National Guidelines for Transport System Management in Australia
Stage 2 content for stakeholder consultation

Mode Specific Assessment

M5 – Travel Behaviour Change
Providing Feedback

This draft document has been published for stakeholder feedback.

Submissions are due: 5pm, Thursday 31 March 2016

All submissions should be in writing and preferably emailed to: NGTSM2016@infrastructure.gov.au

Hard copy submissions can be sent to:
NGTSM Steering Committee Secretariat
National Guidelines for Transport System Management
Commonwealth Department of Infrastructure and Regional Development
GPO Box 594 CANBERRA ACT 2601

For enquiries please contact the NGTSM Steering Committee Secretariat:
NGTSM2016@infrastructure.gov.au | (02) 6274 7921

Disclaimer

This document is a draft for public comment. Please note that as a draft document it has not been approved by any jurisdiction, therefore should not be relied upon for any purpose. An approved revised edition is due to be published in May 2016.
# Table of contents

1 **Introduction** ......................................................................................... 1  
1.1 What are travel behaviour change projects? ........................................ 1  
1.2 Why are separate guidelines needed for TBhC? .................................... 2  
1.3 When should these guidelines be used? ................................................ 3  
1.4 Background ......................................................................................... 5  

2 **Economic analysis framework** .................................................................... 6  
2.1 Background .......................................................................................... 6  
2.2 Theoretical framework ........................................................................... 7  
2.3 Application of framework to TBhC projects ............................................ 9  

3 **Travel demand impacts – diversion rates** .................................................... 13  
3.1 Introduction ............................................................................................ 13  
3.2 Diversion rate interpretation issues ....................................................... 13  
3.3 Diversion rate evidence ......................................................................... 14  
3.4 Default diversion rates .......................................................................... 16  
  3.4.1 Household/community based initiatives ........................................... 18  
  3.4.2 Workplace travel plans .................................................................... 19  
  3.4.3 School travel plans .......................................................................... 23  
3.5 Durability of changes ............................................................................. 24  
3.6 Modelling of travel behaviour change ................................................... 26  

4 **Benefits of TBhC initiatives** ...................................................................... 27  
4.1 Overview ................................................................................................ 27  
4.2 Benefits to mode changers ..................................................................... 27  
4.3 Resource cost corrections ...................................................................... 30  
  4.3.1 Travel time savings ......................................................................... 31  
  4.3.2 Private vehicle operating costs ....................................................... 31  
  4.3.3 Car ownership costs ....................................................................... 31  
  4.3.4 Car parking ...................................................................................... 32  
  4.3.5 Road tolls ......................................................................................... 33  
  4.3.6 Cycle operating costs ...................................................................... 33  
  4.3.7 Walking costs .................................................................................. 33  
  4.3.8 Public transport fares ...................................................................... 34  
4.4 Externality benefits .............................................................................. 34  
  4.4.1 Decongestion .................................................................................... 34  
  4.4.2 Induced traffic effect ........................................................................ 35  
  4.4.3 Road system benefits ...................................................................... 35  
  4.4.4 Accident cost savings – car ............................................................... 35  
  4.4.5 Accident costs – cycle/walk ............................................................... 36  
  4.4.6 Accident costs – Public transport ..................................................... 37
## Economic analysis procedure

5.1 Introduction
5.2 Stages of analysis
5.3 Project definition
5.4 Project costs
5.5 Calculation of project benefits
  5.5.1 Select diversion rates
  5.5.2 Trip lengths
  5.5.3 Unit benefits
  5.5.4 Average cost per trip
  5.5.5 Mode changer perceived net benefits
  5.5.6 Calculate composite benefit value per year
  5.5.7 Calculate total benefit per year
5.6 Appraisal period
5.7 Value for money measure

## Monitoring and Evaluation

6.1 Introduction
6.2 Monitoring focus and outcomes
6.3 Methodology
  6.3.1 Monitoring approaches
  6.3.2 Panel survey v independent samples
  6.3.3 Survey timing
  6.3.4 Monitoring program participants
  6.3.5 Control group
  6.3.6 Sample size
  6.3.7 Systematic survey bias issues
6.4 Maximising survey response
6.5 External monitoring sources

## References

## Appendix A – Worked Example
Table of tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Household programs – default diversion rates</td>
<td>19</td>
</tr>
<tr>
<td>Table 2</td>
<td>Workplace travel plans – scoring and classification</td>
<td>20</td>
</tr>
<tr>
<td>Table 3</td>
<td>Workplace travel plans – default diversion rates</td>
<td>22</td>
</tr>
<tr>
<td>Table 4</td>
<td>School travel plans – default diversion rates for primary and secondary schools</td>
<td>23</td>
</tr>
<tr>
<td>Table 5</td>
<td>School travel plans – default diversion rates for tertiary institutions</td>
<td>24</td>
</tr>
<tr>
<td>Table 6</td>
<td>Mode changer perceived net benefit values ($ per trip)</td>
<td>29</td>
</tr>
<tr>
<td>Table 7</td>
<td>Summary of resource cost corrections and other benefit unit values (cents/km and cents/trip)</td>
<td>39</td>
</tr>
<tr>
<td>Table 8</td>
<td>Default average trip lengths (km)</td>
<td>44</td>
</tr>
</tbody>
</table>
Table of figures

Figure 1: Travel behaviour change and its fit with travel demand management................. 1
Figure 2: Categories of costs associated with a car trip.................................................. 10
Figure 3: Change in perceived costs resulting from TBhC project .................................. 11
Figure 4: Public transport mode share of motorised travel.............................................. 28
1 Introduction

1.1 What are travel behaviour change projects?

This document has been prepared in conjunction with Volume 4 Part 2 of the 2006 NGTSM Guidelines (Urban Transport), to provide additional guidance on the assessment of travel behaviour change (TBhC) initiatives.

TBhC initiatives and programs are a sub-set of travel demand management measures. Through the use of education, information, and marketing-based approaches they aim to encourage voluntary changes in “personal” or “private” travel behaviour to reduce the need to travel, reduce dependence on private cars, and increase physical activity. TBhC initiatives may be targeted at the travel patterns and behaviour of the community at large, or at individuals within households, workplaces or schools and universities. Figure 1 illustrates the relationship between travel behaviour change and other travel demand management measures.

Figure 1: Travel behaviour change and its fit with travel demand management

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Land Use</th>
<th>Network for all users</th>
<th>Travel Behaviour Change</th>
<th>Pricing / taxes</th>
</tr>
</thead>
</table>
| Definition | Shaping community development | Moving people and goods | Voluntary mode shift | Road pricing options
User charges / taxes |
| Examples   | District plan changes
Zoning | Traffic calming
High occupancy vehicle lanes
PT services | Travel planning
Personalised marketing
Ride share | Tolls
Electronic road pricing
Parking supply management |

Travel Behaviour Change Techniques

Community-based initiatives
Household-based initiatives
Workplace Travel Plans
School Travel Plans

Source: Travel Behaviour Change Guidance Handbook, Land Transport NZ, 2004

In Australia TBhC projects have been implemented under various names including Travel Smart, Living Smart, travel blending, etc.
TBhC initiatives are often implemented as packages of complementary measures designed to achieve the overall objectives identified in the second paragraph above. Such packages may include small-scale infrastructure projects and enhancements. For example, a school travel plan might include upgrading of pedestrian crossings while a workplace travel plan might include the provision of bicycle lockers.

1.2 Why are separate guidelines needed for TBhC?

The United Kingdom Department for Transport (DfT) makes a useful distinction between:

- “Hard” measures, defined as measures that have a direct impact on travellers’ generalised cost, whether financial cost, time, or other quality factors that are normally valued and included as components of generalised cost; and
- “Soft” measures, defined as measures that affect behaviour without affecting travellers’ cost, instead changing travellers’ response to cost.

Most economic analysis guidelines are focussed on assessing “hard” measures that change the generalised costs of existing users. Additional guidelines are required for TBhC projects because they mostly comprise “soft” measures and usually do not change the actual service level, quality, or price (and hence generalised cost) of any mode.

Benefit unit values (parameter values) and demand elasticity values for hard measures are provided in the guidelines for public transport and active transport and such measures can generally be assessed using those guidelines. However, the other guidelines do not contain advice on the responsiveness of demand to TBhC soft measures or on valuing the benefits of such measures. These guidelines are intended to fill that gap.

The purpose of many “hard” measures is also to change travel behaviour, for example by: the provision of physical alternatives or rearrangements (such as infrastructure or revamped public transport services); regulation and enforcement; financial and economic stimulation – rewards, fines, taxes, subsidies, pricing policies – usually leaving the individual with little or no choice about how they behave. The distinction between “hard” measures and travel behaviour change, in terms of how they change behaviour, is the means used to achieve any change. TBhC measures tend to approach demand management by supporting and encouraging a change of attitude and behaviour and are generally non-coercive or voluntary in nature.

Some measures that are traditionally referred to as “soft”, such as real time passenger information systems, bus quality improvements, etc., provide benefits that can be valued and included as components of generalised cost. These should be considered as hard measures and do not require this TBhC guidance.

Separate additional guidance on the assessment of TBhC initiatives is also provided due to the following characteristics of such projects:

- Often they comprise a package of several relatively small scale measures
- With other existing project appraisal procedures the required level of appraisal effort is disproportionate to the scale of many TBhC projects
- TBhC projects result in small impacts to a large number of people and the impact tends to be different for each participant whereas with typical transport projects most users tend to be attributed the same benefit
• Evidence on the effects of TBhC initiatives and the durability of changes shows significant variations and is still evolving
• Benefits to travel behaviour changers sometimes appear to be negative when estimated in accordance with standard assessment guidelines and hence require a different valuation approach.

Developing the material in this volume through the collaborative national Guidelines process allows it to act as a standard to promote consistency across Australia in the application of cost–benefit analysis (CBA) to travel behaviour change projects.

1.3 When should these guidelines be used?

These guidelines may be applied when assessing TBhC initiatives involving soft measures and when assessing TBhC packages that include soft measures and small-scale complementary infrastructure enhancements. Such initiatives and packages are likely to be characterised by changes in travel behaviour and mode changing to public transport and active transport modes that occurs in the absence of any significant benefits to the existing users of these modes.

The following are examples of types of TBhC measures that may be assessed using these guidelines:

• Community - or household-based initiatives to support efficient travel decisions
  – Personalised trip analysis and advice (travel blending, trip chaining; forward planning)
  – Pre-trip information about options and conditions for specific trips
  – “Living neighbourhoods”
  – Ride-share matching service
  – Education, information and training

• Community- or household-based initiatives to encourage reductions in the use of cars
  – Marketing of PT / walking / cycling
  – Improve image of PT & other environmentally friendly modes
  – Advertising & education on travel choices, impacts and costs
  – Counter fear of personal insecurity using other environmentally friendly modes
  – Marketing of travel choices (e.g. personalised marketing)
  – Education, information and training
  – Car clubs / car sharing

• School travel
  – Education and training (e.g. TravelSmart; cycle training; street crossing behaviour)
  – Travel plans
  – Establish non-motorised alternatives (walking school buses; cycle trains)

• Workplace trip reduction
  – Workplace parking management / provision
  – Company van pools / ride share
- Voluntary trip reduction
- Flexible work hours
- Guaranteed ride home programmes
- Workplace car sharing

**Substitutes for travel (may be done through workplaces or at a community level)**
- Tele-working
- Tele-conferencing
- Tele-shopping / home shopping
- E-commerce

**Financial inducements to potential users of alternative modes, e.g.:**
- Discounts for walking shoes or cycling gear
- Free cycle maintenance
- Discounted public transport tickets
- Free ticket to try public transport

Workplace travel plans and school travel plans are commonly made up of a “package” of TBhC measures. “Personalised marketing” and “travel blending” projects are also commonly done as packages rather than single measures. The elements of such a package may draw on several of the above measures as well as possibly including small-scale infrastructure and service changes.

These guidelines should not be used to assess projects that involve significant improvements to public transport infrastructure or services, or improvements to cycling and walking infrastructure that can be analysed as hard measures. Such projects should be assessed in accordance with the Public Transport or Active Transport guidelines as appropriate. Where such projects are being undertaken as part of packages with TBhC measures only the soft measures should be assessed with these guidelines.

It is difficult to provide a precise threshold for when infrastructure or service enhancements are small-scale and can be assessed as part of TBhC packages and when they should be assessed separately. Analysts should make a reasonable judgement in borderline cases. TBhC procedures do not attribute benefits to “existing” public transport or active transport users (those who do not change mode) so where components of a package will provide substantial benefits to existing users it will be more appropriate to analyse these separately from the TBhC package.

In summary, TBhC measures that may be assessed using these guidelines include:

- Household-based initiatives (e.g. personalised marketing; “travel blending” or “living neighbourhoods”)
- Community-based initiatives (e.g. travel awareness campaigns; ride share)
- School travel initiatives
- Workplace-based initiatives
- Substitutes for travel (e.g. teleworking).
Workplaces include commercial business operations, government offices and agencies, community organisations, hospitals, tertiary educational institutions etc.

As noted in Section 1.2, the required level of appraisal effort if full CBA procedures are followed is disproportionate to the scale of many TBhC initiatives. The economic analysis procedure outlined in Section 5 and illustrated in the worked example is intended to provide a simplified approach that is appropriate for most TBhC initiatives including smaller scale projects. Economic appraisal may not be justified for very small TBhC initiatives where even the small cost of a simplified CBA is high relative to the cost of the proposed measure.

These guidelines are primarily concerned with the ex-ante economic appraisal of TBhC initiatives. However, guidance on ex-post monitoring and evaluation aspects is also provided in Section 6.

1.4 Background

These guidelines draw on developments and experience over the last 15 years in Australia, the United Kingdom and New Zealand. The economic analysis procedures in these guidelines are based on procedures that were developed for Transfund New Zealand (predecessor of the New Zealand Transport Agency) in 2004 (Maunsell et al 2004a, Maunsell et al 2004b, Maunsell et al 2004c) and the Victorian Department of Transport in 2006 (Maunsell 2006). The New Zealand project included an extensive and thorough review of Australian TBhC projects and project appraisals, and TBhC related reports and papers that had been completed up to that time.

The procedures have been adapted and updated so that they are aligned with the public transport and active transport guidelines and they reflect knowledge gained from more recent monitoring and evaluation of travel behaviour change projects in Australia.

Another useful reference in the development of these guidelines has been the UK Department for Transport’s new Transport Analysis Guidance – Modelling Smarter Choices (DfT 2014).
2 Economic analysis framework

2.1 Background

A number of existing TBhC appraisals and appraisal procedures were examined during the preparation of these guidelines. Key objectives were to investigate what problems had been encountered in applying existing appraisal procedures to TBhC projects, why these procedures were considered unsuitable for TBhC projects, and how, if at all, other countries/jurisdictions had overcome these issues. The New Zealand Transport Agency and the United Kingdom Department for Transport in particular have introduced guidelines in this area in recent years.

Perceived problems and issues raised in relation to TBhC appraisals include the following:

- Existing economic analysis guidelines were mainly focussed on infrastructure projects or projects that change generalised cost for existing users
- TBhC projects often do not change the actual service level, quality, or price (and hence generalised cost) of any mode
- Effects are diverse and dispersed and hence difficult (and/or costly) to measure, estimate and incorporate accurately in an appraisal – the effort involved in this is often not justified by the project cost as TBhC projects tend to be smaller projects
- Uncertainty and apparent variability of the diversion rates and other effects (e.g. lengths and timing of avoided trips)
- Diversity of TBhC projects means that analysts have to adapt existing procedures and cannot just “follow the formula”
- Newness of TBhC means analysts have to make assumptions and projections on limited experience, which results in inconsistent treatment of various aspects in appraisals.

