern the objectives an initiative is likely to meet, which is essential information for the SMT.

Proposals that pass rapid appraisal are then subjected to detailed appraisal.

Detailed appraisal

Detailed appraisal is a comprehensive analysis of the impacts and merit of an initiative. It requires a greater commitment of time and other resources and is undertaken once an initiative passes the SMT and rapid appraisal tests. A detailed appraisal usually involves detailed BCA, plus consideration of non-monetised impacts. All relevant monetised and non-monetised impacts need to be assessed. The AST can be used to summarise both monetised and non-monetised impacts. In addition, a number of other specific, detailed impact assessments are usually required to be separately reported: financial or budget assessments, specific impact analyses and impact statements (e.g. environmental, social, regional, employment, equity).

BCA

BCA plays a central role in the appraisal process, providing an assessment of those impacts that can be monetised. BCA is a standard technique used all over the world and can be applied to a wide range of initiatives in a defensible, comprehensive, transparent and rigorous way. The BCA methodology set out in the Guidelines is tailored to suit transport initiatives in a multi-modal context and where a wide range of options are being explored.

Part 2 of this volume provides significant detail on assessing the monetised benefits and costs in related markets. For example, diverted traffic can be a significant consideration where an initiative causes freight or passengers to switch modes. Or, an initiative may increase traffic on upstream or downstream transport infrastructure. These considerations are important when initiatives have multi-modal aspects.

The timing of options and comparing options with differing risk characteristics are also discussed in detail.

A 'rapid BCA' is a BCA that only takes the main monetised benefits and costs into account. These benefits and costs should be estimated with less accuracy than that expected for a detailed BCA. Non-monetised benefits and costs should also be assessed, noting their potential impact on the benefit–cost ratio (BCR), and be explicitly listed in the AST.

Externalities can be valued using 'default values' in a rapid BCA. This helps to determine the significance of each externality benefit or cost. Significant externalities should be re-estimated at the detailed BCA stage with site-specific data and modelling, to obtain a more detailed value of the externalities. For detailed BCAs, studies may be required to obtain initiative-specific unit values for externalities. For the most part, other parameter values are well-established; hence, the same values are used in both rapid and detailed BCA.

The detailed BCA should include a comprehensive risk assessment with adjustments made to ensure the final results are not biased by over-optimistic estimates of benefits and costs. Sensitivity testing should also be undertaken; although, if a thorough risk analysis has been undertaken, sensitivity testing may not be required.

Appraisal Summary Table (AST)

The AST is a presentation format developed, and first used, by the UK Department for Transport. It addresses the same question as BCA; that is, is an initiative likely to produce a net benefit to society as a whole? However, in contrast to BCA, the AST considers both monetised and non-monetised impacts, with a qualitative assessment of the scale of the non-monetised impacts. The AST presents a summary of all relevant information (monetised and non-monetised) about the net benefit or value of a proposal on an equal footing—side-by-side, on a single page, in a user-friendly format.

Adjusted BCA

The 'adjusted BCA' technique, which may be employed at both the rapid and detailed appraisal stages, is a hybrid of BCA and multi-criteria analysis. It provides flexibility to apply more weight to objectives other than economic efficiency to reflect the relative importance governments place on different objectives. By staying within the BCA framework, adjusted BCA avoids some of the disadvantages of quantitative multi-criteria analysis (BTE 1999b). Adjusted BCA is included in the Guidelines as an optional technique.

Non-monetised assessment

Figure 1.1 also explicitly acknowledges a role for non-monetised assessment in both rapid and detailed appraisal. As mentioned above, non-monetised impacts are a central element of the AST. The difference in non-monetised assessment at the rapid and detailed levels is again a function of the accuracy sought and depth of analysis undertaken in those assessments.

Finalising the process

Other activities will be carried out during the appraisal process such as stakeholder consultation, preliminary engineering design, financial assessment (if the initiative generates revenue), risk assessment, investigation of legal issues, preparation of an Environmental Impact Statement, development of funding options, socio-economic analysis, assessment of overall impact on the economy and consideration of land use implications.

An initiative failing any of the tests—SMT, rapid BCA, detailed BCA and other assessments—should not necessarily be rejected altogether. It may be resubmitted in revised form for consideration in the next round of funding of initiatives. The curved, dashed lines in Figure 1.1 show paths for initiatives that fail the various steps of the process, leading back to either 'options analysis' or complete rejection.

The results of the SMT, BCA, adjusted BCA, AST and other assessments should be consolidated into a Business Case for presentation to the relevant minister.

The final recommendation regarding an initiative is the outcome of Phase 6, 'Prioritisation and Program Development' (discussed in Volume 2).

Evaluation of road maintenance initiatives is addressed in this volume (Section 2.17) and in Volume 5 (Sections 1.5 and 2.17), first in a life-cycle cost minimisation framework, and then in a BCA framework. Treatment of initiatives that combine maintenance and capital characteristics is also discussed (Volume 3, Section 2.17.7).

Parameter values

BCA and financial analysis are standard appraisal techniques. Therefore, appraisals carried out in accordance with Volume 3 should be broadly consistent with the approaches outlined in the existing appraisal guidelines developed within various jurisdictions. The main differences that are likely to arise are in specified parameter values. To promote consistency and comparability between appraisals, the Guidelines recommend using Austroads parameter values for estimating benefits and costs associated with road transport (Austroads 2005c and 2006). Austroads updates these on a regular basis. Austroads parameter values have not been reproduced here, but are referenced at relevant points throughout the Guidelines.

Default externality values are set out in Volume 3, Part 2, Appendix C. Parameter values for public transport are provided in Volume 4 and indicative values for rail transport can be found in Volume 5, Part 4.

Proponents submitting proposals for consideration under the Guidelines appraisal methodology may, in some cases, disagree with particular Guidelines or Austroads parameter values. In these situations, proponents may submit a BCA estimate using their own preferred values, together with a second BCA using the values established by the recommended parameter values as a sensitivity test. Proponents should detail the reasons for departing from the recommended parameter values and justify their preferred values. When checking the validity of the BCA, it will be up to the agency assessing the proposal to decide whether the change of parameter values is justified.

Parameter values should be reviewed and updated at appropriate times. This should occur when significantly improved parameter values are available from research. It is unlikely this updating will occur more frequently than annually.

Once a BCA has been completed using a current set of parameter values, the BCA should not be subsequently revised when the values are updated.

Data needs

The National Transport Data Framework is an ongoing initiative aimed at improving the quality of data for transport planning. As the subsequent SCOT/BTRE data-sharing project leads to improvements in data, it is expected these improvements will assist the project appraisal process detailed in the Guidelines.

1.2 Strategic Merit Test (SMT)

Overview

All the initiatives identified in Phase 4 should be subject to an SMT. Proposals arising from strategic planning (Phases 1 to 3) should reflect jurisdictional objectives, policies and strategies. They should therefore readily pass the SMT. The SMT is particularly valuable when it is applied to proposals that originate from outside the strategic planning process.

The SMT incorporates a series of questions that must be answered for each proposed initiative. The questions identify:

- how well the initiative is expected to contribute to jurisdictional objectives, policies and strategies
- any barriers to the initiative (e.g. risk, dependence on other initiatives), and
- whether proper consideration has been given to alternative solutions or options and to the broader context of the initiative.

The SMT identifies those proposals that should proceed to the next stage of appraisal, proposals that require further scoping, and proposals that should be abandoned because they are inconsistent with jurisdictional objectives, policies and strategies. The SMT provides a largely qualitative, first-order determination of the 'strategic fit' of each proposal.

The SMT is a useful mechanism because it:

- requires proponents to clearly define an initiative and outline how it will meet higher-level objectives
- provides an efficient means to filter proposals before considerable resources are spent on development, including providing an early view on an initiative's likely effectiveness in meeting jurisdictional objectives, and
- highlights where information may be required to substantiate a benefit or cost in preparing a business case.

The documentation developed for the SMT should be the first draft of the Business Case. A sample SMT template is provided in Appendix A. It is based on a template developed by the Department of Infrastructure, Victoria. The template should be completed for each option under consideration.

If a rapid BCA has been undertaken prior to carrying out the SMT, this information can be harnessed to show how the initiative promotes or detracts from government objectives. Appendix A also provides a template for reporting a rapid BCA.

The SMT can be treated as an iterative process to develop a clear specification of the initiative and its objectives, consider the available options and take account of other issues. Government agencies should encourage proponents to submit draft SMT templates at any time on an informal basis for comment and discussion. Such an approach helps:

- decision-makers to gain a good understanding of the proposal and to obtain necessary information
- proponents to understand the approach to appraisal and program development, and
- all parties to work through the issues to arrive at the best outcome for all aspects of an initiative, including options, specification of the initiative including the Base Case, risk management, stakeholder management and correct analysis.

As illustrated in Figure 1.1, the loop back to the options analysis box indicates that initiatives that fail the SMT can be revised; however, some initiatives will fail regardless of the number of iterations.

Assessing strategic merit

The main purpose of the SMT is to determine the strategic merit, or strategic fit, of an initiative. The decision about the overall strategic merit of an initiative is a subjective decision made by government. Given this subjectivity, the Guidelines do not attempt to specify a unique approach for determining strategic merit.

Each jurisdiction is likely to differ in how it assesses strategic merit. It is important, therefore, that each jurisdiction designs a process that is best suited to its circumstances. The process could be as simple as a checklist to record the alignment and contribution of an initiative to jurisdictional objectives, policies and strategies for consideration by the decision-maker.

To aid the process, an indicative tool has been included here for jurisdictions to use or to assist them in designing their own tools for assessing strategic merit. The tool is the Objective Impact Table (OIT).

Objective Impact Table (OIT)

Part G of Appendix A provides an OIT template.

The OIT is similar to the AST (see Section 1.4) but has a narrower purpose. The AST is a tool for summarising all relevant impacts of an initiative as part of a detailed appraisal, and possibly a rapid appraisal. On the other hand, the OIT provides a formal and transparent way to assess an initiative's strategic fit, rather than summarise all its impacts.

The objectives used for the OIT come directly from the strategic planning process (Phases 1 to 3) and, as such, may be highly specific, lacking the balance and comprehensiveness needed for an AST.

The OIT template has five columns:

- Column 1: government objective
- Column 2: impact types
- Column 3: qualitative impacts
- Column 4: quantitative impacts, and
- Column 5: rating.

Column 1:

List the range of government objectives relevant to the initiative.

Objectives can be sourced from high-level jurisdictional strategy documents, network, corridor or area strategies, and route or link plans. Note the source document for each strategic objective after the table.

Column 2:

List the impact types (or sub-objectives) under each objective. This column allows for the multi-dimensional nature of some objectives. For example, if the objective is 'environment', impact types could include noise, local air quality, greenhouse gas emissions, landscape, heritage, biodiversity and water quality.

For some impact types, more than one entry in the table may be required. For example, heritage impacts may include impacts on Indigenous and early settler sites. Congestion impacts may be different for different locations. In these cases, increase the row width in the table, and place each component of the impact on a different line within the table cell.

If the objective in Column 1 is sufficiently specific, leave Column 2 blank. Add and delete rows as necessary.

The objective against which to include an impact may not be immediately obvious. For example, an impact on the tourism industry might be included in the table under the objective of economic development.

Some impacts may not fit under any of the objectives listed. These impacts should not be included in the table. The reason is, as mentioned above, the table is not intended to provide a comprehensive description of all the impacts of the initiative, as is the case for the AST. For example, a smoother road may result in a more comfortable ride for road users. If there is no explicit government strategic objective that covers ride comfort, the impact should not be included. Even some benefits counted in the BCA may be excluded.

The same impact may appear more than once in the table. For example, if reducing corridor transit times and improving international competitiveness are listed as objectives, journey time savings also contribute to improving international competitiveness. Ideally, government objectives will be sufficiently distinct to avoid overlap; however, this cannot be assured. The fact that the same impact relates to more than one objective is relevant information for assessing the strategic merit of an initiative. However, decision-makers considering an OIT need to be mindful of instances where the same impact occurs more than once.

Proponents of an initiative cannot be expected to complete the first two columns by themselves. The government agency assessing the proposal should provide the objectives after consultation with the proponent. References to source documents for objectives should be listed just below the table.

Column 3:

For each impact type, describe the impact in qualitative terms.

Column 4:

For each impact type, specify the impact in quantitative terms, if possible. If the impact is time dependent (e.g. tonnes of CO_2 equivalents per annum), sum the physical quantities over the life of the initiative.

Where a rapid BCA has already been undertaken, any monetised benefits and costs can also be included in the OIT. These monetised components should be expressed as present values measured over the life of the initiative. Using the same notation as for the AST, the present value of a benefit should be denoted 'PVB $ …' and the present value of a cost as 'PVC $ …'

At the bottom of the cell, the totals of any items in the cell that are of similar units are reported.

Column 5:

Include subjective judgments about the direction and strength of impact on each objective via a seven-point scale—three negative levels, a neutral position and three positive levels. This scale is detailed in Table A.1 in Appendix A. Where initiatives have negative impacts, be careful not to assign a low-positive or neutral rating, rather than a negative rating.

While proponents can assign their own ratings, the final ratings used for appraisal should be assigned by the government agency assessing the proposal. Agencies are in a better position to make subjective judgments as they are likely to have a better understanding of the government's objectives and are expected to act with impartiality. More importantly, they can look across a range of proposals to ensure the ratings are relative. Proponents can only compare the initiatives and options they submit.

The final decision should be to decide on the overall strategic merit of the initiative. This decision should be made subjectively by looking down the list of ratings in Column 5, keeping in mind the relative importance of each objective. Only the ratings in Column 5 should be considered. Impacts that do not promote, or detract from, strategic objectives are irrelevant for assessing strategic merit.

In Volume 2, Appendix C, the possibility of having multiple grades of pass for the SMT is raised. It is up to the agency to decide whether they prefer strategic merit to be recorded as a simple 'yes/no' or 'pass/fail', or to have a level of pass via a rating system.

1.3 Rapid appraisal

Rapid appraisal is a cost-effective way of gauging whether an initiative is likely to pass a detailed appraisal. The resources required for a detailed appraisal can then be expended only on initiatives that have a good chance of succeeding.

A rapid appraisal should be undertaken on selected options, quantifying as many benefits and costs as necessary to establish whether an initiative is worth developing further. Rapid appraisal assists with considering or rejecting options by assessing their net benefit, indicating their net economic worth.

A rapid BCA allows consideration of monetised benefits and costs. In a rapid appraisal, non-monetised benefits and costs also need to be explored at an indicative level. The AST can be used to summarise both monetised and non-monetised impacts.

The methodology used for rapid BCA is the same as for the detailed BCA outlined in Part 2 of this volume. However, the estimates for a rapid BCA are less precise and the benefits and costs that are small, or difficult to estimate, can be omitted altogether.

The majority of initiatives submitted for rapid appraisal are likely to be at an early stage of development, with limited planning and limited available data. An estimate of investment costs is essential. Based on the experience of Australian jurisdictions, the expected margin for error in rapid BCAs for investment costs is ±40 per cent.

Where any of the following benefits (or costs) amount to more than 10 per cent of total benefits (or costs), they should, if possible, be quantified:

- changes in infrastructure operating costs
- savings in transport user costs—vehicle operating costs
- savings in transport user costs—time for passengers and freight
- improvements in service quality to users (e.g. reliability)
- gains for generated traffic or traffic using a new service
- benefits or costs from route or mode diversion
- savings in crash costs, and
- externality impacts.

Information about how to estimate these monetised benefits or costs is provided in Part 2 of this volume. Where benefits or costs can be readily estimated using default parameter values (e.g. externalities), an estimate should be made, even if they amount to less than 10 per cent of the total benefits or costs. Where the estimation of a benefit or cost is impossible without using resources above a level appropriate for a rapid BCA, describe the impact qualitatively, with quantitative measures in physical units where possible.

Risks associated with the initiative should be discussed in qualitative terms. Particular attention should be given to risks that could lead to construction costs being substantially higher than estimated and risks that could lead to benefits being substantially less than estimated.

Part D of Appendix A provides a template for setting out the results of a rapid BCA.

Rapid appraisal outcomes

The decision outcomes from the rapid appraisal process include:

- the rapid appraisal has not been undertaken in a satisfactory manner and further work is required before the initiative can be reconsidered
- the initiative is rejected on the grounds that the AST indicates it is unlikely to produce net benefits under a detailed appraisal
- the initiative requires additional consideration of options before it proceeds to a detailed assessment, or
- the initiative appears to yield net benefits and, subject to passing the SMT, it should proceed to a detailed appraisal.

1.4 Appraisal Summary Table (AST)

In the UK, a New Approach To Appraisal (NATA) was adopted in the mid-1990s to improve the consistency and transparency of decisions on all transport initiatives (UK Department for Transport 1998). It does this by addressing the way information is used to inform the decision-making process. Appraisal information about an initiative is assembled in a one-page tabular summary, the AST. Figure 1.2 is an example of an AST. It shows the AST format used by the South Australian Department for Transport, Energy and Infrastructure (DTEI).

The AST summarises information on economic, environmental and social impacts of a transport option, showing both monetised impacts (from BCA) and non-monetised impacts. It allows the decision-maker to subjectively decide if the combined monetised and non-monetised impacts suggest the initiative produces a net benefit, i.e. an increase in net value.

The AST has a number of sections:

- The top few rows provide an opportunity to provide a description of the option being appraised, the problem it addresses, and whether other options have been considered.
- The first column on the left indicates high-level 'objective' categories.
- The second column lists 'impact types' (in the UK, Column 2 is called sub-objectives).
- The third column provides room for qualitative information about the initiative's impacts to be tabled.
- The fourth column allows quantitative information about the initiative's impacts to be documented.
- The fifth column allows an assessment of each impact type to be recorded as a combination of impacts expressed in monetised terms (where appropriate and feasible) and other impacts expressed in non-monetised terms.
- The South Australian adaptation of the AST has an additional column that allows the level of confidence associated with each assessment to be stated.
- The last line of the AST provides an opportunity for the usual summary BCA results to be stated.
- The AST should be supported by more details: footnotes, reports, etc., to provide sound underpinnings to the information in the table.

Figure 1.2: Appraisal Summary Table, South Australian format

NAME OF INITIATIVE	FUNDS $m:	07/08:	08/09:	09/10:	10/11:	TOTAL:
Problem						
Description						
Base Case						
Other options						
SA's Strategic Plan targets						

SA'S STRATEGIC PLAN OBJECTIVES	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE ASSESSMENT			CONFIDENCE
	Capital cost					
	Infra. maintenance cost					
	Infra. operating cost					
Economic:	Journey times					
› Growing prosperity	Vehicle operating cost					
› Fostering creativity	Reliability					
	Regeneration					
	etc.					
Social:	Crashes					
› Improving wellbeing	Public security					
› Building communities	Access to public transport					
	Severance					
› Expanding opportunities	Pedestrians & cyclists					
	etc.					
Environmental:	Greenhouse					
› Achieving sustainability	Noise					
	Local air quality					
	Landscape					
	Biodiversity					
	Heritage					
	Water					
BENEFIT–COST ANALYSIS RESULTS:		PVB=$XXXm; PVC=$YYYm; NPV=$ZZZm; NPV/K=A.A; BCR=B.B				

Notes:
1. 'Assessment' levels (non-monetised): Large –ve; Moderate –ve; Slight –ve; Neutral; Slight +ve; Moderate +ve; Large +ve
2. 'Confidence' levels: VL—very low; L—low; M—medium, H—high; VH—very high
3. PVB=present value benefit; PVC=present value cost; NPV=net present value; BCR=benefit–cost ratio; NPV/K=NPV per $ of capital cost

The objectives (Column 1) need to be structured to ensure a balanced and comprehensive coverage of all likely impact types (Column 2). In the UK, five objectives are used: environment, safety, economy, accessibility and integration across all transport initiatives. The South Australian approach uses the six objectives detailed in 'South Australia's Strategic Plan', grouped under the generic triple bottom line categories of economic, social and environmental.

Each impact type in Column 2 should appear only once in the table, even if it relates to more than one of the objectives in Column 1. It should be assigned to the objective in Column 1 that is a best fit for that impact.

The AST provides a summary of an initiative's relationship to government objectives and the initiative's monetised and non-monetised impacts to assist decision-making. The AST does not indicate the relative importance of the various objectives and associated impacts. The subjective aspect of decision-making is, therefore, left to the discretion of the decision-maker. As the UK Department for Transport (2006, 1.7.4) states:

> The AST does not automatically provide a mechanistic way of estimating value for money, but summarises the effects in each area so that decision-takers have a clearer and more transparent basis on which to make a judgement. The inclusion of any [impact type] in the AST, with the associated qualitative and quantitative analyses cannot be used to imply weightings between objectives in forming decisions.

For more information on the AST as used in the UK, see UK Department for Transport (2006).

Appendix B provides further details on using the AST, including:

- detailed instructions for designing and completing an AST
- a generic road transport example using the format of Figure 1.2, and
- a UK example.

The generic AST template can be downloaded from the ATC website at **http://www.atcouncil.gov.au/documents/NGTSM.aspx**.
The AST is an example of a triple bottom line presentation tool. A report by the South Australian Government on triple bottom line methodologies can be accessed at **http://www.environment.sa.gov.au/sustainability/pdfs/tbl_assessment.pdf**

1.5 Adjusted benefit–cost analysis

The Guidelines provide a new optional appraisal technique, adjusted BCA, for jurisdictions to use where they consider it appropriate.

BCA methodology aims to maximise the economic efficiency objective. It recognises a number of other objectives such as safety and environment, but only as far as they are consistent with economic efficiency. Equity is not taken into account at all. The adjusted BCA methodology is a formal way to re-weight or incorporate non-efficiency objectives.

Adjusted BCA is a hybrid of multi-criteria analysis and BCA, retaining the use of dollar values. Adjusted BCA is not an essential component of the methodology established by the Guidelines, but it is included as an option. The decision to use adjusted BCA should be made by the government agency responsible for developing the investment program, not by proponents of initiatives.

Both rapid and detailed BCAs can be converted into adjusted BCAs. Ways of adjusting BCAs are to:

- replace some market-based values with nominated values (e.g. a lower or zero value of time for non-work travel, higher unit costs for crashes)
- multiply some benefits and costs by weights (e.g. 2.0 for crash costs, 1.5 for cost savings for freight transport or environmental benefits and costs)
- insert subjectively determined monetary values for benefits and costs normally omitted because valuation is not possible (e.g. $1 million for aesthetic benefits), and
- apply a distributional multiplier to the benefits (see below for explanation).

All initiatives being compared must be subjected to the same adjustments. Therefore, it is the agency's responsibility to decide which adjustments should be made and to decide the weights. Any subjectively determined monetary values for impacts normally omitted from a BCA, because they cannot be valued in dollar terms, should be agreed between the government agency and a proponent, after gaining a good understanding of the impact through consultation and expert opinion.

The government agency may decide to make the adjusted BCA assessment purely an internal process. Alternatively, it could provide the weights to proponents of initiatives and let them undertake the task.

When considering equity implications, it can be difficult to estimate how the benefits and costs of initiatives are distributed. The Guidelines propose a simple and practical approach. A small number of groups of people within society should be identified and judgments made about the percentage of benefits that accrue to each group. Distribution of investment costs and infrastructure operating costs are ignored in this simple approach, because investment costs are paid for by governments and private investors and infrastructure operating costs are usually small in comparison to benefits.

The government should assign a weight to each identified group. The weight is multiplied by the proportion of benefits received and the results summed to arrive at a distributional multiplier. Total benefits from the initiative are multiplied by the distributional multiplier. The multiplier will be greater than one for initiatives with favourable distributional effects, and less than one for initiatives with unfavourable distributional effects. An example of this calculation is provided in Section 2.12.

Adjusted net present values (NPV) can be used to compare options. Adjusted BCRs can produce an alternative set of initiative rankings that could be useful in choosing between initiatives in order to develop a program (see Volume 2, Phase 6 for a discussion of program development).

A criticism of adjusted BCA is that it 'distorts' the results of BCAs in such a way that it can favour less economically efficient initiatives over more efficient initiatives. As a safeguard, the Guidelines recommend that adjusted BCA results are never reported separately from the results of the corresponding unadjusted BCA.

1.6 Business Case

The Business Case is the centrepiece for presenting information about a proposed initiative to the decision-maker. The aim is to facilitate a fully informed decision. The Business Case should:

- include all information needed to support the decision-maker and secure necessary approvals from the relevant government agency
- be a stand-alone document, with each initiative requiring a Business Case
- contain information that reflects the full range of impacts, addresses government objectives and priorities, and is appropriately rigorous
- be supported by detailed documents that address specific issues (e.g. Environmental Impact Statement, detailed BCA), and
- be well-presented and easily understood.

As shown in Figure 5.1 in Volume 2, the Business Case for a proposed initiative builds and grows in detail as the appraisal process proceeds.

The Business Case will contain the results of the SMT (including the OIT), BCA, AST and other analyses discussed earlier.

The coverage and level of detail in the Business Case will vary between proposals according to their complexity and approval requirements. For smaller initiatives, only the SMT and rapid appraisal are necessary (see Section 1.7). For larger, more complex initiatives, the final Business Case should report the results of detailed appraisal.

The Business Case will expand and become more detailed as the initiative moves through the appraisal process. The SMT and rapid BCA template in Appendix A should form the first draft of the Business Case. The Business Case should then be subsequently revised and expanded as more detailed and wide-ranging analyses are completed. Figure 5.1 in Volume 2 calls the Business Cases at each of the three levels of appraisal the 'strategic' Business Case, the 'outline' Business Case and, finally, the 'full' Business Case.

