Position Paper 1:
Voluntary travel behaviour change and its potential implications for climate change mitigation and adaptation.

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1 Introduction

Mounting scientific evidence identifies climate change as a serious global risk that requires immediate response from the global community (Stern 2006; Chapman 2007; IPCC 2007a, 2007b, 2007c; Garnaut 2008; Aitken 2009; Ball 2009). Climate change poses a threat to all fundamental human requirements including water, crop yields, health and the surrounding land and environment (Stern 2006; Ball 2009). The extended effects of climate change and the required actions will change the way individuals, communities and businesses function. The issue needs to be addressed using a combination of mitigation and adaptation measures along with technological advances. Rigorous mitigation efforts are presently required to reduce the severity of future consequences to the climate in an effort to reduce the need for future adaptation (Stern 2006; IPCC 2007b). The effects of these mitigation efforts may not be seen immediately, thus adaptation measures are required to deal with the immediate effects of the changing climate.

The primary source of the increased atmospheric concentration of carbon dioxide, the most consequential anthropogenic greenhouse gas, since the pre-industrial period is the use of fossil fuels (IPCC 2007a). Transport represents 14% of greenhouse gas emissions by source (Stern 2006). Greenhouse gas emissions from the Australian transport sector have been found to be the fastest growing emissions source, having risen by 20.3% from 1990 levels with the potential to rise by 38% (AGO 1998; Taylor & Ampt 2003; Taylor 2007). The motor vehicle is the most widely used form of transport in Australia generating the second largest contribution to greenhouse gas emissions in the transport sector (Pramberg 2004; Chapman 2007). The number of motor vehicles in Australia is increasing at a rate higher than our population, indicating that although technological advances in fuel efficiency reduce per vehicle emissions, these improvements will be offset by increased ownership and use (WBCSD 2001; Pramberg 2004; WBCSD 2004; Chapman 2007; IPCC 2007c).

The 2006 Australian Census reported that approximately 60% of people travel to work as the driver of a car (ABS 2006). This demand on traffic infrastructure during peak periods results in traffic congestion in all major cities. With increasing car ownership and use it is logical to expect that congestion will continue to increase and that the period of congestion will tend to extend over more of the day (Stopher 2004). Urban congestion can double the fuel consumption and potential emissions of vehicles, and by 2020 the average avoidable social costs of congestion for Australian capital cities has been estimated at $20.4 billion (BTE 2000; BTRE 2007). Previous studies have found that for 40% of

trips there are viable alternatives to the car, and with minor improvements to alternative travel infrastructure a further 40% of trips could be completed without a car (Brog & John 2001; Chapman 2007). Changes in lifestyle and behaviour patterns can contribute to climate change mitigation through the reduction of greenhouse gas emissions across all sectors (IPCC 2007c).

The issue of motor vehicle emissions must be addressed using a multi-pronged approach focussing on infrastructure and policy, technical improvements, and voluntary individual behaviour change (James & John 1997; Baudains et al. 2001; IPCC 2007c). The focus of this paper is to investigate voluntary travel behaviour change (VTBC) and its role in addressing climate change.

The National Climate Change Research Facility (NCCARF) is leading the research community in a national interdisciplinary effort to generate the information needed by decision-makers in government and in vulnerable sectors and communities to manage the risks of climate change impacts. The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI) is one of eight Adaptation Research Networks hosted by NCCARF. The aim of ACCARNSI is to initiate and develop effective strategies to respond to climate change through mitigation, adaptation and implementation. ACCARNSI brings together researchers and stakeholders with an interest in climate change adaptation for coastal settlements, public and private infrastructure, the built environment and urban regional planning. The Urban Management, Transport and Inclusion node leads the exploration of the implications of projected demographic change in Australian cities and regions for future settlement form and in the critical assessment of integrated land use planning and transport policies in reducing emissions and adapting to climate change. For more information visit www.nccarf.edu.au.

This position paper is one in a series discussing current research and knowledge to further ACCARNSI objectives. The objectives for this paper are to:

- highlight issues and consequences for climate change associated with transport mode choice
- identify the impact of VTBC schemes on transport mode choice, reduction in private car use and the related impact on emissions
- identify the methods for implementing and evaluating VTBC programs
- identify the short term and long term impacts of VTBC including the residual nature of VTBC
- identify best practice case studies
- identify the transferability of VTBC principles to other disciplines
- identify knowledge gaps and priority research areas.

2 Voluntary Travel Behaviour Change: the concept

VTBC falls under a general concept known as Travel Demand Management (TDM). TDM was a concept introduced in the 1980s to described travel interventions made by governments to modify travel decisions so that desirable social, economic and environmental objectives could be achieved and adverse impacts of travel reduced (James & John 1997; Ampt 2001). The focus of TDM has evolved from programs encouraging mode change from private motor vehicle use to more sustainable transport means, to any program engaged in mitigating the negative impacts of motor vehicles (Ampt 2001). TDM measures include urban planning to reduce the demand for motor

vehicle travel, and the use of education and information to instigate voluntary behaviour change (IPCC 2007c).

Voluntary behaviour change is defined as change that occurs when individuals make choices for personal reward without a top-down mechanism, regulation of any sort, or a feeling of external compulsion (Ampt 2004; Ker 2004). This principle can be applied to achieve more sustainable urban transport systems in mitigating and adapting to climate change. Sustainable urban transport systems are defined by their ability to (Minken 1999; May & Taylor 2002; Taylor 2007):

- provide access to goods and services in an efficient way for all inhabitants of an urban area
- protect the environment, cultural heritage and ecosystems for the current generation
- not endanger the opportunities for future generations to reach at least the same welfare level as that of the current generation, including the welfare derived from the natural environment and cultural heritage.