The examination of existing TBhC appraisals did not find a common approach on many of these issues. It is apparent that a significant degree of approximating, aggregating, and averaging will need to be accepted for most small to medium scale TBhC projects.

Most appraisals attempted to deal with the above problems and issues within a CBA framework. This is appropriate for the following reasons:

- Many of the benefits of TBhC projects are of the same types as those of other projects, e.g. travel time savings for remaining road users, and reduced environmental externalities. Unit values for these benefits already exist. It may be more difficult to estimate the effects/changes that these unit values are applied to in the case of TBhC projects, but this problem is likely to lessen as further post-implementation monitoring and evaluation evidence is accumulated.
- Transport authorities are likely to want to propose TBhC initiatives as part of integrated packages of measures that combine road, public transport, and walking/cycling projects, and possibly pricing measures. These will be easier to analyse and compare if consistent appraisal procedures have been used for all components, and for alternative investments.
- Given that a CBA framework forms the basis of the economic analysis guidelines for other modes, a similar framework for TBhC also has the advantage that analysts already have a working knowledge of the framework.
A further advantage of using a CBA framework for TBhC projects is that if such projects are as effective as some experience to date indicates they may be, the use of appraisal procedures that enable them to be compared directly with other types of transport interventions will help to establish their credibility more quickly with policy and funding agencies.

Based on these considerations, a CBA framework is appropriate for appraisal of TBhC projects and these guidelines follow the same general principles set out in the Guidelines for Public Transport, i.e. with:

- Transport system user benefits derived from changes in perceived costs (i.e. changes in consumer surplus) and with resource cost corrections added/subtracted to translate the analysis to resource costs
- Costs and benefits discounted to present values to reflect the relative value of impacts in future years
- Indicators such as the benefit–cost ratio (BCR) and net present value (NPV) used to show the economic merit of the initiative.

2.2 Theoretical framework

Travellers make travel decisions based on their perception of their total ‘cost’ of travel, where this cost includes monetary amounts paid (and perceived as being incurred) and a range of other quality and service factors such as the time, comfort, reliability, security and cleanliness of travel.

The ‘cost’ is usually described as the private generalised cost of travel, but may also be called the perceived cost of travel or the behavioural cost of travel. The private generalised cost of travel is used to forecast the mode and route choice of trips. As it represents the perception of users, it also represents their willingness-to-pay for a journey, and hence is used to value changes in their travel choices. Refer to the Public Transport Guidelines and other volumes of the guidelines for further discussion of generalised cost/price.

A key feature and objective of TBhC initiatives is people changing between modes (e.g. from car to public transport or cycling and walking). When people change modes, they make this decision on the basis of their perception of the relative costs of the alternative modes. Some of these perceived costs are different from resource costs. CBA is based on resource costs, so CBA procedures need to include adjustments (termed resource cost corrections) to offset these differences.

A conventional theoretical framework for CBA of transport projects involving users changing between modes (of which TBhC projects are a subset) assesses the benefits as the sum of the following:

- (A) Benefits of the project to existing users of the “to” mode ¹ (estimated as changes in private generalised cost for that mode, usually including cost, time and comfort aspects)

¹ The “to” mode is generally the mode that is being improved by the transport project. In the examples given here the “to” mode is public transport and/or cycling and walking while the “from” mode is the private car. These would be reversed in the case of a highway improvement.
• (B) Perceived benefits to new users of the “to” mode, including mode-changers (generally valued at half the unit benefits to existing users of the “to” mode)

• (C) Benefits from avoidance of unperceived costs\(^2\) associated with the “from” mode (the previous behaviour of mode changers), comprising:
  - (i) resource cost corrections for mode-changers themselves (including monetary (e.g. car maintenance and other non-fuel variable vehicle operating costs, car parking costs) and non-monetary (e.g. accident trauma))
  - (ii) other resource cost impacts (externalities) on other transport system users or of the transport system (e.g. decongestion and reductions in private car-related environmental and accident externalities)

• (D) Unperceived costs associated with the new users of the “to” mode, comprising:
  - (i) resource cost corrections for mode-changers themselves (including monetary (e.g. public transport fare payments which are perceived as a cost but in fact are a transfer rather than a resource cost\(^3\)) and non-monetary (e.g. health benefits of cycling and walking which may be under-perceived))
  - (ii) other resource cost impacts (externalities) on other transport system users or of the transport system (e.g. environmental, accident, and health externalities (to the extent that costs of less health were being incurred by society other than the behaviour changer)).

Category (A) benefits are the benefits to existing users of the mode that is improved by the infrastructure project or public transport service improvement. Benefits to existing users are changes in generalised cost and usually include mainly aspects of cost, time and comfort.

If people change mode in response to an infrastructure project or public transport service improvement their perceived benefits (B) are valued at half the unit benefits to existing users (A) (i.e. the “rule of a half”). When choosing between modes travellers are assumed to fully perceive relative time and comfort aspects and out of pocket costs such as fuel, tolls, parking charges, and public transport fares. These aspects/costs are taken into account in their choice of mode and are assumed to be included in (A) and (B).

However travellers’ perceived benefits usually do not equate to all of the resource cost changes resulting from a project, which are necessary for transport project appraisal. For the mode changers we therefore also add the resource cost adjustments (C(i) and D(i)). These represent the additional unperceived resource cost savings to the behaviour changers themselves resulting from replacing a car trip with a public transport trip (or cycle/walk trip) that are not included in the perceived (rule of a half) benefit.

\(^2\) Unperceived costs comprise all variances between perceived costs and resource costs and include privately incurred resource costs that are not perceived (e.g. most non-fuel private vehicle operating costs), private costs that are perceived but are not actually resource costs (e.g. fares, tolls, and fuel taxes), and externalities to third parties (e.g. environment and accident-related externalities).

\(^3\) Any increase in operating costs for the “to” mode (in this case public transport) are accounted for, in full, in the costs side of the CBA yet the fare payments, which are a transfer reflecting this same cost, are included in the perceived net benefit of new users of the “to” mode (as a disbenefit). A resource cost correction equal to the fare is required to avoid double counting of costs.
Finally we add the other resource cost impacts on other transport system users or of the transport system (C(ii) and D(ii)). These include decongestion and net environmental externalities.

This is the approach used in the Public Transport Guidelines and it is also considered to be the most appropriate framework for economic appraisal of TBhC initiatives. The approach and principles are also similar to those used for evaluating user benefits in situations where there is induced traffic.

2.3 Application of framework to TBhC projects

TBhC programs change the information available to households and individuals and, partly as a result, their perceptions about alternative travel modes and choices – even where there are no changes to the system itself.

Figure 2 shows the breakdown of costs associated with a car trip into perceived and unperceived components, including externalities.

Normally car drivers only consider the internal perceived costs described above and shown in the darker shaded lower segments in Figure 2. Other internal costs such as non-fuel variable vehicle operating costs and accident costs are considered to be unperceived as shown by the medium shaded dimension X in Figure 2. Externality costs such as environmental effects are also generally considered to be unperceived.
One of the effects of a TBhC project is to provide travellers with information that changes their perceptions of costs of different modes. This is illustrated by the two scenarios on the right hand side of Figure 2. The first scenario shows the situation if the TBhC program corrects a proportion of the internal unperceived costs (X). Dimension Y shows remaining unperceived internal costs of the car trip following the TBhC project. This is the required resource cost correction that is counted as a benefit in addition to the net perceived benefit if a car trip is removed by a TBhC project. The second scenario shows the situation where all internal costs are perceived as a result of the TBhC project and the required resource cost correction is reduced to zero. TBhC projects can also induce mode changes by reducing the perceived costs of “to” modes.

TBhC projects primarily involve “soft” measures such as marketing and information that aim to change perceptions and knowledge about different travel options and choices rather than changing generalised cost. Therefore category (A) benefits are typically zero or negligible for TBhC projects. Some types of TBhC projects, e.g. school travel plans, may involve some infrastructure improvements that change generalised cost for people already using that infrastructure and this may still need to be quantified in some cases if significant. If an initiative will result in significant existing user benefits, the component of the package that is producing these benefits should be assessed separately using the public transport or active transport guidelines.

Also it could be argued that the more accurate perception of costs that is achieved by the TBhC project is a benefit to existing users even if they do not change mode or they already use environmentally friendly modes. This effect is ignored as we are mainly interested in actual behaviour change, not simply changed “travel awareness” without change in behaviour.

Estimating category (B) benefits is therefore difficult with TBhC projects. Normally the benefits to mode changers can be valued at half of the unit benefits to existing users (Category A), but as noted above in the case of TBhC projects such benefits are often zero. The benefit to mode changers cannot be zero or people would be indifferent about changing behaviour. The explanation, as noted above, is that TBhC programs change households’ and individuals’ perceptions about alternative travel modes and choices even where there are no changes to the system itself.

In the case of TBhC projects, people make changes because the new information:
corrects an information gap or misperception and they realise that the alternative actually is more attractive on balance than the private car trip that it replaces, or

- changes their attitude so that they are willing to accept the disadvantages of the alternative mode because they feel that it is the right thing to do, e.g. they are being more environmentally responsible. This is still a valid benefit.

The change in perceived benefits/disbenefits resulting from the TBhC project causes people to make the travel behaviour change as they now perceive the cost of making the trip by car as being higher than the alternative. This is shown in Figure 3.

**Figure 3: Change in perceived costs resulting from TBhC project**

![Figure 3: Change in perceived costs resulting from TBhC project](image)

In the situation without the TBhC project Figure 3 shows that for a particular individual the perceived costs of travel by public transport are greater than by car so car is the preferred mode. The TBhC project causes the individual to become aware of a greater proportion of the actual costs of car travel and as a result the perceived costs of a car trip now exceed those of undertaking the trip by public transport and public transport becomes the preferred mode. The difference between the car total resource cost and public transport total resource cost represents the benefit of this behaviour change. Some of this accrues to the behaviour changer as savings in perceived and unperceived internal costs and some to society due to the lower externality costs associated with a public transport trip compared with a car trip. Note that there is no actual change in the total cost of either the car or public transport trip but that the behaviour change and resulting benefits arise solely from the change in perceived costs brought about by the TBhC project.

In the above example, changes in internal unperceived costs of travel behaviour changers are the category C(i) and D(i) benefits, or resource cost corrections, in the theoretical framework. Category C(i) benefits will include unperceived costs of car use (car maintenance and other non-fuel variable costs, tolls, parking subsidies, part of accident costs, health costs etc.), and D(i) will include public transport fares and cycle costs.

In summary, consistent with the analysis of public transport projects, the economic appraisal of TBhC initiatives involves estimation of the following three main benefit categories:

- User benefits – benefits to travel behaviour changers (the users’ perceived benefits from their changed travel choices)
• Resource cost corrections – changes in the resource costs that are borne by or affect travel behaviour changers but are not perceived by them, and adjustments for transfer payments that are perceived as costs by travellers but do not represent use of any resources

• Externality benefits (disbenefits) – reductions (increases) in resource costs that are neither perceived nor borne by the travel behaviour changer

These benefit categories are considered in more detail in Section 4 of these guidelines.
3 Travel demand impacts – diversion rates

3.1 Introduction

In order to value the benefits of a TBhC project it is necessary to have estimates of the impacts that the project is likely to have on travel demand, including impacts on mode shares, average trip lengths, and any changes in the overall amount of travel.

Diversion rates are the (quantitative) estimates of the differences or changes in travel on various modes between the base case (without the initiative) and project case (with the TBhC initiative). Diversion rates are expressed as changes in mode share, with decreases for some modes (private car) and increases for others (public transport and cycling/walking).

It is also necessary to define the target population that the diversion rate applies to. For example, for a workplace travel plan this might be the total number of people employed at the workplace, and for a household/community based initiative it might be either the total population of the area covered by the initiative or just the households actually contacted or agreeing to participate in the program.

Diversion rates should be based on evidence from similar previous TBhC initiatives that have been implemented and then monitored and evaluated subsequent to implementation. Robust monitoring and evaluation of TBhC initiatives is difficult and expensive. Nevertheless some studies have now been conducted that provide a fair indication of the likely effects of different types of TBhC initiatives in different situations. Default diversion rates based on this evidence are provided in Section 3.4.

3.2 Diversion rate interpretation issues

A significant issue in relation to diversion rates is the different ways that they are expressed and the different target population that the changes are measured against. If diversion rates are derived from relevant local studies, rather than the default rates in this guideline, care is required to identify the approach that has been adopted in each study.

If a diversion rate that was derived as a change in the travel behaviour of the people participating in a TBhC project (which could be quite high) is assumed to apply to the whole population in an area when forecasting the impacts of a TBhC project, the effects are likely to be over-estimated. It is important to be clear what target population the diversion rate applies to, both when collating diversion rates from the literature and when using appraisal procedures to assess potential projects. The different target populations against which diversion rates have been expressed in appraisals and monitoring include:

- Total population in the suburb/area covered by a TBhC project
- Total households in the suburb/area covered by a TBhC project
- Total population or households to be contacted by the project
- Total number of people actually participating in TBhC project
- Total roll of a school covered by a school travel plan
- Total number of students participating in project
- Total number of employees in a workplace
- Combined total of employees and visitors for a hospital.

Diversion rates are sometimes expressed as the percentage point change in mode share and sometimes as the percentage change from the initial mode share. As an example, if the car mode share of all trips (total trips by all modes) is 66 percent without the TBhC project and 62 percent with the project: this might be expressed as either a 4.0 percentage point reduction in car mode share or as a 6.1% ((66 – 62) / 66) reduction from the initial car mode share.

Diversion rates are also sometimes expressed as the percentage change in a variable such as car trips or car vehicle kilometres travelled (VKT) compared with the situation that would have occurred without the TBhC project.

Care is required to avoid misinterpreting and/or misapplying diversion rates.

### 3.3 Diversion rate evidence

Most of the evidence on the effects of TBhC initiatives is drawn from a literature review conducted during the development of New Zealand’s travel behaviour change appraisal procedures in 2004. That study collated diversion rates from a range of projects in Australia, New Zealand and the United Kingdom. This has been supplemented with evidence from subsequent Australian monitoring and evaluation studies.

The observed diversion rates were often represented as a percentage change in the number of trips, or percentage point change in mode shares, but some were also in terms of an increase or decrease in vehicle kilometres travelled.

Some of the diversion rate information was taken from ex-ante assessments rather than from monitoring of projects that have been implemented. However, these tended to be based on previous reports and pilot studies and therefore still reflect actual experience.

Substantial investment was made in TBhC projects in Australia in the first half of the 2000s, particularly in Western Australia, South Australia, Victoria and Queensland.

A paper at the Australasian Transport Research Forum (Roth et al 2003) presented results achieved by Individualised Marketing programs from around the world. Reductions in car driver trips ranging from 6 to 14 percent were observed in the various programs. Based on these findings the paper suggested that reductions in car driver trips could range from 5.5 to 13 percent of whole populations (i.e. including non-participants). The paper also noted European evidence suggesting that little to no maintenance is required for 5 years in order to maintain public transport patronage increases.