Using the template in Appendix A as a guide, a Business Case should include:

- description of the challenge to be addressed
- objectives
- scope and readiness
- description of the initiative
- timing, costs, staging
- an OIT followed by conclusions about the strategic merit of the initiative
- options that were considered and rejected
- relationship with other initiatives
- BCA (detailed, or rapid if detailed appraisal has not yet commenced), including separation of benefits and costs
- adjusted BCA results if the analysis was undertaken by the proponent
- an AST summarising monetised and non-monetised impacts side-by-side
- social impacts, gainers and losers
- stakeholder views, and
- risk assessment.

Additional items that should be included in a full Business Case, but not in the earlier draft Business Cases, include:

- a financial analysis (clearly distinguishing it from the BCA)
- a review of financing options, e.g. public private partnerships
- an Environmental Impact Statement
- a distributional and equity analysis
- budgetary impacts, e.g. the cost of the initiative as reflected in the budget of the relevant government agency
- land use planning implications
- legal issues, and
- an initiative implementation plan, e.g. contracting arrangements and risk management.

Private sector participation introduces additional issues into the Business Case such as:

- public sector comparator (see Section 2.19)
- long-term budgetary impacts when private sector participation creates recurrent spending obligations
- examination of risks accepted by the government, including contingent liabilities, and
- effects of leveraging on BCR (see Section 2.18).

The format of the Business Case will differ between jurisdictions, so no attempt has been made in the Guidelines to develop a detailed template.

Although SMTs and rapid BCAs could be undertaken for a number of options, and detailed BCAs for a smaller number of options, decisions about the best option are often made by the time the Business Case is completed. However, if a final choice is made at ministerial level, the options should all be presented in a single Business Case, with issues and results of analyses for the different options presented side-by-side for comparison.

Developing the Business Case should be an iterative process where the government agency and the proponent work together to reach a mutually agreed outcome. During the process, the proposal may be revised many times to explore and modify options and to ensure that the necessary information is provided and necessary analyses undertaken.

Although the proponent of the initiative prepares the Business Case, the final document should be agreed between the proponent and the responsible agency. Some of the assessments in the Business Case, such as the public sector comparator, are undertaken by the government agency.

1.7 Small-scale initiatives

To use resources available for appraisal in a cost-effective manner, the appraisal effort must be proportionate to the size of the initiative. The Guidelines propose a simple distinction between large and small initiatives.

Defining small-scale initiatives

Jurisdictions will have their own views about what constitutes a small-scale initiative. The Guidelines suggest an upper limit of investment costs of, say, $10 million for small-scale initiatives. This figure may need to be adjusted over time.

Most small-scale proposals will probably be for road initiatives, but small proposals involving rail initiatives or technology solutions should be treated the same way. Intelligent transport systems initiatives will often fall into the small-scale initiative category.

Assessment methodology

For small-scale initiatives, the SMT and rapid BCA elements of the appraisal methodology should be undertaken, but a detailed BCA is not necessary.

1.8 Equity considerations

Initiatives in less densely populated areas tend to achieve lower usage rates. BCRs are therefore generally lower, making it more difficult for initiatives to pass the economic efficiency test of BCA. In these cases, government policy may require greater weight to be given to social, access or equity objectives, relative to economic efficiency (i.e. BCA results).

The Guidelines cater for this through the SMT, the AST and adjusted BCA. Business cases usually also contain explicit reporting of distributional, equity and social impact assessments. The SMT results can be reported at multiple levels (e.g. high pass, low pass, fail) to highlight initiatives that score particularly well on achieving government objectives (see Volume 2, Appendix C). Adjusted BCAs can include a distributional multiplier to tilt the assessment process in favour of initiatives that benefit certain communities (e.g. regional areas). It is still important to undertake a BCA so that initiatives with negative net benefits (net present value < 0) will only be approved where the initiative is considered highly desirable for other reasons.

APPENDIX A

Strategic Merit Test and rapid BCA template

Steps

- Provide details on the title of the initiative and the proponent.
- Describe the challenge that the initiative addresses.
- Describe the initiative.
- Describe the Base Case.
- Estimate the proposed timing and resource requirements of the initiative.
- Assess the strategic fit of the initiative.
- Undertake an options analysis.
- Undertake a BCA, estimate Base Case costs, and provide BCA results.
- Describe the non-monetised impacts of the initiative.
- Identify the gainers and the losers.
- Describe the stakeholder consultation process.
- Identify the major risks.
- Complete the AST.
- Include additional comments and attachments.

Strategic Merit Test and rapid BCA template

TITLE OF INITIATIVE:
Example types › new capital investment (e.g. train line extension, road, inter-modal terminal, etc.) › routine maintenance › periodic maintenance › asset renewal › combination capital and maintenance › major change to operations or services › regulatory change › demand management measure › government initiative or strategy › other (describe)

PROPONENT (CONTACT NAME AND ORGANISATION):

Part A—description of initiative

1. DESCRIBE THE CHALLENGE THE INITIATIVE ADDRESSES
Problems, issues or needs
1.
2.

GOVERNMENT COMMITMENT
Is the government bound to invest in this initiative by legislation, standards or under an existing commitment or agreement? Describe.
If yes, has the government established a time for starting and completing the investment? Provide details.

2. DESCRIBE THE INITIATIVE

At what stage of development is the initiative? What key issues are outstanding?

Describe the initiative in terms of:

- location
- the nature of the initiative, including the estimated cost
- consequential works, and
- the main benefits and costs of the initiative.

Is this the first time the initiative has been proposed? If not, provide details.

Does the initiative fall into the 'small-scale initiatives' category (i.e. investment cost of $10 million or less)? (See section 1.7)

Does the initiative involve revenue collection? If so, what is the pricing policy?

e.g. profit maximisation, revenue target, cost recovery, price set by government

3. DESCRIBE THE BASE CASE

What major capital and maintenance works will be needed in the future if the initiative does not proceed?

Are there other consequences from not implementing the initiative?

What assumptions are made about future developments that will affect the success of the initiative?

e.g. other initiatives being implemented, development of new industries or conurbations

4. ESTIMATE THE PROPOSED TIMING AND RESOURCE REQUIREMENTS

Item no. or stage	Description	Preferred timing	Cost
1.			
2.			
3.			

Part B—assessment of strategic fit

1. HOW DOES THE INITIATIVE IMPROVE TRANSPORT WITHIN THE JURISDICTION?

2. WHAT IS THE OVERARCHING GOAL OF THE INITIATIVE AND WHAT OTHER OBJECTIVES WILL IT PROMOTE?

The answer to this question should be consistent with the description of the challenges addressed in Part A and with the percentage breakdown of the benefits and costs shown in Part C.

3. ARE THE OBJECTIVES OF THE INITIATIVE IN LINE WITH RELEVANT GOVERNMENT OBJECTIVES?

A proposal should show that the initiative contributes to achieving government objectives, using as much detail about the objectives as is available. The Objective Impact Table (OIT) in Part G provides a formal means to address this question.

4. ARE THERE ANY MAJOR RISKS OR CONSTRAINTS ON THE INITIATIVE?

For example, are there potential technical problems with construction and operation, could the initiative cause serious damage to an environmentally sensitive area or are there potential negative social impacts?

5. WHAT OTHER FORMAL PLANNING OR REVIEW PROCESSES ARE REQUIRED?

For example, Environmental Impact Statement, social impact study, land use study.

6. DOES THE SUCCESS OF THE INITIATIVE DEPEND ON OTHER INITIATIVES BEING UNDERTAKEN?

It is possible that the benefits of an initiative may not be realised without other initiatives being undertaken. In this situation, initiatives may be bundled together to assess as a single initiative. Where the related initiative is not dependent on the appraisal process, the Base Case should include an assumption about whether or not a related initiative proceeds and the issue should be fully addressed in the risk assessment.

7. HAS THERE BEEN ADEQUATE CONSIDERATION OF ALTERNATE SOLUTIONS?

Other modes and non-infrastructure solutions may need to be considered. A proposal should show that alternative solutions and options were considered (see Part C). The grounds for rejecting particular solutions and options are reviewed as part of the SMT.

Part C—options analysis

1. UNDERTAKE AN OPTIONS ANALYSIS

What options were considered and what would they achieve? What options were rejected and why?

Include consideration of non-infrastructure options such as regulatory change, provision of improved information, changes to land use planning, pricing measures, operational or managerial changes, *including using new technologies or travel demand management measures. Also consider differences in the size or standard of infrastructure, different routes for new roads or railway lines.*

Is this a single initiative or one of a series of options? If one of a series, list the alternative options to be appraised. (Note: A separate template must be completed for each option. The Base Cases should be identical for all options.)

Can the initiative be divided into stages? If so, list the stages and describe the advantages and disadvantages of each stage.

Can the initiative be divided into smaller initiatives? If so, list the smaller initiatives and explain the reasons for treating them as a single initiative

Part D—rapid benefit–cost analysis

1. LIST THE BENEFITS AND COSTS OF THE INITIATIVE IN THE TABLE BELOW		
Identify the present value, in dollar terms, and the percentages of total benefits and costs, as estimated from the BCA. If no BCA has been undertaken as yet, provide rough estimates of the percentage of total benefits and costs, e.g. 40 per cent savings in road-user costs. See Table 2.1 in Volume 3 of the Guidelines.		
BENEFITS	VALUE ($)	PERCENTAGE (%)
Benefits for existing users (savings in social generalised costs)		
Benefits for diverted and generated traffic (willingness-to-pay minus social generalised costs)		
Benefits (disbenefits) on related infrastructure associated with diverted and generated traffic		
Savings in (additional) infrastructure operating costs including maintenance		
Benefits (disbenefits) derived from positive (negative) externalities		
Safety benefits (disbenefits)		
Other benefits (disbenefits)		
Total benefits		100
	Note: Impacts that are benefits should be positive. Impacts that are disbenefits should be negative.	*Note: Impact percentage figures for disbenefits should be negative.*
Investment costs		NA
Are the values in this table first estimates or expected values derived via a risk analysis? (See Volume 3 and Volume 5, Section 2.11 for explanation.)		

2. CHECK THAT BASE CASE COSTS ARE PROPERLY ADDRESSED	
Have infrastructure costs (including asset renewal costs) in the Base Case been estimated?	Yes ☐ No ☐ NA ☐
Provide the amount as a present value $.	

3. PROVIDE BCA RESULTS *(include BCA spreadsheet)*					
Year discounted to:					
Net present value ($)		Benefit–cost ratio		First-year rate of return (%)	
Internal rate of return (%)		Discount rate used (%)		Initiative life used (years)	

4. DESCRIBE THE NON-MONETISED IMPACTS OF THE INITIATIVE

Describe other benefits and costs that have not been quantified in the BCA?
See Table 2.1 in Volume 3 of the Guidelines, for examples of non-monetised impacts.

5. IDENTIFY THE GAINERS AND LOSERS

Discuss how the benefits and costs of the initiative are distributed throughout society, taking account of secondary impacts. Who are the gainers and losers from the initiative?
See Table 2.1 in Volume 3 for examples of secondary impacts.

Part E—stakeholder consultation

1. DESCRIBE STAKEHOLDER CONSULTATION PROCESS

List the key stakeholders and indicate the degree of consultation that has taken place to date and the level of support received.

What stakeholder sign-offs are required?

What potential exists for part, or full, private sector funding of the initiative?

How was the potential for part, or full, private sector funding assessed?

Is there an intention to seek co-funding from beneficiaries (e.g. other agencies or the private sector)? If not, why? If yes, what is the status of negotiations or commitments to date?

Part F—risk assessment

1. IDENTIFY THE MAJOR RISKS
Identify major risks prior to commencing construction, e.g. approvals not granted, legal challenges, technical problems.
What are the indicative timelines for the resolution of key issues likely to arise prior to commencement of construction?
Describe the major risks to delivery and ongoing success of the initiative. e.g. Does the initiative rely on new or untested technology? Is the timing or are the benefits dependent on the actions of other parties or government actions? Are there external factors beyond government control that could inhibit the achievement of the initiative's objectives?
Describe the major risks on the cost side (e.g. excess costs) and benefit side (e.g. where benefits are not realised).
Can these risks be mitigated? If so, describe proposed risk mitigation measures.
If a risk assessment has already been undertaken, provide the indicative impacts on costs, benefits and initiative timing.

Part G—Objective Impact Table

Project name:

GOVERNMENT OBJECTIVE	IMPACT TYPE	QUALITATIVE DESCRIPTION	QUANTITATIVE DESCRIPTION*	RATING**
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

* Specify units—PVB$ or PVC$ or physical quantity

** See Table A.1 for rating

SOURCE DOCUMENTS FOR STRATEGIC OBJECTIVES.	
('not applicable' may be inserted for non-strategic objectives)	
1	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	

INCLUDE ADDITIONAL COMMENTS

SIGNATURE (OF SECRETARY OF GOVERNMENT DEPARTMENT, AGENCY OR PRIVATE ORGANISATION)
Secretary's signature
Government department, agency, or private organisation

INCLUDE ATTACHMENTS (NUMBERED)

Note: Include electronic copies of spreadsheets containing all economic and financial calculations. Where parameters that differ from those provided in the Guidelines are used, ensure that a justification is provided and that a separate spreadsheet is provided using alternative values.

Table A.1: Assessment rating levels

RATING LEVEL	DESCRIPTION
Large –ve	Major negative impacts with serious, long-term and possibly irreversible effects leading to serious damage, degradation or deterioration of the physical, economic or social environment. Requires a major re-scope of concept, design, location, justification, or requires major commitment to extensive management strategies to mitigate the effect.
Moderate –ve	Moderate negative impact. Impacts may be short-, medium- or long-term and impacts will most likely respond to management actions.
Slight –ve	Minimal negative impact, probably short-term, able to be managed or mitigated, and will not cause substantial detrimental effects. May be confined to a small area.
Neutral	Neutral—no discernible or predicted positive or negative impact.
Slight +ve	Minimal positive impact, possibly only lasting over the short-term. May be confined to a limited area.
Moderate +ve	Moderate positive impact, possibly of short-, medium- or long-term duration. Positive outcome may be in terms of new opportunities and outcomes of enhancement or improvement.
Large +ve	Major positive impacts resulting in substantial and long-term improvements or enhancements of the existing environment.

Source: Derived from *Project appraisal tool for land use—transport projects* (Sinclair Knight Merz 2003, for Planning SA).

APPENDIX

B

Appraisal Summary Table (AST) instructions

B.1 Instructions for designing an AST

Figure 1.2 provides the AST format used by the South Australian Department for Transport, Energy and Infrastructure (DTEI). This Appendix provides a generic version of DTEI's AST template (Table B.1) and instructions for its use. The instructions are based on South Australia's experience and their interpretation of the UK AST model. The instructions provide a guide for other jurisdictions interested in using the AST.

1 Commence with the generic template in Table B.1.

2 Consistent use of the same template across initiatives will allow consistency in appraisal across a jurisdiction. There may, however, in some situations, be a need to vary the AST template between proposals.

3 Column 1 should list the strategic objectives for the jurisdiction or transport system, grouped under the three triple bottom line (TBL) categories (economic, social and environmental). In Figure 1.2, the six objectives of South Australia's Strategic Plan (SASP) are listed.

4 In Column 2, list the *impact types* relevant to the initiative. Each impact type should be listed only once, under the most relevant associated TBL category (economic, social or environmental) in Column 1.

5 Develop (as an attachment to the AST) a description of the meaning of each impact type. Example descriptions of impact types relevant for transport proposals are presented in Table B.2 (see also Table 2.1 in Part 2). These are moulded from the UK model and Australian experience.

6 In compiling Column 2, it is important to avoid double-counting. This is done by checking that when a new impact type is added it does not just represent another impact type that is already listed. This will be greatly assisted by defining each impact type (see Point 5).

For example, assume 'journey time' is listed as an impact type in Table B.2. Any increases in land values resulting from reduced journey time should not be listed as an impact elsewhere in the AST. The former is a capitalisation of the latter.

7 In the AST, the list of economic impact types should generally be limited to the *direct* or *primary* economic impacts of proposals. *Secondary* economic impacts, e.g. economic activity flow-on expenditure effects in the rest of the economy, are generally excluded from the AST (although they may be reported separately in distributional, equity and specific sector impact assessments). There are two reasons for this:

(a) Counting flow-on effects is often double-counting the same benefit passed on to other economic agents.

(b) The Base Case consists of spending the funds in an alternative manner (either within the same sector or within another sector) that will also generate flow-on effects. The relevant measure in the AST is the *net* effect, i.e. Project Case minus Base Case. While detailed analysis can be undertaken of the *net* effect, the rule of thumb is usually to assume the two sets of effects cancel each other out. Detailed analysis to test this is usually only undertaken as an exception, for very large initiatives, or where there are expectations that the *net* effect will be significant.

Section 2.2.1 in Volume 5 provides further discussion of secondary economic impacts.

B.2 Instructions for completing an AST

1 Row 1: Insert the name of the proposal.

2 Row 2: Clearly describe the challenge being addressed.

3 Identify the range of options that can be pursued to address the challenge. Ideally, an AST should be completed for each alternative option, with the set of ASTs presented to the decision-maker. The AST template presented here is for the preferred Project Case option, with a row to list other options considered.

4 Row 3: Provide a brief 'description' of the best option, denoted here as the 'Project Case' or the 'with project' case.

5 Row 4: Clearly specify the Base Case against which the proposal is being compared. The Base Case is also referred to as the 'without project' case. This rarely consists of doing nothing. It usually consists of business as usual, i.e. sufficient expenditure to ensure a continuation of the existing, or minimum, level of service.

6 Row 5: Briefly describe the 'other options' for addressing the challenge, and why they are inferior to the preferred Project Case.

7 Row 6: This row contains a number of blank boxes. List any key jurisdictional targets to which this initiative makes a significant contribution. List only the most relevant and significant targets.

8 For each impact type (Column 2), briefly express in Column 3 the impact of the proposal in qualitative terms. Attach to the AST a page of referenced footnotes as required (as illustrated in Tables B.5 and B.6).

9 For each impact type, where possible, briefly express in Column 4 the impact in quantitative terms in natural units. For example:

- for greenhouse gas emissions, natural units are tonnes of CO2, and
- for safety, natural units are reduction in accidents, lives saved, injuries avoided, etc.

10 Decide which impacts can be monetised and those that can only be expressed in non-monetised terms.

11 For each impact type, make an assessment in Column 5 of the size or scale of the impact using the following approaches:

11.1 *Monetised impacts*: Determine the present value (PV) of each impact over the appraisal period. The PV of impacts that are benefits should be denoted by PVB $x million, i.e. present value benefits. The PV of impacts that are costs should be denoted by PVC $y million, i.e. present value costs.

The sum of all PVBs, and the sum of all PVCs, should then be recorded in the bottom row of the AST, along with standard benefit–cost analysis results (e.g. NPV, BCR, etc).

Where a specific computer model has been used to determine monetised discounted results for benefits and costs, the name of the model should be stated, and details of the model made available.

11.2 *Non-monetised impacts:* Each non-monetised impact should be assigned a 'rating' level between Large –ve to Large +ve from the scale detailed in Table B.3. The UK Department for Transport (2006, Unit 1.1) provides detailed guidance for selecting a rating for a large number of impact types. Detailed guidance does not yet exist in Australian jurisdictions. If the UK reference is used, relevance to Australian conditions should be carefully assessed.

12 For each assessment rating in Column 5, assign a 'confidence' level rating from Table B.4 in Column 6.

B.3 AST examples

Table B.5 provides a completed AST for a generic road transport example and Table B.6 provides accompanying footnotes.

Table B.7 provides a UK example of a completed AST.

Table B.1: SA's Generic AST Template

NAME OF INITIATIVE	FUNDS $m: 07/08:		08/09:		09/10:		10/11:		TOTAL:	
Problem										
Description										
Base Case										
Other options										
SA's Strategic Plan targets										

SA'S STRATEGIC PLAN OBJECTIVES	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE
	Capital cost				
	Infra. maintenance cost				
	Infra. operating cost				
Economic:					
› Growing prosperity					
› Fostering creativity					
Social:					
› Improving wellbeing					
› Building communities					
› Expanding opportunities					
Environmental:					
› Achieving sustainability					
BENEFIT–COST ANALYSIS RESULTS:		PVB=$XXXm; PVC=$YYYm; NPV=$ZZZm; NPV/K=A.A; BCR=B.B			

Notes:
1. 'Assessment' levels (non-monetised): Large –ve; Moderate –ve; Slight –ve; Neutral; Slight +ve; Moderate +ve; Large +ve
2. 'Confidence' levels: VL—very low; L—low; M—medium, H—high; VH—very high
3. PVB=present value benefit; PVC=present value cost; NPV=net present value; BCR=benefit–cost ratio; NPV/K=NPV per $ of capital cost

Table B.2: Description of impact types

IMPACT TYPE	DESCRIPTION
Capital cost	Up-front investment, plus any non-recurrent expenditure elsewhere in the evaluation period.
Infrastructure maintenance costs	Effect on infrastructure maintenance costs.
Infrastructure operating costs	Effect on infrastructure operating costs.
Journey time	Effect on time involved in transport: walk (access) time, wait time at public transport stops, in-vehicle time.
Reliability/quality	Effect on service reliability, journey time variability and journey quality (e.g. comfort).
Vehicle/bus/train/etc. operating costs	Effect on vehicle/bus/train/etc. operating costs: fuel, tyre wear, lubricants, repairs and maintenance, etc.
Regeneration	Extent to which the initiative assists regeneration of areas the government has designated for regeneration.
Crashes/accidents	Effect on the number and severity of crashes/accidents and the impact on people, including deaths, serious injuries, minor injuries, property damage.
Public security	Effect on the level of security and safety people experience in public places.
Access to public transport	The extent the initiative increases the number of people or locations that fall within minimum standards for access to public transport, e.g. within 500 metres of a public transport stop. Any improvements in journey quality should be captured under the reliability/quality impact category above.
Severance	The degree to which infrastructure and transport services act as a physical barrier to non-users of these facilities to access people and services elsewhere in the community.
Mobility impaired	Extent to which access to public transport is improved for people who are mobility impaired.
Pedestrians and cyclists	Extent to which the initiative impacts on pedestrians and cyclists.
Greenhouse	Effect on greenhouse gas emissions and the impact on society.
Noise	Effect on noise and the impact on the community.
Local air quality	Effect of various emissions on local air quality.
Biodiversity	Effect on biodiversity.
Heritage	Effect on local heritage—buildings and other items with heritage value.
Water	Effect on level of water pollution and the impacts.

Table B.3: Non-monetised assessment rating levels

RATING LEVEL	DESCRIPTION
Large –ve	Major negative impacts with serious, long-term and possibly irreversible effects leading to serious damage, degradation or deterioration of the physical, economic or social environment. Requires a major re-scope of concept, design, location, justification, or requires major commitment to extensive management strategies to mitigate the effect.
Moderate –ve	Moderate negative impact. Impacts may be short-, medium- or long-term and impacts will most likely respond to management actions.
Slight –ve	Minimal negative impact, probably short-term, able to be managed or mitigated, and will not cause substantial detrimental effects. May be confined to a small area.
Neutral	Neutral—no discernible or predicted positive or negative impact.
Slight +ve	Minimal positive impact, possibly only lasting over the short-term. May be confined to a limited area.
Moderate +ve	Moderate positive impact, possibly of short-, medium- or longer-term duration. Positive outcome may be in terms of new opportunities and outcomes of enhancement or improvement.
Large +ve	Major positive impacts resulting in substantial and long-term improvements or enhancements of the existing environment.

Derived from *Project appraisal tool for land use—transport projects* (Sinclair Knight Merz 2003, for Planning SA).

Note: The rating names and descriptions in this table are the same as in Table A.1.

Table B.4: Assessment confidence levels

CONFIDENCE LEVEL	DESCRIPTION
Very Low (VL)	Best guess of professional assessing outside area of expertise, gut feel, no relevant studies or data. Not suitable basis for 'rating' greater than 'slight +ve' or less than 'slight –ve'.
Low (L)	Professional judgment within area of expertise. However, no relevant studies or data available. Not suitable for score greater than 'slight +ve' or less than 'slight –ve'.
Medium (M)	Some background information, but either dated, lacking appropriate detail or lacking accuracy to form the basis for a firm assessment. Not suitable for a score greater than 'moderate +ve' or less than 'moderate –ve'.
High (H)	Substantial information, perhaps patchy in parts (date, accuracy, detail) but sufficient to provide an accurate assessment with a fair degree of confidence.
Very High (VH)	Recent, relevant and accurate studies with appropriate detail and analysis to form a rigorous and defensible basis for the assessment. Assessment has a very high degree of confidence.

Derived from *Project appraisal tool for land use—transport projects* (Sinclair Knight Merz 2003, for Planning SA).