VTBC schemes aim to shift travel mode choices to more sustainable options by providing appropriate information, assistance, motivation or incentives, to induce people to voluntarily choose to travel in ways which benefit themselves, the community and the environment (Stopher & Bullock 2003; Chatterjee & Bonsall 2009). VTBC encompasses a range of programs including personal travel planning, travel awareness campaigns, workplace travel plans, school travel plans and car sharing schemes (Chatterjee & Bonsall 2009). The general consensus is that VTBC programs lead to reductions in car use whilst increasing public transport use, walking and cycling (Ampt & Rooney 1998; James 1998; Ampt 1999; Rose & Ampt 2001; Marinelli & Roth 2002; Stopher & Bullock 2003; Ker 2004; Pramberg 2004; AGO 2005; Tideman et al. 2006; Bonsall 2009; Brog et al. 2009; Chatterjee 2009; DTEI(SA) 2009; Seethaler & Rose 2009).

VTBC provides a mechanism to address both mitigation and adaptation to climate change. Applied now, VTBC acts as a mitigation technique to reduce greenhouse gas emissions contributing to climate change. Behaviour change induced by VTBC must be maintained into the future to avoid facing the same transport emissions dilemma as seen today. The VTBC approach may be used to refresh and reinforce the need for sustainable behaviour choices.

In order to motivate, target and develop behaviour change in individuals, VTBC schemes employ psychological principles (TravelSmart Victoria 2002; Seethaler & Rose 2003; Ampt 2004; Seethaler & Rose 2004, 2005). VTBC measures are currently founded on two main social theory paradigms; community development and social marketing.

Community development is a bottom-up approach to VTBC using external support to encourage individuals to analyse their current behaviour, the underlying causes for this behaviour, and to develop a plan to change (Ife 1996; Ampt 2004).

Social marketing has been traced to Kotler and Zaltman (1971) where the term was used to refer to the application of marketing as a solution for social and health problems. Several definitions of social marketing exist, the most fitting with respect to VTBC being: the application of marketing technologies developed in the commercial sector to the analysis, planning, execution and evaluation of programs designed to influence the voluntary behaviour of target audiences in order to improve their personal welfare and that of society (Andreasen 1994, 1995). The key features of this definition

are the focus on voluntary behaviour change without coercion or enforcement, the concept of exchange in that the individual receives benefits from changing, and that the benefits will accrue to the individual and society, not the marketing body (Ampt 2003, 2004; Stead et al. 2007a; Powell & Thurston 2008).

Australia is a pioneer of VTBC programs, with efforts underway in all of the capital cities (James 1998; Ampt 1999; James et al. 1999; Marinelli & Roth 2002; Taylor & Ampt 2003; Ampt 2004; Pramberg 2004; Stopher 2004; AGO 2005; Tideman et al. 2006; Taylor 2007; Bonsall 2009; Brog et al. 2009; DTEI(SA) 2009). The advent of the National Travel Behaviour Change Program (NTBCP) in 2004 has also impacted the uptake of VTBC measures across the country. Funded by the federal government, the NTBCP is a nationally coordinated effort to address the growth of transport sector greenhouse gas emissions using individual travel behaviour decisions (Pramberg 2004). The target of the NTBCP was to engage 186,663 households nation-wide, to deliver a sustained reduction of 3.9 million vehicle kilometres travelled (VKT), equivalent to a reduction of 1.2 million tonnes of carbon dioxide emissions by June 2013 (Pramberg 2004; Stopher 2004).

VTBC schemes in Australia are generally marketed under the banner of TravelSmart. TravelSmart initiatives in Australia typically include community wide household level initiatives, workplace and school travel plans (Ker 2004). TravelSmart programs are undertaken through the application of two general VTBC philosophies, travel blending and individualised marketing.

2.1 Travel Blending

Travel blending, initially developed as part of the Clean Air 2000 program, is an approach based around empowering individuals to reduce car use by focussing on their activities and choices (Ampt & Rooney 1998; Ampt 1999; Tisato & Robinson 1999; Stopher 2004). Travel blending uses a diary based household interview system in which participants receive a series of four kits containing information booklets and travel diaries, over a nine-week period (Tisato & Robinson 1999; Rose & Ampt 2001). The information received from the initial travel diaries is used to provide the household with a summary of their travel patterns and resultant emissions, with suggestions for reducing vehicle use. A subsequent set of travel diaries are recorded four weeks later. Changes in travel patterns from the diaries are relayed back to the household. Travel blending advocates planning in advance to incorporate blending the mode of travel (i.e. car, public transport, walking, or cycling) and blending the activities required by the household (e.g. achieving multiple objectives in one trip or at one location)(Ampt 1999).

2.2 Individualised Marketing

Individualised marketing is the general term that will be used in this paper to refer to all trademarked schemes which use targeted information for individual travellers to reduce car use and increase use of sustainable transport modes. The widely used VTBC technique of individualised marketing (Ker 2004; Brog et al. 2009) attempts to shift transport mode by providing information about the transport related infrastructure and services available to the specific individual (Stopher et al. 2004). This method is based on the assumption that a proportion of the community is un-informed about sustainable travel options (Taylor 2007). Information provided generally includes public transport timetables and route maps, cycling and walking maps. The technique uses interviews, normally conducted via the telephone, to segment people into three main groups resulting from their responses to a set of simple questions (John 2001; Ker 2004). Each household is

then provided with a customised implementation plan based on their specific needs as determined during the interview.

3 VTBC Impacts

Generally the objectives of VTBC schemes are to reduce the amount of car travel or increase the use of more sustainable modes in order to reduce greenhouse gas emissions, however there are also a set of beneficial subsidiary effects that have been reported from the implementation of VTBC. As VTBC programs expand so too will the benefits. Taylor and Ampt (2003) provide a comprehensive summary of the benefits recorded from VTBC schemes and how they are observed, as summarised below:

Reduction of congestion

- reduction in distance travelled by car
- reduction in time spent travelling by car
- reduction in distance and time spent travelling by car at high demand times
- reduction in distance and time spent in congested areas
- increase in car sharing

Reduction in air pollution and greenhouse gas emissions

- change in mode selection
- reduction in distance travelled
- reduction in losses generated starting and stopping engine
- improvement in car maintenance
- reduction in car ownership, reducing embedded energy