Another paper at the same forum (Stopher et al 2003) reported the findings of a “critical appraisal” of travel behaviour modification programs in Australia. This indicated that the reduction in car driver trips was in the order of 7 to 9% for those who participate in a project and 5 to 7% for a target population as a whole (allowing for non-respondents). UK evidence summarised in the Smarter Choices report (Cairns et al 2004) suggested a lower range of 1% to 5% reduction in all car driver trips over 10 years.

The most extensive monitoring and evaluation project in Australia in recent years was conducted by the Institute of Transport and Logistics Studies (ITLS) which is also reported in an ATRF paper (Stopher et al 2013).
During the four-year period from 2004 to 2007, various TBhC programs were implemented in South Australia, Victoria, Queensland and the ACT using social marketing and community development initiatives. The ITLS study measured the travel patterns of a number of households in these states over a 5 year period from 2007 to 2012, following the completion of the TBhC programs. GPS devices were used to measure household members’ travel over a 15 day period in September to November each year. The survey covered roughly 120 households per year, of which approximately 80 had participated in TravelSmart and 40 households had not participated (the control group). Each year some households declined to continue participating and were replaced with new households to maintain the numbers in each state and in the participant and control groups.

The ITLS study concludes that the aggregate analysis of the six waves of long term data (one before TravelSmart implementation and one each year for five years after implementation) indicate that there has been a continuing decrease in total person kilometres of travel (PKT) by car over the five-year monitoring period for both TravelSmart and non-TravelSmart households. Non-TravelSmart households performed consistently more PKT per day than their TravelSmart counterparts, and the difference between the two remained more or less the same throughout the monitoring period. This suggests that TravelSmart households succeeded in reducing PKT by car during the implementation of this intervention, and then maintained their lower level of driving though the long-term monitoring. There is no evidence of a return by the overall sample to levels of driving that match those prior to the TravelSmart intervention. Presumably other factors have led to a continuing decrease in PKT by car for all households in the areas surveyed in subsequent years.

A limitation of the study report is that it does not show what proportion of the decrease in PKT by car was matched by an increase in travel by other modes and what proportion was simply a reduction in the amount of travel. This is important in determining the net benefits of a TBhC initiative.

The study also observed that the measured reductions in PKT almost certainly include some level of change due to other reasons. TravelSmart non-participants decreased their vehicle kilometres travelled by 15.3 percent over the five years while participants decreased their vehicle kilometres travelled by 18.2 percent. Almost half of the reduction for both participants and non-participants occurred in the last two years of the study, well after the TravelSmart programs had been delivered. The difference between these results suggest that TravelSmart household programs may achieve an approximate (non-statistically reliable) one-off reduction in car travel of approximately 2.9 percent and maintain this over the medium term (5 years +), but that other factors appear to have had a much greater effect on changes in travel over the monitoring period.

Prior to the above 5-year monitoring study, the ITLS performed a shorter duration TravelSmart monitoring study, also using GPS data logging, for the South Australian Department of Transport, Energy and Infrastructure (Stepher et al 2009). This was expanded into the subsequent larger 5-year study.

A conclusion from the above evidence is that the long term effect of TBhC household/community programs is probably lower than some of the ranges suggested in the early years and is more in line with the ranges noted in the United Kingdom. Another conclusion is that the changes achieved by TBhC programs do appear to persist over the medium to long term.

The UK Smarter Choices report (Cairns et al 2004) presented a range of diversion rates for 10 different types of TBhC projects surveyed in that report. It also provided diversion rates for the combined effect of overlapping TBhC initiatives recognising the potential to double count impacts if diversion rates are simply added together.
Workplace travel plans in the UK achieved reductions of 5% to 9% in all car trips to/from work in the area and appear to be able to achieve larger reductions due to being tailored to particular workplaces and hence able to influence a greater proportion of the population (the workforce at the workplace in this case).

A significant issue is the range of diversion rates that can apply for the same type of TBhC project in different situations. For example in the case of workplace travel plans, where there is a considerable amount of experience and evidence, the UK Smarter Choices report found that broadly:

- 10% of travel plans achieve no change
- 20% reduce car use by >0 – 10%
- 35% reduce car use by >10 – 25%
- 25% reduce car use by >25 – 35%
- 10% reduce car use by over 35%

Australian experience for all types of TBhC projects has been similar. For example, Perkins (2001) conducted a statistical analysis of the observed travel behaviour change against a set of commonly measured socio-demographic characteristics. Perkins’ paper analysed the results of the implementation of Travel Blending pilot programs in Adelaide and concluded that the characteristics that explained a significant amount of the variation in the total number of trips made by a household were unable to explain any significant amount of the change in travel behaviour, suggesting no relationship between socio-demographic characteristics and the diversion rates achieved by a project. The paper concluded that either the travel behaviour change is explained by a set of characteristics not currently measured or that the sample size was too small to determine any relationship. However, it was highlighted that those individuals who used cars the most tended to make the greater degree of positive change.

Research in Western Australia in 2005, while not conclusive, indicated at least a partial relationship between TBhC diversion rates (for household programs) and suburb form (land use mix, connectivity, amenity for active transport, and public transport options) in Perth.

The work to derive default diversion rates described in the next section attempted to differentiate the factors that might contribute to higher or lower diversion rates and to provide different sets of diversion rates based on these. However, often there were no statistically significant differentiating factors and it needs to be accepted that the effects and hence benefits are always likely to be uncertain. The best results will be achieved by drawing on all available experience, selecting target areas with the greatest potential to achieve the proponent organisation’s objectives, and investing effort in good design and implementation of TBhC projects.

### 3.4 Default diversion rates

Default diversion rates are provided for work travel plans, school travel plans and household/community based projects. These have been collated from the New Zealand and Victorian studies and reviewed in the light of more recent evidence from monitoring studies of TBhC initiatives in Australia.
If TBhC project proponents and analysts have different diversion rates, supported by sound evidence, that they consider would be more applicable for their particular project, these may be used instead of the default rates. Different diversion rates can also be used for sensitivity testing.

Originally it was envisaged that there would be a number of different sets of default diversion rates for each of the TBhC project types based on characteristics of the target population and the scope of the TBhC programs. However, statistical analysis of the available data on results of TBhC projects did not support greater disaggregation than what has been provided.

Results reported in previous evaluations and papers are often an upper bound because they only report the observed behaviour changes for a certain subset of the population. For example, the reported diversion rate may be, say a 14 percent reduction in car as driver mode share amongst those who participated in the program. This does not take into account the individuals that did not participate in the program (such individuals can be classified into two categories, those who did not respond/could not be contacted to participate in the program and those who chose not to participate in the program). The 14 percent diversion is an upper bound because for this same reduction to apply across the entire population requires the assumption that all non-participants would have made the same average change as those who participated. Basing default diversion rates only upon the upper bounds will result in a consistent overestimation of the likely benefits from a TBhC project.

To make a correction for this, a lower bound was calculated in these cases by adjusting the reported diversion rate for the program participation rate. The assumption for calculating the lower bound is that individuals in the target population that do not participate make no change in their travel behaviour and that they have average mode share prior to the implementation of a TBhC project.

Information about the TBhC program will disseminate throughout a community resulting in the actual diversion rate for a target population being between the upper and lower bounds. The default diversion rates are based on mid-points between upper and lower bounds.

**Default diversion rates are presented as percentage point changes in mode shares,** chosen in preference to percentage changes relative to initial (base case) mode shares. The use of percentage point changes supports simplified analysis procedures. Using change relative to initial mode share would require the initial mode shares of trips in a community, company or school to be known prior to the analysis. Also, tables of default diversion rates would be more complex, as would the resulting calculations. Fortunately the evidence from TBhC projects implemented to date is that the percentage point change in mode share does not appear to vary significantly across projects with different initial mode shares.

---

4 For example, if the initial mode shares of total trips by all modes are 85% car and 10% PT (and 5% other) and a project changes this to 80% car and 15% PT this is a change of -5 percentage points for car mode share and +5 percentage points for PT. The percentage change relative to initial car mode share is -5.88% (-5/85). If initial mode shares were 75% car and 20% PT and a project changed this to 70% car and 25% PT this would still be a -5 percentage point change in car mode share and +5 percentage point change for PT. However, in this case the percentage change relative to initial car mode share would be -6.67% (-5/75).
The use of percentage point changes for the default diversion rate values might be seen as placing a constraint on the analysis because it assumes that total trip numbers are unchanged. In the derivation of default diversion rates it is necessary that the sum of the diversion rates for the ‘from’ modes equals, in magnitude, the sum of the diversion rates for the ‘to’ modes (and they will be opposite in sign). This ensures that total mode share sums to 100 percent. This constraint can be overcome, if necessary for a particular TBhC project, by including an additional “to” mode labelled “no trip” with a diversion rate equal to the percentage reduction in total trips (also see Section 5.5.2).

The benefits for a particular mode changer depend on both the ‘from’ mode and the ‘to’ mode. For example, the benefits associated with cycling will differ from walking, due to different length of car journeys replaced, and the different level of physical activity. However, the distinction in benefits between car as passenger and car sharer is not so well defined. Primarily the difference between the two will depend on average trip lengths and since this is likely to be marginal it is assumed that there will be no difference in trip lengths for car sharer and car passenger trips. Hence, for appraisal purposes the two are the same, so car as passenger incorporates the diversion to car sharer.

### 3.4.1 Household/community based initiatives

After considerable investigation and statistical analysis, the New Zealand and Victorian studies concluded that household programs cannot be categorised into groups with similar diversion rates based upon socio-economic or other characteristics of the area, or the measures to be implemented. Similar TBhC household programs have been implemented in a number of different areas, and the diversion rates observed have varied from one area to the little consistent relationship to any of the above criteria.

Given the above findings, a standard set of default diversion rates is provided based on the average of all household/community projects that have been undertaken and monitored. A low set of default rates is also provided based on the average of the bottom half of diversion rates achieved, to account for any projects that may not implement the full range of initiatives that have become standard in household based programs such as TravelSmart, or where public transport services or cycle/walk facilities are poor: the decision to use the low set is at the discretion of analysts.

The two sets of default rates were estimated by sorting data into ascending order based on the change in car as driver mode share. The standard set of diversion rates for each mode used the average mode shares from the whole sample, while the low set used the average from the half of results with the least change in car as driver. It was also necessary to adjust these values to meet the constraint of mode share summing to 100%.

The two sets of default diversion rates for Household based programs are shown in Table 1.
Table 1: Household programs – default diversion rates

<table>
<thead>
<tr>
<th></th>
<th>Car as Driver</th>
<th>Car as Passenger</th>
<th>PT</th>
<th>Cycling</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>-1.0%</td>
<td>-0.2%</td>
<td>0.5%</td>
<td>0.3%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Standard</td>
<td>-3.1%</td>
<td>-0.5%</td>
<td>1.4%</td>
<td>0.9%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

These percentage point changes apply to the whole population in the area (e.g. suburb) targeted by the TBhC program (the target population), not just the households or people in that area who agree to participate in the program.\(^5\)

It is recommended that the standard diversion rate profile based on the average of all case studies is used for most household TBhC projects. The low set of default rates, based on the average of the bottom half of diversion rates achieved, may be more appropriate for any projects that may not implement the full range of initiatives that have become standard in Household based programs such as TravelSmart, and where public transport services or cycle/walk facilities are poor.

The WA Department of Transport has accumulated a significant database of results from 16 TBhC household/community projects in Perth (delivered to a target population of 388,733 residents). These results indicate that Perth has achieved higher than average diversion rates of -5% car-as-driver, 0% car-as-passenger, +2% PT, +1% cycling, and +2% walking. TBhC project proponents may consider using higher diversion rates than the standard rates if they have a suitable depth of evidence to support this and their projects are delivered with matching content and commitment.

### 3.4.2 Workplace travel plans

A large number of workplace travel plans were analysed for to determine diversion rate impacts. After considerable investigation, there was found to be insufficient data to determine statistically significant differences between the diversion rates that were achieved with different combinations of characteristics. Instead, an approach that assigns one of three default diversion rates to a project based on a scoring system was favoured.

A proposed project is scored against the measures listed below and then classified into a set of default diversion rates based upon the aggregate score:

- Car parking management strategies
- Public transport service improvements and/or public transport subsidies
- Improvements to walking/cycling facilities
- Promotion of ride sharing.

---

\(^5\) If the target population only comprised the TBhC program participants in the area covered by the program the diversion rates would be higher but the target population would be lower so that the resulting numbers of mode-changers would be the same.
Evidence in the literature suggests that the most significant factors in achieving lower car as driver mode share are initiatives targeted at the availability of parking, and provision of an adequate substitute for car commuting. Parking management strategies and public transport service improvements or subsidies are the two types of measures that address these barriers most directly and are thus weighted more heavily.

The scoring and classification worksheet for workplace travel plans is shown in Table 2. The various categories and guidance for scoring are described in the paragraphs following the table.

Table 2: Workplace travel plans – scoring and classification

<table>
<thead>
<tr>
<th>WORKPLACE TRAVEL PLANS SCORING AND CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parking management strategy</strong></td>
</tr>
<tr>
<td>Is there a car parking constraint/issue</td>
</tr>
<tr>
<td>No strategy</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Parking management score</td>
</tr>
<tr>
<td>Are these attributes part of the Travel Plan</td>
</tr>
<tr>
<td>Public transport service improvements</td>
</tr>
<tr>
<td>Public transport subsidies</td>
</tr>
<tr>
<td>Ride sharing matching service</td>
</tr>
<tr>
<td>Improved cycling/walking facilities</td>
</tr>
<tr>
<td>Total Score (out of 6)</td>
</tr>
<tr>
<td>Diversion Rate</td>
</tr>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>High</td>
</tr>
<tr>
<td>Separate diversion rates are provided</td>
</tr>
<tr>
<td>Car parking management strategies</td>
</tr>
</tbody>
</table>

A wide range of measures could fall into the category of a parking management strategy including, but not limited to, the introduction of car parking fees, parking cash-out schemes and restricting/reducing the supply of car parking spaces. It is also important to consider the current parking situation, i.e. whether there is currently ample car parking space or whether parking availability is already constrained.
It is suggested that projects be given scores of zero, one or two for parking. A score of zero would be applicable if current parking arrangements adequately meet demand and a parking management strategy is not implemented as part of the plan. This reflects the fact that without a parking issue, and without the introduction of parking demand management, there are fewer incentives for individuals to change.

If parking arrangements are already constrained in some way (i.e. there is a parking issue), it is more probable that individuals are seeking an alternative mode and that the travel plan will stimulate a change in mode. In this case a project should receive a score of one.

A travel plan that introduces a parking management strategy is also likely to deter people from driving to work (e.g. by charging for parking some individuals will consider it more attractive to travel by another mode) and should receive a score of one.

Implementing a single parking management strategy is probably not as effective as the introduction of a number of measures (e.g. introducing parking charges, and reducing the number of car parks available for staff). However analysis of the case study data did not show sufficient evidence to justify a higher score for the introduction of a combination of parking management strategies.

A score of two should be assigned in situations when there is an existing parking issue/constraint and the workplace travel plan involves the introduction of one or more parking management strategies.

Public transport service improvements

Improvements to public transport systems could be through the provision of new bus/train routes, or through the introduction of new services along existing routes. The provision of a company shuttle bus could also count as a public transport system improvement.