Table B.5: AST—Generic road transport example

NAME OF INITIATIVE	BYPASS OF OUTER EASTERN REGION OF METROPOLIS	FUNDS $m: 07/08:	08/09:	09/10:	10/11:	TOTAL:
Problem	Increased congestion and delays on the Eastern Arterial Road into Metropolis. Affects its suitability as a declared National Highway, with significant impact on freight transport movements of exports to the Port of Metropolis.					
Description	Involves the construction of a new high speed, high standard, and controlled access road to bypass the Eastern Region and draw traffic off the Eastern Arterial. The new bypass would become the National Highway and the Eastern Arterial would revert to a state arterial road.					
Base Case	Traffic coordination to maximise capacity on the Eastern Arterial, at grade flaring of intersections where cost is low, banning certain movements on the Eastern Arterial and certain types of traffic.					
Other options	Three other options were assessed: (a) upgrading the Eastern Arterial to a high standard road, with road widening and grade separation of major intersections (b) the introduction of a toll on the Eastern Arterial to limit traffic growth (c) upgrading services in the parallel rail corridor. Each of these options were considered inferior to the bypass option (1).					
Metropolis State's Strategic Plan targets						

STRATEGIC PLAN OBJECTIVES	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE
	Capital cost			PVC $252m	H
	Infra. maintenance cost	New asset provided, hence increased maintenance cost (2)		PVC $10m	H
	Infra. operating cost	Mainly lighting costs		Slight –ve	H
Economic:	Journey times	Substantial travel time savings	10 minute saving	PVB $423m	H
	Vehicle operating cost	Greater travel distance		PVB -$15m	H
	Journey quality, reliability	Smoother flow, fewer stops, reduced driver frustration (3)	Bypasses 24 sets of traffic lights	Large +ve	H
	Regeneration	Some induced demand in local rural area (4)		Mod –ve	M
Social:	Crashes	Reduced crash outcome overall (5)		PVB $45m	H
	Public security	Little change from base case (6)		Neutral	H
	Access to public transport	Principal bus corridor remains Eastern Arterial, little change (7)		Slight +ve	L
	Severance	Moderate on new road (8)		Mod –ve	M
	Pedestrians & cyclists	Generally longer length of travel for pedestrians to cross (9)		Slight – ve	M
Environmental:	Greenhouse	Increased efficiency on Eastern Arterial, offset by extra traffic generation (10)		Mod –ve	L
	Noise	Lower on Eastern Arterial, higher on new route (11)		Slight –ve	M
	Local air quality	(12)		Mod +ve	M
	Landscape	Impacts on existing landscape offset by project landscaping (13)		Slight +ve	M
	Biodiversity	New road will be used to maximise +ve's, but some loss likely (14)		Slight +ve	M
	Heritage	Some impact on aboriginal heritage, minimal other heritage impact (15)		Slight –ve	L
	Water	Stormwater retention basins required (16)		Slight +ve	M
BENEFIT–COST ANALYSIS RESULTS:		PVB=$453m; PVC=$262m; NPV=$191m; NPV/K=0.8; BCR=1.8			

Notes:

1. 'Assessment' levels (non-monetised): Large –ve; Moderate –ve; Slight –ve; Neutral; Slight +ve; Moderate +ve; Large +ve
2. 'Confidence' levels: VL—very low; L—low; M—medium, H—high; VH—very high
3. PVB=present value benefit; PVC=present value cost; NPV=net present value; BCR=benefit–cost ratio; NPV/K=NPV per $ of capital cost
4. See Table B.6 for notes/assumptions.

Table B.6: AST—Generic road transport example—Footnotes

REFERENCE	NOTES/ASSUMPTIONS
(1)	See Attachment X for a report comparing the 4 options.
(2)	Additional maintenance will result from the expanded infrastructure, with the project resulting in an additional 18km of new expressway standard facility.
(3)	The bypass will be more reliable, with no signalised intersections, and higher speed of travel.
(4)	The new expressway bypass could lead to induced demand for residential and commercial development both along the route and in small townships in the peri-urban areas to the north east of the Eastern Region. This will put pressures on the important existing agricultural and mining industries in those areas. Unless government land use policy can prevent such development, there could be significant cost in terms of lost economic output.
(5)	The bypass will significantly reduce longer distance traffic along the Eastern Arterial. Reduced congestion on the Eastern Arterial should lead to reduced crashes on that road. The expressway standard of the new bypass will ensure a relatively low crash frequency on that road.
(6)	The situation along the Eastern Arterial is not expected to change significantly, and there will be limited pedestrian activity along and adjacent to the new bypass.
(7)	As congestion on the Eastern Arterial decreases, public transport travel times and reliability should improve. On the other hand, lower congestion will also make car travel more attractive. The net impact on public transport patronage is uncertain.
8)	Land use on new bypass consists of multiple and single owner allotments, and a nearby small township. Opportunities for pedestrians, cyclists and vehicle movements across the bypass route will exist at a few specific locations only, and be designed for minimal severence. Some inconvenience due to indirectness of accessibility. Little change on Eastern Arterial.
(9)	Along the new bypass, pedestrian movements and stopping buses will not be allowed. No significant change on the Eastern Arterial.
(10)	Greenhouse impacts are complex and difficult to assess. Further research required in this area. However the following overview is considered a subjective assessment of the outcome. Reduced traffic on the Eastern Arterial (compared to base case), implies improved operational efficiencies and decreased delays, with consequent decrease in greenhouse gases. However, this may be a short term result, with the potential of lower congestion resulting in induced/latent car demand. On the new bypass, the traffic that transferred from the Eastern Arterial will experience smoother flow, but have to travel a longer distance. There will also be an increase in traffic volumes over time. Any induced demand from accelerated urban development outside the designated urban area (e.g. in rural townships) will add to this -ve impact.
(11)	Expect lower noise levels on the Eastern Arterial once the new bypass is built. On new bypass, the expected high volumes will result in noise levels much higher than existing levels. Given the rural type environment, and the relatively lower background noise count, and conditions that will not restrict noise travel, the impact could be expected to be greater, even if noise suppressing features are engineered into the design.
(12)	Similar comments to (10). The difference is that the Eastern Arterial has residential land use adjacent to the road, and hence a high exposure. The improvement above the base case could be interpreted as a greater +ve impact. On the new bypass, where residential land use is sparser, there will be less exposure (or diffused exposure due to separation distance from the highway) to the -ve impacts of air quality from increased traffic.

REFERENCE	NOTES/ASSUMPTIONS
(13)	The new bypass will cross a number of rural land-uses and will have a significant visual impact on the broader landscape. The bypass corridor will have a landscape design developed and implemented to minimise the impact on amenity of the corridor. This will be centred on the use of locally indigenous species, potentially significantly increasing the amount of indigenous vegetation in the region. Some opportunity to upgrade landscaping on sections of the Eastern Arterial.
(14)	A small amount of remnant native vegetation may be removed on the new bypass route at a couple of locations. This may also result in some habitat loss for fauna species. Any vegetation removed will be replaced at an appropriate replacement rate as part of the landscape design (as outlined above). Opportunities exist to use the new bypass route to provide an improved length of corridor to support fauna and flora habitat. No biodiversity impact expected along the Eastern Arterial.
(15)	There are various Non-Aboriginal heritage sites along the new bypass route. Aboriginal heritage is an issue. There are a number of Aboriginal skeletal remains along the bypass route. An Aboriginal Heritage Survey will be undertaken in consultation with the local Aboriginal Community. There is a risk that Aboriginal Heritage sites may be encountered along the alignment. There are no known sites along the likely alignment options at this stage. No European or Aboriginal heritage issues are anticipated along the Eastern Arterial.
(16)	There will be a significant increase in the amount of stormwater coming off the new bypass. This will require the installation of stormwater detention devices, with a potential for aquifer recharge. The high speed nature of route will reduce the pollution per vehicle km. On the Eastern Arterial, the improved traffic conditions should provide improved (less volume) run off.

Table B.7: Appraisal Summary Table, UK example

Version of 24 July 1998

A23 COULSDON (GOL)		1996 SCHEME—1.7KM D2 BYPASS	COST £39.9m	
Problems		High flows (31,000 vpd) on A23 through Coulsdon town centre cause delays, diversion onto local roads, high accident rates and disruption of bus and coach movements. Associated pollution in the town centre.		
Other options		Traffic management was considered in very early assessments. Transport 2000 suggested a smaller scale scheme at the Public Inquiry. Option of single carriageway has been considered, but would offer little cost saving		
CRITERIA	SUB-CRITERIA	QUALITATIVE IMPACTS	QUANTITATIVE MEASURE	ASSESSMENT
Environmental impact	Noise	Benefits from removal of traffic from Coulsdon town centre.	No. properties experiencing (w/s): › Increase in noise 48 › Decrease in noise 179	net 131 properties win with scheme
CO_2 Tonnes added 0–2000	Local air quality	Air quality improves as traffic removed from Coulsdon town centre.	No. properties experiencing: › improved air quality 129 › worse air quality 3	-130PM_{10} -772 NO_2
	Landscape	Line of route is in urban setting and closely parallels the existing railway line.	–	Neutral
	Biodiversity	Adversely affects important chalk grassland habitat forming part of site of local conservation importance.	–	Moderate -ve
	Heritage	Slight impact on one listed building and archaeological area of potential, but mitigation agreed.	–	Neutral
	Water	There are particular concerns with this scheme regarding the impact of contaminated land on the underlying aquifer, which is used for public water supply. Further investigations will be required to determine whether or not an acceptable solution can be identified.	–	Large -ve
Safety	–	Accident rates in Coulsdon town centre are currently above national average.	Accidents 760 Deaths 8 Serious 184 Slight 590	PVB £8.1m 36% of PVC
Economy	Journey times & VOCs	Town centre flows fall to 20% of pre-opening levels, but total traffic (on both old/new routes) would increase by over 20%.	peak N/A inter-peak N/A	PVB £154m 690% of PVC
	Cost	–	–	PVC £22.4m
	Reliability	Currently highly congested and forecast to get worse.	Route stress Before: 130% — After: 48%	Moderate Mod rel. to PVC
	Regeneration		Serves regeneration priority area?	No
Accessibility	Public transport	Increased reliability of public transport journey times in Coulsdon town centre.	–	Moderate +ve
	Severance	Over 7 000 people experience substantial relief from community severance.	–	Large +ve
	Pedestrians and others	Facilities for pedestrians would be improved in town centre.	–	Large +ve
Integration		Croydon UDP[b] supports use of strategic network by longer distance traffic and improving conditions for cyclists and pedestrians.	–	+ve
COBA[a]			PVB £160m PVC £22 NPV £140m BCR 7.2	

Source: UK Department for Transport (1998), Chapter 12, http://www.webtag.org.uk/archive/nata/understanding/12.htm#tables

a. Cost Benefit Analysis. Method/software for calculating transport economic efficiency figures

b. Unitary Development Plan

2 Analytical techniques

Volume 2 of the Guidelines presents a three-stage appraisal process in which BCA plays a key role. Volume 3 of the Guidelines explains the appraisal process in detail, including a full discussion of BCA. Volume 4, Part 1 complements and extends Volume 3 in the application of BCA to urban public transport.

The BCA approach and terminology varies to some extent between Volumes 3 and 4; although, most importantly, the final results should be identical if correctly implemented. The differences are a result of the history of development of appraisal methodologies for urban and non-urban transport initiatives.

Volume 3 presents a BCA approach consistent with a conventional economic appraisal. The approach in Volume 4 reflects the methodology that has evolved in practice in urban transport appraisal. It has developed in a way that easily converts the outputs of large, computerised, travel-demand models into correct BCA results. It makes specific use of the concept called 'resource correction', which is not used in Volume 3.

Part 2 in Volume 3 details the steps in undertaking a BCA. The steps for financial analysis are detailed in parallel, as many of the estimated values are required by both types of analysis. Much more detailed information is provided in Part 2 in Volume 5, which has corresponding section numbers to help users locate information.

The steps in undertaking a BCA, as set out in this part of the Guidelines, are detailed below and can be found in the following sections:

2.1 Specify the initiative and analyse options

2.2 Identify the benefits and costs

2.3 Estimate investment costs

2.4 Make demand forecasts

2.5 Estimate infrastructure operating costs

2.6 Estimate user benefits

2.7 Estimate cross-modal and network effects

2.8 Estimate safety benefits

2.9 Estimate externality benefits and costs

2.10 Discount benefits and costs, calculate summary results

2.11 Assess risk and uncertainty.

2.1 Specify the initiative and analyse options

Steps

2.1.1 Describe the initiative

2.1.2 List the objectives the initiative will achieve

2.1.3 Check whether the initiative is properly scoped

2.1.4 Consider whether the initiative should be staged

2.1.5 Identify constraints that could inhibit the initiative from proceeding

2.1.6 Specify the Base Case

2.1.7 Identify and analyse options

2.1.8 Consider pricing assumptions (where applicable)

2.1.9 Consider private sector funding

2.1.10 Is a financial analysis needed?

2.1.1 Describe the initiative

Describe the initiative, including its location, physical characteristics, function, estimated cost, timing and main benefits. At the detailed appraisal stage, describe the initiative in much greater detail than at the rapid appraisal stage.

2.1.2 List the objectives the initiative will achieve

Show how the initiative contributes to achieving government transport system objectives using as much available detail as possible.

Here is a starting checklist for clarifying the objectives. Will the initiative:

- meet mandatory safety needs
- maintain current service levels or standards
- expand or increase service levels or standards, or
- provide a new service altogether?

The BCA can assist to clarify the objectives of an initiative. Look at the relative sizes of the different benefits. Revise the stated objectives of an initiative if they prove to be inconsistent with the benefits and costs revealed by the BCA.

In the proposal, show how the benefits from the initiative align with government transport system objectives. Following the Guidelines process outlined in Part 1, this is done as part of the SMT. At the broadest level, these objectives are likely to include promoting:

- economic efficiency
- economic development and trade
- environmental amenity and sustainability
- safety
- security, and
- accessibility, social cohesion and equity.

Consult government strategy documents (e.g. corridor strategies) for detailed objectives that specifically apply to the initiative, given its type and location. The funding government agency should be able to assist. Provide references to source documents for government objectives.

2.1.3 Check whether the initiative is properly scoped

If the initiative consists of discrete or separate components, each one must be justified as if it were an independent initiative. (See Volume 2, Section 4.3 for a discussion on relationships between initiatives.) Where the impacts of a series of initiatives are closely interdependent, consider grouping the initiatives together and then treating them as a single initiative.

Only combine initiatives when a single initiative, implemented by itself, produces little or no benefit until another initiative (or initiatives) is completed. In other words, there has to be significant synergies between the initiatives. To test this, there are said to be significant synergies if the NPV of the group of related initiatives, assessed together as though they were a single initiative, is significantly greater than sum of the NPVs of the initiatives assessed individually.

If there are few, or no, synergies between initiatives, they should be appraised separately.

2.1.4 Consider whether the initiative should be staged

Breaking an initiative into stages can make financing easier, by spreading funding needs over time, and can reduce risks by providing opportunities to delay or cancel later project stages.

2.1.5 Identify constraints that could inhibit the initiative from proceeding

The proposal should identify major constraints and show how the initiative is feasible, given these constraints. The SMT template in Part 1 asks for this information.

Many options can be ruled out quickly because they fail to satisfy constraints. Constraints may involve technical, environmental or public acceptability considerations.

2.1.6 Specify the Base Case

The proposal should specify the Base Case, including any significant assumptions about actions that need to be undertaken in the Base Case, and one-off, future events that affect benefits or costs.

A BCA is always a comparison between a Base Case (without the initiative) and a Project Case (with the initiative). Usually, the Base Case consists of whatever would be done in the absence of any new initiative being implemented or by following a business-as-usual scenario. It is rarely the same as the 'do-nothing' scenario. The Base Case may have to include assumptions about further maintenance and replacement of existing infrastructure.

When detailing the Base Case, think about whether there are future, one-off events that could affect benefits and costs of initiatives. Implementation of other transport initiatives can affect benefits and costs of the initiative being analysed. In some cases, benefits may be contingent on other initiatives being implemented.

Ask these questions:

- What assumptions are being made about future developments that will affect the success of the initiative?
- Are there other consequences from non-implementation of the initiative?
- What is the nature and timings of other transport initiatives being implemented?
- What government strategies should be consulted for information about future, one-off events that could affect benefits and costs?

Where there is some uncertainty about a one-off event, make the BCA calculations with and without the assumption, as a sensitivity test or as part of the risk assessment (see Section 2.11).

2.1.7 Identify and analyse options

Demonstrate that different options for the initiative were considered. Provide the reasons for eliminating options.

Governments are keen to see innovative options considered as part of the proposal, including options that make better use of existing infrastructure, reducing the need for major capital expenditures.

Starting with a challenge that needs to be addressed, rather than starting with a particular solution, should help to maintain focus on options. Consult government strategic planning documents for ideas about challenges. Consultation with stakeholders can help identify options and reject options that are unlikely to succeed. Include a statement of the challenge being addressed by the initiative in the proposal. This can help to demonstrate that all options were thoroughly considered.

Here are some questions to consider during the options analysis phase:

- Can the challenge be met to different degrees? There is often a choice between initiatives of different sizes or different standards of infrastructure.
- Are there ways of addressing the challenge that do not involve large capital investment? For example:
  - integrating land use planning with transport planning
  - education programs (e.g. Travel Smart)
  - regulatory and policy measures (e.g. pricing measures, speed limits, route limitations for particular vehicle types)
  - technology measures (e.g. intelligent transport systems).
- Can implementation of the initiative be broken into stages and, if so, how?
- Are the options consistent with government strategies and objectives?
- For new roads, or railway lines, are there options for different routes?
- Are there options for reducing external costs generated by the initiative?
- Are there options to reduce, or better manage, risks?
- Are there constraints that make the option problematic or impractical?
- Is the option prohibitively expensive or too risky?

At the identification stage, many options can be dismissed with little or no analysis, for example, when they fail to satisfy constraints or are clearly too expensive relative to other options.

Other options will not be easily dismissed and will require more analysis. An initiative can be specified as a number of options in the proposal, leaving it to subsequent rounds of the assessment process—the SMT, rapid appraisal, detailed appraisal, Business Case, recommendations or minister's decision—to determine the best option. Deferral of choices to later stages can be the best course of action where there are contentious issues that cannot be settled on economic grounds alone.

Always use the NPV, or incremental BCR, to choose between options on economic grounds, never the BCR or internal rate of return (see Sections 2.10.3 and 2.10.5).

2.1.8 Consider pricing assumptions (where applicable)

Specify any assumptions about charging for infrastructure usage.
See Section 2.4.7 on developing pricing assumptions.

2.1.9 Consider private sector funding

Show that consideration was given to private sector funding for part, or all, of the initiative.

2.1.10 Is a financial analysis needed?

State whether a financial analysis is required. Financial analysis is required when the initiative generates revenues.

2.2 Identify the benefits and costs

Steps

2.2.1 List the benefits and costs and classify them

2.2.2 Leave out depreciation

2.2.3 Be clear about the point of view of the BCA

2.2.4 Set the appraisal period

2.2.5 Be clear about whether you are working in real or nominal terms

2.2.1 List the benefits and costs and classify them

Having specified the initiative (or initiatives if options are being assessed) and the Base Case, a good place to start a BCA is to prepare a list of all the benefits and costs. As explained in Box 2.1, BCA aims to be as all-encompassing as possible, taking into account all impacts on society. Table 2.1 provides a checklist that covers most of the benefits and costs associated with transport initiatives.

The table distinguishes three types of benefits and costs:

- Monetised benefits and costs are usually included in the BCA of a land transport initiative.
- Non-monetised benefits and costs are included if they can be readily valued in monetary terms. Attempts to value non-monetised benefits and costs can involve expensive surveys that yield results with very wide margins of error. Explicit recognition should be given to non-monetised benefits and costs by describing them in qualitative terms and, where possible, quantifying them using natural units.
- Secondary or flow-on impacts, are benefits and costs that are passed on, or redistributed, within the economy. The most accurate measurement of benefits and costs can usually be achieved by measuring them as close to their source as possible. Therefore, it is better to measure them as the primary impacts listed in the first column of Table 2.1, rather than as secondary impacts. Counting both primary and secondary impacts in a BCA is double-counting and leads to distorted results.

Benefits and costs can be further classified according to whether they accrue before the initiative commences operation (investment costs) or during the operating phase.

Box 2.1: What BCA and financial analysis do

When identifying the benefits and costs to include in a BCA, it is helpful to understand what BCA does and its relationship with financial analysis.

BCA aims to identify and express, in monetary terms, all the gains and losses (benefits and costs) created by an initiative to all members of society, and to combine the gains and losses into a single measure. If the result, expressed as a net present value, is positive, that is, total benefits exceed total costs, implementation of the initiative will be an economically efficient use of resources. Australia, *as a whole*, will be better off. The words 'as a whole' are emphasised because there will be losers as well as gainers. A positive result from a BCA means that the total gains exceed the total losses.

BCA is a well-established methodology that is widely employed by government departments and consultants in a range of areas. It permits initiatives to be compared, not only in respect of different transport modes, but also between the transport sector and other sectors of the economy. It can also be applied to non-infrastructure solutions such as the introduction of new technology or changed management practices.

BCA aims to summarise, in a single number, the combined benefits and costs to *all members of society*. In contrast, financial analysis aims to summarise, in a single number, the combined benefits and costs to *a single entity*, the owner or operator (if leased) of the initiative. Financial analysis considers the monetary costs and revenues to the owner, or operator, contemplating the investment, e.g. benefits are replaced with revenues from sales minus operating expenses. Identifying and measuring benefits and costs are usually simpler for a financial analysis than for a BCA, because, in financial analysis, the analyst needs to focus only on cash flows. Financial analysis becomes more complicated when taxation and financing costs are also included in the analysis.

While analysts have considerable leeway in making assumptions, the rules about which benefits and costs to include in a BCA and ways of valuing them are, for the most part, straightforward. If correctly followed, a BCA can result in comprehensive coverage of benefits and costs, without double-counting.

Table 2.1: List of benefits and costs

MONETISED	NON-MONETISED**	SECONDARY IMPACTS
Investment costs	Amenity value	Employment (construction and operation phases)
Planning and design	Barrier effects on humans and on biodiversity	Tourism
Site surveying	Biodiversity and ecosystems	Land values
Site preparation	Heritage	Industry development
Investigation, data collection and analysis	Aesthetic value	Community spirit/pride
Legal costs	Culture	Communication
Administrative costs	Increased comfort, cleanliness and security for passengers	Connectivity
Land acquisition	Reduced damage to freight and reduced pilferage	Information sharing
Construction costs	** In most cases, the reason these benefits and costs are 'non-monetised' is because it is too expensive to undertake the surveys necessary to produce reasonable estimates of the values people place on them. See Volume 5, Section 2.9.2 for a brief discussion of the techniques available for estimating externality costs. For damage and pilferage to freight, consigners and transport operators are often unwilling to divulge the extent of the problem.	Social cohesion
Consequential works		Increased incomes
*Benefits and disbenefits**		Access to services
Savings in vehicle/train operating costs		Production levels
Savings in time costs for passengers and/or freight		Productivity for industries
Improvements in service reliability		
Savings in crash/accident costs		
Reduced environmental externalities (noise, pollution)		
Savings in infrastructure operating costs including maintenance and administration		
Benefits associated with diverted and generated traffic		
Scrap or residual values of assets		
* Some of these benefits could have a negative sign because they are disbenefits, e.g. increases in environmental externalities.		

2.2.2 Leave out depreciation

Never include depreciation of capital assets in a BCA, because the full cost of the asset to society is taken into account when the resources are consumed to create the asset. Depreciation is a bookkeeping entry designed to spread capital costs over time in order to facilitate comparisons with operating profits for performance monitoring. For financial analysis, exclude depreciation on the grounds that it is not a cash flow. For financial analyses carried out after tax, depreciation is relevant where it affects taxation payments.

2.2.3 Be clear about the point of view of the BCA

BCAs are normally undertaken from the point of view of society as a whole. They may be undertaken from the point of view of a subset of society such as people living in a particular state, territory or region. If a BCA is undertaken from the point of view of a subset of society, indicate it clearly and never present the regional result in isolation from the whole-of-society result.

BCAs from the point of view of a state, territory or region are extremely difficult to carry out in practice because of the problem of distinguishing between benefits that accrue to people within the area and benefits that accrue to people outside the area. A regional BCA is therefore likely to have a higher margin of error.

2.2.4 Set the appraisal period

Set the appraisal period at the expected life of the asset created by the initiative in its intended use. It is usual to assume a 30-year life for road initiatives (except bridges, which have much longer lives) and a 50-year life for rail initiatives. Intelligent transport system (ITS) initiatives will have shorter lives. Volume 4, Part 1 includes a table of typical economic lives for infrastructure assets associated with public transport. Prepare forecasts of benefits and costs for each year of the initiative's life.

When comparing options with different lives for a particular initiative, make adjustments to ensure a valid comparison. There are two ways to do this:

- find a common multiple of the lives (for example, 150 years for a 30-year road project and a 50-year rail project), or
- convert the NPV to an annuity over the initiative's life.

Note that adjusting for different lives is necessary only for estimating NPVs to compare mutually exclusive options. It is not required for ranking initiatives by BCR to satisfy a budget constraint.

Where jurisdictions set maximum appraisal periods (e.g. 30 years), estimate benefits for the full life of the asset. Then take the present value of benefits for the remaining life of the asset beyond the set appraisal period. Treat it as a residual value (see Section 2.3.3 on residual values).

2.2.5 Be clear about whether you are working in real or nominal terms

It is usual to undertake BCAs in real terms and financial analyses in nominal terms. In proposals that include both a BCA and a financial analysis, ensure that the assumptions are consistent and, in so far as possible, show how the two analyses relate to each other (for example, by links within a spreadsheet). There should be inflation adjustments that convert between the BCA in real terms and the financial analysis in nominal terms.