Reduction in noise pollution

- reduction in the distance travelled by car
- reduction in the number of cars

Increased use of environmentally friendly travel modes

- increases in pedestrian and bicycle activity and public transport trips

Reduction in land uptake for transport infrastructure

- less space required to park cars
- reduction in the size of car owned

Increase in revenue from public transport

- increase in public transport fare receipts
- increase in public transport patronage

Improved road safety

- increase in pedestrian and cycling safety
- decreased frequency of reported accidents

Improved personal safety

- increased activity and interaction in streets
- reduced reports of local crime

Social benefits to the community

- generally result in increased social interaction and trust at a community level, identified using community participation surveys
- increase in recognition of local heritage and culture
- decrease in number of 'complaints-without-solutions' to local councils
- increased community initiated projects

Economic development benefits

- increase in local shopping
- redevelopment of local facilities to meet community needs
- increase in property prices when local community efforts increase safety or positive perceptions of the community

Health benefits

- increase in fitness levels due to more walking and cycling
- increase in health levels due to less in-car pollution effects
- decrease in doctors' visits due to social and health rewards
- lower stress levels
- increased levels of satisfaction and self-esteem due to social and health benefits

4 Measuring Behaviour Change

There are two general reasons for measuring behaviour change. Firstly to provide a method of feedback to participants in VTBC schemes to encourage and support their travel decisions. Secondly, to evaluate the effectiveness of VTBC interventions, regarding the overall effect on reducing car use or the comparative cost and benefits of VTBC versus infrastructure changes, or the comparative effectiveness of intervention types. In undertaking an evaluation the distinction between these types of evaluations will determine the information and level of detail required. As VTBC has no physical product such as those produced by traditional infrastructure projects, the main focus is in evaluating behavioural outcomes (Morton & Mees 2005; Chatterjee 2009). Evaluating behaviour is a significant challenge due to the many uncontrolled external factors that influence individual decision making. Evaluation is a controversial area with VTBC practitioners, and is widely discussed in the literature (Ampt & Richardson 1994; Ampt 2001; Stopher & Bullock 2003; Taylor & Ampt 2003; Richardson et al. 2004; Stopher et al. 2004; Morton & Mees 2005; Stopher et al. 2006; Stopher et al. 2007; Stopher & Greaves 2007; Stopher & Swann 2007; Taylor 2007; Bonsall 2009; Chatterjee 2009; Chatterjee & Bonsall 2009; Cohen 2009; Stopher et al. 2009). Debate regarding the appropriateness of conclusions drawn in published evaluations demonstrates a need for more robust verification of the impact of VTBC to allow comparison with other TDM options and to determine the most effective way to implement VTBC. The challenge of robust evaluation must be met not only to improve VTBC implementation, but to prove its worth as an instrument in climate change adaptation and mitigation.

4.1 Measuring VTBC for Participant Feedback

The detail and quality of information required to provide participant feedback varies greatly from that required to evaluate the VTBC scheme itself. Rose and Ampt (2001) deduce that perfect information is not needed in order for people to change their travel behaviour. Participants require suggestions on how to improve their travel behaviour, or support to continue their positive actions.

Commonly travel diaries identifying changes in participant travel behaviour are used to provide quantitative feedback on how participants can improve, or reward them for their efforts. Travel diaries generally record all trips made using start and finish time or odometer readings, trip purpose and mode selected. The analysis of the diaries is limited to basic comparisons between the trip time or distance recorded over the life of the VTBC program, and qualitative review of mode selection to recommend alternatives. The analysis of the diaries is undertaken to act as a guide and support and does not require statistical significance or need to be comparative to other participants. Therefore the information required to measure behaviour change in this manner is quite basic.

4.2 Evaluating VTBC Effectiveness

Evaluating a VTBC application requires measuring the impacts of the scheme. Seven objectives have been identified for consideration in any VTBC evaluation (ITSL 2010):

- economic efficiency: impacts related to increased economic efficiency for example where effective work times are increased due to less time spent in congested traffic through the reduction of car use
- liveable streets: impacts where streets become more liveable due to increased pedestrian and cyclist traffic, greater social interaction and improved perception of personal security, and less transport infrastructure such as car parks
- environmental protection: impacts that contribute to reducing emissions
- equity, social inclusion and accessibility: impacts that improve social interaction, self-esteem and satisfaction
- safety and security: impacts where there are actual or perceived improvements in personal safety
- economic growth: impacts that affect local economic development
- finance: impacts that result in increased revenue for government bodies such as increased public transport revenue.

There exists a common perception that VTBC will reduce car use wherever it is undertaken, however there is an ongoing expectation to prove the impact of VTBC schemes (Cohen 2009). Conducting a robust evaluation of a VTBC program is a complicated and resource intensive procedure. Developing a statistically sound evaluation with a high level of confidence can often overshadow the cost of implementing the scheme itself. The difficulties in evaluating VTBC schemes are discussed in the following sections and can be categorised as:

- detecting and measuring change
- variability of travel behaviour
- statistical confidence
- evaluating externalities
- independence of evaluators.

4.2.1 Detecting and Measuring Change

In order to determine the changes that have occurred in travel behaviour there needs to be a requisite understanding of the travel behaviour before and after the VTBC intervention. This is determined for VTBC programs using before and after travel surveys temporally spaced to detect stable changes in behaviour. The survey period should be long enough to represent normal travel behaviour. The survey

should also represent all segments of the population in order to match the socio-demographic profile of the community (Seethaler & Rose 2009). To establish the effect of the VTBC intervention ideally the surveys should obtain estimates of numbers of trips, numbers of activities, total distance travelled by mode, total time spent travelling by mode, and the modes of travel used (Stopher et al. 2004; Stopher et al. 2009). The reliance on individuals and households to accurately report on these factors can decrease the confidence of the evaluation through the introduction of errors. There are two methods to supplement the travel surveys in an attempt to quantitatively verify household travel surveys and reduce self-reporting errors: odometer surveys, and GPS surveys.

Odometer surveys record the VKT by household vehicles. While odometer surveys do not indicate changes in behaviour such as mode selection or trip chaining, the method reduces error in trip reporting as missed trips can be inferred from the start/finish odometer readings, and respondents have limited opportunities to falsify information to provide the answer expected by the survey. Stopher and Swann (2007) demonstrate that for the purpose of tracking household vehicle use over time odometer surveys involve little burden to respondents, provide targeted, highly accurate data, and are representative of the population.