If a workplace travel plan includes any such improvements to the public transport system (though it is not limited to those listed above) then a score of one is appropriate, and zero otherwise.

Two sets of diversion rates are estimated, one set for when there are no public transport service improvements as part of the travel plan and one set for when service improvements or subsidies are included.

Public transport subsidies

Public transport subsidies could be either in the form of a subsidy to an operator (to improve services and/or reduce fares) or through direct fare subsidies to employees (e.g. free or subsidised weekly/monthly tickets). A score of one should apply if public transport subsidies are a measure to be included in a work travel plan, and zero otherwise.

Ride sharing

Ride sharing can be promoted in a number of ways, through the provision of preferential parking for car sharers or through the introduction of a ride sharing matching service or similar. It is considered that if the travel plan introduces a ride sharing measure (or a number of measures), then a score of one should apply, and a score of zero otherwise.
Improvements to cycling/walking facilities

Improving the conditions for cyclists and pedestrians will encourage the use of these two modes. Two common improvements to cycling and walking facilities are the improvement to onsite facilities (e.g. lockers, showers, bike storage etc.) and the improvement to external facilities (e.g. cycling paths/tracks/lanes). A score of one should apply if a cycling/walking measure is implemented and zero otherwise.

Select appropriate diversion rate based on score

The scoring system is intended to assign individual projects the correct magnitude of car-as-driver mode share reduction. Within the case studies reviewed, the distribution of this percentage point change across the ‘to’ modes is influenced by the measures implemented by the travel plan. For plans that do not include any public transport service improvements it is expected that the diversion to public transport will be similar to diversion to the other ‘to’ modes. For a project that is done in conjunction with public transport service improvements or includes company provided transport (e.g. shuttle from nearest train station) the evidence suggests that a far greater proportion of the mode shift will be to public transport. Hence separate sets of diversion rates are derived for ‘with public transport measures’ and ‘without’.

The recommended sets of diversion rates for use in the appraisal of workplace travel plans are shown in Table 3.

Table 3: Workplace travel plans – default diversion rates

<table>
<thead>
<tr>
<th>Score Set</th>
<th>Car as Driver</th>
<th>Car as Passenger</th>
<th>PT</th>
<th>Cycling</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>WITH PT service improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or less</td>
<td>Low</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>&gt;2 but &lt;5</td>
<td>Medium</td>
<td>-5.0%</td>
<td>1.3%</td>
<td>2.6%</td>
<td>0.3%</td>
</tr>
<tr>
<td>5 or more</td>
<td>High</td>
<td>-12.9%</td>
<td>3.3%</td>
<td>7.4%</td>
<td>1.0%</td>
</tr>
<tr>
<td>WITHOUT PT service improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or less</td>
<td>Low</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>&gt;2 but &lt;5</td>
<td>Medium</td>
<td>-5.0%</td>
<td>1.3%</td>
<td>1.3%</td>
<td>0.6%</td>
</tr>
<tr>
<td>5 or more</td>
<td>High</td>
<td>-12.9%</td>
<td>3.3%</td>
<td>3.7%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

The target population for these diversion rates is the total workforce (number of employees) at the workplace covered by the travel plan.

Back-testing of this scoring system with actual case studies (mainly from UK experience) showed a good match for the ‘from’ mode (car as driver) diversion rates but considerable variation in distributions across the ‘to’ modes. This was found to depend on whether or not projects involved or were accompanied by public transport service improvements.

The adoption of an alternative set of distributions for the ‘to’ modes, for workplace travel plans that were not accompanied by public transport service improvements, as shown in the lower half of Table 3, improved the accuracy of the scoring system.

Estimation of ‘without PT’ diversion rates was done by assuming that half the public transport diversions (in the ‘with’ sets) is redistributed between walking and cycling. The amount that either walking or cycling receives is weighted by the relative sizes of the two in the ‘with’ group of diversion rates.
3.4.3 School travel plans

Evidence on the effects of school travel plans comes mostly from the UK. This was supplemented with Australian data for tertiary institutions, in particular from Victoria.

The only differentiating factor between primary, secondary and tertiary educational institutions that gave clearly different sets of diversion rates is the level (age group) of the school or institution, i.e. whether primary, secondary or tertiary. Other factors such as socio-economic level of the area may be considered likely to cause differing effects but any such differences were not discernible from the evidence.

Primary school students typically only have a short journey, are often accompanied by their parents, and generally do not use public transport. Secondary school students have longer journeys on average, relative to primary, and make substantial use of public transport. Tertiary institutions are different again. Student trip lengths vary significantly, with students living on campus or in close proximity having very short journeys, whereas others commute long distances. Also, the majority of tertiary students hold a driver licence and have access to a car.

The mean percentage point change in car as passenger for primary and secondary schools combined is used as the default ‘from’ diversion rate for both primary and secondary schools.

In the case of primary schools, the ‘to’ diversion rates are considered to be mainly cycling and walking. Evidence suggests that public transport is generally not an important mode for most primary schools, largely due to the relatively short journey distances for most students.

A proportion of children attending private primary schools do use public transport, possibly because such schools have a wider catchment area than public schools. The default diversion rates for secondary schools are more appropriate for such schools.

Default diversion rates for secondary schools were estimated for public transport, cycling and walking. There is limited evidence on proportions of ‘to’ mode shares. Based on experience and judgement public transport is considered to account for most diversion and cycling is considered to receive the least change.

The default diversion rate values for primary and secondary schools are shown in Table 4. The secondary school diversion rate profile is also appropriate for private primary schools. The target population that these diversion rates apply to is the total school roll.

Table 4: School travel plans – default diversion rates for primary and secondary schools

<table>
<thead>
<tr>
<th></th>
<th>Car as Passenger</th>
<th>PT</th>
<th>Cycling</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary schools – public</td>
<td>-9.0%</td>
<td>0.5%</td>
<td>2.0%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Secondary schools</td>
<td>-9.0%</td>
<td>5.0%</td>
<td>3.5%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Default diversion rates for tertiary institutions were derived from a post-implementation review of a TravelSmart program at Melbourne’s Monash University Clayton Campus. University campuses vary significantly in their location and transport availability. Monash is considered to represent an average of the characteristics of tertiary campuses and hence the default diversion rates will be appropriate for programs covering several tertiary institutions in different locations as well as individual institutions with similar “middle-ring” locations and transport facilities.
Adjustments to the default diversion rates may be justified for travel plans for individual institutions that are located in more central locations close to a CBD or more distant outer metropolitan locations. Given the size of workforce at many tertiary institutions, it would also be appropriate to cross-check diversion rates against the default rates for workplace travel plans, particularly if both staff and students are targeted by the travel behaviour change program.

In some States the types of measures included in travel plans for tertiary institutions are closer to those in workplace travel plans than school travel plans. However, this does not mean that workplace diversion rates should be applied for tertiary institutions. Adjustments to default diversion rates for tertiary institutions could be made if the travel plan implementation is directed more at staff than students or than students and staff.

The Monash University TravelSmart program led to a 9.2 percentage point reduction in car-as-driver mode share by first year students compared with the previous year and significant increases in car-as-passenger and public transport mode shares. These results have been rounded to obtain the default diversion rates.

The default diversion rates for tertiary institutions are shown in Table 5.

<table>
<thead>
<tr>
<th></th>
<th>Car as Driver</th>
<th>Car as Passenger</th>
<th>PT</th>
<th>Cycling</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary institutions</td>
<td>-9.0%</td>
<td>3.5%</td>
<td>5.0%</td>
<td>0.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

### 3.5 Durability of changes

The default diversion rates in the previous section apply to the first year benefits after the implementation of a TBhC project. An economic appraisal also requires an understanding of the likely trend of benefits in future years. There are two interrelated aspects to this that need to be decided:

- Whether benefits of TBhC projects persist or decay over time, and at what rate
- Whether travel by all modes grows at the same rate in future years.

An issue for the appraisal procedure is whether benefits of TBhC projects persist or decay after the completion of the program. The following four possibilities have been suggested based on experience to date:

- Benefits decay over time (in the absence of periodic ‘maintenance’ efforts)
- Benefits can be maintained by ongoing “maintenance” expenditure
- Benefits are durable without maintenance
- Benefits increase over time.
Some early TBhC economic appraisals assumed that benefits would decay over time or that maintenance expenditure would be required. For example, the paper by Tisato and Robinson (1999) included an assumption that benefits of (an individualised marketing program in Adelaide) would decay without maintenance. To maintain the level of benefits they included cost estimates for annual reinforcement programs and periodic (five year) repeats of the travel diary.

Other papers give examples of TBhC programs where benefits appeared to have been sustained for up to four years after the program and more recent evidence supports the case that benefits may be self-sustaining without specific maintenance. The most intensive study was the recent ITLS 5-year monitoring project (Stopher et al 2013) that found no drop-off in the effect of TBhC programs in four states over the five years from 2009 to 2013. This was achieved without any systematic follow-up reinforcement TBhC programs.

The UK Smarter Choices report discussed the possibility of ongoing growth in benefits in future years but there does not appear to be any evidence to support this (without further TBhC investment).

It is intuitively plausible that if TBhC programs provide information that corrects misperceptions about alternative travel options and modes that people were not aware of, many of the people making changes will find the new option to be an improvement and will not have an incentive to revert. Reversion is more likely in cases where people were persuaded to change to a less convenient option because this was more environmentally sustainable. People in this situation may be more likely to revert without occasional reinforcement. If TBhC projects are implemented along with infrastructure changes this may also help to increase the durability of benefits.

Analysis of previous experience indicates that for household/community initiatives there appears to be some reversion to previous travel choices over the first nine months following the TBhC project but that people who have not reverted by this time tend to stay with their new travel choice. Experience from Perth over a four to five year period in the 2000s indicated stable mode shares at the same proportions as they settled at 9 – 12 months after the TBhC project. This finding, reported in Maunsell et al 2004b, was drawn from a number of papers on the Perth TBhC experience between 1999 and 2004.

Default diversion rates are based on results from before and after surveys. The first “after” surveys are typically undertaken around 12 months after implementation of a project when the initial reversion described above has already occurred.

Therefore appraisals of household/community projects could generally assume that benefits will be retained in future years with little or no maintenance expenditure, subject to adopting a suitable appraisal period.

Workplace travel plans and particularly school travel plans are more likely to require ongoing maintenance expenditure due to staff and student turnover. In the case of workplace travel plans, some of this will become part of the companies’ cost of business but in the case of school travel plans this may require ongoing expenditure which would need to be estimated and included in the analysis. Embedding the learning of road rules and about active travel in the school curriculum may reduce the need for ongoing expenditure.
A related issue is whether travel by all modes would grow at the same rate in future years. In other words if underlying growth in total travel is forecast at 2% per annum, is it reasonable to assume the same growth rate for trips by all modes in the absence of any intervention, and is the TBhC project likely to change the relative future year growth rates in addition to the initial shift in mode shares?

Possible assumptions that could be adopted are that trips on all modes grow at the same rate as underlying demand growth, or that, after the initial response, there is no further growth in the changed trips — all subsequent growth in each mode is what would have occurred anyway in the absence of the TBhC project.

The preferred option in this case is to assume that benefits of the TBhC project do not grow in line with traffic growth in future years. This is not to say that trips by alternative modes will not grow but rather that this is underlying growth that would have occurred anyway in the base case and is not attributable to the TBhC project. It could only be attributed to the TBhC project if the project was being repeated each year and “diverting” the usual proportion of the growth in car trips.

### 3.6 Modelling of travel behaviour change

For smaller TBhC initiatives, which are likely to account for the majority of projects, the most cost-effective approach for estimating benefits is likely to be spreadsheet calculations using diversion rates, trip lengths, benefit unit values and other default data provided in this guideline. However, for major TBhC programs and packages involving significant expenditure it may be appropriate to consider using a strategic transport network model to assist with estimating the benefits.

The UK Department for Transport’s TAG Unit M5.2 Modelling Smarter Choices provides helpful guidance on the use of four-step multi-modal transport network models for estimating TBhC benefits. The guidance in UK TAG M5.2 is directed primarily at modelling practitioners. However TAG M5.2 also contains advice that is relevant to the economic assessment of TBhC initiatives more generally.

As noted earlier, TAG M5.2 makes a distinction between hard measures and soft measures in a TBhC package. It notes that there is some evidence about the combined effects of several TBhC measures, but much less evidence about the isolated effects of individual “soft” measures in a form that can be included in models. The suggested approach to modelling packages of TBhC initiatives is to use a step-by-step approach, where hard measures are modelled specifically using the existing model demand vs generalised cost relationships, and adjustments for soft measures are used in order to achieve the diversion rates suggested by the evidence (e.g. the default diversion rates). Once adjustments have been made that achieve the expected diversion rates, the model outputs can be used as estimates of the economic benefits.
4 Benefits of TBhC initiatives

4.1 Overview

As discussed in Section 2.3, existing users of individual transport modes generally do not receive a benefit in TBhC project appraisals. If some components of a TBhC package do result directly in a change in generalised cost for existing users of the affected mode, these are considered “hard” initiatives and should be analysed with the relevant PT and active transport guidelines. With “soft” TBhC initiatives only the travel behaviour changers will receive a benefit (or they would not make a change). Since this cannot be estimated by the traditional rule-of-a-half method from existing user benefits an alternative valuation approach is required, as described below.6

The alternative user benefit estimation approach is based on users’ perceived costs so overall project benefits also need to include resource cost corrections for unperceived resource costs as well as externality benefits.

4.2 Benefits to mode changers

Section 2.3 explained that the perceived benefits to mode changers are a valid benefit to estimate and include in the economic appraisal of TBhC projects. This approach is consistent with theory incorporated in transportation planning modelling and in the assessment of benefits to induced traffic. This section discusses the derivation of appropriate values for use in TBhC project appraisals.

In a 2004 ATRF paper, Winn (2004) described a method and derived estimates of the benefits perceived by mode changers from the mode split relationships incorporated in strategic transport planning models. These relationships reflect the change in mode shares between two modes that will result from changes in the relative perceived generalised costs of the two modes.

The mode split between two modes is a function of the difference in perceived generalised cost between the two modes. The relationship can be used in reverse to determine the change in perceived generalised cost difference that is required to achieve an observed change in mode share. Because the mode share relationships in the transport models are calibrated to actual observed travel choices this generalised cost difference can be equated to the perceived benefit associated with a given change in mode share.

6 To the extent that a TBhC initiative reduces car trips, remaining highway users may also receive a decongestion benefit. This benefit is estimated and included in the CBA procedure described in these TBhC guidelines. However, while this could be interpreted as an existing user benefit, it is not one that can be used with the rule of a half to estimate the perceived net benefit of mode-changers.
Winn described the estimation process as follows:

“For the valuation of the user benefits associated with changes in the mode of travel a logit based mode split model is used. This model form is commonly used in four stage strategic transport models to allocate trips between motorised and non-motorised modes and between public transport and motor car within the motorised category. The market share of one mode compared to another is a function of the difference in generalised cost, with a slope parameter governing the rate of change and a shift parameter included to take account of the attributes not included in the generalised cost formulation.

Figure 4 illustrates the public transport share of motorised transport using typical parameters found in the Melbourne Integrated Transport Model (2000). Notice that where there is no difference in generalised cost public transport accounts for 35% (not 50%) of trips. This reflects the inherently superior comfort and convenience attributes of car-based travel (that are not accounted for in the generalised costs).