Provided real or nominal prices are used consistently, the end results should be identical. Discounting nominal values at a nominal discount rate produces the same discounted result as discounting real values in real terms. The reason is that using a nominal discount rate converts nominal prices back into present day dollars. The relationship between a real and a nominal discount rate is as follows:

$$(1+i)=(1+r)(1+f)$$

where i is the nominal discount rate, r is the real discount rate and f is the inflation rate. If working in nominal terms and the inflation rate varies, allow the nominal discount rate to vary accordingly.

2.3 Estimate investment costs

Steps

2.3.1 Develop a time line for tasks from planning to completion

2.3.2 Estimate costs for each year

2.3.3 Estimate a residual value (if applicable)

2.3.4 Estimate land costs (if applicable)

2.3.1 Develop a time line for tasks from planning to completion

Investment costs are costs that:

- are essential for the initiative to proceed
- will be avoided if the initiative does not proceed[1]
- will be incurred before the initiative commences operation, and
- are paid for by the investors.[2]

Investment costs include:

- planning and design
- site surveying
- site preparation
- investigation, data collection and analysis (economic, environmental, social, market research, etc.)
- legal costs
- administrative costs
- land acquisition
- construction costs (labour, materials, insurance, etc)
- consequential works.

2.3.2 Estimate costs for each year

Value all costs in a BCA at social cost. See Boxes 2.2 and 2.3 for an explanation. For most investment costs, the social cost will be the same as the market price. For financial analysis, use financial costs.

Include land costs where appropriate. See Section 2.3.4 for further detail.

Buildings or houses that have to be demolished to make way for the initiative should be valued at market prices (net of selling costs), plus demolition costs minus scrap value. Include relocation costs for occupants.

Labour costs should generally reflect market rates with an allowance for labour on-costs. Income and payroll taxes should *not* be deducted. (See Box 2.3 for details).

'Construction externalities' refers to costs imposed on others by the construction process, for example, disruption to traffic, severance, noise and dust. Valuation of environmental externalities is discussed in Section 2.9.

1 Leave out any planning, design and investigation costs already incurred at the time of undertaking the BCA. The decision about whether or not to proceed with the initiative will have no effect on these costs.

2 Investment costs form the denominator in the BCR, used to rank initiatives for the purpose of allocating funds from a budget (see Section 2.10.4 in Volumes 3 and 5). Costs of negative externalities caused by construction should certainly be included in a BCA, but are not relevant for capital budgeting. They should therefore be treated as disbenefits.

For vehicles used in construction, a rental cost should be included to cover wear and tear and usage of capital tied up in the equipment. Value the fuel they consume at resource cost; that is, exclude fuel excise, goods and services tax (GST) and subsidies.

Estimate the amount of time required for each phase of implementation of the initiative and total the costs for each year.

Be transparent about how the investment costs are estimated by showing them item by item, including physical quantities of inputs and unit costs. The level of detail should differ between rapid and detailed BCAs. If financial and resource investment costs are different, provide both costs. Financial costs are required for financial analysis, funding and budgeting purposes.

For rapid BCA, expect investment costs to be estimated within ±40 per cent of the actual amount. For detailed BCA, the expected level of accuracy is ±10 per cent.

Forecasts of construction costs are notorious for optimism bias. People fail to consider what can go wrong and there is an incentive to keep investment costs down to improve BCA and financial results. Section 2.11 on risk analysis provides a way to minimise optimism bias, but it is unlikely to be applied at the rapid BCA stage.

2.3.3 Estimate a residual value (if applicable)

There may be some value remaining in infrastructure at the end of its life. It could have value when sold intact or as scrap. One way to estimate the resale or scrap value is to take a proportion of the replacement cost.

Section 2.2.4 details estimating a residual value where asset life exceeds the appraisal period.

Count the residual value of an initiative as a benefit at the end of the final year of the appraisal period.

2.3.4 Estimate land costs (if applicable)

Determine whether the land required for an initiative has an opportunity cost. Examples of land having *no* opportunity cost include land required for access purposes and land that is too narrow to have an alternative use.

Value land at its market price at the time of commencement of the initiative, even if it has been acquired in the past at a lower or higher price, because this represents its opportunity cost. If the land has already been acquired, use the market price net of selling costs. If the land is yet to be purchased, include all acquisition costs.

Be wary about the possible effects on land prices of expectations about the initiative proceeding.

If land costs are included with investment costs, and the land may have an alternative use at the end of the initiative's life, it may be appropriate to include the value of the land as a residual. See Section 2.3.4 in Volume 5 for a discussion, including advice on estimating the residual value.

Box 2.2: Economic benefit and cost terminology

TERM	DESCRIPTION
Willingness-to-pay	The maximum amount a consumer is willing to pay for a given quantity of a particular good or service (rather than go without it). Total value that consumers place on a given quantity of a good or service. It is measured as the total area under the demand curve up to a given quantity.
Consumers' surplus	The surplus of consumers' willingness-to-pay over and above what they actually pay for a given quantity of a good or service. It is measured as the willingness-to-pay area under the demand curve above the price paid.
Resource cost/ opportunity cost	The value forgone by society from using a resource in its next best alternative use.
Private cost	Cost incurred by an individual transport user or service provider. Private costs are valued at money prices, where applicable, and may include user costs, but external costs imposed on others are excluded.
External cost	Cost imposed on third parties, including time lost from delays, accident risks and environmental impacts (valued at resource costs where applicable). The cost of an externality.
Money price	The money price paid to use a service.
User cost	Costs incurred by a transport user in addition to the money price—waiting time, time in transit, unreliability, damage to freight, passenger discomfort, additional costs to complete the door-to-door journey. Quality attributes such as time and reliability, need to be expressed in dollar terms based on user valuations.
Generalised cost/ private generalised cost	The sum of money price and user cost, with any additional costs to complete the door-to-door journey valued at money prices.
Social generalised cost	The full cost to society valued at resource cost, including user costs and external costs. Any additional costs to complete the door-to-door trip are valued at resource cost.
Perceived price	A subset of private generalised cost that is perceived by the user. For example, car drivers may perceive time but not vehicle operating costs.
Financial cost	Cash-flow expense incurred by purchasing resources through markets at market prices.

Box 2.3: Resource and opportunity costs

The term 'opportunity cost' refers to the benefit that would accrue from using a resource in its next best alternative use. For example, the value of land in BCA (and financial analysis) should be the current market price, not the price paid for it in the past. 'Resource cost' is the opportunity cost of resources used, measured from the point of view of society as a whole.

Differences between private and resource costs arise when, for a given cost, the opportunities forgone are different for the individual incurring the cost and for society as a whole.

Taxes, subsidies, tariffs, import quotas and non-competitive pricing by producers can all cause resource costs to differ from private costs. Take the excise on fuel as an example. The cost to society of an extra litre of fuel consumed (excluding externalities) consists of the cost of earning the foreign exchange required to pay for importation of oil, plus refining, transport and storage costs. The private cost consists of this resource cost plus the tax, which is a 'transfer' to the government. Resource costs values used in BCAs are sometimes referred to as shadow prices.

To convert private costs to resource costs, it is usually sufficient to simply exclude taxes (fuel excise, goods and services tax), subsidies and tariffs from inputs such as fuel, tyres, vehicles and trains.

For labour costs, it is usually more correct in BCAs not to deduct income taxes and payroll taxes to obtain resource costs because of a different assumption about labour supply. The opportunity cost of additional labour resources is assumed to be forgone production elsewhere in the economy. The wage cost incurred by the employer measures the value of this production.

In rare cases, where labour would be otherwise unemployed, a shadow price below the market cost may be used. The shadow price is given by the following formula:

$$(\text{pre-tax wage} - \text{income tax} - \text{payroll tax} - \text{unemployment benefit} + \text{presentation costs})/2$$

where presentation costs consists of items such as annualised relocation costs, transport to and from work, and special clothing. For further explanation and a derivation of this formula see Volume 5, Section 2.3.5.

If production of an input causes an externality, the cost of the externality should be included in the resource cost.

2.4 Make demand forecasts

Steps

2.4.1 Decide on the unit of demand

2.4.2 Segment the market

2.4.3 Ascertain the base for projection

2.4.4 Make Base Case forecasts

2.4.5 Make Project Case forecasts—diverted traffic

2.4.6 Make Project Case forecasts—generated traffic

2.4.7 Develop pricing assumptions (if applicable)

Benefits from transport initiatives are usually strongly related to infrastructure utilisation levels. So demand forecasts play a critical role in appraisal of initiatives.

2.4.1 Decide on the unit of demand

Possible units of demand include:

- vehicle or train numbers
- passenger numbers, freight tonnes or freight containers, and
- passenger-kilometres or freight tonne-kilometres.

All of these are expressed per period of time (day, week, year).

If forecasts are passenger numbers, freight tonnes or freight containers, they need to be converted into vehicle or train numbers at some stage of the appraisal. Be transparent about the conversion factors used.

2.4.2 Segment the market

The level of accuracy achievable in the demand forecasts will depend, in part, on the extent to which the analyst segments the market. Classifications include trip purpose (passengers only), time (peak/off-peak), commodity (freight only), transport mode, load type (freight only, bulk, non-bulk), vehicle or train type and origin–destination pair.

The level of market segmentation will depend on data availability, the nature of the initiative and whether the analysis is a rapid or detailed BCA.

2.4.3 Ascertain the base for projection

Recent demand data is needed to serve as a starting point for the projections. Consistent data are required for trend analysis and aggregating across transport modes.

2.4.4 Make Base Case forecasts

Make demand forecasts for both the Base and Project Cases. In the absence of generated and diverted traffic, they will be identical.

There are three broad categories of forecasting methods:

- simple extrapolation of past trends
- extrapolation by relating the forecast variable to one or more explanatory variables (usually through an econometric model based on economic theory), and
- application of informed judgment based on available evidence, including guidance from scenario analysis.

These methods are not mutually exclusive and will often be used in combination. The choice of technique will depend on data availability, the amount of effort chosen to apply to forecasting, and the extent to which extrapolation of past trends is considered warranted.

Extrapolation cannot be the sole forecasting technique employed when there is a likelihood of changes that bear no relationship to the past. Projections may have to be adjusted to allow for one-off events such as implementation of other transport projects or development of new industries or residential areas. This requires judgment. When preparing appraisals, provide details about the judgments applied in making forecasts.

For projections based on population, the Australian Bureau of Statistics (ABS) is a useful source of population forecasts (medium series), including at the statistical local area level. Some jurisdictions prefer to use their own population forecasts. For some purposes such as traffic models, break down any aggregate forecasts into small area forecasts.

2.4.5 Make Project Case forecasts—diverted traffic

Diverted traffic refers to passengers, freight or vehicles that switch from another mode of transport, or another route within the same mode, to take advantage of the new initiative.

To estimate diverted traffic, obtain an estimate of the maximum volume of traffic that could potentially divert for each market segment. Then estimate the proportion of the potentially divertible traffic likely to divert. Accuracy will be greater the more the market is segmented, because the propensity to divert depends on characteristics such as origin–destination and time-sensitivity.

The simplest way to estimate the proportion of traffic likely to divert is to nominate a percentage using judgment. Preferably, past experience with similar initiatives and market knowledge will inform those judgments.

If a small number of shippers are responsible for a considerable percentage of the divertible freight, ask them directly about their probable responses to the proposed change.

A simple quantitative method is to use the concept of cross elasticity. Where there are quality improvements such as time savings that can impact on the amount of diverting traffic, the price could be expressed as a 'generalised cost' (see Box 2.4 for an explanation). Logit models are a more sophisticated technique for predicting impacts of initiatives on mode or route shares. The logit model splits up the market between modes and routes according to how they compare in terms of price, time taken and other quality attributes.

For rapid BCAs and many detailed BCAs, values for elasticities based on studies by others may need to be assumed, including overseas studies. BTRE (2004a) is a convenient source of such elasticities. Since surveys are very expensive to undertake, they are only justified for detailed BCAs of very large initiatives or programs of related initiatives.

Levels of traffic diversion may increase over time as transport users have time to adjust. The literature sometimes distinguishes between short-run and long-run elasticities. If this applies to the initiative, consider allowing for a 'ramp up' period during which the level of diversion builds up gradually to the long-run level.

2.4.6 Make Project Case forecasts—generated traffic

Generated traffic is new demand induced by the initiative.[3] If the new traffic comes from a specific source such as a new industrial development or land use change that is expected to occur as a consequence of the initiative, collect information about the source to estimate levels of generated traffic. Where the sources of generated traffic are more diverse, a price elasticity of demand could serve as the basis of estimation. The comment about a 'ramp up' period for diverted traffic applies equally to generated traffic.

3 From an economist's point of view, all additional traffic using the infrastructure in the Project Case, compared with the Base Case, is 'generated traffic' regardless of the source. Generated traffic may be divided into 'diverted traffic' and 'induced traffic' depending on its source. However, transport planners use the terms 'induced traffic' and 'generated traffic' interchangeably referring to traffic that is new altogether. Because the Guidelines are aimed at a broader audience than economists, the transport planners' terminology has been adopted.

Where there is considerable uncertainty about levels of generated traffic, a sensitivity test can be undertaken by estimating traffic levels with and without the generated traffic. The risk analysis is an opportunity to explicitly consider the uncertainty associated with generated traffic.

2.4.7 Develop pricing assumptions (if applicable)

Where infrastructure use is charged, make assumptions about prices; price levels will affect levels of demand (existing, diverted and generated). Factors affecting prices include the demand curve, costs and the objective of price setting (profit maximisation, economic efficiency maximisation, revenue target or cost-recovery target). Constraints relating to the forms of charging available also need to be taken into account (e.g. extent to which charges can vary with time of day).

Although a discussion of pricing is at the end of Section 2.4, prices may have to be estimated simultaneously with developing demand forecasts. The demand curve is needed to estimate the price, and then the price is needed to estimate the quantity demanded.

Prices are critical for estimating revenues for financial analyses.

Box 2.4: Generalised costs and perceived prices

Allowance for changes in the quality of transport services in BCAs can be simplified by using the 'generalised cost' concept.

To make a journey, transport users incur additional costs on top of the money price. The additional costs, termed 'user costs' here, fall into two categories: (1) negative quality attributes, and (2) costs incurred by transport users at the start and end of a trip to complete the door-to-door movement.

Time taken is usually the most important negative quality attribute, followed by unreliability. Unreliability can be measured by the standard deviation of trip time or frequency of running behind schedule by a given amount.

To incorporate them into generalised cost, time taken and unreliability should be expressed in dollar amounts. Transport users will have a distribution of values for time and unreliability. Calculation of user costs for a group of users requires quality aspects to be costed at average values.

Examples of the additional costs of a door-to-door journey include: for passengers—waiting time, walking and parking, and for freight—pick-up, delivery and packaging. In some cases, these involve money costs and, in some cases, time lost. The value of waiting time is usually different from the value of in-vehicle time (see Volume 4, Part 1).

The different components of user cost, all expressed in dollar terms, are simply summed. The generalised cost is the sum of user costs and the money price of the main mode of transport used.

When estimating benefits of transport initiatives using prices defined in terms of generalised costs, it is necessary to define supply costs as 'social generalised costs'. Social generalised costs are the full costs to society of a door-to-door journey, including costs of negative quality attributes, valued in resource terms. While the private and resource values of time and other quality attributes will be the same, taxes and subsidies could cause private and resource costs of vehicle operation to diverge; social and private user costs may differ.

Transport users may ignore some costs when making decisions. Car drivers may see fuel and other vehicle operating costs as a fixed cost they pay periodically, rather than a variable cost that changes with distance and speed. 'Perceived price' is derived by deducting from generalised cost the costs that users are assumed not to perceive. The Guidelines use the term 'perceived price' rather than the more usual 'perceived cost', because consumer behaviour is generally considered to be driven by prices.

See Volume 4, Part 1, Section 3.2.1 and Volume 5, Section 2.3.5, for further discussion.

2.5 Estimate infrastructure operating costs

Steps

2.5.1 Identify infrastructure operating costs and classify them into time- and usage-related components

2.5.2 Make Base Case and Project Case projections, and take the difference

2.5.1 Identify infrastructure operating costs and classify them into time- and usage-related components

The term infrastructure operating costs refers to the costs of continuing to provide the infrastructure after the initiative has commenced operation. The primary infrastructure operating cost is maintenance (see Table 2.2).

Table 2.2: Road and rail maintenance costs

ROAD	RAIL
Routine maintenance	**Routine maintenance**
Vegetation control	Vegetation control
Patching potholes	Clearing drains/culverts
Repairing/replacing signs and other roadside furniture	Repairing telecommunications equipment
Clearing drains/culverts	Repairing signalling
Repainting line markings	Repairing train control systems
	Minor sleeper replacement
	Repairs to damage caused by accidents
Periodic maintenance	**Periodic maintenance**
Resealing	Formation rehabilitation
Stabilisation	Ballast cleaning
Re-sheeting	Tamping
Asphalt overlay	Rail grinding
Roughening concrete pavements	Major sleeper replacement
	Re-sleepering
	Re-railing

Maintenance costs are usually classified into routine and periodic categories. Routine maintenance costs involve small tasks that are undertaken frequently. Periodic maintenance costs involve more expensive works undertaken at intervals of several years.

For cost estimation purposes, it is useful to split infrastructure operating costs into time-related and usage-related costs. Time-related costs are the same each year, regardless of the level of traffic. Routine maintenance costs tend to be largely time-related (as opposed to usage-related) and reasonably constant from year to year. Usage-related costs vary with the level of traffic and, therefore, are dependent on demand projections. Vehicle or train mix, gross weights and speeds may also be relevant. Rail cost models often distinguish between fixed and variable track-maintenance costs. Models of periodic maintenance costs for roads with bitumen surfaces typically make pavement deterioration a function of time, initial pavement strength, usage by heavy vehicles and climate.

Maintenance costs in either the usage- or time-related categories can be affected by the weather and by major accidents leading to random variations from year to year. If impacts of uncertain events are potentially significant, use the techniques for dealing with risk in Section 2.11.

The funding jurisdiction may require the domestic labour component of infrastructure operating costs to increase each year by the specified percentage forecast growth in real wages. The labour component may be expressed as an estimated percentage (*p*) of total infrastructure operating or maintenance costs. In this case, increase total cost each year by *1+pg/10 000* where *g* is the specified percentage annual growth in real wages. For example, if labour costs were estimated to comprise 70 per cent of maintenance costs and real wages were assumed to grow at 1 per cent per annum, multiply total maintenance costs each year by 1.007 = 1 + (70 × 1/10 000).

2.5.2 Make Base Case and Project Case projections, and take the difference

Estimate infrastructure operating costs for the Base and Project Cases, projecting them forward over the life of the initiative. If Project Case operating costs are below Base Case operating costs, the difference between them is a benefit for the initiative. This could occur if the new infrastructure replaces ageing infrastructure that was costly to maintain. Conversely, if Project Case operating costs exceed Base Case operating costs, the difference between them is a cost to the initiative. This occurs if the new infrastructure generated new maintenance costs on top of those of the existing infrastructure.

Road

See Section 2.17 for further discussion of projecting road maintenance costs, including situations where maintenance cost savings are a significant benefit and where maintenance is budget constrained. See Austroads (2005c, p.2) for some indicative road maintenance costs.

Rail

For rail, in addition to maintenance, there are infrastructure operating costs associated with train control and system management. For BCAs and financial analyses of proposals, only the avoidable costs of the proposal are relevant—the costs that would be avoided if the initiative did not proceed. Take care to ensure that any changes in infrastructure operating costs that appear in the analyses are real changes in these costs and directly attributable to the initiative.

See Volume 5, Part 4 for some indicative track maintenance and train control costs.

2.6 Estimate user benefits

Steps

2.6.1 Determine methodologies for estimating impacts of the initiative on user costs

2.6.2 For existing traffic, take the difference between total social generalised costs for the Base and Project Cases

2.6.3 For diverted and generated traffic, take the difference between the increase in willingness-to-pay and social generalised costs for the Project Case

2.6.1 Determine methodologies for estimating impacts of the initiative on user costs

For most transport initiatives, the bulk of the benefits accrue (at least in the first instance) to users of the infrastructure. Trains, trucks and cars save operating costs; passengers and freight save time. There may be other benefits to transport users such as improved reliability or greater comfort for passengers, or less damage to freight. Both reductions in costs and improvements in service quality can lead to increases in usage—diverted demand, sourced from other routes or modes, and generated demand, which is altogether new traffic.

Estimates of vehicle or train operating costs and times taken for the Base and Project Cases for each year of the initiative's life are also needed. For detailed BCAs, use computer models to derive these estimates. The computer models may estimate benefits and costs for selected years, for example, at five-year intervals, and interpolate for the intervening years. For rapid BCAs, a greater level of interpolation and extrapolation is acceptable.

Computer models require data on the infrastructure and on the vehicles or trains using the infrastructure (quality and quantity). For improvements to road and rail line-haul infrastructure, there is a four-step process:

1. estimate free speeds (the speeds and times taken in the absence of any interference from other vehicles or trains)
2. adjust speeds downward and travel times upward to allow for congestion (including time lost at intersections for urban traffic and in passing loops for trains)
3. estimate levels of consumption of inputs (fuel, time, see Table 2.3), and
4. multiply input consumption levels by unit costs.

Here, the term 'unit costs' refers to the average price, cost or value of inputs; for example, fuel per litre, time per hour, hourly wage rates for drivers and crew, lubricating oil per litre, cost per tyre and so on. For some inputs, private and resource unit costs differ. For example, the resource unit cost of fuel will exclude excise causing it to be less than the private cost, which is the market price. Ensure the correct unit costs for estimating a financial cost or a resource cost are used (see Boxes 2.2 and 2.3 for explanations of financial and resource costs).

Table 2.3: Road vehicle and train operating costs[a]

ROAD	RAIL
Fuel	Fuel
Passenger time (car), crew wages (truck)	Crew wages
Capital (truck only)[b]	Crew training
Oil	Passenger/freight time
Maintenance labour	Capital (locomotive and wagons)[b]
Spare parts	Lubricants
Tyres	Locomotive and wagon service (labour and parts)

a. Differences in terminology and classification between the two modes reflect the different approaches taken.

b. Savings in truck, locomotive and wagon capital costs reflect 'fleet benefits' from time savings; that is, the same transport task can be performed with a smaller number of trucks or locomotives and wagons. Capital costs for cars can be ignored because time savings will, for the most part, not result in any reduction in the size of car fleet. The cars will spend more time parked.

Unreliability can be measured in standard deviations of trip times. Under plausible assumptions, the value of unreliability in trip times will be proportional to the number of standard deviations multiplied by the value of time. See Volume 5, Section 2.6.1 for details.

In Volume 4, Part 1, dealing with public transport, unreliability is measured as unexpected waiting and travel time. 'Average lateness' in minutes is multiplied by the value of time times a weighting factor. The weighting factors are greater than unity, reflecting the greater disutility people experience from unexpected delays. The weighting factor is higher for unexpected waiting time at a bus stop or train station compared with unexpected waiting time in a vehicle.

See Volume 5, Part 3 for a general discussion of ways to measure unreliability.

Normally, the calculations for a number of different vehicle or train types (e.g. for road: cars, rigid trucks, articulated trucks, B-doubles, road trains) will need to be undertaken.

Since infrastructure utilisation fluctuates by time of day, day of week and season, and costs to users change with the level of infrastructure use when there is congestion, the computer model may have to loop around many times to cover the full range of utilisation levels.

The funding jurisdiction may require an increase to the crew costs for commercial vehicles and trains each year by the specified percentage forecast growth in real wages. Since the value of time is based on wage rates, increase the value of time by the specified percentage growth factor, if required. Note that the specified annual increase in the value of time is likely to be less than that for crew costs, because the value of the non-work component of the time value should grow more slowly than real wages. Growth factors may also be specified for values of crash costs and some externalities. See Volume 5, Section 2.6.1 for an explanation.

For estimating perceived prices, the costs of the door-to-door journey, on top of the line-haul cost, need to be included. A change in service frequency for a scheduled service will affect waiting times and hence perceived prices.

2.6.2 For existing traffic, take the difference between total social generalised costs for the Base and Project Cases

'Existing traffic' is traffic that uses the infrastructure affected in both the Base and Project Cases (not diverted or generated traffic). The quantity of existing traffic is, by definition, the same in the Base and Project Cases.

For existing traffic, estimate the total social generalised costs for the Base and Project Cases and take the difference. The word 'total' here means costs for all existing users added together (number of users × average social generalised cost).

The benefit for existing traffic is therefore:

$$Q_1(AC_1 - AC_2)$$

where Q_1 is the level of existing traffic, and AC_1 and AC_2 are the average social generalised costs for the Base and Project Cases respectively.

Changes in money and perceived prices for existing traffic are irrelevant. Any differences between the changes in money prices and social generalised costs represent transfers between transport users and others, not additional benefits or costs created. Any differences between the changes in perceived prices and social generalised costs are illusory. For example, a benefit from savings in fuel consumed occurs even if the savings are not perceived by car drivers.

By using *generalised* costs, the benefits to transport users of time savings and improvements in other quality aspects of the service provided are accounted for.

2.6.3 For diverted and generated traffic, take the difference between the increase in willingness-to-pay and social generalised costs for the Project Case.

If demand is assumed to be perfectly inelastic (no diverted or generated traffic), skip this section. Note that the term 'generated traffic' here refers to *traffic* not *users*. Any increase in usage by existing *users* is treated as generated traffic.

The *gross* benefit to diverted and generated traffic from using the infrastructure affected by the new initiative is given by their willingness-to-pay (WTP)—the area under the demand curve between the Base Case and Project Case traffic levels. The demand curve should be specified as a function of perceived price.