GPS surveys can also be used to supplement household travel surveys. GPS surveys can be undertaken either for cars used in the household or individuals carrying portable GPS devices. As GPS technology improves with cheaper, smaller, and less inhibitive devices the GPS survey could replace the household travel survey due to the comprehensive information provided (Stopher et al. 2007).

Stopher et al. (2009) conducted a comparative study of GPS and odometer surveys as part of the TravelSmart Households in the West project undertaken in South Australia (Section 6.2). The study determined that a GPS panel survey with a sample size of around 200 households was more statistically robust than the comparative odometer survey sampling from over 1000 households. The odometer survey results were found to be inconclusive in this case and would have ideally required double the sample size to produce statistically significant results. The GPS survey was the largest study ever conducted in Australia. The GPS data also provided a more detailed picture of participants travel behaviour capturing details such as the mode of transport, the number of trips made, trip duration and distance travelled. The success of the GPS evaluation survey demonstrated in this project highlights its value for use in the widespread application of VTBC programs in Australia.

The use of before and after surveys for the purposes of evaluation can impact on the application of the VTBC scheme through a phenomenon referred to as ‘instrument reactivity’ (Seethaler & Rose 2009). Seethaler (2005) described this phenomenon and found four scenarios are possible regarding instrument reactivity in a TravelSmart application, where the before surveys affect travel behaviour before the VTBC intervention, change the uptake response, or have no effect on behaviour or participation. The study concluded that there exists a residual instrument reactivity, but mitigation measures such as a large interval between the before survey and the TravelSmart intervention and different branding of materials can be used to reduce this effect.

4.2.2 Variability of Travel Behaviour

As noted in the previous section, before and after surveys are required to detect and measure the behaviour change related to VTBC implementation, however travel patterns are not static. Travel behaviour can change for many reasons other than VTBC intervention. Changes in household structure, moving house and new jobs are all examples of external influences that affect travel

behaviour. Travel behaviour has also been found to be seasonal; patterns change according to school holidays and also reflect change of seasons through the year (Stopher et al. 2009).

Temporal patterns and rhythms can also be detected at a smaller scale relating to travel behaviour. Axhausen et al. (2002) conducted a six week continuous travel diary of 139 German households in order to determine the reporting period required to enable detailed observation of the rhythms of daily travel. The survey collected the following data:

- socio-demographic characteristics of the household and members
- commitments of participants to regular private, social and civic activities
- details of the vehicles and public transport tickets owned by the household
- six week continuous travel diary with geo-coded destinations recorded
- attitude and values survey regarding different transport modes and general values
- daily weather conditions and forecasts.

The collection of this data allowed analysis concerned with the temporal rhythms of the travel of respondents by comparing the similarity between days, the patterns developed, and the interaction between activities, trip duration and frequency. The purpose of collecting this type of data is to determine the optimal travel survey duration in order to accurately represent temporal rhythms and variation.

Travel behaviour also varies geographically in response to factors such as public transport availability and distance to major business centres (Dodson 2007). Stopher and Bullock (2003) suggest that the application of VTBC in outer suburbs has a lower impact than inner metropolitan suburbs. Therefore VTBC application to these regions may be limited, and instead target areas with the appropriate geographic and infrastructure characteristics. Studies have also shown strong evidence in Australia that participants have different characteristics and attitudes to non-participants, with participants forming a minority of the community, representing around three in ten households (Taylor & Ampt 2003; Taylor 2007). As such the evaluation of area specific TravelSmart interventions cannot be extrapolated to indicate uptake or impact over the greater metropolitan area.

Evaluation surveys should be conducted such that a stable temporal pattern with respect to travel behaviour is identified in order to establish whether travel behaviour has changed in response to VTBC scheme and whether the change is sustained beyond the formal application of the program. Control groups, households or individuals unaffected by the VTBC program, can be used to capture the effect of external influences on travel behaviour over the same period. The timing of the evaluation surveys must also be undertaken to account for the effects of seasonality so as not to infer changes due to the implementation of VTBC that are actually attributed to the inherent variability of travel behaviour. The evaluation must also take into account the profile of respondents and ensure that the profile is replicated through the various surveys such that different socio-demographic effects are not attributed to the VTBC intervention (O'Fallon & Sullivan 2004). All of these factors also require consideration of sufficient sample size to generate statistically significant results.

4.2.3 Statistical Confidence

The order of magnitude of the changes generally reported by VTBC programs are relatively small in statistical terms, requiring a large data set and subsequently large sample sizes in order to report the

changes with confidence (Ker 2004; O'Fallon & Sullivan 2004; Richardson et al. 2004; Stopher et al. 2004; Stopher & Swann 2007; Stopher et al. 2009).

Generating statistical confidence has proven particularly difficult with small, pilot studies given the small budget and area of application. This has given rise to the argument that the comprehensive documented results for existing VTBC applications should provide enough evidence of success removing the need for continued evaluation of effectiveness for new applications (Ker 2004). The predilection of proving the value of VTBC applications often leads to the publication of results drawn from sample sizes too small to derive robust conclusions and no indication of the confidence of the result. This can result in false representation of the success of VTBC applications and may mislead the direction of future applications. Published results need to be well documented and statistically sound, or alternatively suggest that the findings are indicative only (O'Fallon & Sullivan 2004).

The method of approach and the parameters selected for analysis in the evaluation surveys can reduce the sample size required, but may increase the complexity of the surveys. Richardson et al. (2004) describe several survey design components that affect the sample size required to generate statistically significant results:

- detecting changes in the number of trips undertaken requires a smaller sample size than measuring changes in VKT or travel time
- repeated cross-sectional surveys (a snapshot of a random selection of the population at a single point in time) require larger sample sizes to detect changes than panel surveys (a longitudinal style survey gathering data over time using the same population sample)
- daily travel diaries require larger sample sizes to detect changes compared to a weekly travel diary, although the difference can be minimised using a panel survey and recording the same day of the week for each wave
- detecting changes in household travel requires smaller sample sizes compare to individual travel data
- detecting changes in car usage requires smaller sample sizes than public transport usage.