As a further illustration; if the current public transport mode share of motorised travel was 10% (which occurs if public transport costs are $10 more than car costs), then a reduction in public transport costs relative to car of about $5 (500 cents) would be required to raise the public transport mode share to 20%.

Figure 4: Public transport mode share of motorised travel

This information can be used in the following way to infer a value for the user benefits of those who switch from car to public transport for the same type of journey:

- in the example TBhC application considered, a 15% increase in public transport trips and a consequent increase in the public transport share of motorised trips from 13% to 17% was assumed (i.e. a four percentage point increase in public transport mode share); this is consistent with experience in Australia and internationally;
- applying the relationship shown in Figure 4 suggests a change in the generalised costs of public transport compared to car of around $2 (200 cents) would be required to effect this shift, and
the rule of a half should be applied to set the average benefit per user at half the full benefit (a downward sloping demand curve implies that some (marginal) car users would require only a small change in cost to switch while some would require the full $2 shift to move).

A similar approach may be followed to value the benefits for those switching from car travel to walking and cycling. This analysis assumes a 10% increase in walk trips and a 75% increase in cycling (from a low base), raising the walk/cycle share of all trips from 25% to 29% (a four percentage point increase in active transport mode share). The Melbourne Integrated Transport Model parameters suggest a change in relative generalised cost of about $1.50 is required to achieve this change indicating that the average benefit for those switching is $0.75.”

For these guidelines the analysis described above has been generalised to derive mode-changer perceived net benefit values for TBhC initiatives that result in different diversion rates than the 4 percentage point diversion assumed in Winn’s example).

A similar approach was used to derive mode changer perceived net benefit values during development of the New Zealand TBhC appraisal procedures. This gave similar benefit values to those obtained by Winn. The Winn values were also reviewed and reaffirmed in a TravelSmart economic analysis for the Victorian Department of Infrastructure in 2006 (Maunsell 2006).

Table 6 shows the proposed perceived net benefit values to be used for mode changers following further review of the above analysis. These values have been updated to 2014 from the values derived earlier and rounded slightly, reflecting the degree of approximation in the methodology for their estimation.

<table>
<thead>
<tr>
<th>Mode Change</th>
<th>Size of mode change (percentage points)</th>
<th>Benefit ($/trip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car driver to public transport</td>
<td>1</td>
<td>$0.35</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>$0.70</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>$1.40</td>
</tr>
<tr>
<td>Car driver to cycle/walk</td>
<td>1</td>
<td>$0.25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>$0.50</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

It is proposed to use the same benefit values for peak and off-peak periods because the model relationships produced little difference or were not reliably different. Values for other percentage point changes in mode share may be interpolated or extrapolated from Table 6.

Consideration was given to whether different benefit values may apply in cities with less extensive public transport choices but again evidence was not available to confirm or refute this. There appears little reason for the values for people changing from car driver to cycle/walk to vary by location as the perceived benefits are likely to be similar wherever they occur.
It is worth restating that the mode-changer perceived net benefit values in Table 6 are the net total of all the savings and costs that the average mode-changer perceives they are incurring when changing to the new mode. As these values are derived from a multi-modal transport network model they incorporate the net saving across all the usual perceived cost components that are included in the private generalised costs of the “from” and “to” modes in such models. For example for highway trips the components include travel time, fuel, tolls and perceived parking charges. The values also include any other intangible perceived benefits and costs that are not specifically itemised in the model but are incorporated in the logit model and calibration factors that are used to ensure that the transport model reflects observed mode choice decisions and mode shares.

Previous studies have noted that the method and detail of obtaining benefit values from mode choice relationships is still evolving and suggested the following issues for further consideration and investigation:

- It is likely that the mode choice relationship will change as a result of the TBhC project itself, i.e. the position and slope of curve may change from that represented in the strategic transport model and therefore indicate different benefits.
- We might not be measuring the slope at a point on the curve that is representative of mode changers. Changers might tend to come mostly from a particular (flatter or steeper) part of the curve.
- More information is needed on how the mode choice models are constructed. The statistical validity of the curve will depend on how much detailed survey data on actual travel characteristics and choices has been used to calibrate the model.

### 4.3 Resource cost corrections

This section discusses the benefit and disbenefit components that are internal to (i.e. directly affect) mode changers but that are not fully perceived and included in the mode changer net benefit values in the previous section.

One of the main ways that TBhC projects seek to change travel behaviour is by informing and educating travellers about the full costs of travelling by different modes, particularly by private car. It follows that the “misperception” of resource costs by travel behaviour changers is likely to be less in the project case than without the TBhC project and therefore that different resource cost correction values might be required for TBhC projects than for public transport and active transport projects that do not include such information and education aspects.

The following paragraphs discuss each of the normal benefit categories, whether they require resource cost corrections, and whether TBhC project-specific resource cost corrections need to be derived. Parameter unit values for benefits and resource cost corrections and externality benefits are not presented here. These should be obtained from the relevant guidelines volumes (public transport, active transport or highway) and/or parameter values appendices.
4.3.1 Travel time savings

Travel time savings (or increases) do not need to be assessed directly when using the recommended perceived cost approach because travel time changes and related impacts are considered to be fully internalised in the mode changer net benefit values estimated in the previous section. This includes effects such as differences in travel time by different modes, differences in the value of that time, other time costs such as waiting, transfers, etc., and trip time reliability. All of these tend to be readily taken into account by users based on their experience and directly influence their mode choice and other travel behaviour decisions.

4.3.2 Private vehicle operating costs

A proportion of vehicle operating costs are perceived by motorists and hence taken into account in their mode choice decision. However it is normally considered (and reflected in multi-modal transport models) that motorists only perceive the fuel component of vehicle operating costs and therefore that, in public transport economic appraisals. A resource cost correction is required for the difference between this and total VOC resource costs avoided as a result of their mode change. Furthermore, fuel costs are perceived in market prices which include fuel excise duty and indirect tax (GST) which are not resource costs.

The resource cost correction for reductions in private vehicle operating costs therefore normally includes two components:

- A positive correction for the unperceived non-fuel resource costs.
- An offsetting negative correction for the duty and tax proportions of fuel costs which are part of perceived cost but are not resource costs.

One of the objectives of TBhC projects is to provide information that corrects people’s misperceptions of the costs of private car use. For TBhC project appraisals it is assumed that TBhC projects will provide sufficient information to make users aware of a greater proportion of the previously unperceived vehicle operating costs and hence their perceived costs will be equal to resource costs7. A VOC resource cost correction of zero should therefore be adopted for TBhC projects.

4.3.3 Car ownership costs

Car drivers who transfer to public transport and/or cycling and walking may be able to avoid the need to own a car due to the change in mode. If this is the case, and given the general conclusion that motorists do not perceive vehicle depreciation or the opportunity cost of capital when making individual travel decisions, a resource correction is normally needed to take account of the additional, unperceived resource saving. However, for similar reasons to private vehicle operating costs the resource cost correction for reduced car ownership should be set to zero for TBhC projects.

---

7 This assumption does not mean that people perceive all non-fuel costs as a result of the TBhC project. Rather they perceive enough of the non-fuel costs so that their total perceived cost, which includes fuel taxes, equals the total resource cost (which does not include the taxes). This is not a demanding assumption.
4.3.4 Car parking

Reduced car usage results in a reduction in the demand for parking facilities. The resource costs of car parking include the opportunity cost of using land for parking, the capital cost of parking facilities, and the provision of adequate security.

Motorists are charged a fee for the use of parking. This charge differs depending on the destination of a journey and the time of day that the journey is made. Parking charges are higher for trips to the CBD and during peak times, and lower for off peak and non-CBD trips. For many commuters car parking is subsidised or provided free by employers. Also, many businesses, shopping centres and other destinations provide free parking. Overall, the parking fees paid by car users are less than the resource cost of providing parking. Motorists who change to public transport or active modes are likely to consider only the parking fee that they actually save in their perceived net benefit. People are assumed not to be aware of, or take account of, any difference between the fee they pay and the actual resource cost of providing the parking facilities so a resource cost correction is required for this difference.

In the absence of specific research it is normally estimated that, on average, only about 50 percent of car parking resource costs are perceived. Hence a resource cost correction equal to the remaining unperceived 50 percent is applied.

Some cities impose CBD parking levies which partially or wholly offset this difference and these should therefore be taken into account when determining resource cost corrections for car parking.

The Public Transport Guidelines provide further discussion on estimating a resource cost correction for car parking.

Some of the strategies included as part of TBhC projects are measures to make car users more aware of the full costs of car parking so it is assumed that TBhC projects will reduce the misperception of car parking resource costs and hence the required resource cost correction will be less than for public transport projects. Nevertheless many commuters will continue to benefit from car parking that is subsidised or provided free by employers and hence will not perceive any change.

For TBhC project appraisals it is assumed that, on average, TBhC initiatives will reduce the resource cost misperception by a half, resulting in TBhC participants perceiving 75 percent of resource costs after implementation of the TBhC initiative. Therefore, for each car driver trip diverted to public transport or active transport a resource cost correction of 25 percent of the car parking resource cost (per trip) should be included in the benefits.

The car parking resource cost per trip is obtained by dividing the daily parking resource cost by two (i.e. between the inbound and return trips). The car parking resource cost correction is not applied for avoided car passenger trips, only avoided car driver trips.
4.3.5 Road tolls

A resource cost correction is required for road tolls. Tolls are charged to recover the capital and operating costs of toll roads and therefore could be considered to reflect a resource cost. However, sometimes tolls are just charged to recover the cost of purchasing a concession from the government to charge tolls on an existing road. In either case, by the time trips are made on a road the capital costs are “sunk” and use of the road causes minimal on-going resource costs. Trucks may cause pavement wear and the road operator needs to provide traffic management and incident response functions but these costs are small compared to the financing and amortisation of the capital costs.

It might also be argued that cars impose congestion costs on other road users in peak periods and that the tolls reflect this resource cost. However congestion costs and reductions in congestion are explicitly estimated in an economic analysis. It would be double counting to include tolls paid by new highway users (or saved by lost users) as a resource cost in a project evaluation in addition to the congestion costs (or savings) resulting from changes in traffic volume. Each of the foregoing explanations result in the conclusion that tolls are a transfer and the resource cost of tolls is zero.

Savings in toll payments form part of the perceived benefits of toll road users who transfer to public transport and hence are included in the mode-changer perceived net benefit values in Section 4.2. If a TBhC initiative will divert trips from a toll road, a resource cost correction is required because this perceived saving is not actually a resource cost saving. The resource cost correction for a trip diverted away from a toll road is a negative amount equal to the full toll saving, i.e. it reduces total benefits.

From a practical viewpoint it will usually be difficult to identify whether avoided car trips due to TBhC projects would have used a toll road so this resource cost correction is not included in benefit unit values in Table 7. If a TBhC initiative will significantly reduce trips on a particular toll road, the reduction in toll payments should be quantified and included as a resource cost correction.

4.3.6 Cycle operating costs

Resource cost values for cycle operating costs are provided in the active transport guidelines and/or parameter appendices.

People changing mode from car to cycle are likely to be aware of the probable incremental cycle costs. It could be argued that, as with cars, people do not fully take into account infrequent costs such as tyres and maintenance. However TBhC projects typically correct these misperceptions and the same is likely to apply for cycle costs. TBhC project appraisals should assume that cycle costs are correctly perceived and taken into account in the mode changer net benefit value and therefore adopt a resource cost correction of zero for cycle costs.

4.3.7 Walking costs

In theory these would be treated the same as cycle costs but are ignored because they are likely to be negligible.
4.3.8 Public transport fares

A resource cost correction is also required for public transport fares. This is because fares are, in the first instance, a benefit gained by public transport users before they become a financial transfer (from mode changer to public transport operator). They are not an actual resource cost. If the public transport operator does incur additional operating costs, these are accounted for directly in the cost side of the economic analysis. The person changing to public transport perceives fares as a cost but they are not a resource cost so it is necessary to make a resource cost correction (as a benefit) equal to the (tax inclusive) amount of fare. Tax inclusive fare is used because this is the cost that the mode changer perceives.

Analysts should use average fares for the city where the TBhC project is to be implemented. The average fare per passenger is included as a resource cost correction benefit for each trip diverted to public transport as a result of the TBhC project. An average child concession fare should be used for appraisal of school travel plans.

A fare resource cost correction is required for all trips that divert to public transport including former car passenger trips as well as car driver trips.

4.4 Externality benefits

In addition to the internal perceived and unperceived benefits and disbenefits to travel behaviour changers, TBhC projects also result in externality effects on other transport system users and on society. These are discussed in the following paragraphs.

4.4.1 Decongestion

Decongestion refers to the reduced congestion costs (time and vehicle operating cost) experienced by remaining road users as a result of some car drivers changing to public transport or active transport modes - it does not include the saving to the mode changers themselves as this is part of their internalised benefit. Travel time savings provide most of the decongestion benefits with vehicle operating cost savings typically contributing only about 5 – 10 percent of the total decongestion benefits.

Methods for estimating decongestion impacts are discussed in more detail in the Public Transport section of the Guidelines. For most TBhC projects it will be appropriate to make a simple estimate by multiplying the reduction in vehicle kilometres travelled with a unit value for congestion relief benefits in terms of cents per vehicle-kilometre of reduced car travel under relevant traffic conditions. Unit values per vehicle kilometre of avoided car travel under various conditions are provided in the parameter unit values document/appendix.
4.4.2 Induced traffic effect

The reduction in congestion resulting from TBhC projects is likely to make car travel more appealing for other potential road users, leading to increases in car use by other individuals and thereby partially reducing the first round decongestion benefit. The induced traffic effect should be valued as a disbenefit equivalent to 50 percent of the decongestion benefit. In other words half of the potential 'first-round' decongestion benefits are offset by induced traffic disbenefits. Further explanation and background supporting this assumption is provided in the Public Transport Guidelines.

4.4.3 Road system benefits

Road system benefits include the benefit of reduced road maintenance and deferral of road capacity increases. It would be valid to include road maintenance savings but these are negligible for the numbers of car trips and/or car vehicle kilometres that are likely to be removed by TBhC projects. Deferral of capacity is not included because it is also considered to be negligible. Furthermore it would not be correct to include both the value of deferring improvements and the full decongestion benefit discussed above. If the capacity improvements were undertaken rather than deferred, the congestion levels would be less and the decongestion benefit theoretically somewhat lower.

4.4.4 Accident cost savings – car

A shift of some car drivers to public transport or cycling and walking can result in a decline in the number of accidents due to fewer car-kilometres of travel. This may be offset by the change in the number and severity of accidents due to changes in road traffic conditions such as higher speeds\(^8\).

Accident costs can be considered in three parts: internal costs (i.e. affecting the travel behaviour changer) that are perceived and hence included in the mode changer net benefit value, internal costs that are not perceived and hence require resource cost correction and external costs borne by others.