The increase in WTP can be estimated using the rule-of-a-half as:

$$\text{Increase in WTP} = \frac{1}{2}(P_1+P_2)(Q_2-Q_1)$$

where Q_1/P_1 and Q_2/P_2 are the Base Case and Project Case quantities and prices respectively. The *Ps* are perceived prices paid or incurred by users. If there is no diverted or generated traffic, $Q_1 = Q_2$, and there is no WTP benefit.

To obtain the net benefit to society arising from the diverted and generated traffic, deduct the social generalised costs incurred by society to create the benefit. Hence the net benefit from diverted and generated traffic is:

$$\frac{1}{2}(P_1+P_2)(Q_2-Q_1) - AC_2(Q_2-Q_1).$$

See Boxes 2.5, 2.6 and 2.7 for diagrammatic explanations and a numerical example.

If diverted traffic is present, there may be additional benefits or costs to consider on the mode or route from which the traffic diverts. See Section 2.7.

Note that there are other ways to estimate benefits. Some of these are shown in Section 2.6.3 in Volume 5. The method shown here was selected because, in most situations, it is the simplest.[4]

4 Combining the formulas for benefits for existing traffic and for diverted and generated traffic, the formula for the benefit area is:

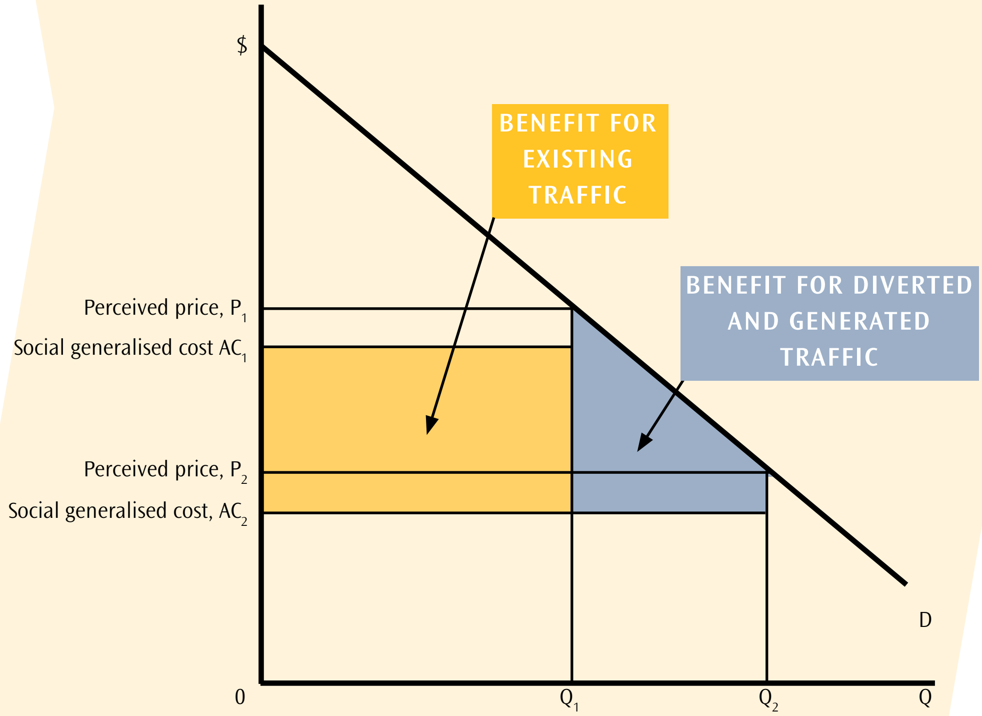
$$Q_1(AC_1-AC_2) + \frac{1}{2}(Q_2-Q_1)(P_1+P_2) - (Q_2-Q_1)AC_2, \text{ which simplifies to:}$$

$$\frac{1}{2}(Q_2-Q_1)(P_1+P_2) - (Q_2AC_2 - Q_1AC_1).$$

If perceived prices and social generalised costs are equal, that is, $P_1 = AC_1$ and $P_2 = AC_2$, the combined benefit is $\frac{1}{2}(P_1-P_2)(Q_2+Q_1)$, which is the area of the consumers' surplus gain.

Box 2.5: Diagrammatic explanation of user benefit estimation: price > cost

The diagram shows the case where perceived price exceeds social generalised cost, for example, due to the fuel excise. The initiative reduces both perceived price and social generalised cost, with subscript 1 indicating the Base Case and subscript 2, the Project Case. Infrastructure use is determined by the intersection of perceived price with the demand curve (expressed as a function of perceived price). The benefit, with respect to existing users, is the area of the rectangle between the Base and Project Case levels of social generalised costs up to the level of existing traffic, Q_1. For diverted and generated traffic (Q_1 to Q_2), the increase in WTP is the area under the demand curve between Q_1 and Q_2, while the benefit for this traffic is the WTP area minus Project Case social generalised costs.



Box 2.6: Numerical example of user benefit estimation: price > cost

In this numerical example, the initiative results in a reduction in perceived prices from $2.00 to $1.80. Existing traffic is 10 000 units. The fall in perceived prices induces additional diverted and generated traffic of 2000 units. Social generalised costs per user fall from $1.40 to $1.20.

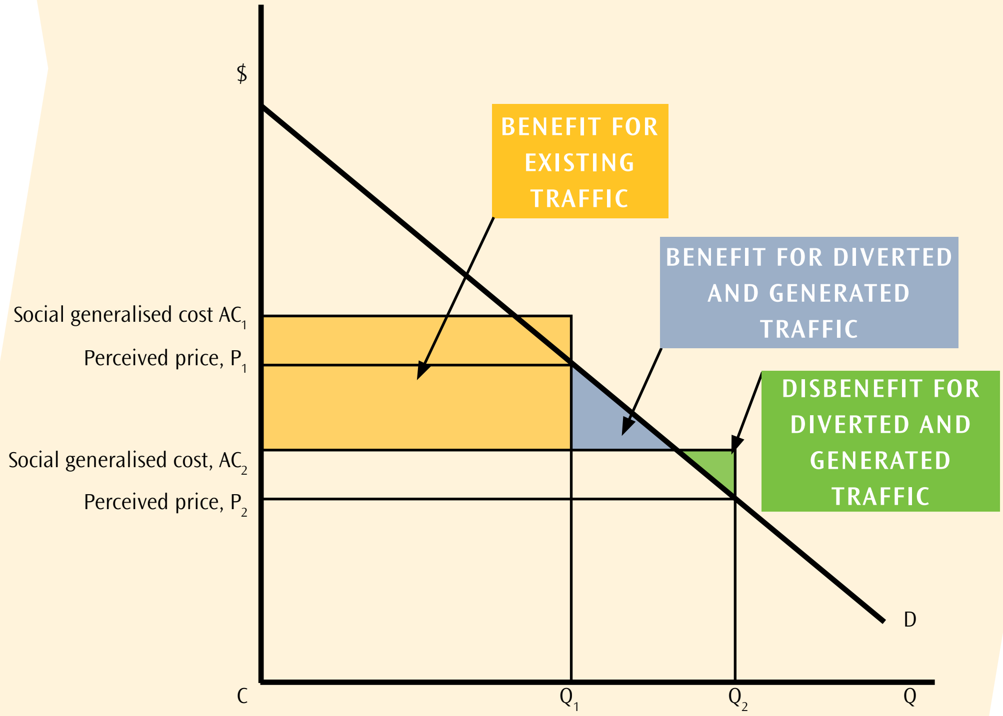
Existing traffic: Total social generalised costs fall from $14 000 = 10 000 × $1.40 to $12 000 = 10 000 × $1.20, leading to a benefit to society of $2000.

Diverted and generated traffic: The gross benefit to users (or the WTP) is $3800 = 2000 × ($2.00 + $1.80)/2. The social generalised cost to society of creating this benefit is $2400 = 2000 × $1.20. The net benefit from the increased WTP is therefore $1400 = $3800 – $2400.

Total benefit: The total benefit to society is the sum of benefits for existing traffic and for diverted and generated traffic, i.e. $3400 = $2000 + $1400.

Box 2.7: Diagrammatic explanation of user benefit estimation: cost > price

The diagram shows the case where social generalised cost exceeds perceived price, due to either a subsidy or users failing to perceive some of the costs they incur. The initiative reduces both perceived price and social generalised cost, subscript 1 indicating the Base Case and subscript 2, the Project Case. Infrastructure usage is determined by the intersection of perceived price with the demand curve (expressed as a function of perceived price). The benefit in respect of existing users is the area of the rectangle between the Base and Project Case levels of social generalised costs up to the level of existing traffic, Q_1. For diverted and generated traffic (Q_1 to Q_2), the increase in WTP is the area under the demand curve between Q_1 and Q_2. The benefit for this traffic is the WTP area minus Project Case social generalised costs. The result is a triangle of positive benefit for traffic for which WTP exceeds social generalised cost, minus a triangle of disbenefit for traffic for which the social generalised cost exceeds WTP.



2.7 Estimate cross-modal and network effects

Steps

2.7.1 Determine whether cross-modal and network effects matter

2.7.2 Estimate benefits or costs on parallel infrastructure due to diverted and generated traffic

2.7.3 Estimate benefits or costs on upstream and downstream infrastructure due to diverted and generated traffic

2.7.1 Determine whether cross-modal and network effects matter

Refer to this section when undertaking a BCA of an initiative that alters the use of other transport infrastructure in addition to the infrastructure created or improved by the initiative being appraised, regardless of mode.

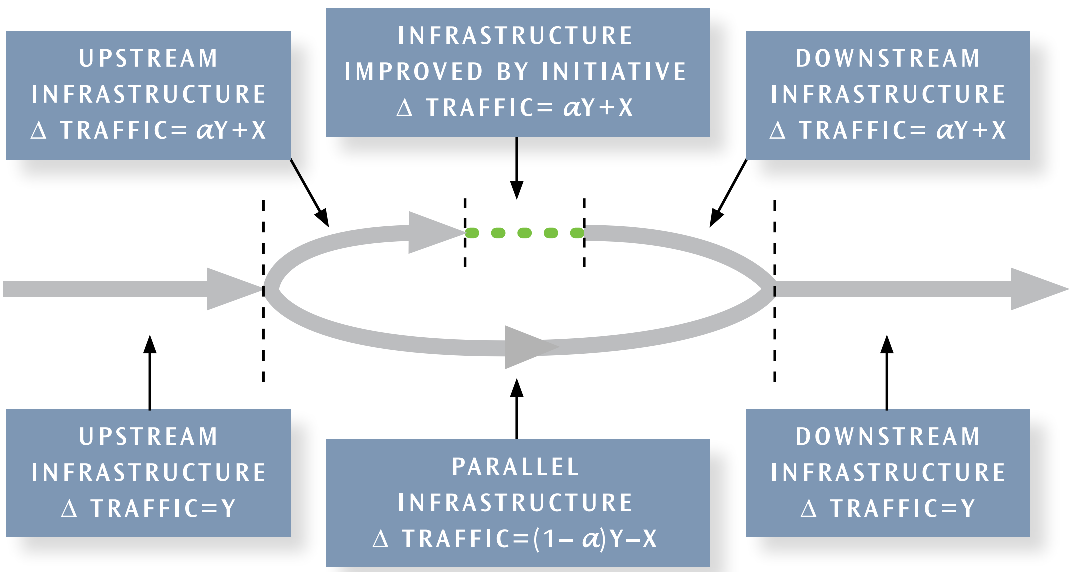
Determine which of these two categories the effect fits into:

- diverted demand (substitution)—where passengers or freight switch from parallel infrastructure to the infrastructure created or improved by the initiative being appraised (e.g. a rail upgrade that attracts freight from road, an urban road improvement that reduces traffic on alternative routes), or
- upstream/downstream effects (complementarity)—where additional use of infrastructure created or improved by the initiative being appraised causes increased use of upstream or downstream infrastructure (e.g. a road or rail upgrade that results in additional usage in other parts of the route or at terminals).

See Figure 2.1 for an illustration of the concepts defined here.

Figure 2.1: Related infrastructure and traffic changes

Diverted traffic = X
Generated traffic = Y
Proportion of generated traffic using improved infrastructure = α



2.7.2 *Estimate benefits or costs on parallel infrastructure due to diverted and generated traffic*

Compare the perceived price paid by transport users with the marginal social generalised cost (including externalities, safety and infrastructure operating costs) for the related infrastructure with altered demand. If they are practically the same, there are no further benefits or costs to consider. Note that where the source of the diverted traffic is a congested road, the absence of congestion pricing may result in the perceived price being below the social generalised cost.

If the marginal social generalised cost is above the marginal perceived price paid, there will be an additional benefit in respect of the related infrastructure. If costs are constant with respect to traffic level (no changes as a result of reduced congestion), then:

additional benefit = quantity of diverted and generated traffic ×
(average social generalised cost – average perceived price).

If costs fall as a result of reduced congestion on the related infrastructure, use the marginal social generalised costs and marginal perceived prices, averaged over the Base Case and Project Case traffic levels. Obtain an approximate average for marginal social generalised cost by taking the halfway point between the Base Case and Project Case levels. The same applies for marginal perceived price.

If the marginal social generalised cost is *below* the marginal perceived price paid, there will be an additional *cost* in respect of the related infrastructure. If costs are constant with respect to traffic level, use the formula given above. The result will be a negative number that should be subtracted from the total benefits of the initiative.

When projecting social and private costs of related infrastructure into the future, adjust them upward for increasing congestion due to traffic growth over time and downward for cost reductions due to likely expansions of, or improvements to, the related infrastructure. Allow for feedback effects on the quantity of diverted traffic.

If the diverted traffic significantly reduces the economic viability of potential investment initiatives on the infrastructure that is the source of the diverted traffic, there is a case of related initiatives. See Volume 5, Section 2.1.11 for advice.

For an example illustrating estimation of benefits from diverted traffic, see Box 2.8.

Box 2.8: Numerical example of estimation of benefits from diverted traffic

A rail infrastructure upgrading initiative results in a diversion of 1000 tonnes of freight per annum from road transport to rail.

Without congestion

The social generalised cost of the door-to-door movement by road over the route is $100 per tonne. The perceived price by road for the door-to-door task is $90 per tonne. There is an annual benefit of 1000 tonnes x ($100 – $90) = $10 000.

If the perceived price by road is $105 per tonne—in excess of the social generalised cost—the annual benefit is negative: 1000 tonnes x ($100 – $105) = –$5000, a cost of $5000.

With congestion

Say the road is congested. The Base Case marginal social generalised cost and perceived price are $100 and $90 respectively. Due to reduced congestion on the road following the loss of traffic, the Project Case marginal social generalised cost and perceived price are $94 and $86 respectively. The average (halfway point) of the Base Case and Project Case marginal social generalised costs is ($100 + $94)/2 = $97. The average (halfway point) of the Base Case and Project Case perceived prices is ($90 + $86)/2 = $88. The benefit from traffic diversion is then 1000 tonnes x ($97 – $88) = $9000.

2.7.3 *Estimate benefits or costs on upstream and downstream infrastructure due to diverted and generated traffic*

For increased usage of downstream or upstream transport infrastructure, the procedure is the same as for diverted traffic with some reversals of the direction of impacts.

Compare the perceived price paid by transport users (including all taxes and charges) with the marginal social generalised cost (including externalities, safety and infrastructure operating costs) for the related infrastructure with altered demand. If they are practically the same, there are no further benefits or costs to consider. Note that where related infrastructure experiencing increased traffic as a result of the initiative is a congested road, the absence of congestion pricing may result in the perceived price being below the social generalised cost.

If the marginal social generalised cost is *below* the marginal perceived price paid, there will be an additional *benefit* in respect of the related infrastructure. If costs are constant with respect to traffic level (no changes as a result of reduced congestion), then:

additional benefit = quantity of new traffic ×
(average perceived price – average social generalised cost).

If costs rise as a result of increased congestion on the related infrastructure, use the marginal social generalised costs and marginal perceived prices, averaged over the Base Case and Project Case traffic levels. Obtain an approximate average for marginal social generalised cost by taking the halfway point between the Base Case and Project Case levels. The same applies for marginal perceived price.

If the marginal social generalised cost is above the marginal perceived price paid, there will be an additional cost in respect of the related infrastructure. If costs are constant with respect to traffic levels, use the formula given above. The result will be a negative number that should be subtracted from the total benefits of the initiative.

When projecting social and private costs of related infrastructure into the future, adjust them upward for increasing congestion due to traffic growth over time and downward for cost reductions due to likely expansions of, or improvements to, the related infrastructure. Allow for feedback effects on the quantity of traffic using the infrastructure on which the initiative occurs.

If the additional traffic using related infrastructure has a major impact on the economic viability of potential investment initiatives, there is a case of related initiatives. See Volume 5, Section 2.1.11 for advice.

For an example illustrating the estimation of costs of upstream–downstream effects, see Box 2.9.

Box 2.9: Numerical example of estimation of costs from upstream–downstream effects

A rail infrastructure upgrading initiative results in an additional 1000 tonnes of freight per annum travelling along a feeder road leading to the rail terminal.

Without congestion

The social generalised cost of carrying the freight on the feeder road is $10 per tonne. The perceived price is $9 per tonne. Using the formula described in Section 2.7.3, there is an annual benefit of 1000 tonnes x ($9 – $10) = –$1000, a cost of $1000.

If the road perceived price is $11 per tonne—in excess of the social generalised cost—there is an annual benefit: 1000 tonnes x ($11 – $10) = $1000.

With congestion

Say the road is congested. The Base Case marginal social generalised cost and perceived price are $10 and $8 respectively. Due to increased congestion on the road following the increase in traffic, the Project Case marginal social generalised cost and perceived price are $14 and $12 respectively. The average of Base Case and Project Case marginal social generalised cost is ($10 + $14)/2 = $12. The average of Base Case and Project Case perceived price is ($8 + $12)/2 = $10. The benefit from traffic diversion is then 1000 tonnes x ($10 – $12) = –$2000, a cost of $2000.

2.8 Estimate safety benefits

Steps

2.8.1 Estimate crash rates for each severity level or crash type for each year in the Base and Project Cases

2.8.2 Multiply crash rates by unit costs

2.8.3 The benefit is Base Case crash costs minus Project Case crash costs

2.8.1 Estimate crash rates for each severity level or crash type for each year in the Base and Project Cases

For initiatives where safety benefits are a relatively small proportion of the total, use default crash rates.

Road

The most recent published sets of crash rates in Australia as a function of road characteristics (e.g. width, number of lanes, divided, undivided) are Austroads (2005c, p.13) for non-urban roads and Austroads (2004b) for urban roads. These crash rates are expressed per 100 million or million vehicle-kilometres of travel, implying that total crash numbers are proportional to traffic levels and that vehicle mix (proportion of heavy vehicles) is not relevant. Clearly, these are simplifying assumptions. At some time in the future, crash rates that vary with volume–capacity ratio and vehicle mix may become available.

For initiatives where safety is the primary objective (crash cost savings comprising a high proportion of total benefits), consider adopting a more detailed, site-specific approach. If the data is available, estimate Base Case road crash rates from the history of crashes at the site. For rapid BCAs, tables are available of percentage crash reductions by treatment type and crash type (for example, DOTARS 2006). For detailed BCAs, to predict impacts of an initiative on crash rates, undertake statistical analysis of time-series crash-rate data from similar sites where similar initiatives have been undertaken, or of cross-section data from sites similar to the Base Case and Project Case sites. Remember to adjust for differences in traffic volume and mix, 'regression to the mean' and general trends in crash frequencies due to non-site-specific factors such as changes in driver attitudes, law enforcement or car safety. There are many methodological pitfalls. For discussion of statistical analysis of site-specific crash rates, see BTCE (1995) and BTE (2001).

Rail

Much of the foregoing discussion for road crash rates also applies to rail accident rates. However, published default rail accident rates are not available.

2.8.2 Multiply crash rates by unit costs

Road

Austroads publishes average road crash costs for four categories of severity—fatality, serious injury, minor injury and property damage only—split by state and urban/non-urban areas (Austroads 2005c, p.14 and 2006, p.16), based on BTE (2000).

See also Appendix A of Austroads (2004a) for road-user movement (RUM) crash costs. These tables show the average costs by RUM code for all reported crashes in Western Australia (WA) in the period 1997 to 2000, and the average costs by RUM code for casualty crashes in WA in the same time period. Selected RUM-based crash costs are based on WA data, recalculated to 30 June 2002 values.

Rail

BTRE (2003) estimated total costs of rail accidents in Australia, but did not convert them to unit costs in the way Austroads did for the total road crash costs in BTE (2000). See Volume 5, Part 4, Annex 2 for some indicative default values for rail accident costs including sources based on system-wide averages. For rail, costs of delays to trains caused by accidents can be very significant.

2.8.3 The benefit is Base Case crash costs minus Project Case crash costs

No further explanation is required.

2.9 Estimate externality benefits and costs

Steps

2.9.1 Apply default values

2.9.2 Estimate externalities specific to the initiative (if required)

2.9.3 The benefit (or disbenefit if negative) is the Base Case externality costs minus the Project Case externality costs

Externalities can be thought of as side effects of an initiative on third parties. Examples include noise, atmospheric and water pollution, climate change caused by greenhouse gas emissions, and severance (barrier effects). Since these effects are outside the price system, they are difficult to value in monetary terms. Nevertheless, significant progress has been made in recent years in the development of statistical and survey techniques to elicit people's valuations of environmental externalities (hedonic pricing, contingent valuation methods). However, these techniques are far from perfect and are resource intensive.

2.9.1 Apply default values

In rapid BCAs and in detailed BCAs where particular externality costs are not critical (that is, small in relation to total benefits and costs), use default values.

Default values are standard unit costs that can be applied across the board to obtain an estimate of externality costs. The level of approximation can be reduced if default values vary with population density (e.g. rural and urban) and for different intensities of the externality. Although only a rough guide, employing a default value for an externality is usually preferable to the alternative of giving it a zero value.

Use the default parameters in Appendix C. See Volume 5, Section 2.9 for the assumptions behind each externality value in Appendix C, and for steps for their application for each externality type.

The default values represent broad average values applicable to initiatives in all Australian jurisdictions. The list is not complete due to data inadequacies. The valuation of externalities is an evolving area of expertise, and the values should therefore be treated with caution. If these values are considered to be inappropriate for the initiative being appraised, use other values, providing a justification for their use and a sensitivity test using the Guidelines values.

The default values are expressed in common units of monetary value per vehicle-kilometre (vkm) travelled (cents/vkm) or per net tonne-kilometre (cents/ntk). Values are disaggregated for private cars, light trucks, medium trucks, heavy trucks and buses, and some are further disaggregated by location (urban and rural).

In order to employ default values in a BCA, use estimates of vkm for each vehicle type and location for the Base Case and Project Case for each year of the initiative's life. Multiply these by the default externality values.

2.9.2 Estimate externalities specific to the initiative (if required)

If, after using the default values, some externalities are significant, then, as part of a detailed BCA, consider undertaking modelling or survey work to identify externalities specific to the impacts of the initiative being appraised.

The first step will be to estimate the quantities of the externalities in physical terms for the Base and Project Cases.

The second step is to value the externalities. When valuing an externality, the aim is to find out how much the affected people are willing to pay to avoid the externality, or how much they are willing to accept to put up with it. Techniques to do this include hedonic pricing, stated preference surveys, and estimation of mitigation costs or damage and avoidance costs.

2.9.3 The benefit (or disbenefit if negative) is the Base Case externality costs minus the Project Case externality costs

If it is not possible to value an externality with default values or site-specific research, then describe the nature, size and impacts of the externality quantitatively in physical units, where applicable, and then qualitatively.

2.10 Discount benefits and costs, calculate summary results

Steps

2.10.1 Choose a discount rate
2.10.2 Assemble benefits and costs by time period
2.10.3 Calculate the NPV
2.10.4 Calculate the BCR
2.10.5 Calculate the incremental BCR (if applicable)
2.10.6 Calculate the internal rate of return (IRR) (if required)
2.10.7 Calculate the first-year rate of return (FYRR)
2.10.8 Calculate NPV for the financial analyses (if applicable)

2.10.1 Choose a discount rate

Discounting is necessary because a dollar of benefit in the future is worth less than a dollar of benefit today. BTE (1999b, p. 78) and BTRE (2005) recommend that the level of the discount rate be set at the long-term government bond rate. The value of the government bond rate in real terms can be obtained from the real yield for indexed bonds (see the Reserve Bank of Australia www.rba.gov.au). In practice, however, use the discount rate nominated by the funding jurisdiction.

2.10.2 Assemble benefits and costs by time period

Adopt an end-of-year convention for discounting purposes, where all benefits and costs are assumed to occur at the end of the year in which they occur.

Set 'year zero' at the time of the commencement of construction. Investment costs occurring during year zero are not discounted. Investments costs incurred during year one will be discounted by one year. Discount forward any investment costs (e.g. avoidable planning and design costs[5]) **incurred** prior to the commencement of year zero (years minus one, minus two and so on) by multiplying by $(1+r)^t$.

With the life of the initiative assumed to commence at completion of construction, the number of years over which discounting occurs will be larger than the initiative's life. For example, if an initiative takes two years to construct and has a 30-year life, there will be 32 years of benefits and costs to discount, the final year's net benefits being discounted by 31 years (the first year being discounted by zero years).

2.10.3 Calculate the NPV

The summation of all annual discounted present values of a stream of benefits or costs is called the 'present value' of that stream. The net present value (NPV) of an initiative is the difference between the discounted stream of benefits and the discounted stream of costs. The NPV is given by:

$$NPV = \sum_{t=0}^{n} \frac{B_t - OC_t - IC_t}{(1+r)^t}$$

where:

- t is time in years
- n is number of years during which benefits and costs occur
- r is the discount rate
- B_t is benefits in year t
- OC_t is infrastructure operating costs in year t, and
- IC_t is investment costs in year t.