Seethaler and Rose (2009) provide an indicative example of the sample sizes required for statistical significance with reasonable confidence. The study compared the sample size required to detect a 10% change in VKT for Australian TravelSmart applications, recorded in weekly travel diaries using a cross-sectional survey design compared to a panel survey design. To estimate the 10% change within a 5% error level, the before and after cross-sectional survey required a sample of 758 households compared to only 242 households with a panel survey design. Applying the participation rates recorded from other Australian VTBC applications they concluded 629 households would need to be recruited to achieve a final sample of 242 households.

The burden on participants resulting from the survey design can also affect the evaluation process. The length of the survey period, the number of waves of a panel survey and the detail required by the survey can all impact on the response rates and hence the data available for evaluation. Motivating the response to measurement and maintaining it over a period of time has been found to be a substantial challenge (Stopher et al. 2004; Stopher et al. 2009).

The design of the evaluation survey has to form a balance between the questions that the evaluator wants to answer and the resources available. A substantial number of evaluations published in the

past have not taken this relationship into account and undertaken intensive evaluation questions with sample sizes that produce insignificant results. The results from these evaluations are in turn inconsequential, and the resources would be better directed to developing statistically significant relationships.

4.2.4 Evaluating Externalities

Evaluating the indirect benefits, or externalities, of reducing car usage are difficult to quantify and methods for assessing these changes are not well developed (Tisato & Robinson 1999; Stopher et al. 2004; Stopher et al. 2009). Generally benefit cost analysis (BCA) techniques are applied to develop a comparable impact rating based on economic measures, represented as a dollar value. The BCA represents these impacts in monetary terms by valuing the resources consumed at their market value and the impacts on those affected according to their willingness to pay to avoid the negative and to receive the positive project outcomes (Winn 2004).

There have been few comprehensive BCA undertaken for VTBC schemes. Ker and James (1999) reported a comprehensive BCA for the application of individualised marketing in South Perth, using conservative values from published sources where project specific information was unavailable. The other BCA studies that have been undertaken for Australian applications are limited in their consideration of impacts and often focus on a subset of measurable parameters. For example Tisato and Robinson (1999) in their evaluation of an Adelaide travel blending program and Winn (2004) in the BCA of a Melbourne TravelSmart program, intentionally neglect health benefits due to the difficulty involved in ascertaining their equivalent dollar value.

Whilst there are some major challenges in appraising all the costs and benefits associated with VTBC programs, the BCAs undertaken suggest that VTBC programs are highly effective in Australia with respect to their benefit cost ratio (BCR) as compared to other supply side initiatives which typically generate BCR of 1 to 2 (Winn 2004). For the range of parameters considered, Ker and James (1999) reported BCR of between 4 to 33 under low and high impact scenarios, Tisato and Robinson (1999) reported a BCR of 5.7 under an average impact scenario, and Winn (2004) reported BCR of 2.9 to 10. It would be reasonable to assume that the inclusion of the externalities currently not investigated would strengthen the BCA comparison of VTBC against traditional policy or hard engineering solutions.

4.2.5 Independence of Evaluators

The evaluation of VTBC schemes by the same body actioning the scheme can lead to the introduction of bias errors. In order to complete a critical appraisal of a scheme it is recommended to use independent third party evaluators to remove this cause of systematic errors (Morton & Mees 2005; Stopher et al. 2006; Taylor 2007; Stopher et al. 2009). Stopher et al. (2009) take this concept one step further to also remove bias of selection towards intervention participants by conducting the evaluation surveys in a completely blind manner, where the evaluators surveyed a totally independent sector of the community with no knowledge of the households that had participated in the TravelSmart application.

4.3 Evaluating Specific VTBC Instrument Effectiveness

Evaluating the effectiveness of various VTBC instruments is an important task to assist shaping future VTBC applications. Direct comparative evaluations between interventions using an individualised marketing approach as opposed to a travel blending approach cannot be undertaken

as individualised marketing results are measured against the whole target population, whereas travel blending results are reported with respect to the number of participants (Ker 2004).

However, it is possible through perception studies to determine which TravelSmart tools participants feel are most effective in encouraging VTBC. Zhang et al. (2009) undertook an extensive perception study of over a thousand TravelSmart participants to evaluate the effectiveness of the four most frequently used tools applied in a large scale VTBC application in Adelaide for which the overall objective was to reduce car use (refer Section 6.2). A telephone survey of TravelSmart participants was used to evaluate the four tools which comprised a journey plan, a walking and cycling map, an affirmation letter and a local activity guide. Zhang et al. (2009) summarised that for the Adelaide TravelSmart application the cycling and walking map appeared to be the most effective tool, encouraging people to walk more and ultimately achieving the goal of reducing car use to a greater extent than the other tools investigated. In terms of changes in the number of trips made through car driving, public transport use or travel as passenger, there was found to be no significant difference between the treatments.

4.4 Summary

Overall, the literature on evaluations conducted for VTBC schemes support their effectiveness as an instrument in reducing car use. However, as the preceding paragraphs allude, there is much refinement and research required to improve this area of VTBC methodology. The challenges of VTBC evaluation for future applications can be summarised as (Stopher et al. 2006; Taylor 2007; Chatterjee & Bonsall 2009; Stopher et al. 2009):

- determining what questions need to be answered through evaluation and understanding the resources required to generate a statistically significant answer
- conveying the importance of robust evaluation as a tool for improving and advocating future VTBC applications, and the resources required to achieve this
- ensuring the independence of evaluators to reduce bias errors
- measuring changes in the program participants, the entire targeted populations and in a comparable control group isolated from the intervention over time in order to differentiate with certainty between the effects of external factors and the changes related to the intervention and establish the long term effects of VTBC interventions
- collecting comprehensive data including trip rates, VKT, travel time by transport modes, and choice of travel mode
- substantiating self reported travel changes recorded in travel diaries using supplementary GPS surveys or odometer surveys
- accurately measuring changes over smaller sample sizes using the recommended panel survey approach
- minimising respondent burden to assist in maintaining response rates over time, whilst providing comprehensive information on behaviour changes which may involve further developing GPS surveys to provide a low burden, reliable method for collecting data.