---

\(^8\) In typical urban conditions, at the margin any reduction in total accident numbers due to reduced traffic volumes is likely to be offset by increased accident costs due to higher speeds. However, the effect of speeds on urban accident costs appears not to be well researched. If the two effects are assumed to be equal/opposite there would be no net effect on car accident costs. However if such an assumption was adopted it should apply to all urban transport economic appraisals. Hence this issue is noted for future consideration but the conventional assumption of accident cost savings due to avoided VKT is adopted in these guidelines.
There is little information available on the extent to which people perceive accident risks and costs and take this into account in their travel choices. If it is considered that people take full account of the accident risk and costs to themselves then this is already included in the mode changer net benefit value and only the externality costs need to be added. However if people under-perceive their accident costs a resource cost correction is required. Intuitively it is likely that people do not perceive much accident cost and therefore most if not all of their internal accident cost will require a resource cost correction. If this is the case the resource cost correction plus the externality costs will equal the total resource cost of accidents. Accident resource cost values are available in the parameter values volume/appendix and it is therefore considered that these should be used for the combined value of resource cost correction and externality.

For TBhC projects it will be appropriate to make a simple estimate by multiplying the reduction in vehicle kilometres travelled with a unit value for accident saving benefits per vehicle-kilometre of avoided car travel in relevant road traffic conditions.

4.4.5 Accident costs – cycle/walk

The same considerations apply in relation to cycle and walking accident costs as for car accident costs. Two additional considerations with cycle and walk accident costs are that people who change from car to walking and in particular cycling probably have a fairly clear perception of the associated accident risk (so possibly some of it is included in the mode changer net benefit value), and that an increase in the number of pedestrians and cyclists might actually lead to a fall in the average per kilometre accident cost per pedestrian or cyclist (referred to as the “safety in numbers effect”).

Mode changers to walking and in particular cycling probably have some perception of the associated accident risk so possibly some of this (disbenefit) is included in the mode changer net benefit values. If their internal costs are perceived and already included in the mode changer net benefit values the required resource cost correction is zero and only the external proportion of the accident costs needs to be counted as a disbenefit. However, when cyclists and pedestrians are involved in accidents, external costs are likely to be much smaller than in motor vehicle accidents. For TBhC projects even these costs will be offset to some extent by the “safety in numbers effect” so overall any changes in cycling and walking accident externality costs are likely to be negligible and can be assumed to be zero in TBhC assessments.
4.4.6 Accident costs – Public transport

Accidents still occur with public transport, as indicated by claims made against public transport agencies by passengers and damage caused to public transport and other vehicles. In most cases TBhC projects will not change the distance actually travelled by public transport vehicles and hence public transport vehicle accident costs attributable to the project can be assumed to be zero. For TBhC packages that include increases in public transport services, and public transport project appraisals in general, accident disbenefits should be estimated using the increase in public transport vehicle kilometres and relevant resource cost unit values in the parameter unit values appendix/document.

4.4.7 Environmental externality reductions

Environmental externalities include local air pollution, noise, and water pollution, and greenhouse gas emissions. Less car use reduces environmental costs, according to the reduction in vehicle-kilometres of travel and changes in traffic congestion. Resource cost unit values for the environmental benefits from reduced car use are presented in the parameter unit values appendix/document. The resource value of various environmental impacts is expressed in relation to the quantity of vehicle use i.e. car-kilometres of travel. The quantity of saved car-kilometres needs to be estimated to determine the monetary value of the benefit. As the resource value of environmental costs is not generally perceived by motorists, the benefit will be equal to the total reduction in car-kilometres of travel multiplied by the appropriate (marginal) unit resource value of environmental benefits.

Public transport vehicles also cause externalities such as noise and air pollution that impose costs on the community. As discussed above under public transport accident costs, in most cases TBhC projects will not change the distance actually travelled by public transport vehicles and hence environmental externality costs attributable to the TBhC project can be assumed to be zero.

4.4.8 Health (fitness) benefits of cycling/walking

Parameter unit values for health benefits of cycling and walking are provided in the Active Transport Guidelines and/or its accompanying parameter values appendix. For TBhC project appraisals the health benefits of cycling and walking are considered in three components in the same way as accident savings or costs. However unlike accident savings it seems implausible that at least some of these benefits are not perceived by mode changers and hence not included in the mode changer net benefit values. One of the main selling points of TBhC projects, that results in people taking up cycling or walking, is the promotion of the health benefits.

As an approximation it is assumed that half of the total health benefit is perceived by the mode changer and hence already included in the mode changer net benefit values.

---

9 Some public transport accidents are likely to change in proportion to the numbers of trips such as slips and trips at stations and when boarding and alighting however these have been assumed to be relatively minor. This could be an area for refinement.
Consequently only the remaining half of the benefits is explicitly included in the appraisal as a combined value covering internal unperceived benefits (requiring a resource cost correction) and/or externality benefits to society (e.g. avoided hospital and other health care costs). This benefit is estimated by multiplying the increase in cycling and walking distance of people who divert to active transport modes due to the TBhC initiative by 0.5 times the respective unit values for health benefits of cycling and walking from the parameter unit values appendix/document.

4.4.9 Other - not quantified

A number of other potential benefits are identified in some appraisals of TBhC projects but have not been quantified to date. These include:

- Reduced community severance
- More sustainable land use/urban form
- Community cohesion
- Improved security/safety to the community
- Less dependence on fossil fuels
- Viability of local shops and businesses
- Synergy with other marketing initiatives

These impacts are generally harder to quantify and include in appraisals, but some of them may be as worthwhile as some of the other quantifiable impacts. Some of these benefit types could also apply to other types of transport initiatives and some of them can be achieved possibly more effectively by more targeted non-transport policies.

4.5 Summary of resource cost corrections and externality benefits

The required resource cost correction and externality benefit unit values discussed in the above sections are indicated in Table 7 (yellow highlighted cells).
Table 7: Summary of resource cost corrections and other benefit unit values (cents/km and cents/trip) [values to be advised]

<table>
<thead>
<tr>
<th></th>
<th>Peak</th>
<th>Off peak</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large city¹</td>
<td>Other city²</td>
</tr>
<tr>
<td>Car driver per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>VOC resource cost correction</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Congestion externality x 0.5¹</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Accident costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Environmental costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per trip</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per trip to/from CBD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per trip to/from other destinations</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Car passenger per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>VOC resource cost correction</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Congestion externality x 0.5¹</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Accident costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Environmental costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per trip</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per trip to/from CBD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Parking resource cost correction per trip to/from other destinations</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Public transport passenger per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Accident costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Environmental costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fare resource cost correction</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total per trip</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Cycling per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Accident costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Health effect</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Walking per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Accident costs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Health effect</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total per km</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

These values are costs per kilometre or per trip. They become benefits if a trip is avoided, or costs if a trip is added. A negative value indicates that the effect is a benefit of that trip, e.g. health effects are benefits of cycling and walking trips.

Notes:
1 Large city = population ≥ 1 million
2 Other city = population < 1 million
3 Net congestion externality is 0.5 x congestion externality to account for induced traffic effect which acts in opposite direction
4 Car passenger per km values are 50% of car driver values (rather than zero) to account for a proportion of trips being made specifically for the passenger
5 Economic analysis procedure

5.1 Introduction

TBhC projects tend to result in small impacts to a large number of people. They are much more difficult to evaluate than conventional projects because the impact tends to be different for each participant whereas with simple road projects for example most users tend to be attributed the same benefit. This leads to a conflict between procedures that accurately reflect all of the different individual responses to TBhC projects (but which may cost more to actually apply than the cost of the project being evaluated) and procedures that are cost effective to use but that may involve significant approximations and averaging of the effects on different participants.

The analysis procedures recommended in this guideline seek to strike an appropriate balance between these two criteria for most TBhC projects. More detailed, disaggregated analysis, possibly including the use of strategic transport models may be considered for large-scale TBhC projects.

5.2 Stages of analysis

Economic analysis of TBhC initiatives involves the following steps:

1. Define the type and scope of the TBhC initiative or package that is to be analysed (e.g. workplace travel plan, school travel plan, household and community based initiatives)

2. Separate out any “hard” measures (e.g. cycling/walking infrastructure or public transport improvements) for separate analysis using relevant guidelines (see Section 1.3)

3. Identify the target population (e.g. all employees at workplace, total population of an area to be covered by a TravelSmart household individualised marketing program)

4. Determine the costs of the proposal

5. Determine the expected level of diversion (the changes in mode shares)

6. Determine average trip lengths and any other trip changes by different modes

7. Obtain unit costs for each trip type. Use unit values provided in separate parameter values document if appropriate or TBhC specific values in this guideline where general values are not available or are not applicable

8. Determine average costs per trip per head of target population – combine average trip lengths (6) with unit costs (7) for each trip type and multiply by diversion rate percentages (5)

9. Determine average mode changer perceived net benefit per head of target population

10. Determine average total benefit per trip per head of target population – sum of average trip costs avoided (8) less average trip costs of new trips (8) plus average mode changer perceived benefit (9)
11 Calculate composite benefit value per year – multiply average total benefit per trip (10) by average trips per day and an appropriate annualisation factor.

12 Calculate the annual TBhC benefits – Multiply composite benefit value per year (11) by target population (3).

13 Discount the costs and benefits over the period of analysis (a default analysis period of 10 years is suggested).

14 Calculate benefit cost ratio and net present value.

15 Conduct sensitivity tests if required.

More details and guidance on the above steps is provided in the following sections. A worked example is provided in Appendix A.

5.3 Project definition

Poor project specification and ‘scope creep’ leading to cost overruns are common problems with public transport projects and other infrastructure projects. TBhC projects are less susceptible to cost overruns because they are relatively predictable. Also they are scalable and less visible. This means that if unforeseen costs arise during implementation the coverage of a program may be reduced to keep it within the approved budget without this impacting in a highly visible way on the overall project.

Nevertheless, any reductions in scope will change either the target population of a TBhC initiative or the effectiveness of the initiative, both of which will reduce the overall benefits so it is important for projects to be well researched, scoped and costed.

Project appraisal normally requires the definition of a base case and a project case with project costs and benefits being determined as the differences between these cases. This is simplified for TBhC projects as discussed in the following sections.

5.4 Project costs

Base Case costs will normally include capital and recurrent expenditures needed over the appraisal period in order to continue to provide either the existing services or a variant of these services that offers a similar service level and quality. The project case includes corresponding costs for the project scenario with the project cost being calculated as the difference between the two cost streams. However, TBhC initiatives do not usually result in any savings of potential base case costs so, for TBhC project appraisals, the TBhC initiative can be assumed to be independent of and additional to all other expenditure. The only difference between base case and project case costs is the cost of the TBhC initiative itself (including any budgeted future year costs) and therefore the estimated cost of the TBhC initiative is used directly as the project cost in the appraisal.

TBhC project costs are likely to include:

• Government department staff time for development and facilitation of programs
• Production of information and education material
• Personnel time and expenses (in-house or consultants) to deliver the program
• Small-scale infrastructure or transport service changes

In some places, TBhC initiatives are jointly funded and promoted by state and local governments. Project costs should include the costs incurred by both levels of government.

With workplace travel plans, some of the implementation costs are likely to be incurred by businesses. These do not need to be included in project costs in the economic appraisal as businesses are assumed to gain offsetting benefits that are also not included (and would be difficult for TBhC project proponents to estimate). It is assumed that the benefits that businesses obtain must at least equal, in some form or other, the investment that they make or they would not participate in the travel plan.

All costs should be included for school travel plans, regardless of whether schools are public or private, because all funding for these programs is either from government or fees paid by students, whose benefits are included in the CBA.

Public transport operating costs would need to be included as a cost if the increase in demand resulting from a TBhC project was sufficiently great to require the operation of additional services. It is assumed that for off-peak travel there is generally spare capacity to handle the likely mode changes to public transport resulting from TBhC projects and that there will be no additional public transport operating costs associated at off peak times. Some larger scale household-based projects may result in greater increases in public transport demand but these tend mostly to influence off-peak trips when spare capacity is greatest.

For peak period trips it is considered that increases in patronage may lead to marginal increases in operating costs (given that existing services are at capacity in peak periods). Therefore, in principle, additional public transport operating costs should be included for new peak period public transport trips resulting from TBhC projects. However, it is considered that if the demand for public transport increases by sufficient to require additional public transport services, these would probably be subject to a separate economic assessment in accordance with the Public Transport Guidelines. In this case, the additional public transport operating costs would be included as a cost in that separate analysis and should be ignored in the TBhC appraisal. If the increase in peak period public transport demand from the TBhC project is only small the potential additional costs of any additional services could also be ignored10.

Existing public transport users could experience an increase in crowding costs if a TBhC initiative caused diversion to public transport in peak periods and public transport capacity was not increased. This would be a disbenefit for the TBhC initiative and, if significant, should be included as an additional per-kilometre cost for public transport in the unit values in Table 7.

In general the costs of post-implementation monitoring should be excluded from the economic appraisal even though this might be a significant cost for TBhC projects and is likely to be included as part of funding requests. This is because monitoring is not specifically included in the costs of other types of projects and should not be an additional hurdle for TBhC projects. Rather, the additional monitoring costs should possibly be regarded the same as research and development or demonstration project expenditure.

---

10 Care needs to be taken with TBhC projects that involve both hard and soft initiatives. It is possible for mode changer net benefits of the soft TBhC initiatives to be double counted in the new user benefits of the hard initiative e.g. public transport infrastructure or service improvement.
5.5 Calculation of project benefits

Benefits are the total resource costs of the avoided private car trips minus the resource costs of the replacement trips on public transport and active transport. As explained in the previous sections, the resource cost changes are calculated by combining mode-changer perceived net benefits, resource cost corrections for unperceived costs (and savings), and externalities.

Benefit values are calculated as a total annual benefit of the proposed TBhC project. The procedure for calculating this value is as follows.

5.5.1 Select diversion rates

Select the appropriate set of diversion rates for the type of TBhC project from the range of default diversion rates in Section 3, or local evidence if this is more relevant, and robust. These are a measure of the expected percentage point change in mode share from car as driver to other main modes which have been derived from past experience on similar projects. The diversion rates represent the differences between base case and project case travel behaviour resulting from the TBhC initiative.

5.5.2 Trip lengths

Benefits of TBhC projects also depend on the lengths of the car trips that are avoided and the lengths of the replacement trips on other modes. For most TBhC initiatives the main effect is that trips are still made but they are made by a different mode following the TBhC intervention. The diversion rates in Section 3 are based on all avoided car-as-driver trips being replaced by trips on other modes (with trip lengths as in Table 8).