A positive NPV means that the initiative represents an improvement in economic efficiency compared with the Base Case. Use the NPV to compare mutually exclusive options for the same initiative.

2.10.4 Calculate the BCR

The BCR is the present value of benefits minus operating costs divided by the present value of investment costs. That is:

$$BCR = \frac{PV(B-OC)}{PV(IC)} \quad \text{where} \quad PV(B-OC) = \sum_{t=0}^{n} \frac{B_t - OC_t}{(1+r)^t}, \text{ and } \quad PV(IC) = \sum_{t=0}^{n} \frac{IC_t}{(1+r)^t}.$$

A BCR greater than one implies a positive NPV.

The BCR measure is used to rank initiatives from an economic efficiency perspective where there is a budget constraint.

Never use BCRs to choose between mutually exclusive options for the same initiative, because they remove the effects of different scales of the initiatives.

5 Leave out any planning and design costs already occurred at the time of undertaking the BCA because they will not be affected by any decision to proceed with the initiative.

2.10.5 Calculate the incremental BCR (if applicable)

Instead of using the NPV to choose between mutually exclusive options, the incremental BCR (IBCR) can be used instead. It is defined as:

$$IBCR = \frac{PV(B_2-OC_2)-PV(B_1-OC_1)}{PV(IC_2)-PV(IC_1)}$$

where the subscripts represent options 1 and 2. The IBCR is best suited for comparing options involving different scales of initiative. Increases in the scale of initiative are worthwhile as long as the IBCR exceeds one. In a budget-constrained situation, do not accept increases in scale of the initiative with an IBCR below the cut-off BCR.

2.10.6 Calculate the internal rate of return (IRR) (if required)

Central agencies sometimes require reporting of the internal rate of return (IRR).

The IRR is defined as the value of the discount rate at which the NPV equals zero. It represents the minimum discount rate at which the initiative is viable in economic terms. There is no formula for the IRR. It needs to be found by iteration. Spreadsheet packages, such as Excel and Lotus 123, have functions that do this.

The IRR can be used in the same way as the NPV to indicate whether or not an initiative will be of benefit to society as a whole. It provides an indication of the economic worth of an initiative without requiring specification of a discount rate.

The IRR has no other uses. Never use the IRR to rank initiatives or to choose between mutually exclusive options as this amounts to comparing initiatives using different discount rates.

2.10.7 Calculate the first-year rate of return (FYRR)

The first-year rate of return (FYRR) is the level of benefits minus operating costs in the first year of operation of the initiative discounted to year zero, divided by the present value of investment costs. That is:

$$FYRR = \frac{B_{t_f}}{(1+r)^{t_f}} \Big/ \sum_{t=0}^{t_f-1} \frac{IC_t}{(1+r)^t}$$

where t_f is the first year of operation of the initiative.

The FYRR can indicate whether an initiative's optimal implementation time is in the past or future, and hence whether deferral is warranted. Provided the assumptions underlying the criterion are met (see Volume 5 for details), the optimal implementation time is the first year in which the FYRR is greater than the discount rate.

All initiatives should be subjected to the FYRR test and the result reported in the Business Case.

2.10.8 Calculate financial NPV for the financial analysis (if applicable)

The principles of discounting for financial analysis are the same as for BCA. The discount rate for financial analysis will be the weighted average cost of capital (WACC) from the point of view of the entity for which the financial analysis is being undertaken. WACC is calculated by multiplying the cost of each capital component by its proportional weighting and then summing:

$$WACC = \frac{E}{V} r_e + \frac{D}{V} r_d (1-T)$$

where:

r_e = cost of equity

r_d = cost of debt

E = the market value of the firm's equity

D = the market value of the firm's debt

V = E + D

E/V = percentage of financing that is equity

D/V = percentage of financing that is debt

T = the corporate tax rate.[6]

2.11 Assess risk and uncertainty

Steps

2.11.1 Undertake simple sensitivity analyses

2.11.2 Decide on the level of detail for a risk analysis

2.11.3 Identify risky variables and sources of risk

2.11.4 Assign alternative values to risky variables

2.11.5 Assign probabilities to events

2.11.6 Identify states of nature and associated probabilities

2.11.7 Calculate expected values of BCA results

2.11.8 Calculate probability-based values of investment costs if required

2.11.9 Use a computer program if the analysis becomes too complicated

2.11.10 Consider risk management strategies

All benefits and costs that go into a BCA are forecasts of the future. Risk and uncertainty arise from the possibility that a forecast will prove to be wrong.

Distinguish between downside risk and pure risk. Downside risk arises because people usually do not to consider what can go wrong, causing assessments to be biased in favour of the initiative. If downside risk has been eliminated from projections, the remaining variation about the expected value is called pure risk. In most cases, pure risk can be ignored in BCAs. See Volume 5, Section 2.11 or BTRE (2005) for an explanation.

For financial analyses, the weighted average cost of capital will include a risk premium. It compensates lenders and shareholders for bearing the risk that the firm will go bankrupt. It is not a mechanism to offset optimism bias in financial calculations.

Do not add a risk premium to the discount rate for BCAs. It can distort ranking of initiatives. See Volume 5, Section 2.11 or BTRE (2005) for an explanation.

2.11.1 Undertake simple sensitivity analyses

Sensitivity analysis is a simple way to analyse the uncertainty surrounding BCA results, but it is a limited tool. In its most basic form, it involves changing one variable at a time by a standard percentage, say, +10 per cent followed by -10 per cent, or by an absolute amount to gauge how much NPV changes. If the NPV changes by only a small amount (e.g. ±10 per cent change causes a ±3 per cent change in NPV), it implies that the uncertainty surrounding the variable is not very important and is not critical to decision-making. Conversely, if the affect on NPV is large in percentage terms, the robustness of the BCA can be called into question. It may be worthwhile to expend more resources to obtain a better estimate of the variable, though this will do nothing to reduce risk arising from inherent volatility of the variable.

6 Source: http://www.investopedia.com/terms/w/wacc.asp. Accessed 6 November 2006.

Choose the percentage variations used for sensitivity tests, bearing in mind the range of plausible values that a variable can take. The amounts the variables change by do not have to be symmetrical.

Table 2.4 shows the sensitivity ranges for road initiatives recommended by Austroads.

Spreadsheets are ideally suited to conducting sensitivity tests. Group the list of parameters likely to be tested in an easily accessed part of the spreadsheet (e.g. upper left corner).

Present the results in terms of percentage or absolute deviations in NPV and BCR in a table.

Table 2.4: Sensitivity variables and ranges recommended by Austroads

VARIABLE	SUGGESTED MINIMUM VALUE	SUGGESTED MAXIMUM VALUE
Capital cost [a]		
Concept estimate	–20% of estimate	+20% to 35% of estimate[b]
Detailed costing	–15% of estimate	+15% to 25% of estimate[b]
Final costing	–10% of estimate	+10% to 20% of estimate[b]
Road-agency operating and maintenance costs	–10% of estimate	+10% of estimate
Traffic		
Total traffic volume (AADT)	–10% to –20% of estimate	+10% to +20% of estimate
Proportion heavy vehicles	–5 percentage points	+5 percentage points
Average car occupancy	–0.3 from estimate	+0.3 from estimate
Traffic growth rate	–2% pa (absolute) from the forecast rate	+2% pa (absolute) to the forecast rate
Traffic generated by specific (uncertain) developments	Zero	As forecast
Traffic diverted or generated by the initiative	–50% of estimate	+50% of estimate
Traffic speed changes	–25% of estimated change in speed	+25% of estimated change in speed
Changes in crash rates	–50% of estimated change	+50% of estimated change

a. The appropriate range for capital costs depends on the detail of investigations, designs and costing. The concept estimate relates to initial pre-feasibility or sketch-planning estimates. The final costing relates to estimates after the final design stages.

b. The range of values relates to different types of initiative. Costing for more routine initiatives (e.g. road shape correction, resealing) are generally more accurate than those for larger initiatives (e.g. new motorway construction).

Source: Austroads 1996, p. 28; and 2005a, p. 27.

2.11.2 Decide on the level of detail for a risk analysis

The SMT and rapid BCA template requires proponents to address a series of questions about the risks of their proposed initiatives. Some of these relate to risks that the initiative will be delayed. There is a question about describing the major risks on the cost side (e.g. excess costs) and benefit side (e.g. where benefits are not realised). For the SMT and rapid BCA, it is not necessary to go further by conducting a state-contingent assessment as described here.

For detailed BCAs, governments reasonably expect a state-contingent analysis, which may require the use of computer software. The larger the initiative, the greater the level of detail warranted. Discuss the level of detail required with the government agency assessing the proposal.

The remainder of this section is concerned with the state-contingent approach. This approach helps to minimise downside risk or optimism bias, that is, to ensure that the results of BCAs are expected values (the means of probability distributions). It provides a thought process that disciplines the analyst to ask a complete set of 'what if?' questions.

2.11.3 Identify risky variables and sources of risk

The main sources of risk for investment initiatives are:

- construction costs that differ from the expected because of changes in input costs or unforeseen technical factors
- operating costs that differ from the expected because of changes in input costs or unforeseen technical factors
- demand forecasts that differ from the expected, a risk that rises the further into the future the projections are made
- environmental impacts that differ from the expected or are unforeseen, and
- network effects, where an asset is part of the network (for example, an individual length of road or rail track) and decisions made elsewhere in the network impact on the initiative in question.

2.11.4 Assign alternative values to risky variables

Identify the possible values, or ranges of values, that risky benefits and costs (or variables affecting them) can take. Technically, each value (or range of values) that a variable can take is called an event. Wherever possible, identify circumstances associated with each event (e.g. equipment breakdowns, adverse weather, technical difficulties, unanticipated environmental or planning requirements, industrial disputes, population levels).

Be wary of simply assuming a symmetrical probability distribution around the estimated value of a variable. This presupposes that the estimate is the central value and will not lead to proper consideration of sources of optimism bias.

It may help to prepare checklists based on experience, examine similar current or previous initiatives, hold a brainstorming session or compile historical information. An Environmental Impact Statement (EIS) should identify environmental risks. Exclude events with very small probabilities of occurring, taking into account the size of the probability and the impact on benefits or costs.

2.11.5 Assign probabilities to events

In most cases, make subjective judgments about probabilities. In some cases, historical data or engineering models can assist. For each risky variable, the probabilities of all possible events must sum to one.

2.11.6 Identify states of nature and associated probabilities

Next, identify all combinations of events that can occur (technically called 'states of nature'). Compiling an event tree can be a useful tool for this task (see Box 2.10). Then calculate the probability of each state of nature. The probability of a state of nature is the product of the probabilities of all the constituent events. The probabilities of all possible states of nature must sum to one.

2.11.7 Calculate expected values of BCA results

Each state of nature will be associated with a unique stream of year-by-year benefits and costs. Note that both the Base and Project Cases can vary in different states of nature because external factors such as the weather and economic conditions can affect both. Calculate BCA results (NPV, BCR, IRR and FYRR) for each state of nature. Multiply each result by the probability of the associated state of nature and sum to obtain expected values (see Box 2.10).

2.11.8 Calculate probability-based values of investment costs if required

Calculate probability-based values of investment costs if the funding jurisdiction requires it. An example is the P90 cost, the estimated cost level with only a 10 per cent chance of being exceeded. Note that the result is for information only. It is not an input to the BCA, except possibly as a sensitivity test.

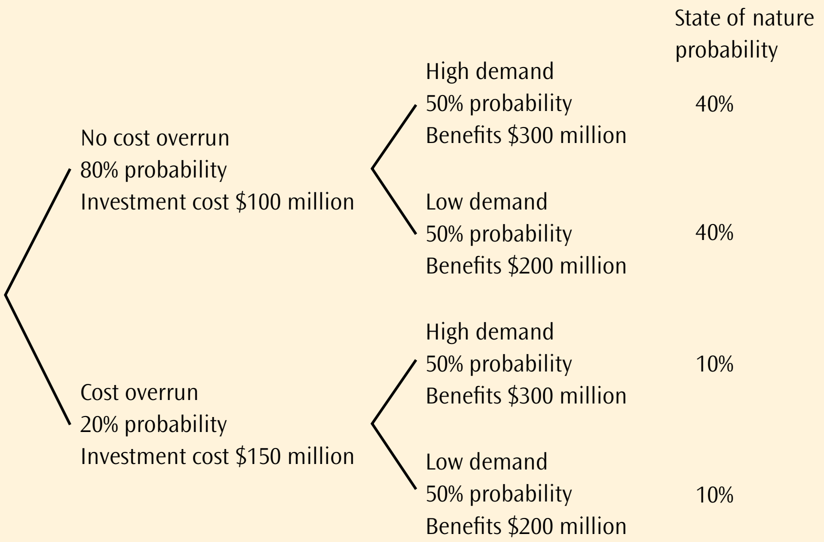
2.11.9 Use a computer program if the analysis becomes too complicated

Where the number of states of nature or the number of uncertain variables is large, the combinations of input values can become extremely large. To facilitate the process, use computer software packages such as @RISK. This software links with spreadsheet programs such as Excel and Lotus 123. The program allows probability distributions for continuous variables to be specified. See Austroads (2002) for guidance.

If computer software is used to estimate expected values of BCA results, the software will also provide estimates of the variances. Ignore the variances. For public sector initiatives, they are, in most cases, not relevant to decisions about whether initiatives should proceed or about ranking initiatives. See BTRE (2005) or Volume 5, Section 2.11 for an explanation.

Box 2.10: Example of calculation of expected NPV and BCR

The present value of investment costs for a new initiative is $100 million with an 80 per cent probability, and $150 million with a 20 per cent probability if major cost overruns occur. The present value of benefits is $300 million with high demand and $200 million with low demand with a 50:50 chance of either. The diagram shows the event tree and probabilities for the four states of nature.



The table shows calculation of the expected NPV and BCR.

INVESTMENT COST EVENT	COST ($m)	DEMAND EVENT	BENEFIT ($m)	PROB	NPV ($m)	PROB x NPV	BCR	PROB x BCR
No overrun	-100	High	300	0.4	200	80	3.0	1.2
No overrun	-100	Low	200	0.4	100	40	2.0	0.8
Overrun	-150	High	300	0.1	150	15	2.0	0.2
Overrun	-150	Low	200	0.1	50	5	1.3	0.1
Expected value						140		2.3

2.11.10 Consider risk management strategies

Consider changes to proposals that can increase expected NPVs by reducing either the probabilities or the costs of adverse events. Often, these changes will involve expending additional resources with certainty (e.g. building a stronger bridge). Use the state-contingent approach to assess the economic viability of each option and to compare options.

Deferring the initiative is a risk management strategy that can be assessed on an expected NPV basis. A wait-and-see approach could be adopted until the outcome of some uncertain future event is known.

2.12 Adjusted benefit–cost analysis

Steps

2.12.1 Determine whether an adjusted BCA is required

2.12.2 Determine which adjustments to make

2.12.3 Replace values for certain parameters with nominated values

2.12.4 Multiply specified benefits or costs by a weighting factor >1 to give the benefit or cost greater weight and <1 for less weight

2.12.5 Insert subjectively determined monetary values for particular non-monetised benefits or costs

2.12.6 Make percentage estimates of how the benefits are distributed among nominated groups

2.12.7 Calculate the distributional multiplier and adjust the benefits accordingly

2.12.8 Calculate adjusted NPV and BCR and report results

2.12.1 Determine whether an adjusted BCA is required

Section 1.5 explains adjusted BCA. The funding agency will decide whether using adjusted BCA methodology is necessary and if proponents of initiatives are to make any adjustments.

2.12.2 Determine which adjustments to make

Adjustments will fall into one or more of the categories set out in Sections 2.12.3 to 2.12.6.

2.12.3 Replace values for certain parameters with nominated values

The government agency to which the proposal is submitted will supply the adjusted parameter values.

2.12.4 Multiply specified benefits or costs by a weighting factor >1 to give the benefit or cost greater weight and <1 for less weight

The government agency to which the proposal is submitted will supply the weighting factors.

2.12.5 *Insert subjectively determined monetary values for particular non-monetised benefits or costs*

Subjectively determined money amounts may be set for one-off, non-monetised benefits or costs such as aesthetic impacts or effects on flora or fauna. Consult with the government agency to which the proposal is submitted to agree on the values. Obtain a thorough understanding of the impacts through consultation with other stakeholders and experts.

2.12.6 *Make percentage estimates of how the benefits are distributed among nominated groups*

If the funding agency decides to use a distributional multiplier, the first step is to estimate how the benefits are likely to be distributed among the nominated groups. Estimate the percentage of total benefits accruing to each group. Note that benefits can accrue well outside the geographical area of the initiative. The origins and destinations of passengers and freight benefiting from a transport improvement, and the vehicle mix, could be important indicators of how benefits are distributed. Because of the difficulty in forecasting distributional impacts of initiatives, the estimation process will inevitably involve judgement, more so in the rapid adjusted BCA stage. Consult with the funding agency about the calculations and judgements made in estimating distributions of benefits.

2.12.7 *Calculate the distributional multiplier and adjust the benefits accordingly*

Obtain from the funding agency the weights to be used for the nominated groups. For each group, multiply the weight by the estimated proportion of benefits accruing to the group, and sum the results. This is the distributional multiplier. See Box 2.11 for a simple worked example. Note that the distributional multiplier is applied to benefits only, not to benefits less infrastructure operating costs.

Box 2.11: Numerical example showing calculation of distributional multiplier for an adjusted BCA

In this example, benefits are split three ways. The distributional multiplier is 1.1.

	SHARE OF BENEFITS	WEIGHT	SHARE X WEIGHT
Metropolitan	30	0.5	0.15
Regional	50	1.5	0.75
National	20	1.0	0.2
Total	100		1.1

2.12.8 *Calculate adjusted NPV and BCR and report results*

Having adjusted individual benefits and costs according to Sections 2.12.3 and 2.12.4, sum the benefits less operating costs for each year, including any subjectively determined money values under Section 2.12.5. Do the same for investment costs. Multiply the benefits by the distributional multiplier if applicable (if the steps in Sections 2.12.6 and 2.12.7 were performed).

Finally, calculate the adjusted NPV and BCR.

2.13 Application to road initiatives

Road infrastructure improvements usually lead to savings in road-user costs by improving free speeds (the maximum speeds vehicles can achieve legally and safely without interference from other vehicles) or by increasing capacity.

Non-urban roads

Austroads (2005c; 2006) provides values for private and resource unit costs (e.g. $ per litre of fuel, $ per litre of lubricating oil, $ per tyre, vehicle repair, and maintenance costs in $ per kilometre travelled, and $ per hour of time). Values of time are provided for car passengers, truck drivers and freight. These values are recommended for use.

Make an assumption about the distribution of hourly traffic volumes over the year. Ideally, use site-specific information for the initiative. Data at this level of detail is not usually available, so assume a distribution based on data from a comparable site. For information on hourly volume distributions, see Austroads (2003a).

For non-urban roads, computer models such as HDM4 estimate road-user costs given infrastructure characteristics (e.g. number of lanes, lane widths, curvature, gradient, shoulder widths and so on), traffic level and vehicle mix. Austroads has tested the road-user cost parts of all major Australian non-urban road benefit–cost analysis models to ensure that they comply with a uniform standard (see Austroads 2005b for a discussion). To ensure credible estimates for road-user cost savings, use a model that meets Austroads harmonisation standards.

Town bypass initiatives

For town bypass initiatives, savings in road-user costs occur for traffic that continues to use the existing town road and for traffic that uses the bypass. First, obtain an estimate of the total amount of traffic that could potentially use the bypass. Traffic levels on the highway outside the town provide upper limits for through traffic. Origin–destination data is helpful for estimating through traffic. It is possible that some local traffic travelling from one end of the town to the other may use the bypass. A number-plate survey of traffic entering and leaving the town can reveal the amount of traffic that travels through the town without stopping (and therefore would definitely use the bypass), the amount of traffic that stops for a short time and continues on (and therefore *may* use the bypass), and the traffic that terminates in the town.

Then make an assumption about the proportion of total through traffic that will use the bypass. For traffic that stops for a short period of time, make an assumption taking into account the availability of alternative stopping places.

Use a non-urban road-user cost model to estimate road-user costs on the bypass. For traffic on the road through the town, options include use of the non-urban model with a speed constraint imposed or the simple urban vehicle- operating cost model in Austroads (2005c; 2006).

Urban roads

For non-urban road initiatives, network effects are either non-existent or very simple as in the town bypass case. In contrast, in urban areas, network effects are pervasive as drivers choose between alternative routes to minimise their travel times. Analysts use computer models of urban transport networks to estimate Project Case traffic levels and the savings in system-wide user costs on roads and other modes. Even for rapid BCAs, there may be little choice but to undertake some network modelling, if only at a high-level.

See Volume 4, Part 2 for a detailed treatment of urban transport modelling.

Ensure that the road-user costs predicted by the network model are at least broadly in line with the predictions of the simple model for estimating urban vehicle operating costs in stop–start and freeway conditions in Austroads (2005c; 2006). Volume 4, Part 1 provides unit costs for estimating costs of urban buses and values of time for passengers.

2.14 Application to rail initiatives

Rail infrastructure improvements usually lead to some combination of reduced costs (savings in train operating costs, infrastructure operating costs or maintenance costs) and improved service quality; for example, reduced transit times, more convenient departure times for customers, increased reliability or reduced damage to freight.

Part 4 in Volume 5 provides a list of computer models that can predict impacts of rail initiatives on train performance and costs. Models that simulate the motion of a single train can predict the impacts of improvements in track alignments and gradients on journey times and fuel consumptions (the 'free speed' stage in the four-step generic cost model presented in Section 2.6.1 of this volume).

Models of interacting trains take account of fast trains travelling behind slow trains and interactions at junctions and crossing loops as illustrated by train path diagrams (the congestion stage in the generic cost model presented in Section 2.6.1). As well as increasing times taken, train interactions will add to fuel consumption. Effects of improvements in alignments and gradients may still need to be passed on to a train interaction model to predict their final effects on train operating costs and journey times.

The harmonisation tests for cost models and the standard unit costs that exist for appraisal of road initiatives do not exist for rail. See Volume 5, Part 4 for some indicative rail cost information. Austroads (2005c; 2006) values of time for passengers may be employed with adjustments made for rail for the different mix of work and non-work passengers on trains, and the lower average incomes for non-urban rail passengers. Austroads (2003b, p. iii), the source of the value of time savings for freight reported in Austroads (2005c; 2006), states that the value for freight time derived in the study 'are likely to be applicable across all modes'. Volume 4, Part 1 provides unit costs for estimating costs of urban rail and tram services, including values of time for passengers.

Cost savings may not necessarily be passed on in full from the track manager to the train operator, or from the train operator to the customer. This is obviously important for financial analysis. It is relevant for BCA in so far as prices affect levels of diverted and generated demand.

Quality improvements directly benefit customers. However, a rail operator could capture part of the benefit from a quality improvement by charging a higher price.

2.15 Application to new services where traffic is diverted

When undertaking a BCA of an altogether new transport service, the gross benefit is the entire willingness-to-pay area under the demand curve. Measurement of the benefit requires knowledge of the demand curve over a substantial part of its length—information that is extremely difficult to obtain.

Where the source of the demand for the new service is traffic diverted from an existing service, estimate the combined benefit of the new service and benefits and costs in respect of the existing service (if such benefits or costs exist due to perceived prices differing from social generalised costs as discussed in Section 2.7) as:

- the total social generalised cost of use of the existing service by the diverting traffic (value of resources saved), minus
- the saving in total social generalised cost of use of the new service by the diverting traffic (value of additional resources consumed).

There are two vital points to note about applying this method (see Volume 5, Section 2.15 for detailed explanations):

- It takes full account of any benefits or costs in respect of the existing service from which traffic is diverted. Do not undertake the procedure in Section 2.7 for estimating benefits or costs from diverted traffic.
- The total social generalised costs for transferring traffic are for the traffic that actually transfers, not an average for all traffic using the existing service. The transferring traffic is likely to be at one end or the other of the distribution of values of quality attributes.

Time is the main quality attribute in generalised cost. The diverted users are unlikely to have the average values of time (and other quality attributes). Transport users have a distribution of values of time. Those users who divert from a faster, more expensive mode to a slower, cheaper mode (e.g. from road to rail) will be those at the low end of the distribution of values of time. The lowest value of time is zero. The highest value of time for diverting users is equal to the price reduction experienced by switching to the new service. Users with higher values of time will not switch to a slower, cheaper mode. Any value of time that exceeds the money price difference per hour of time saved is therefore invalid. A reasonable approximation of the value of time to the diverting users is half the money price difference per hour of time saved.

Where diversion is from a slower, cheaper service to a faster, more expensive service, the diverting users are those at the high end of the distribution of values of time. Market research is needed to discover just how high. The money price difference between the two services per hour of time saved provides a lower boundary to the value of time, because only users who value the time saving above the price increase they pay will divert. Use the money price difference per hour of time saved as the value of time, if no credible higher values are available.

An example to illustrate the potential benefits arising from a new service is shown in Box 2.12.

See the corresponding Section 2.15 in Volume 5 for discussion of estimating benefits from traffic generated by a new service (as distinct from traffic diverted as discussed above).