5 Residual VTBC

Whilst VTBC measures have been shown to be successful in changing behaviour it is also necessary to understand what happens when the active application of the program ceases. This involves considering

what the long term or residual effect the TravelSmart program has on the participants, the targeted community and indirectly on the general population.

The occurrence of a residual effect is proposed on the same psychological principles used as a basis for VTBC concept, that is, personal responsibility and an individual's lifestyle framework (Ampt 1999, 2004; Hughes & Di Pietro 2005; Nye & Burgess 2008). Nye and Burgess (2008) concluded that the durability of a particular behaviour was largely determined by how well it fit within the existing lifestyle framework. The personal and environmental gains achieved by changing travel behaviour are typically compatible with the individual's ethics and the concept of personal responsibility in making the ethical choice, providing sufficient motivation for the behaviour change to be sustained (Ampt 1999, 2004).

Seethaler and Rose (2009) addressed the idea of residual VTBC with a study that used a week long odometer panel survey to assess the effect of a one-off, large scale community based TravelSmart intervention in Melbourne. The study found that the TravelSmart application did not induce a statistically significant effect on the average daily VKT twelve months after the intervention.

Contrary to these results, the bulk of evidence documented in voluntary behaviour change literature supports a residual effect in community and individual travel behaviour beyond the period of evaluation for the projects. In Australian applications there has been documented evidence for sustained behaviour change beyond a 2.5 year evaluation period (John 2001; Marinelli & Roth 2002). Marinelli and Roth (2002) discussed evidence from German VTBC applications where behaviour change was sustained beyond a 4 year period. Taylor and Ampt (2003) found that behaviour change is sustained and may intensify over the short to medium term. However, due to combination of the limited duration of evaluations over the long term and the newness of the VTBC approach there is a lack of historical data to infer the lasting effects of VTBC interventions. Longer term studies are required to determine the duration and extent of behaviour change and whether VTBC is propagated outside of the engaged community. Longer term studies could also be used to infer whether it is necessary to conduct maintenance for VTBC implementations. Maintenance may entail refresher information, or updates on the success of the implementation and would also serve the purpose of reaching new community members and could be used concurrently with long term evaluation surveys.

6 Moving Forward with VTBC in Australia

The preceding review has illustrated that substantial experience and knowledge has been developed in Australia by VTBC practitioners. VTBC has been applied in various situations and with different approaches. The consensus stands that VTBC is an effective tool in reducing private car use and subsequently greenhouse gas emissions, mitigating and adapting to climate change through the adoption of a sustainable lifestyle. Given this success, practitioners should now turn their focus to consider how to move forward with VTBC in Australia. This includes considering the following topics:

- widespread application of VTBC
- example of best practice in Australia
- extending the concept to sustainable lifestyles in general
- implementing and managing interventions
- research requirements for advancing VTBC.

6.1 Widespread Application of VTBC

Section 4.2.2 discusses the variability of travel behaviour with respect to time, geography, service and infrastructure availability, and individual characteristics. With this in mind, the application of TravelSmart to entire cities may be infeasible given the resources required and the likely 'hit and miss' nature of reaching the people most likely to take up the program. A targeted approach to the application of TravelSmart is recommended. This involves selecting areas where there are the least external barriers to people reducing private car use. This could be achieved by developing a screening process to determine geographic areas with a set of characteristics that may result in TravelSmart having a greater impact, for example, good public transport infrastructure, local conveniences, demographics, topographically suitable for walking or cycling, and distance to business centres. This could be achieved using a multi-criteria analysis approach employing a GIS based application.

The diversity of the Australian community also requires VTBC interventions to consider how to include as many demographics as possible. Language and cultural barriers may isolate individuals that would otherwise participate in the scheme. Woodruff et al. (2005) undertook a study of TravelSmart tools to engage culturally and linguistically diverse community groups in Victoria. This involved translating information kits into several different languages common in the region and providing multi-lingual contact officers. Such actions form part of the methodologies employed by best practice applications as presented in Section 6.2.

The Australian Greenhouse Office (2005) also stressed the need for a common application and evaluation framework across Australia. They envisioned that such a framework would include modules and tools that can be combined to meet the specific needs of each project. This framework should be based on best practice and should evolve over time as improvements are made in VTBC practices. The following section describes a case study that would be suitable to form the baseline for future methodologies of large scale VTBC projects in Australia.

6.2 Best Practice Case Study: TravelSmart Households in the West

A common VTBC framework should be based on best practice approaches. The TravelSmart Households in the West project, as described in DTEI(SA) (2009), provides comprehensive, readily available information on the methodologies employed in a highly successful VTBC intervention undertaken in Adelaide as part of the National Travel Behaviour Change Program. The methodologies used in the application and evaluation of this project represent the benchmark for future widespread application of VTBC schemes in Australia.

The project was undertaken over three local government areas comprising 4.5% of the total Adelaide metropolitan area and including 13% of its population with a diverse socio-economic representation. The project area was characterised by the fact it hadn't previously been exposed to a VTBC intervention, alternative transport was accessible, and there were several major entertainment and business centres. The project aimed to (Tideman et al. 2006; DTEI(SA) 2009):

- reduce private car use through VTBC
- achieve ongoing change in travel behaviour
- directly engage people within their own settings and cultural context in an attempt to make the program accessible for the maximum number of socio-demographics

- provide simple, motivating tools and techniques addressing the most significant barriers to behavioural change
- develop partnerships with key stakeholders
- independently evaluate results with statistical confidence
- be effective and efficient on a broad scale.

The application involved a combination of community development and individualised marketing approaches. 191 community groups were engaged in the project, helping to influence community opinions and offer support to individuals. 22,103 household were engaged at an individual level. Prior to the commencement of the project, a community perceptions survey on private car use and sustainable travel options was undertaken. A follow up survey was conducted after the project had concluded to determine changes in community attitude. The before and after surveys showed a significant shift in community perceptions on private car use and sustainable transport options.