Table 8 provides default average trip lengths for different modes in different situations. These have been synthesised from Australia and New Zealand travel survey data for various size cities. The values in Table 8 are appropriate averages that will be convenient to use for most TBhC project appraisals. Analysts may substitute relevant trip lengths from local surveys if they consider these to be more robust and applicable for their TBhC initiative.
Table 8: Default average trip lengths (km)

<table>
<thead>
<tr>
<th></th>
<th>Large cities (pop ≥ 1 million)</th>
<th>Other cities (pop &lt; 1 million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak</td>
<td>Off peak</td>
</tr>
<tr>
<td></td>
<td>To/from CBD</td>
<td>Other destination</td>
</tr>
<tr>
<td><strong>Commuting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car driver</td>
<td>14.0</td>
<td>12.5</td>
</tr>
<tr>
<td>car passenger</td>
<td>13.0</td>
<td>11.5</td>
</tr>
<tr>
<td>public transport</td>
<td>18.0</td>
<td>17.0</td>
</tr>
<tr>
<td>cycle</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>walk</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Other trips</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car driver</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>car passenger</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>public transport</td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>cycle</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>walk</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Primary school</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car driver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>car passenger</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>public transport</td>
<td>11.5</td>
<td>11.5</td>
</tr>
<tr>
<td>cycle</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>walk</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Secondary school</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car driver</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>car passenger</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>public transport</td>
<td>11.5</td>
<td>11.5</td>
</tr>
<tr>
<td>cycle</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>walk</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Tertiary institution</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car driver</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>car passenger</td>
<td>11.0</td>
<td>11.0</td>
</tr>
<tr>
<td>public transport</td>
<td>17.0</td>
<td>17.0</td>
</tr>
<tr>
<td>cycle</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>walk</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

It would not be correct to base the benefit of car trips avoided on the average trip lengths for car as driver from Table 8 and then the cost or benefit of the additional trips by environmentally friendly mode on the average lengths for these modes. This would imply that a 14 km car-as-driver trip could be replaced by, say, a 7 km cycle trip. Therefore the costs for car-as-driver trips are based on the average trip lengths of the modes that people divert to rather than the average for all car-as-driver trips. This recognises that walk and cycle trips are more likely to replace shorter car trips, and conversely that long car trips are more likely to divert to public transport. The benefit of avoided car as driver trips is calculated based on a weighted average of the trip lengths of the “to” modes.
Some TBhC initiatives have a particular emphasis on reducing the number of car trips and the overall distance travelled by combining or “chaining” some activities that were previously undertaken by separate trips, or by eliminating the need to travel altogether, e.g. teleworking and teleconferencing. For these projects, it would be appropriate to include an additional “no trip” category to the diversion rates in Section 3 and use the car-as-driver trip lengths for this “to” mode in the “from” mode weighted average trip length calculation. However, for most types of TBhC initiatives this will not be necessary and the diversion rates to other modes in Section 3 can be used without further adjustment.

5.5.3 Unit benefits

Obtain unit costs for each of the parameters shown in Table 7 for trips by:

- Car as driver
- Car as passenger
- Public transport
- Cycle
- Walk

Unit costs are obtained from the parameter unit values document/appendix for each mode. Note that some costs are a unit value per kilometre and some are a unit value per trip. Some unit values will need to be adjusted for the purposes of TBhC economic analysis as specified in Section 4.

5.5.4 Average cost per trip

The next step is to combine the per-kilometre and per-trip costs (and benefits) from Table 7, and average trip lengths from Table 8 to calculate total average cost per trip for each mode in each of the following situations (as relevant):

- Peak and off-peak periods
- Large cities and other cities (population less than one million)
- To CBD or other destinations
- For commuting, other, primary school, secondary school and tertiary education trip purposes

The results of these calculations are the total costs associated with an average trip by each mode in different time periods, locations, and trip purposes, and apply equally in the base case and the project case. Note that, as shown in Table 7, the per-kilometre and per trip costs include resource cost corrections and externalities. In the step described in Section 5.5.6 the costs of base case trips that are avoided in the project case (e.g. car driver trips) become a benefit. The costs of the diverted trips on the new modes in the project case become a disbenefit, except for trips that have a negative cost, e.g. cycle and walking trips due to health benefits, in which case the trips add to benefits.
The average costs per trip are multiplied by the diversion rate percentages to obtain average costs per trip per head of target population. This results in average trip costs for the whole target population including the majority that do not change.

5.5.5 Mode changer perceived net benefits

The mode changer perceived net benefit values for people changing from car driver to public transport and car driver to cycle/walk are then calculated based on the values in Table 6. The benefit per mode changer is determined by the percentage point change from car to the relevant mode and then converted to a weighted average benefit for all people changing from car to other modes. This benefit value is then multiplied by the “car as driver” diversion rate to obtain the average value per trip of this benefit. In cases where diversion rates indicate that some people divert from “car as driver” to “car as passenger” the weighted average benefit for all people changing from car to other modes is multiplied by the sum of the diversion rates to public transport, cycle, and walk.

5.5.6 Calculate composite benefit value per year

A composite benefit value per year is then determined as follows:

- Calculate total benefit per person per trip for target population
- Multiply by trips per day and an appropriate annualisation factor to obtain overall composite benefit value per year per head of target population.

The diversion rates for car as driver are always a negative value (i.e. percentage point reduction) so when these are combined with the average trip costs (which are always positive) the result is a negative value (saving) representing the benefit of avoided trips. Diversion rates for public transport, cycle, and walk are positive values so when these are combined with the average cost of a trip the result is positive (i.e. a cost) if the additional trips involve net costs, or negative (i.e. a benefit) if the trips involve net benefits (e.g. due to health benefits of cycling and walking).

The total benefit per person per trip is calculated as the total of avoided “from” trip costs minus the total of “to” trip costs plus the total mode changer perceived net benefits.

This is then multiplied by the average trips per person per day and relevant days per year to obtain the overall composite benefit value per year. The following default days per year assumptions can be used unless different local evidence is available:

- Household/community initiatives 365 days.
- Workplace travel plans 230 days
- School travel plans 190 days
The composite benefit calculation should also reflect the proportion of travel behaviour change that occurs in the peak and off peak periods. This is accounted for in different average costs per trip for the different periods in Section 5.5.4. Default assumptions are:

- Household/community initiatives 15% peak
- Workplace travel plans 100% peak
- School travel plans 55% peak (assume all “to school” trips are in peak, “from school” trips are 10% in peak, 90% in off-peak)

The default assumption of 15 percent of changed trips in household/community TBhC projects being in the peak period is based on overseas experience that most trip change is off-peak. Estimates from studies indicate a range of 0 – 20 percent being peak trips. The assumption of 15 percent peak trips also captures the fact that there are only 230 workdays per person.

5.5.7 Calculate total benefit per year

The composite benefit value calculated by the above method represents an average benefit per head of target population and allows for the fact that the majority do not make substantial change and that there are also a proportion who do not participate in the program at all for one reason or another.

The composite benefit value per year is multiplied by the total of the target population to obtain the TBhC project benefits for the first year after implementation.

5.6 Appraisal period

TBhC appraisals reviewed in the preparation of these guidelines used appraisal periods between one year and 30 years with most using appraisal periods of 5 or 10 years. The appraisal period did not appear to be related to the total project cost but rather to consideration of the likely longevity of the TBhC impacts. It does seem appropriate that TBhC projects should generally use a shorter appraisal period than the standard periods of 30 or 50 years when they are mostly “soft” measures that do necessarily generate a permanent change.

A 10-year appraisal period is considered the maximum appropriate length for TBhC projects, reflecting the evidence that benefits appear to be sustainable without maintenance for at least 5 years, and the absence of experience of the durability of benefits beyond ten years. This could be reviewed in future in the light of ongoing monitoring of projects.

The main exception would be if a project includes items of infrastructure that are expected to have a service life longer than 10 years. However this may be uncommon for most of the infrastructure changes likely to be made as part of TBhC measures, particularly in urban areas so can be ignored. Significant items of infrastructure likely to have longer lives than 10 years will require separate appraisal in any case.

5.7 Value for money measure

A benefit cost ratio and net present value are appropriate value for money measures for TBhC initiatives.
Project the first year benefits of the TBhC initiative as a uniform annual benefit over the appraisal period and discount the benefit stream to a present value using the standard discount rate. Calculate a present value of costs by discounting any future year implementation and maintenance costs and summing these together with the year 0 implementation costs.

The benefit cost ratio comprises:

- **Numerator** – discounted net perceived and indirect benefits and disbenefits to all travel behaviour changers, other transport system users affected by the project, and all other external effects
- **Denominator** – discounted costs of the TBhC project to the public sector (i.e. Commonwealth, State and other government entities, including councils)

Calculate a net present value as the discounted benefits less the discounted costs.
6 Monitoring and Evaluation

6.1 Introduction

This section provides guidance on monitoring methodologies that will assist in the collection of useful data for ex-post evaluation of TBhC initiatives with least effort and cost. Monitoring for workplace and school travel plans is more straightforward than that for community- or household-based initiatives – there is a clearly identifiable target population and generally the focus is on specific trip types and purposes (e.g. commuting to and from work or the journey to and from school). In the case of community- and household-based initiatives, a wide variety of trip types and purposes by all members of a household are canvassed over varying times of the day and week. This creates a significant challenge to measure such potentially complex changes to travel behaviour with precision.

This section focuses on the methodology for the monitoring program, as well as identifying the monitoring focus for data for collection. No specific advice is given on questionnaire design or analysis of the data collected.

Given that there are various methodologies available to monitor TBhC initiatives each with their own strengths, weaknesses, and complexities, only basic information can be provided here. Project proponents are advised to seek the advice of credible market research and travel measurement firms, particularly those with experience in monitoring these types of initiatives. Questionnaires and survey design must be tailored to the objectives to be met and the information required.

It is important that the monitoring task is designed as an integral part of the overall TBhC program (it often accounts for a substantial part of the overall program costs). The ‘before’ monitoring task is at least as important as the ‘after’ monitoring task in contributing to any conclusions on the effectiveness of the initiative. Thus the overall monitoring program needs to be designed at an early stage, along with the design of the initiative, not considered only as an after-thought following implementation of the initiative itself.

6.2 Monitoring focus and outcomes

The primary outcome to be measured in monitoring TBhC initiatives is generally the overall change in VKT. Based on this indicator, it is possible to calculate benefits including decongestion, vehicle operating costs (including reductions in fuel use), environmental impacts (such as local air quality, CO₂ emissions and water quality) and accident reduction impacts.

Other key outcomes to be measured are changes in person kilometres travelled by mode. This is needed to identify the extent to which private motor vehicle trips have been replaced by public transport or cycling and walking trips as distinct from the extent to which trips have been eliminated altogether by “trip chaining”, using telecommunications, or by alternative activities. This greater level of disaggregation is needed to calculate changes in mode share and benefits such as the health benefits of active modes. If monitoring is performed at this level the results can also be aggregated to obtain overall change in VKT.

The focus of monitoring efforts should be on collecting evidence of both the mode share (for all modes) and the change in VKT as a “single occupancy vehicle” driver by all household members living in the target population area.
Note that this focus on VKT is particularly important for household-based initiatives, as in some cases programs aim to achieve "smarter" car use, wherein the mode may not change, but the VKT does.

Various methods are available to collect VKT or person-kilometres travelled data from participants in a given TBhC initiative. In the case of school and workplace travel plans, where the trip under observation is well defined (usually home to work or school, sometimes combined with other destinations / stops), it is more reliable to obtain geocode-able addresses than to rely on respondent estimates of the distances involved. For community and household-based initiatives, where a wide range and number of possible trips are involved, other methods may be preferable.

In addition to the mode shift and reduction of car driver vehicle kilometres, it is suggested that data be collected regarding the change in physical activity levels of the target population as this has an effect on the overall health and well-being of the community. This will be achieved if all travel by any mode is monitored at the individual person kilometre level.

It is recognised that organisations and local authorities may have other objectives within their monitoring programs, such as changes in target population attitudes (as opposed to behaviour), evaluating awareness of the TBhC initiative or the level and quality of information received. These may be added into the questionnaire(s) as desired. For example the aims of TBhC initiatives may include reductions in congestion or improvements in safety around schools for example. The objectives of the proponent and funding organisations will influence the prioritisation of TBhC initiatives and most likely the factors that are to be monitored to measure performance against those objectives.

6.3 Methodology

TBhC monitoring programs establish the “before” travel patterns for all members of the respondent household or other target population and then evaluate the change in these patterns “after” the implementation of the various components (e.g. education, encouragement / free trials and information) of the TBhC initiative.

6.3.1 Monitoring approaches

The most common approach to date is to survey randomly selected households in the target population area. Historically this focussed on the use of travel diaries. These can provide full details of trips undertaken by a household, and, given sufficient sample size, changes in total travel (trips, person- and vehicle-kilometres travelled) may be estimated for all modes. Usually travel diaries cover between 1 and 7 days, although with anything over 1-2 days there is likely to be a significant loss of response and accuracy. Issues to do with sample size, respondent drop-off, and bias are discussed further below.

Given the need to monitor changes in VKT, odometer-based surveys are an alternative (or complement) to travel diaries. Such surveys could record odometer readings for household vehicles at long intervals (e.g. 3, 6 or 12 months apart) and directly derive VKT and VKT changes by household. However, using this method on its own will not permit assessment of mode shifts, changes in vehicle occupancy, or changes in trip chaining behaviour. Other problems include: car may be sold; preferred car may change in multi-car household; and/or long trips distort results.
More recently in Australia, successful monitoring of TBhC initiatives has been achieved by fitting of Global Positioning System (GPS) devices to both people and vehicles to record person-kilometres travelled and vehicle-kilometres travelled respectively. These devices have considerably greater accuracy than travel diaries, which have been found to have significant discrepancies between actual travel and reported travel – as high as 20 percent. Short trips, the ones most likely affected by TBhC programs, are the most common type of trip omitted in travel diaries. GPS devices can easily produce information for one week’s travel for a household, including travel times, destinations and trip duration. The ability to collect data for a whole week substantially reduces the sample size requirements for a monitoring program and may reduce respondent fall-off rates.

In Western Australia household programs have started to include monitoring as part of the TBhC intervention so participating households are asked a few questions about how they travel (mode and number of minutes) in the first and final coaching calls as another indicator of change. Although not statistically robust, such an approach does provide a cost effective early indicator of the effectiveness of the TBhC initiative.

6.3.2 Panel survey v independent samples

Regardless of what type of survey is adopted to monitor the project outcomes, there is the need to consider whether a “panel survey” or “independent samples” (also known as cross-sectional surveys) will be used. Panel surveys, wherein the same respondents are used for the before and after surveys, are considerably more statistically efficient than independent samples (where different groups are surveyed in either survey), and hence generally preferred as lower sample sizes can be used for a given degree of confidence. However, panel surveys suffer from progressive drop-off of responses in successive surveys, which is especially important in cases of medium or longer term monitoring and can only be partially overcome through a good survey approach and/or adopting unusually large sample sizes for the before survey (to allow for respondent loss in after surveys).

6.3.3 Survey timing

Travel patterns (especially for environmentally friendly modes) are substantially affected by seasonality: the before and after surveys should be undertaken 12 months apart (in the same month of the year), regardless of the monitoring approach. Hence, typically the initial after survey would be 12 months following the before survey, with program implementation between these two points. If this is not feasible, it is desirable that the after survey be at least nine months following project implementation to allow for new behaviour patterns to settle down and not record very short-term impacts. If this is the case, extra care will also need to be taken to account for seasonality factors that could be influencing monitoring results. It is probably beneficial to repeat after surveys in order to monitor the stability of changes. Any subsequent “after” surveys should typically be at 12-month intervals.

It is known that there is considerable variability in travel across the days of the week and by travel mode. Given this, it is essential that surveys are spread across days of the week and, where the same households are being surveyed before and after, the survey days of the week should be the same in both.
On any given day, travel is affected significantly by weather, special events, or other factors. Some of these variation factors can be avoided (e.g. avoid monitoring just before or after statutory holidays or other local special events). For others it is difficult to do so, it may be necessary to rely on the control group being similarly affected (discussed below).

6.3.4 Monitoring program participants

The population of all households in the TBhC project area – those that participate in the program and those that do not (although it is useful to separate these in the analysis) – should be included in the monitoring program. This allows inclusion of “diffusion” effects, where the project positively affects non-participants’ behaviour, providing a much better basis (than just participating households) for assessing aggregate effects of the project.