Box 2.12: Numerical example of using information on diverted traffic to estimate benefits from a new service

A new railway line will divert 100 000 tonnes of freight per annum from road transport. The social cost (not generalised) of carrying freight by road over the route is $100 per tonne. The social cost (not generalised) by rail is $60 per tonne.

The money prices charged for the task are $90 per tonne by road and $70 per tonne by rail. Consignors of freight save $20 per tonne by switching from road to rail, but they experience a reduction in service quality because rail is slower. The road trip takes 8 hours and the rail trip 10 hours. Consignors who value the two hours of additional time at amounts greater than $20 will not switch modes. Those who switch modes must consider the extra two hours to be valued between $0 and $20 per tonne, or between $0 and $10 per tonne per hour. In the absence of more concrete information about the value of time for transferring traffic, it is reasonable to assume that it averages out at $5 per tonne.

The social generalised costs for the diverting traffic is, for road, $140 per tonne = $100 + 8 hours × $5 and, for rail, $110 per tonne = $60 + 10 hours × $5.

The net benefit from the traffic diversion to the new service is therefore:

- saving in social generalised cost from reduced road use—$140 × 100 000 = $1.4 million, minus
- additional social generalised cost of rail use—$110 × 100 000 = $1.1 million.

The benefit from freight diverting to the new infrastructure is therefore 40.3 million per annum.

2.16 Application to flood immunity initiatives

Steps

2.16.1 Identify the benefits

2.16.2 Obtain primary flooding and traffic information

2.16.3 Estimate each benefit

Initiatives that improve flood immunity of road or rail infrastructure reduce the frequency and duration of closures due to floods, and the damage to the infrastructure. Benefits accrue to transport users, to producers and consumers dependent on transport and to road and rail infrastructure providers.

2.16.1 Identify the benefits

Potential benefits include savings in:

- waiting time
- diversion to alternative routes
- returning to the point of origin
- decisions not to travel or to delay travel
- use of air transport
- loss of perishable goods
- lost production
- demurrage of ships

- size of inventories
- wash away of transport infrastructure
- other short-term damage to transport infrastructure, and
- long-term damage to transport infrastructure.

Potential disbenefits include:

- causeways impeding flows of floodwaters resulting in the flood spreading, and
- improved access for heavy vehicles to saturated, damage-prone road pavements.

2.16.2 Obtain primary flooding and traffic information

Primary information requirements for appraisal of initiatives that improve the flood immunity of road or rail infrastructure are estimates of:

- the number of times the road or rail line is closed per year and the average duration of closure in days or hours, and
- the volume of traffic or trains for each day or hour of closure of the road or rail line with information about the traffic's characteristics; for example, proportions of cars and trucks by type; numbers and types of engines and wagons, tonnages, passenger numbers; and quantities and types of freight carried.

Where flooding is seasonal and road closure is regular and expected, as is the case in some far northern areas of Australia during the wet season, residents and businesses will be prepared for road closures. In these cases, it is important to use seasonal traffic flow data because many road users will not travel during the wet season.

Estimate proportions of traffic that will:

- wait
- divert to alternative routes, where alternatives exist
- turn back, and
- wait at their points of origin or not travel at all.

It may be possible to estimate some of these proportions by modelling transport-user choice between options based on the relative private generalised costs of the options. The longer the expected waiting time, the more traffic will divert to alternative routes. People en route will compare the lower of the costs of waiting and diverting (the two alternatives if they continue their journey) with the cost of turning back and returning later. The longer the road or rail closure, the greater the number of transport users who will have the opportunity to choose not to travel.

2.16.3 Estimate each benefit

As the list of potential benefits is long, refer to the corresponding Section 2.16 in Volume 5 for advice on how to estimate each of the benefits listed above.

2.17 Application to maintenance initiatives

Steps

2.17.1 Is the initiative maintenance or capital or a mixture of the two?

2.17.2 Do not assess rail maintenance for government funding

2.17.3 Do not assess routine road maintenance

2.17.4 Select a cost minimisation model for periodic maintenance

2.17.5 Calibrate and run the model

2.17.6 Find the set of treatments with a given marginal BCR (if applicable)

2.17.7 For combination capital and maintenance initiatives, treat the initiative as being one of either capital or maintenance

2.17.1 Is the initiative maintenance or capital or a mixture of the two?

Maintenance expenditures restore an existing asset that has deteriorated, part or all of the way up to its initial standard, or slow the rate of future deterioration. In contrast, capital expenditures create new infrastructure or raise the standard of existing infrastructure above its initial level. Some initiatives do both.

2.17.2 Do not assess rail maintenance for government funding

Undesirable incentives, which could lead to under-investment and below-optimum operating conditions, may result from governments funding rail maintenance and renewals.

An infrastructure operator with commercial objectives has no incentive to spend on maintenance if the government has agreed to pay for it. Furthermore, the operator can invest in lower-quality infrastructure that has higher maintenance costs, spend less on wheel and rail grinding that helps to preserve tracks, and allow trains to travel faster, placing greater strain on tracks.

Of course, government funding of rail capital initiatives can create incentives in the opposite direction to over-invest in infrastructure quality to save on maintenance costs. This needs to be taken into account by the government agency providing funding for capital initiatives during the identification and appraisal phases.

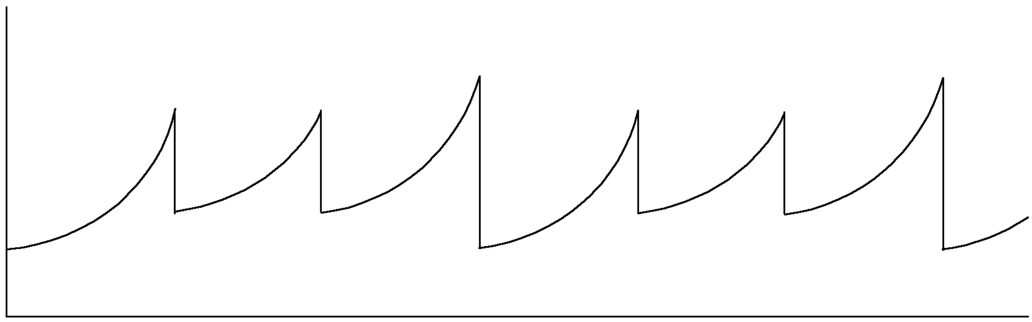
2.17.3 Do not assess routine road maintenance

As noted in Section 2.5, maintenance activities can be categorised into routine and periodic. Routine maintenance does not vary greatly from year to year. There is little to be gained from testing the economic worth of routine maintenance activities except possibly for standards applied across a network.

2.17.4 Select a cost minimisation model for periodic maintenance

Figure 2.2 shows how a bitumen pavement deteriorates over time, but rehabilitations (including complete reconstructions) considerably improve roughness or restore it to as-new levels. The rate of deterioration depends on the pavement strength, the standard of maintenance (reseals and patching), weathering and damage from vehicles.

Figure 2.2: Pavement cycles



It is not easy to specify a Base Case for maintenance initiatives because the alternative is not to do nothing, but, rather, to carry out a large range of possible combinations of maintenance treatments at different times. Life-cycle cost minimisation obviates the need to specify a Base Case. It aims to find the combination of treatments and timings that minimises the discounted present value of total social generalised costs. Social generalised costs here comprise road-user costs (which become larger as road condition deteriorates), costs to the road agency, delays to road users while maintenance works are being carried out and costs of externalities and crashes associated with maintenance activities and road condition.

Computer models that forecast road maintenance treatments for minimum social costs include HDM4, dTIMS, ARRB Group's Pavement Life Cycle Cost and PLATO models, and the BTRE's Road Infrastructure Assessment Model (RIAM) (at a strategic level only).

When using these models, set upper and lower bounds on either roughness levels or cycle lengths in order to avoid extreme solutions. Equity considerations or meeting community expectations about minimum road standards could also lead to upper bounds being imposed on roughness levels in models.

2.17.5 Calibrate and run the model

The model should already have a road-user cost sub-model within it—either a full model or a regression equation. Check to ensure the sub-model is in line with Austroads standards (see Section 2.13). The menu of treatments and the costs of the treatments may be unique to the jurisdiction or region. Some notional social costs for road maintenance are available in Austroads (2005c, p.2).

If imposing a budget constraint for a single segment of road considered in isolation, the constraint must take the form of a *present value* of future available funds. For a large number of segments at various stages of their life cycles being assessed together in a single modelling exercise, there is also the option of imposing a series of year-by-year constraints.

The result of the exercise will be a list of treatments with their optimal implementation times, for many years into the future.

2.17.6 Find the set of treatments with a given marginal BCR (if applicable)

There may be a need to estimate maintenance BCRs when:

- choosing between capital and maintenance initiatives if funds are constrained, or
- developing a maintenance program that achieves a given cut-off BCR (presumably the same as for capital spending to optimise the funding split between maintenance and capital works).

For a given road segment, first run a life-cycle cost minimisation model for a series of budget constraints (expressed as present values of road-agency costs). Increase the budget constraint by uniform amounts, starting with a low level, finishing when the constraint has ceased to matter (the point of unconstrained cost minimisation). As funding is increased, total social generalised costs should fall. For each pair of adjacent budget constraints:

$$\text{marginal BCR} = 1 - \frac{TSGC_2 - TSGC_1}{RAC_2 - RAC_1}$$

where *TSGC* is the present value of total social generalised costs comprised of road-user costs, road-agency costs and all other costs associated with maintenance works, and *RAC* is the present value of road-agency costs, that is, the budget.[7] The numerator and the denominator in this expression should have opposite signs.

The marginal BCR indicates the benefit to society from spending an additional dollar on road maintenance. It can be compared with the cut-off or marginal BCR of capital spending. Guidelines of some jurisdictions term it an incremental BCR.

Box 2.13: Numerical example of calculation of marginal BCR for maintenance

Say that for a segment of road, the budget for periodic maintenance is set at a present value of \$1.0m (RAC_1). A computer model tests a large number of alternative ways to spend the money with different combinations of treatments and timings. It finds that the lowest achievable present value of road-user costs is \$20.0m. The total social generalised cost ($TSGC_1$) is then \$21.0m.

If the budget is increased to a present value of \$1.1m (RAC_2) and the computer model is rerun, the lowest achievable present value of road-user costs is found to be \$19.5m. The total social generalised cost ($TSGC_2$) is then \$20.6m.

The additional \$0.1m present value spent on maintenance saves road users a present value of \$0.5m. The net benefit to society as a whole is an NPV of \$0.4m.

Applying the formula:

$$\text{Marginal BCR} = 1 - \frac{TSGC_2 - TSGC_1}{RAC_2 - RAC_1} = 1 - \frac{20.6 - 21.0}{1.1 - 1.0} = 1 - \frac{-0.4}{0.1} = 1.0 + 4.0 = 5.0$$

An additional dollar of present value spent on maintenance of this particular road segment produces a benefit to society as a whole of \$5.

2.17.7 For combination capital and maintenance initiatives, treat the initiative as being one of either capital or maintenance

Many road initiatives have capital and maintenance characteristics together—they *both* upgrade capacity and replace ageing infrastructure.

In these cases, first determine the optimal set of maintenance treatments for the road *without* any capital component (infrastructure improvement), subject to a marginal BCR constraint or budget constraint, if it exists in practice. This gives the Base Case for assessing the capital improvement. Then determine the optimal set of maintenance treatments in the Project Case by forecasting maintenance costs *with* the capital improvement.

The next step depends on whether the initiative is being treated as a maintenance or capital initiative. If the capacity expanding component is relatively minor (e.g. widening and

7 With RAC fixed, the life-cycle cost model will minimise the sum of road-user and all other relevant social generalised costs. If TSGC is split into RAC and road-user and other social generalised costs (RUOSGC), the formula becomes marginal BCR=

$$1 - \frac{(RUOSGC_2 + RAC_2) - (RUOSGC_1 + RAC_1)}{RAC_2 - RAC_1} = -\frac{RUOSGC_2 - RUOSGC_1}{RAC_2 - RAC_1}$$

rehabilitation), treat it as maintenance. If the maintenance component is relatively minor, treat it as capital. If the initiative is expected to result in significant diverted or generated traffic, it will be necessary to treat it as capital expanding in order to apply benefit–cost analysis. The cost minimisation approach applied to maintenance initiatives cannot take account of benefits from new traffic (see Volume 5, Section 2.17.4 for an explanation)

If the initiative is being treated as maintenance and a marginal BCR hurdle rate has been set, use the formula for marginal BCR in Section 2.17.6, but add the investment cost both to RAC_2 and $TSGC_2$. The savings in road-user costs from the capital improvement will feature in $TSGC_2–TSGC_1$ together with, and indistinguishable from, the savings in road-user costs from the maintenance improvement. The resultant BCR must exceed the maintenance hurdle rate for the initiative to be a worthwhile use of maintenance funds.

If the initiative is being paid for out of the capital fund, estimate the BCR in the usual way and use the BCR to rank the initiative against other initiatives. However, if budget constraints are expected to continue for maintenance in the future, the opportunity cost of a maintenance dollar saved could be greater than one dollar. For example, if the marginal BCR for maintenance is 3.0, a dollar of maintenance saved could be spent on other maintenance works that benefit society by $3. A saving of a present value of $1m in maintenance costs to the road agency is worth a present value of $3m to society as a whole. Where future maintenance costs are budget constrained, adjust maintenance savings in the BCA upward by a shadow price factor, μ, equal to the expected marginal BCR for maintenance in the future. See Volume 5, Section 2.10.4 for a discussion of the use of a shadow price factor for infrastructure operating costs where they are budget constrained.

Box 2.14: Numerical example of BCR Calculation for combination capital–maintenance initiative

A combination maintenance and capacity expanding road initiative has an investment cost of $30m. The present value of optimised maintenance costs to be incurred by the road agency is $50m in the Base Case and $30m in the Project Case, so there is a maintenance benefit of $20m. The present value of road-user costs is $300m in the Base Case, reducing to $270 in the Project Case—a road-user benefit of $30m. There is no diverted or generated traffic.

The present value of total social generalised cost in the Base Case is $350m, consisting of $50m maintenance costs and $300m road-user costs. Total social generalised cost in the Project Case is $330m, made up of the $30m investment cost, $30 maintenance costs and $270m road-user costs.

If the initiative is treated as maintenance, the marginal BCR can be estimated as follows:

$$\text{Marginal BCR} = 1 - \frac{TSGC_2 - TSGC_1}{RAC_2 - RAC_1} = 1 - \frac{(30+30+270)-(50+300)}{(30+30-50)} = 1 - \frac{-20}{10} = 3.0\ .$$

If the initiative is treated as capital, NPV is given by – investment cost ($30M) + road-user benefit ($30M) + μ × maintenance benefit ($20M). If the marginal BCR for maintenance funding μ is 3.0, then the NPV is $60m.

The BCR will be $\frac{(30-270)+\mu(50-30)}{30} = \frac{30+\mu 20}{30}$. If μ = 3.0, then BCR = 3.0.

This shows that the two approaches are equivalent if the initiative achieves the marginal BCR when treated as a maintenance initiative. However, in practice, particularly if the capital component is significant, the marginal BCR estimated using the maintenance formula could exceed μ.

2.18 Application to private sector participation: toll roads and leveraging

Steps

2.18.1 Identify impacts of private sector participation on BCA

2.18.2 Adjust the BCA for toll impacts

2.18.3 Estimate the 'BCR of leveraging' (where leveraging will ease the budget constraint)

2.18.4 Estimate 'leverage-adjusted BCR' (where the proposal will divert funds from more attractive government investments)

2.18.1 Identify impacts of private sector participation on BCA

Compared with the option of full public provision, private sector participation can affect the economic attractiveness of an initiative in four ways:

1. Imposing a toll, or other additional charge, will alter the perceived price paid by users, which affects infrastructure usage. This in turn affects benefits and costs.
2. The private sector may be able to undertake certain tasks better than the public sector (lower social costs).
3. Private sector funding can free up scarce government funds for other uses, including other infrastructure initiatives.
4. Private sector participation can allow implementation of initiatives that have BCRs too low to attract full government funding, but still above one. With a BCR above one, society is better off with the initiative being implemented compared with the alternative of it not being implemented.

2.18.2 Adjust the BCA for toll impacts

Add tolls to the perceived prices for use of tolled roads and re-estimate traffic levels throughout the network.

If the toll functions as a congestion price, bringing perceived prices nearer to marginal social generalised costs, there could be some additional benefit compared with the untolled situation. In contrast, on an uncongested road, a toll could reduce benefits to the extent that it causes the perceived price on the tolled road to exceed marginal social generalised cost.

Consider whether the toll splits the traffic by value of time. A toll on a freeway that bypasses a congested alternative route, or routes, could divert road users with relatively high values of time onto the toll road, and discourage low-value users. In this situation, if the average value of time for all traffic is used to estimate the benefits accruing to users of the toll road, the benefits could be underestimated.

To allow for traffic splitting by value of time, assume a frequency distribution of values of time for road users within each vehicle class—cars grouped by work and non-work and by number of occupants, and freight vehicles by type and value of freight carried. A vehicle will use the toll road if its value of time (including perceived vehicle operating costs converted to a time basis) exceeds a critical value: $v^*=\pi/(t_1-t_2)$ where π is the toll, t_1 is the lowest achievable time taken on alternative routes, and t_2 is the time taken on the tolled road ($t_2<t_1$). Make a separate benefit calculation for each value-of-time bin in the frequency distribution for each vehicle class.

2.18.3 *Estimate the 'BCR of leveraging' (where leveraging will ease the budget constraint)*

Use the 'BCR of leveraging' to test whether private sector participation in a road initiative is desirable on economic grounds.

Recalculate benefits and costs allowing for:

- the effects of tolling or additional charges as discussed in Section 2.18.1
- the costs of tolling (administration, capital and operating costs of equipment including toll booths, delays to vehicles stopping at toll booths), and
- any operating efficiencies achievable by the private sector that the public sector is unable to match.

The private sector option is preferred if the BCR of leveraging exceeds one, that is:

$$\frac{p(\mu-1)}{\beta_g-\beta_p} > 1$$

where:

- p = the proportion of the initiative's capital cost funded by the private sector
- μ = the marginal BCR (the cut-off BCR or BCR of the marginal project)
- β_g = the BCR of the initiative fully funded and operated by the government, and
- β_p = the BCR of the initiative with private sector involvement and tolling.

The decision rule tests whether the gain from having additional funds available to spend on other transport initiatives outweighs the loss of benefits from tolling less cost savings from more efficient private sector operation. The role of μ in the formula is to account for the gain to society that accrues from the private sector's contribution, freeing up scarce government funds to spend on other transport initiatives having BCRs of around μ. See Box 2.15 for a numerical example.

The value of μ is known only to the government. It is therefore the role of the government, not the proponent of the initiative, to perform the test.

Box 2.15: Numerical example of BCR of leveraging

Say that after ranking initiatives, an initiative that just missed out had a BCR of 2.5 and a cost of \$100m. The cut-off BCR, μ, is 2.5. A private sector contribution of \$100m to undertake a more highly ranked initiative frees up government funds to undertake this lower ranked initiative, generating a net gain to society of \$150m = \$100m × 2.5 – \$100m.

Say that the more highly ranked initiative costs \$200m, has a BCR of 4.0 (β_g) untolled (without leveraging) and has a BCR of 3.5 (β_p) tolled (with leveraging). A decision to leverage causes society to forgo \$100m = (4.0–3.5) × \$200m.

Taking both impacts together, society is better off by \$50m = \$150m – \$100m with leveraging.

Since the private sector contributes \$100m towards the \$200m leveraged initiative, the value of *p* is 0.5.

Using the formula, the decision to leverage is found to be warranted on economic grounds because the BCR of leveraging:

$$\frac{p(\mu-1)}{\beta_g-\beta_p} = \frac{0.5x(2.5-1)}{4.0-3.5} = 1.5>1 .$$

2.18.4 *Estimate the 'leverage-adjusted BCR' (where the proposal will divert funds from more attractive government investments)*

If the BCR for an initiative with and without private sector participation is below the cut-off BCR ($\beta_p < \mu$ and $\beta_g < \mu$), the initiative will miss out on government funding. However, provided the BCR with private sector participation is still above one ($1.0 < \beta_p < \mu$), society may still be better off if the initiative is implemented compared with the alternative of missing out on the initiative altogether.

If $1.0 < \beta_p < \mu$, society is better off implementing the initiative provided that the leverage-adjusted BCR is greater than the marginal or cut-off BCR, that is:

$$\frac{\beta_p - p}{1-p} > \mu \, .$$

The decision rule tests whether the net benefits from the initiative outweigh the opportunity cost of the government contribution in terms of forgone spending on initiatives with BCRs of around μ.

Box 2.16: Numerical example of leveraging-adjusted BCR

Say the cut-off BCR, μ, is 2.5. The government would not normally fund an initiative with a BCR (without tolling) of 2.2 (β_g). Say this initiative costs \$100m and the private sector offers to fund half of the initiative ($p = 0.5$). With tolling, the initiative has a BCR of 2.0 (β_p). The net gain to society from implementation of the initiative with leveraging is then \$100m = \$100 × 2.0 – \$100m.

However, the government's contribution comes at the expense of other initiatives having BCRs of 2.5. Diverting the \$50m to the leveraged initiative causes society to forgo \$75m = \$50m × 2.5 – \$50m in benefits.

Taking both impacts together, society is better off by \$25m = \$100m – \$75m with the leveraging initiative being implemented.

Using the formula, the decision to implement the leveraged initiative, at the expense of other more highly ranked initiatives, is found to be warranted on economic grounds because the leverage-adjusted BCR:

$$\frac{\beta_p - p}{1-p} = \frac{2.0-0.5}{1-0.5} = 3.0 > \mu = 2.5 \, .$$

Note that the approaches in Sections 2.18.3 and 2.18.4 treat the amount of government funds available for transport initiatives as being rigidly constrained. If funds are not constrained, all initiatives with a BCR greater than one can be implemented. Consequently, there is no advantage from private sector participation increasing the total amount of funding available, nor a disadvantage from the government contribution diverting funds from higher-BCR projects. Decisions about whether or not to leverage can be made by comparing β_p and β_g.

The discussion in Sections 2.18.3 and 2.18.4 also assumes that investment costs are the same with and without leveraging. If they are not, comparisons between options must be undertaken on an NPV basis, allowing for an opportunity cost of the marginal dollar of government funds of μ.

2.19 Application to private sector participation: public sector comparator

Steps

2.19.1 Determine whether the public sector comparator model (PSC) is applicable

2.19.2 Specify a reference project

2.19.3 Develop a raw PSC

2.19.4 Make competitive neutrality adjustments

2.19.5 Undertake a comprehensive risk assessment and analysis

2.19.6 Categorise the risks into transferable and retained risks

2.19.7 Categorise private sector proposals into conforming and non-conforming

2.19.8 Calculate the total cost or net cash flow for a whole private sector proposal

2.19.9 Compare the PSC and the various private sector proposals to determine best outcome

2.19.1 Determine whether the public sector comparator model is applicable

There are three major differences between the PSC and BCA methodologies:

1. BCA asks whether an initiative should proceed. It can also help with making choices between options offering different types and levels of service. The PSC cannot inform a decision about whether an initiative should proceed. The PSC takes as given: (a) that the initiative will proceed, and (b) the type and level of service to be provided. It helps to identify and choose between options for private sector participation, including the option of no private sector participation at all.
2. BCA aims to maximise benefits minus costs. The PSC aims to minimise the cost of providing a given service. It is a cost-effectiveness analysis.
3. BCA aims to maximise net economic benefits for *society as a whole*. The PSC aims to minimise costs to the *government*. Hence, it is a form of financial analysis. It could be described as a financial cost-effectiveness analysis. It could be argued that an economic cost-effectiveness analysis is preferable. The counter argument is that the heavy demands for government funds and tight budgets lead governments to focus on the budgetary costs of service delivery.

Undertaking a BCA precedes using the PSC to help determine the best method of delivery. The PSC is one of the 'other analyses' shown in the Figure 1.1 flowchart in Part 1 of this volume. Development of the PSC is the role of the government agency administering funding, not the initiative proponent.

Development of a PSC for an initiative is a complex task. The material presented in the Guidelines is aimed at giving users an overview only. To use the tool, consult detailed PSC guidelines and seek expert advice.

Start to develop the PSC early on in the appraisal process in broad terms, updating and augmenting it as options are refined and the detailed BCA proceeds. Include the final version of the PSC analysis in the Business Case. Undertake independent audits of the PSC and of the comparisons with private sector proposals.

2.19.2 Specify a reference project

A reference project provides the specified level and quality of service on the assumption that it is delivered by a state-owned corporation. It includes specification of the financing, design, construction, maintenance and operation of an initiative (e.g. tolled motorway) for the indicated concession period.

2.19.3 Develop a raw PSC

The raw PSC provides the base costing of the reference project, that is, under the public procurement method. It includes all capital and operating costs and revenue associated with designing, building, owning, maintaining and delivering the service. Being a financial analysis, the PSC includes only cash flows, not depreciation. It does not include any valuation of risks, so values of costs and revenues are likely to be biased.

The discount rate used should be the cost of capital to the government. The bond rate is applicable if the government could be assumed to be able to borrow at that rate without restriction. However, if the amount the government can borrow is restricted and borrowing at the bond rate to fund one initiative comes at an opportunity cost of greater reliance on private sector funds for other initiatives, then a WACC to the government should be used. The discount rate for the PSC should be risk-free because risk is taken account of explicitly in the analysis. See Volume 5, Section 2.19.3 for more explanation. Seek advice on the discount rate to use from the treasury or finance department in the funding jurisdiction.