The TravelSmart intervention was initiated using a letter of introduction mailed to over 65,000 households to introduce the project and pave the way for the next phase. The secondary phase involved a guided conversation over the phone or face to face with a trained TravelSmart officer to discuss the household travel requirements and the negative aspects of car use. The third phase of the intervention used direct coaching of the household with a TravelSmart officer to devise a solution to reduce car use for the benefit of the individual, and providing a series of tools designed to encourage people to change their travel behaviour. Table 1 describes the tools used and the frequency with which they were provided to participants.

The focus of the project then moved in to what was referred to as a legacy building stage. A network of organisations and people were identified as TravelSmart Friends and were subsequently trained or mentored to continue support in the community to reduce car use. This approach fulfils a maintenance niche after the conclusion of the TravelSmart project in order to sustain changes through the community in a socially regulated manner.

Evaluation of the program was undertaken primarily to measure statistically significant changes in household travel behaviour with a focus on private car use, and to understand what caused VTBC. The blind evaluation was undertaken by an independent third party and conducted in a manner disassociated from the TravelSmart project to eliminate bias in the reporting of results (Stopher et al. 2009). The evaluation was undertaken using two concurrent methodologies, GPS surveys and odometer surveys, to compare the effort and the robustness of the evaluation results to advance further research in measuring behaviour change. As discussed in Section 4.2.1, the GPS survey produced statistically significant results while the odometer survey results were found to be inconclusive (Stopher et al. 2009). Table 2 summarises the application of the two methodologies for the project.

Table 1 TravelSmart Households in the West description of tools and the frequency of distribution (DTEI(SA) 2009)

Tool	Frequency	Description/Use	How the tool encouraged VKT reduction
Local activities	27.6%	Guides to local shops, services, clubs and activities to assist people to use local alternatives	Encouraged use of local facilities so people walked, cycled or trip chained
Access guide	17.1%	A map for people who wanted to walk or cycle more	Increased walking or cycling
Affirmation letter	14.2%	A letter to praise past VKT reduction and to reinforce the benefits the person articulated	Reinforced any previous behaviour change and encouraged further change
Kids activities	11.1%	Activity pages for children of different ages to encourage adult participation in a discussion about changing travel behaviour	Encouraged family thinking of ways to reduce car travel
Journey planner	10.7%	Individually tailored journey plan using public transport, cycling or walking in place of a car	Increased public transport, walking or cycling
Promotional postcards	5%	Reinforced the benefits of behaviour changes (save time, money, health)	Encouraged behaviour change
Ideas letter	4.5%	A letter to remind participants of the changes that they decided on during the initial conversation	Reinforced any planned behaviour change
Good news letter	2.7%	Request for permission to use their story to encourage other people and increase commitment to behaviour	Reinforced any previous behaviour change and encouraged others to change
Kilometre monitor	2%	Self monitored recording of VKT for one week	Generated awareness of VKT and encouraged pride in reduction
Shopping list	1.6%	To assist in organising shopping trips to be travel efficient	Increased trip chaining
Memory jogger	0.3%	To keep track of travel over a week, then options identified and discussed with TravelSmart officer	Generated thought and discussion of any potential behaviour change
Travel blending	0.3%	A one week travel diary with personalised feedback identifying travel changes that fit into their lifestyle	Reduced car use by any means
Work from home	0.2%	Information about working from home	Reduced car use for the journey to and from work

Table 2 Evaluation methods summary (DTEI(SA) 2009)

Method	Description	Sample Size	Measurement Interval
GPS survey	Tracking individual travel for 7 day periods using GPS data logger	Average panel of 218 households	Annual survey (3 waves conducted)
Odometer survey	Recording odometer readings from all cars in the household for 7 day periods	Panel of 1,166 households	Surveyed every 4 months (8 waves conducted)

A multiple wave approach was used for both evaluation methods, with the first wave conducted prior to the initiation of the project, and the final wave undertaken after the conclusion of the project in order to establish the behaviour changes at regular intervals. A panel survey approach was used with panels of participants and non-participants (control group).The rolling wave panel survey approach was selected based on the perceived benefits including:

- average daily VKT could be calculated accounting for daily variations such as weather conditions, therefore allowing trends to be identified
- variation was minimised by using the same households in each survey wave
- if circumstances prevented a household participating in a single wave, the average daily VKT could be inferred from the data provided in the previous and subsequent waves
- changes in the household that may explain changes in household VKT were tracked over the length of the evaluation.

The following statistically robust findings were taken from the TravelSmart Households in the West evaluation (DTEI(SA) 2009; Stopher et al. 2009):

- car travel was reduced by participants on weekdays and weekends by an average 10.4km per household per day, representing an 18% reduction. Non-participants showed a significant 6% increase in distance travelled. The total reduction of VKT per day for participating households was 229,850 vehicle-km while non-participants increased daily VKT by 605,030 vehicle-km. The GPS device was unable to distinguish between car drivers and passengers. As such, ride sharing was not represented in these results, inferring a potentially larger decrease in VKT than reported
- participants exceeded the greenhouse gas abatement target of the National Travel Behaviour Change Project, saving a total of 86 million VKT, equivalent to 28,000 tonnes of greenhouse gas emissions
- participants learnt to make fewer trips, significantly reducing the number of journeys by 5%, while non-participants increased the number of trips made by 3.8%
- participants learnt to travel more efficiently reducing travel time significantly on weekends and week days as opposed to non-participants who increased time travelling
- significant household savings in fuel were an additional benefit totalling $11.6 million based on average petrol prices over the evaluation period, equal to a $525 saving per participating household
- public transport patronage rates in the TravelSmart project area showed more than a 6% increase in 2005-6, and continued increase in 2006-7. This compared to a 1% increase in 2005-6 patronage and a 1% decrease in 2006-7 patronage in metropolitan areas outside of the project area.

This example has highlighted how a systematic and robust intervention can have significant impacts on travel behaviour for large scale applications of VTBC in metropolitan areas and at the same time contribute to informing and improving the field for future applications.