It is preferable to involve the whole household, rather than just an individual from the household, in the monitoring program. TBhC projects generally provide information and incentives on a household basis and, thus the effects are likely to diffuse through the household, meaning that travel behaviour changes could be under-estimated if only one individual from that household was monitored.

6.3.5 Control group

Regardless of which monitoring approach is taken, control groups are essential to allow robust evaluation, particularly of household/community programs. Although some adjustments for “external factors” may be possible in the absence of a control group (see below), these are most unlikely to be sufficient on their own.

The control group area should be as comparable as possible to the program area (but unaffected by the program) in terms of similar socio-demographics, car ownership and use levels, public transport levels of service and use, topographical features, and distance from central business district. Often, control groups are selected from suburbs adjacent to those where the program is being delivered. However, care is needed to ensure that these control group areas are not subject to the indirect influence of the program (e.g. through local press publicity etc.).

It is important that other local changes do not occur in either the project area or control area that may impact on travel behaviour of residents, such as increases in public transport services in anticipation of increased demand as a result of the TBhC initiative or other transport system changes (new roads, changes in public transport services, other TBhC initiatives introduced). Often it will not be possible or desirable to prevent or delay these. The important thing is to record when they occur and make appropriate effort to distinguish the effects from these changes from those of the TBhC project.

6.3.6 Sample size

The required sample size to assess a defined degree of change, with a given level of statistical confidence, will depend on a range of factors and it is best to obtain specialist advice for establishing the appropriate sample size for a particular project.

Sample sizes are essentially (almost) independent of the size of the population concerned (for large populations).
6.3.7 Systematic survey bias issues

For a random monitoring survey of all households, the typical before and after (successful) response rates are in the order of 50%. Given this, the dangers of non-response (or self-selection) bias are considerable — that is, the change in the behaviour of the responding sample may differ substantially from that of the non-responding households, in a way that is unknown. Hence, there is no reliable basis to extrapolate the sample results to the whole population’s behaviour as, for example, less mobile households have a greater propensity to respond than more mobile households, but more mobile households may make bigger behavioural changes.

Some corrections can and should be made for this problem by comparing statistics (e.g. age, income, car ownership, etc.) for the respondent sample with those for the area population as a whole; and differentially expanding from the sample to the total population. However, it should be recognised that these may not totally correct the entire problem.

6.4 Maximising survey response

The main problem relates to after surveys, as before survey data for households that do not complete the after survey cannot be used in panel surveys. It is therefore critical to minimise any drop-off from before to after responses. Suggestions for achieving this include:

- Reference may be made to standard market research texts on how to maximise survey response.
- Surveys need to be designed to be as simple as possible for respondents to complete.
- Personalised contact is likely to help (face-to-face contact is probably ideal).
- Incentives – there is debate about the (cost) effectiveness of incentives in encouraging response, but it is reasonable to expect appropriate incentives (particularly for the after survey) would help.

6.5 External monitoring sources

A variety of ‘external’ monitoring sources might be used for before versus after evaluation, to verify, supplement or potentially replace project-specific household surveys. These could use data that is collected in any event, usually for other purposes, or surveys undertaken for this particular purpose.

Examples are:

- Public transport patronage data (from electronic ticketing or other sources)
- Road traffic counts
- Cycle and pedestrian counts (not commonly undertaken).

Such data will establish changes in trips at a point or over a public transport route. They will not establish changes in trips by a given set of households.
If a program is undertaken on a metropolitan-wide scale, changes in trips by metropolitan households in total may be reasonably inferred. However, it will not generally be possible to identify to what extent the trip changes are the result of the program, to what extent they result from other factors. If a program is undertaken over a limited area (as is typically the case), then the impacts of the program on traffic counts, etc. will rapidly diminish further from the area. Even within the area, the impacts are likely to underestimate the changes in travel by area residents, because of the through traffic component. However, in particular circumstances, reasonable inference about the effects on travel by area residents might be made. In drawing any conclusions from external monitoring data, it will be necessary to compare any local changes in the area of the program with any changes in the wider area (as the ‘control group’).

For larger scale programs, such external surveys can provide useful evidence. However, this should normally be regarded as supplementary to, rather than in place of, direct household surveys.

For small-scale programs, any changes in travel observed in external surveys are likely to be very small. Therefore, external monitoring sources will be of little practical use.
References


Maunsell Australia Pty Ltd, 2006, TravelSmart III: Evaluation Procedure (draft), prepared for the Department of Infrastructure, Victoria.


Appendix A: Worked Example - Economic appraisal of household/community program

Project details

Location: Large city > 1 million population

Total population of target area: 10,000

TBhC program costs:

Year 1 $2 million;

Year 5 $200,000 (reminder campaign)

Select diversion rate profile

<table>
<thead>
<tr>
<th></th>
<th>Car as Driver</th>
<th>Car as Passenger</th>
<th>PT</th>
<th>Cycling</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>-3.1%</td>
<td>-0.5%</td>
<td>1.4%</td>
<td>0.9%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Proportion of diverted trips in off-peak: 85%

Collate trip lengths

Collate relevant trip lengths (e.g. default values from Table 8) and calculate weighted averages.

<table>
<thead>
<tr>
<th></th>
<th>Peak</th>
<th>Off peak</th>
<th>Weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car driver</td>
<td>10.0</td>
<td>8.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Car passenger</td>
<td>9.0</td>
<td>7.5</td>
<td>7.7</td>
</tr>
<tr>
<td>public transport</td>
<td>12.0</td>
<td>11.0</td>
<td>11.2</td>
</tr>
<tr>
<td>cycle</td>
<td>5.0</td>
<td>4.5</td>
<td>4.6</td>
</tr>
<tr>
<td>walk</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Household programs target all trips (not just trips to/from CBD)
Collate parameter unit values

Collate relevant parameter unit cost values and calculate weighted average costs per kilometre and per trip by each mode (see Section 5.5.3).

<table>
<thead>
<tr>
<th></th>
<th>Peak 15%</th>
<th>Off peak 85%</th>
<th>Weighted average</th>
<th>Weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Car driver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC RCC</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net congestion ext</td>
<td>60</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident ext</td>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental ext</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per km</td>
<td>74</td>
<td>14</td>
<td>23</td>
<td>0.23</td>
</tr>
<tr>
<td>per trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking RCC</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>0.25</td>
</tr>
<tr>
<td>Total per trip</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Car passenger</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per km</td>
<td>50%</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC RCC</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net congestion ext</td>
<td>30</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident ext</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental ext</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per km</td>
<td>37</td>
<td>7</td>
<td>11.5</td>
<td>0.115</td>
</tr>
<tr>
<td>per trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking RCC</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per trip</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Public transport passenger</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident costs</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental costs</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per km</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>per trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare resource cost correction</td>
<td>-300</td>
<td>-200</td>
<td>-215</td>
<td>-2.15</td>
</tr>
<tr>
<td>Total per trip</td>
<td>-300</td>
<td>-200</td>
<td>-215</td>
<td>-2.15</td>
</tr>
<tr>
<td><strong>Cycling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cycle resource cost correction</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident costs</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health effect</td>
<td>-8</td>
<td>-8</td>
<td>-8</td>
<td>-0.08</td>
</tr>
<tr>
<td>Total per km</td>
<td>-8</td>
<td>-8</td>
<td>-8</td>
<td>-0.08</td>
</tr>
<tr>
<td><strong>Walking</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident costs</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health effect</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-0.20</td>
</tr>
<tr>
<td>Total per km</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-0.20</td>
</tr>
</tbody>
</table>

Positive values indicate a cost; negative values indicate a benefit or positive resource cost correction. Per kilometre unit values for car passenger are set at 50% of car driver values based on a proportion of trips being undertaken for the passenger.
The net congestion externality is half of the congestion externality per kilometre. This adjusts for the induced traffic effect which is estimated to offset half of the decongestion benefit when a car-km is removed from the traffic stream.

**Calculate composite benefit value**

1. Calculate average benefit (cost avoided) per head of target population for avoided car driver trips:

<table>
<thead>
<tr>
<th>Cost per trip of car driver trips which change to:</th>
<th>Trip length</th>
<th>per km costs</th>
<th>per trip costs</th>
<th>total costs ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transport trip</td>
<td>11.2</td>
<td>0.230</td>
<td>0.25</td>
<td>2.81</td>
</tr>
<tr>
<td>cycle trip</td>
<td>4.6</td>
<td>0.230</td>
<td>0.25</td>
<td>1.30</td>
</tr>
<tr>
<td>walking trip</td>
<td>2.0</td>
<td>0.230</td>
<td>0.25</td>
<td>0.71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefits from avoided car driver trips which are replaced by:</th>
<th>total costs per trip ($)</th>
<th>Diversion rates</th>
<th>Pro-rata diversion</th>
<th>Avg benefit (Costs avoided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transport trip</td>
<td>2.81</td>
<td>1.4%</td>
<td>-1.21%</td>
<td>0.034</td>
</tr>
<tr>
<td>cycle trip</td>
<td>1.30</td>
<td>0.9%</td>
<td>-0.78%</td>
<td>0.010</td>
</tr>
<tr>
<td>walking trip</td>
<td>0.71</td>
<td>1.3%</td>
<td>-1.12%</td>
<td>0.008</td>
</tr>
</tbody>
</table>

2. Calculate average benefit (cost avoided) per head of target population for avoided car passenger trips:

<table>
<thead>
<tr>
<th>Cost per trip of car passenger trips which change to:</th>
<th>Trip length</th>
<th>per km costs</th>
<th>per trip costs</th>
<th>total costs ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transport trip</td>
<td>11.2</td>
<td>0.115</td>
<td>0</td>
<td>1.28</td>
</tr>
<tr>
<td>cycle trip</td>
<td>4.6</td>
<td>0.115</td>
<td>0</td>
<td>0.53</td>
</tr>
<tr>
<td>walking trip</td>
<td>2.0</td>
<td>0.115</td>
<td>0</td>
<td>0.23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefits from avoided car passenger trips which are replaced by:</th>
<th>total costs per trip ($)</th>
<th>Diversion rates</th>
<th>Pro-rata diversion</th>
<th>Avg benefit (Costs avoided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transport trip</td>
<td>1.28</td>
<td>1.4%</td>
<td>-0.19%</td>
<td>0.002</td>
</tr>
<tr>
<td>cycle trip</td>
<td>0.53</td>
<td>0.9%</td>
<td>-0.13%</td>
<td>0.001</td>
</tr>
<tr>
<td>walking trip</td>
<td>0.23</td>
<td>1.3%</td>
<td>-0.18%</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note that diversion rates are the diversion rates of each “to” mode pro-rated to sum to the “from” (car passenger) diversion rate of –0.5%.
3 Calculate average net benefit (benefits minus costs) per head of target population for the replacement trips taken on new modes:

<table>
<thead>
<tr>
<th>Cost per trip of trips undertaken on new mode of:</th>
<th>Trip length</th>
<th>per km costs</th>
<th>per trip costs</th>
<th>total costs ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transport</td>
<td>11.2</td>
<td>0.010</td>
<td>2.15</td>
<td>-2.04</td>
</tr>
<tr>
<td>cycle</td>
<td>4.6</td>
<td>-0.080</td>
<td>0</td>
<td>-0.37</td>
</tr>
<tr>
<td>walk</td>
<td>2.0</td>
<td>-0.200</td>
<td>0</td>
<td>-0.40</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Net benefits of replacement trips undertaken by:</th>
<th>total costs</th>
<th>Diversion</th>
<th>Avg benefit (Costs avoided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transport</td>
<td>-2.04</td>
<td>1.4%</td>
<td>0.029</td>
</tr>
<tr>
<td>cycle</td>
<td>-0.37</td>
<td>0.9%</td>
<td>0.003</td>
</tr>
<tr>
<td>walk</td>
<td>-0.40</td>
<td>1.3%</td>
<td>0.005</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td></td>
<td>3.6%</td>
<td><strong>0.037</strong></td>
</tr>
</tbody>
</table>

Public transport trips result in net benefits due to the fares resource cost correction while cycling and walking trips result in net benefits due to the health benefits.

4 Calculate mode changer net perceived benefits per head of target population.

<table>
<thead>
<tr>
<th>Benefits to mode changers for:</th>
<th>Rate per 1%</th>
<th>Benefit per person</th>
<th>Avg benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversion from Table 6</td>
<td></td>
<td></td>
<td>C = (100xAxB)</td>
</tr>
<tr>
<td>car driver to public transport</td>
<td>1.4%</td>
<td>0.35</td>
<td>0.49</td>
</tr>
<tr>
<td>car driver to cycle</td>
<td>0.9%</td>
<td>0.25</td>
<td>0.23</td>
</tr>
<tr>
<td>car driver to walk</td>
<td>1.3%</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Weighted average benefit per changer</td>
<td></td>
<td></td>
<td>0.36</td>
</tr>
<tr>
<td>Average mode changer benefit</td>
<td>-3.1%</td>
<td></td>
<td><strong>0.011</strong></td>
</tr>
</tbody>
</table>

A weighted average benefit of $0.36 per trip is calculated for all car drivers who change to public transport or active transport. This is multiplied by 3.1% to derive the average mode changer benefit of $0.011 per head of target population.

No mode changer perceived benefit values have been identified for car passengers who transfer to public transport or active transport.

5 Add up components of benefit per head of target population.

| Benefits of avoided car driver trips             | 0.052       |
| Benefits of avoided car passenger trips          | 0.004       |
| Benefits of replacement trips                    | 0.037       |
| Mode changer perceived net benefits             | 0.011       |
| **Total average benefit per head of population per trip** | **0.104** |

This total benefit of $0.104 is the average net benefit value per trip per head of population (i.e. allowing for the non-participants).
Calculate composite benefit value per year

Multiply average benefit per head of population by number of trips per year.

Composite benefit value per person per year:

\[ \text{Average benefit} \times \text{trips per day} \times \text{days per year} = \$0.104 \times 3 \times 365 = \$113.73 \]

Calculate total benefits per annum

Multiply composite benefit value per year by target population to obtain total benefits per year.

Total benefit per annum = \$113.73 \times 10,000 = \$1.137 \text{ million} \]

Calculate BCR and NPV

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost ('000)</th>
<th>Benefit ('000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.935</td>
<td>2000 1869 0</td>
</tr>
<tr>
<td>2</td>
<td>0.873</td>
<td>0 1137 993</td>
</tr>
<tr>
<td>3</td>
<td>0.816</td>
<td>0 1137 928</td>
</tr>
<tr>
<td>4</td>
<td>0.763</td>
<td>0 1137 888</td>
</tr>
<tr>
<td>5</td>
<td>0.713</td>
<td>200 143 1137 811</td>
</tr>
<tr>
<td>6</td>
<td>0.666</td>
<td>0 1137 758</td>
</tr>
<tr>
<td>7</td>
<td>0.623</td>
<td>0 1137 708</td>
</tr>
<tr>
<td>8</td>
<td>0.582</td>
<td>0 1137 662</td>
</tr>
<tr>
<td>9</td>
<td>0.544</td>
<td>0 1137 619</td>
</tr>
<tr>
<td>10</td>
<td>0.508</td>
<td>0 1137 578</td>
</tr>
<tr>
<td>Total</td>
<td>2012</td>
<td>6925</td>
</tr>
</tbody>
</table>

Benefit cost ratio = \$6.93M / \$2.01M = 3.4

Net present value = \$4.91 \text{ million}