Note that being a financial analysis, the PSC will be undertaken in nominal terms, so a nominal discount rate will be employed.

2.19.4 Make competitive neutrality adjustments

Remove any net competitive advantages or disadvantages that accrue to a government business by virtue of its public ownership. Advantages from public ownership typically include taxes, such as land and company tax, which are levied on private enterprises only. Disadvantages typically include regulatory costs such as greater reporting requirements imposed on public sector enterprises. Adjusting for competitive neutrality means that taxes levied only on private firms are added in, and additional regulatory costs imposed on public enterprises deducted.

2.19.5 Undertake a comprehensive risk assessment and analysis

Use the state-contingent approach outlined in Section 2.11 to obtain expected values of individual cost and revenue items and for overall results.

2.19.6 Categorise the risks into transferable and retained risks

Transferable risks are those that a private sector organisation is likely to be able to manage better than the public sector. Examples include risks relating to construction and operating costs. Retained risks are those that government imposes on itself; for example, risks arising from possible changes in the scope of the initiative, changes in laws, and government decisions to implement other proposals.

The difference between the expected value of a cost or revenue item and the base value in the raw PSC is a measure of the cost of the risk. Using this measure, the total financial transaction consists of:

Raw PSC + competitive neutrality adjustments + transferable risk + retained risk.

Transfer of a risky cost to the private sector is preferable where the price the private sector charges for incurring the cost is less than the expected value of the cost if it was borne by the government. The PSC can therefore assist governments in negotiations with the private sector about which risks it should bear, and at what price.

2.19.7 Categorise private sector proposals into conforming and non-conforming

Conforming proposals have the same set of risk transfers as the PSC. Full consideration should still be given to non-conforming proposals because they may offer better outcomes than the conforming proposals.

2.19.8 Calculate the total cost or net cash flow for a whole private sector proposal

When calculating the total cost, or net cash flow, for a whole private sector proposal, value costs borne by the private sector at their net cash flows *to the government*; that is, the amounts the government pays to the private sector to bear the transferred risks. Deduct any payments made to the government. Value costs not borne by the private sector (risks retained by the government) at their expected values as estimated in the PSC exercise as the PSC aims to minimise costs to the government.

2.19.9 Compare the PSC and the various private sector proposals to determine best outcome

When comparing whole private sector proposals with the PSC, compare on the basis of cost minimisation. An exception occurs where the proposal involves significant revenues accruing to the government. The comparison is made on the basis of net cash-flow maximisation.

Consider also any non-monetised differences between private sector proposals and service provision by the government.

2.20 Post-completion evaluation

Steps

2.20.1 Determine what is to be evaluated
2.20.2 Determine the standards of comparison
2.20.3 Determine the depth and frequency of post-completion evaluation
2.20.4 Appoint evaluators
2.20.5 Collect and assess data, prepare report
2.20.6 Undertake ex-post BCAs of selected initiatives

Post-completion evaluation of individual initiatives, or of entire programs, provides lessons from past experience that can lead to improvements in the capital investment process for the future. See Volume 2, Phase 8 for a broader discussion of performance review.

2.20.1 Determine what is to be evaluated

First, determine the subject of the evaluation. It could be a single initiative, a group of initiatives that have something in common, or a whole investment program. Second, decide on the stage, or stages, of the decision and implementation processes that are to be evaluated. Table 2.5 lists the stages that might be evaluated, in line with Figure 1.1 in Part 1 of this volume.

2.20.2 Determine the standards of comparison

Post-completion evaluations can be applied to the process that led to the outcomes and to the outcomes themselves.

Process reviews look at how the outcomes were achieved. The outcome reviews can point to whether or not a process has worked well. But bear in mind that a faulty process can still produce a good outcome, due to luck.

Outcome reviews involve comparing actual with predicted outcomes. For an outcome review, the standards of comparison are external standards of desirable attributes of outcomes (e.g. correct BCA methodology) and benchmarks or forecasts established during a previous process. To streamline post-completion evaluations, set the benchmark levels during the appraisal and design stages (e.g. construction costs, physical quantities and unit costs of inputs, timing of construction, operating costs, demand levels, revenues, benefits, environmental impacts).

Carry out process and outcome reviews simultaneously for a single stage so that any process-related reasons for successes or failures can be explored. The outcome review at one stage can point to process issues in earlier stages.

Table 2.5 lists the stages at which process and outcome reviews can be undertaken and shows sources for standards of comparison for outcome reviews.

Table 2.5: Types of post-completion review

PROCESS REVIEW	OUTCOME REVIEW	
	Actual outcomes	**Sources of predicted outcomes**
Identification, consideration of options	Initiatives identified	Government strategy documents, stakeholder views of options
Appraisal	BCA, SMT, other analyses, Business Case	Guidelines, knowledge of correct methodologies, Austroads publications, government strategy documents
Recommendation	Recommendation for or against	Business Case
Planning and design, budget development	Detailed specification of initiative, scope, cost estimates, risks during implementation stage	Business Case, design guidelines
Delivery	Initiative in place, actual costs	Business Case, plans and designs, budget
Operation	Performance	Business Case

The timing of the evaluation matters. A stage in Table 2.5 can be evaluated only after the stage has been completed. For the initiative operation stage, allow time to establish levels and trends with adequate certainty, and be selective about the variables assessed so as to avoid premature comparisons.

2.20.3 Determine the depth and frequency of post-completion evaluation

Subject all initiatives to some basic level of post-completion evaluation using benchmarks set during the appraisal and design phases.

To make best use of limited resources available for post-completion evaluation, for detailed evaluations, select initiatives that are:

- large
- appear to have gone badly or exceptionally well
- a recurring type of initiative
- particularly risky, including pilot initiatives for testing innovations

- strategically important
- long-term, undertaking interim evaluations, say, annually
- staged, undertaking evaluations of each stage, or
- programs involving a series of smaller initiatives.[8]

2.20.4 Appoint evaluators

- Independent evaluators should be appointed — do not allow those responsible for the initiative to evaluate their own work.

2.20.5 Collect and assess data, prepare report

Having discovered where process or outcomes are good or poor, look for the reasons for the results. Separate consequences of internal management and planning processes from impacts of external factors. Aim to identify lessons for the future; do not allocate blame for past mistakes or state what should have been done with the benefit of hindsight. Where external factors had an adverse impact, consider whether actions should be taken in the future to mitigate such occurrences.

Be wary of making recommendations for major changes to processes based on a single post-completion evaluation. Keep the recommendations in broad terms, suggesting a direction for change.

2.20.6 Undertake ex-post BCAs of selected initiatives

An ex-post BCA compares the actual outcome with a hypothetical Base Case in which the initiative does not exist. The central question is, 'With hindsight, how strong was the economic justification for the initiative?'

The original BCA could be used as the basis for the ex-post analysis by replacing the assumptions (costs, demand forecasts) with actual outcomes. Project the current level of demand forward for the remaining life of the initiative. This type of exercise serves a secondary purpose of providing a review of the original BCA.

An ex-post BCA may be accompanied by an assessment of the broader impacts of the initiative — regional, environmental, social, financial.

8 Based on Austroads (2005d, p.4).

APPENDIX

C

Default externality values

Table C.1: Passenger vehicles c/vkm

EXTERNALITY *	URBAN	RURAL	SOURCE
Air pollution (primarily petrol) *a *b	2.45	0.02	Updated Pratt (2002)
Greenhouse/climate change (primarily petrol)	0.30	0.30	Updated Pratt (2002)
Noise *b	0.78	0.00	Austroads (2003c; 2006)
Water	0.37	0.037	Modified Pratt (2002) & Austroads (2006)
Nature and landscape	0.33	0.11	Austroads (2006)
Urban separation	0.56	0.00	Austroads (2003c; 2006)

* All costs are adjusted to 2005 $A.

*a Assume Watkiss (2002) $/tonne for carbon monoxide, oxides of nitrogen, particulate matter and total hydrocarbons (population weighted average).

*b Assume urban value for rural towns.

Table C.2: Freight vehicles (Urban) c/ntkm

EXTERNALITY *	LIGHT	MEDIUM	HEAVY	SOURCE
Air pollution (primarily diesel) *a *b	24.69	4.68	0.97	Updated Pratt (2002)
Greenhouse/climate change (primarily diesel)*c	1.73	0.20	0.07	Updated Pratt (2002)
Noise	2.56		0.26	Austroads (2003c; 2006)
Water	3.7		0.1	Modified Pratt (2002) & Austroads (2006)
Nature and landscape	1.67		0.26	Austroads (2006)
Urban separation	2.45		0.22	Austroads (2006)

* All costs are adjusted to 2005 $A.

*a Assume Watkiss (2002) $/tonne for carbon monoxide, oxides of nitrogen, particulate matter and total hydrocarbons (population weighted average).

*b Assume urban value for rural towns.

*c Greenhouse costs are based on $10/tonne carbon dioxide equivalent.

Table C.3: Freight vehicles (Rural) c/ntkm

EXTERNALITY *	LIGHT	MEDIUM	HEAVY	SOURCE
Air pollution (primarily diesel)*a *b	0	0.05	0.01	Modified Pratt (2002)
Greenhouse/climate change*c	1.73	0.20	0.07	Updated Pratt (2002)
Noise*b	0.00		0.026	Austroads (2006)
Water	0.04		0.06	Modified Pratt (2002) & Austroads (2006)
Nature and landscape	0.02		0.11	Austroads (2006)
Urban separation	0.00		0.00	Austroads (2006)

* All costs are adjusted to 2005 $A.
*a Assume Watkiss (2002) for $/tonne carbon monoxide, oxides of nitrogen, particulate matter and total hydrocarbons (population weighted average).
*b Assume urban value for rural towns
*c Greenhouse costs are based on $10/tonne carbon dioxide equivalent

Table C.4: Public transport (buses only c/vkm)

EXTERNALITY	BUSES (URBAN)	BUSES (RURAL)	SOURCE
Air pollution (primarily diesel) *a *b	19.1	0	Updated Pratt (2002)
Greenhouse/climate change (primarily diesel) *c	0.83	0.83	Updated Pratt (2002)

* All costs are adjusted to 2005 $A. Note: Further work on these values is required and they should be treated with caution. These values are initial estimates only and have not been adjusted for vehicle occupancy.
*a Assume Watkiss (2002) for $/tonne carbon monoxide, oxides of nitrogen, particulate matter and total hydrocarbons (population weighted average). Estimates may also be higher due to $/tonne costs applied.
*c Greenhouse costs are based on $10/tonne carbon dioxide equivalent.

Table C.5: Rail calculations (urban values only) c/ntkm

EXTERNALITY	RAIL	SOURCE
Air pollution *a	0.33	Updated Pratt (2002)
Greenhouse/climate change *b	0.03	Updated Pratt (2002)
Noise	0.14	Laird (2005)
Water *c	0.01	Modified Infras/IWW (2000)
Nature and landscape *c	0.08	Modified Infras/IWW (2000)
Urban separation *d	0.08	Modified Infras/IWW (2000)

* All costs are in 2005 $A.

*a and *b applies the calculation methodology adopted in BTE (1999a) for heavy trucks only.

*c Estimated by scaling Infras/IWW (2000) nature value for heavy duty vehicles and rail freight.

*d Estimated by scaling Infras/IWW (2000) urban value for heavy duty vehicles and rail freight.

If these parameters are considered inappropriate for the initiative, use other values with a justification and a sensitivity test using the above values.

For further discussion on the assumptions and steps for application for the above parameters, see Section 2.9 in Volume 5.

APPENDIX

D

Abbreviations

ABS	Australian Bureau of Statistics
ALGA	Australian Local Government Association
AST	Appraisal Summary Table
ATC	Australian Transport Council
BCA	Benefit–cost analysis
BCR	Benefit–cost ratio
BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
BTRE	Bureau of Transport and Regional Economics
COAG	Council of Australian Governments
COBA	Cost Benefit Analysis. Method/software for calculating transport economic efficiency figures
DOTARS	Department of Transport and Regional Services
DTEI	(South Australian) Department for Transport, Energy and Infrastructure
EIS	Environmental Impact Statement
FYRR	First-year rate of return
GDP	Gross Domestic Product
GST	Goods and Services Tax
IBCR	Incremental benefit–cost ratio
IRR	Internal rate of return
ITS	Intelligent transport systems
NPV	Net present value
NPV/K	NPV per $ of capital cost
OIT	Objective impact table
PCE	Post-completion evaluation

PSC	Public sector comparator
PV	Present value
PVB	Present value of benefits
PVC	Present value of costs
RAC	Road-agency cost
RIAM	(BTRE's) Road Infrastructure Assessment Model
RUM	Road-user movement
RUOSGC	Road-user and other social generalised costs
SA	South Australia
SASP	South Australia's State Strategic Plan
SCOT	Standing Committee on Transport
SMT	Strategic Merit Test
TBL	Triple bottom line
TSGC	Total social generalised cost
UDP	Unitary Development Plan
UK	United Kingdom
WA	Western Australia
WACC	Weighted average cost of capital
WTP	Willingness-to-pay

APPENDIX

E

Glossary

Adjusted benefit–cost analysis	The adjusted BCA technique is a hybrid of the BCA and multi-criteria analysis techniques. It produces an alternative ranking of initiatives with objectives given different weights from the weights implicit in standard BCAs. Adjusted BCA retains the dollar measuring rod of standard BCA. The relative significance of particular benefits and costs is altered by adjusting them using subjectively determined weights.
Appraisal	Process of determining impacts and overall merit of a proposed initiative, including the presentation of relevant information for consideration by the decision-maker. Undertaken in Phase 5.
Area	Defined geographic space and all the transport routes within it. Incorporates the pathways that enable the movement of people and freight between the diverse and multi-directional set of origins and destinations within the area. Most relevant in urban settings.
Assessment	Generic term referring to quantitative and qualitative analysis of data to produce information to aid decision-making.
Average Annual Daily Traffic (AADT)	Total number of vehicles passing a point on a road in a year divided by 365 (or 366 for a leap year).
Base Case	A BCA is always a comparison between two alternative states of the world. The Base Case is the state of the world in the absence of the initiative being implemented. The Project Case is the state of the world with the initiative being implemented.
Benefit–cost analysis (BCA)	Analysis of the benefits and costs to society of a proposed initiative. Aims to value benefits and costs in monetary terms and provide a summary indication of the net benefit. Mainly undertaken in Phase 5 of the Framework.
Benefit–cost ratio (BCR)	Ratio of the present value of economic benefits to the present value of economic costs of a proposed initiative. Indicator of the economic merit of a proposed initiative presented at the completion of benefit–cost analysis. Commonly used to aid comparison of initiatives competing for limited funds.

Business Case	A document that brings together the results of all the assessments and analyses undertaken of a proposal for an initiative. It is the formal means of presenting information about a proposal to aid decision-making. It includes all information needed to support a decision to proceed with the proposal and to secure necessary approvals from the relevant government agency.
Challenge	Reason for action that results from a gap between actual and desirable outcomes. In this document, used as a generic term that covers related terms such as problem, issue, deficiency, opportunity and need.
Congestion pricing	The policy of charging drivers a fee that varies inversely with the level of traffic on a congested roadway. The aim of congestion pricing is to ensure that, when roadway space is a scarce resource, it is allocated efficiently between competing users. It is also known as variable pricing and, in the US, as value pricing.
Consumers' surplus	The surplus of consumers' willingness-to-pay over and above what they actually pay for a given quantity of a good or service. It is measured as the willingness-to-pay area under the demand curve above the price paid.
Corridor	The parallel or competing modal routes between two locations (e.g. road and rail routes between two capital cities). A corridor is multi-modal where more than one mode operates, and uni-modal where only a single mode operates (e.g. in many rural areas).
Corridor/area strategy	A cooperative long-term plan that identifies the transport challenges within a corridor or area and the potential initiatives and priorities to meet those challenges. Mainly developed in Phase 3.
Default values	Standard unit costs that can be applied across the board to obtain an estimate of externality costs, if more appropriate values for a particular situation are not available. Employing a default value is usually preferable to the alternative of giving it a zero value.
Demand forecasting	Estimating transport demand in a particular year or over a particular period. Undertaken in Phases 3 and 5.
Depreciation	The amount that an asset reduces in value over one year, due to wear and tear or environmental factors. Adapted from the Macquarie Dictionary.
Discount rate	The interest rate at which future values are discounted to the present and vice versa.
Discounting	The process of converting money values that occur in different years to a common year.
Distributional effect	A change (positive or negative) in the economic welfare of a group of individuals or firms caused by an initiative.
Diverted traffic	Freight or passengers that switch from one mode or route to another as the result of an initiative.
Economic efficiency	Any change for which the gainers could compensate the losers out of their gains and still have some gain left over is said to be an improvement in economic efficiency. Maximum economic efficiency is said to be obtained when no further changes of this type are possible.

Elasticity	A mathematical measure used in economics to describe the strength of a causal relationship between two variables. An elasticity value can be interpreted as the percentage change in the dependent variable in response to a one per cent change in the independent variable.
Environmental Impact Statement	A detailed written statement analysing the environmental impacts of a proposed action, adverse effects of the initiative that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources.
Evaluation	Specific process of reviewing the outcomes and performance of an initiative after it has been implemented. Undertaken in Phase 8.
External cost	Cost imposed on third parties, including time lost from delays, accident risks and environmental impacts (valued at resource costs where applicable). The cost of an externality.
Externality	An effect that one party has on another that is not transmitted through market transactions. An example is noise pollution from vehicles: those operating the vehicles disturb other parties such as nearby residents, but a market transaction between these parties is absent.
Existing traffic	Traffic that uses the infrastructure in question in both the Base and Project Cases (in contrast with diverted and generated traffic). The quantity is existing traffic is, by definition, the same in the Base and Project Cases.
Financial analysis	The evaluation of the benefits and costs, measured in cash-flow terms, to a single entity.
Financial cost	The cash-flow expenses incurred by purchasing resources through markets at market prices.
First-year rate of return (FYRR)	Benefits minus operating costs in the first full year of operation of an initiative, divided by the present value of the investment costs, expressed as a percentage. The first-year rate of return is used to determine the optimum timing of initiatives.
Generalised cost	The sum of money price and user cost, with any additional costs to complete the door-to-door journey valued at money prices. Synonymous with private generalised cost.
Generated traffic	Freight or passengers that are induced by an initiative; that is, they would not exist but for the initiative.
Hurdle BCR	Minimum acceptable benefit–cost ratio that a proposed initiative must attain before it can be considered for funding.
Incremental BCR (IBCR)	Ratio of the present value of increase in benefit to the increase in investment cost that results from switching from one option to the adjacent, more expensive option. The incremental BCA is used to choose between different options for a particular initiative, having different levels of investment cost.
Infrastructure	Civil engineering structures that have been built to facilitate the movement of people and/or goods for various social and business reasons.
Infrastructure operating costs	The costs of providing the infrastructure after the initiative has commenced operation, e.g. maintenance, administration, operating costs of a facility.

Initiative	Any action to address a transport challenge. It could consist of an infrastructure or non-infrastructure intervention. The term 'project' is often used for such actions but it is limited by a perceived association with infrastructure.
Investment costs	The costs of providing the infrastructure before the initiative has commenced operation, e.g. planning and design, site surveying, site preparation, investigation, data collection and analysis, legal costs, administrative costs, land acquisition, construction costs, consequential works, construction externalities.
Intelligent transport systems	Integrated application of modern computer and communications technologies to transport systems to improve transport safety, use of infrastructure, transport operations and the environment.
Internal rate of return (IRR)	The discount rate that makes the net present value equal to zero.
Jurisdiction	Australian Government, state or territory government, local government, or a combination.
Life of initiative	The number of years over which the benefits and costs of an initiative are assessed following completion of construction.
Link	Homogeneous segment of a route. Includes an inter-modal facility.
Maintenance	Incremental work to restore infrastructure to an earlier condition or to slow the rate of deterioration. Distinct from construction and upgrading.
Money price	The money price paid to use a service.
Multi–criteria analysis	A loose collection of tools to assist decision-making where the aim is to promote a number of different objectives or criteria.
Multi-modal	Has several meanings. Can refer to passenger or freight movements that use more than one transport mode (e.g. road and rail). A 'multi-modal focus means an approach to addressing transport challenges that considers the full range of potential solutions across all modes.
Mutually exclusive	In the BCA context, the term is used to refer to options where choice to adopt one option precludes adoption of all the other options.
Network	Collection of routes that provide inter-connected pathways between multiple locations for similar traffics. Can be multi-modal (typically comprising several uni-modal networks) or uni-modal.
Net present value (NPV)	The discounted present value of a stream of benefits and costs over time. The term 'net' signifies that costs have been included in the stream as negative values.
Nominal prices	A value or price at a given time. Nominal prices rise with inflation.
Non-infrastructure solutions	Initiatives that make better use of existing infrastructure and avoid the need for large capital expenditures.
Objective	Statement of a desired outcome that has not yet been attained.
Opportunity cost	The value forgone by society from using a resource in its next best alternative use. Synonymous with resource cost.
Option	Alternative possible solution to a challenge.

Options analysis	Identification and assessment of alternative initiatives/solutions and variants of initiatives/solutions that promote the same set of objectives or address the same set of problems.
Parameters	Qualitative values applied consistently in appraisals. They are usually unit costs of impacts.
Perceived price	The subset of private generalised cost that is actually perceived by the user. For example, car drivers may perceive time but not vehicle operating costs.
Post-completion evaluation (PCE)	A review of a completed set of actions to determine whether the desired or forecast ends have been realised, and to explain the reasons for the outcomes. The aim is to discover lessons for the future. Undertaken in Phase 8.
Private cost	Cost incurred by an individual transport user or service provider. Private costs are valued at money prices, where applicable and may include user costs but exclude external costs imposed on others.
Private generalised cost	The sum of money price and user cost, with any additional costs to complete the door-to-door journey valued at money prices. Synonymous with generalised cost.
Program	Suite of appraised initiatives to be delivered within a specified time frame and sequence.
Real prices	Prices that have been adjusted to remove effects of inflation. They apply for a particular Base Year, e.g. 2004 dollars.
Reliability	The probability that a system will perform its intended function under stated conditions for a stated period of time. Adapted from ISO 15686-3. As a quality attribute of a transport service, on-time performance.
Residual value	The value of an asset at the end of the evaluation period. In BCA calculations, it is counted as a negative cost at the end of the life of the initiative.
Resource cost	The value forgone by society from using a resource in its next best alternative use. Synonymous with opportunity cost.
Risk	A state in which the number of possible future events exceeds the number of events that will actually occur, and some measure of probability can be attached to them (Bannock et al 2003, p. 338).
Road-user costs	Costs of operating vehicles on roads, including time costs. Crash costs may or may not be included.
Route	Physical pathway connecting two locations for a particular mode. In land transport, consists of a continuous length of infrastructure (road, rail line). In shipping and aviation, delineated by operating or regulatory or administrative practices (shipping lane, air route).
Sensitivity analysis	Changing a variable, or a number of variables, in a model to discover how it affects the model's output or outputs.
Shadow price	A social cost used in a BCA that differs in magnitude from the corresponding private cost.
Strategic merit/ strategic fit	Extent to which objectives of a proposed initiative align with objectives and policies of the government as set out in strategy and other documents.

Strategic Merit Test	Largely qualitative series of questions that provides a first-order determination of the 'strategic merit or fit' of an identified initiative. Identifies proposals that should proceed to the next stage of appraisal, proposals that require further scoping, and proposals that should be abandoned because they lack strategic fit. Also includes checks to ensure that the initiative has been properly formulated and is feasible.
Strategic planning	High-level planning involving fundamental direction-setting decisions. Narrows down the types of options that will be pursued. Involves consideration of present and future environments. Asks questions such as: 'Are we doing the right thing?' 'What are the most important issues to respond to?' and 'How should we respond?' Balances many competing considerations including value judgements, subjective assessments and political considerations. Involves iteration, stakeholder consultation and analysis.
Social generalised cost	The full cost to society valued at resource cost, including user costs and external costs. Any additional costs to complete the door-to-door trip are valued at resource cost.
Traffic	As used throughout this volume, transport users in general regardless of mode and unit of measurement, e.g. passengers, cars, trains.
Transfer payment	A sum of money that changes hands without any net change in total economic wellbeing; that is, one person's gain is another person's loss.
Transport system	For a particular jurisdiction (or a multi-jurisdictional setting), comprises the following elements: • relevant transport networks—sets of routes that provide inter-connected pathways between multiple locations for similar traffics • transport user sub-system—people, goods and vehicles/wagons/etc. using the network • regulatory and management sub-system—regulatory regime and systems for managing the traffic that uses the network (including access arrangements, registration and licensing, traffic management centres and intelligent transport systems) • transport operating environment e.g. land- use development patterns that generate traffic on the transport network • physical environment e.g. geographic features, climate, air quality, and social environment e.g. accessibility, amenity, liveability.
Vehicle operating cost	The costs of operating a vehicle, including fuel, oil, tyres and repair and maintenance costs.
User costs	Costs incurred by a transport user in addition to the money price—waiting time, time in transit, unreliability, damage to freight, passenger discomfort, additional costs to complete the door-to-door journey. Quality attributes such as time and reliability need to be expressed in dollar terms based on user valuations.
Willingness-to-pay (WTP)	The maximum amount a consumer is willing to pay for a given quantity of a particular good or service (rather than go without it). Total value that consumers place on a given quantity of a good or service. It is measured as the total area under the demand curve up to given quantity.

APPENDIX

F

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Index

C

D

E

F

G

I

L

M

N

O

P

R

S

T

U

W

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