6.3 Extending the VTBC Concept

The principles of voluntary behaviour change have been successfully applied to travel, as such it is useful to consider where similar principles have been employed in other disciplines and whether VTBC can be diversified to instigate general sustainable behaviour choices.

As discussed in Section 2, the practice of social marketing originally served as a public health intervention. Marketing campaigns were developed to improve awareness and accessibility to prompt voluntary behaviour change towards products and services such as contraceptives, hand soap and immunisation (Cairns & Stead 2009). This practice has been extended further in the public health sector with the principle of social marketing also applied to facilitate healthy lifestyles. This practice has been popular in the United Kingdom where there exist several examples of the application of social marketing to encourage voluntary behaviour change with respect to lifestyle choices. Powell and Thurston (2008) describe the Our Life program as a voluntary behaviour change program with the aim to 'motivate the public to protect its own health and to develop an environment that supports healthy lifestyle choices'. Stead et al. (2007a) reviewed the effectiveness of social marketing interventions in influencing youth versus adult individual behaviour change to prevent smoking, alcohol use, illicit drug use and physical activity. The report found significant short term positive effects in youth interventions with sustained effects more than two years after the intervention for smoking and alcohol interventions. Adult interventions showed mixed results, especially with respect to smoking, however still proved effective in influencing lifestyle choices. Stead et al. (2007b) discuss the implications of using social marketing to tackle obesity due to the methods proven ability in changing dietary and exercise behaviour. Powell and Tapp (2009) extend the principles of social marketing to describe a method for confronting problem gambling.

Further case studies are described outside of the public health arena where social and community based marketing has been extended to (McKenzie-Mohr 2000a, 2000b; Abrahamse et al. 2005; Cullbridge 2010; McKenzie-Mohr 2010):

- waste minimisation and recycling
- energy consumption
- water use
- biological control
- littering
- sustainable harvests for fishing and agriculture
- minimising the use of pesticide, herbicide, fertiliser and other environmental contaminants
- social problems such as bullying, child abuse, speeding and drink driving
- green construction and retrofitting.

The examples of voluntary behaviour change interventions provided above usually target a limited category of behaviours. In attempting to establish greener, more sustainable lifestyles for climate change mitigation and adaptation there are many behaviours that could be targeted by such schemes. As such it is valuable to determine whether it is suitable to use a single intervention to instigate change across multiple behaviours impacting on the environment.

The EcoTeam Program (ETP), applied to over 20,000 households worldwide, targets approximately 100 different household behaviours under six categories in order to promote durable, green lifestyle

changes (Staats et al. 2004). The six behaviour categories dealt with by the ETP are waste minimisation, gas consumption, electricity consumption, water, transport, and consumer behaviour. Similar to the Australian TravelSmart VTBC interventions, ETP uses information and feedback to generate behaviour change. Where Australian VTBC applications use a combination of community group and individual interactions, as demonstrated in Section 6.2, the ETP operates using groups of 6 to 10 people (from 4 to 6 households) who have an existing relationship, for example neighbours, friends, or club members. This group focus increases the social pressure to change and sustain green behaviours, and provides long term community support once the active program has concluded. The teams meet once a month over the life of the 8 month program addressing the various behaviour changes over this time. Participants record their individual behaviour changes measuring energy use, water use, waste reduction and reduction in private car use. Participants receive feedback during the course of the program, and continue to receive feedback at the conclusion of the intervention on the accumulated effects of the ETP program worldwide through quarterly newsletter updates. The independent evaluation of two ETP applications conducted in the United Kingdom (Nye & Burgess 2008) and the Netherlands (Staats et al. 2004) have found durable changes in participant behaviour with respect to green choices for waste and recycling, energy use, shopping and food purchasing, transport and water use. Nye and Burgess (2008) qualitatively reported that the most commonly changed behaviours in the UK ETP application were waste minimisation through recycling, composting, and smarter shopping, and changing consumer behaviour by buying locally grown goods. Staats et al. (2004) conducted a three year longitudinal evaluation for the Netherlands applications finding that improvements in behaviour were maintained or increased two years after the completion of the ETP. The smallest behavioural change measured in the Netherlands case was a 7% reduction in water consumption, while the largest change was a 32% reduction in the amount of solid household waste (Staats et al. 2004).

The results of the public health and ETP applications show that voluntary behaviour change principles can be generally applied across different behaviours resulting in significant and sustainable behaviour change. This opens the door for possibly expanding TravelSmart in Australia to a ‘LiveSmart’ principle encouraging sustainable lifestyle choices. This has implications for the widespread application of TravelSmart. The extended program would employ different selection criteria for determining suitable application areas and require a much broader expertise with respect to management and implementation.

6.4 Coordinating VTBC Programs

The expansion of TravelSmart over a wider area and scope requires significant resources, expertise and the ability to reach into the community, all of which on such a wide scale are difficult to acquire from a single entity. While small scale pilot projects have been successfully conducted by single entities, the expansion of the VTBC program would traverse political boundaries and require greater resources for application. Therefore a coordinated effort across multiple organisations in the public and private sector is required to implement and manage future VTBC programs in Australia. This has been demonstrated by the best practice case study TravelSmart Households in the West in Section 6.2, where the project was managed by the state government, sourced funds from the federal government, undertaken and evaluated by independent private contractors, and the project headquarters were hosted by a local school (DTEI(SA) 2009). A management and organisation structure is required to facilitate the successful application of VTBC across Australia, but must be

flexible enough to take into account the local differences between each application. A coordinated approach provides the means to achieve a goal that would be near impossible to undertake as a single entity.

A possible model framework for this coordinated effort can be adapted from the Transport Management Associations (TMAs) operating in the United States, Canada and Europe. The first TMAs were established in the United States in the early 1980s and served to establish a public-private coordinated body to implement transportation management strategies addressing traffic congestion, mobility and transport related environmental problems in specific geographic areas (Luten 2006). TMAs represent areas with common transport related characteristics, and are not formed according to political boundaries. TMAs vary with the composition of stakeholders, and operate in a manner to best address the specific issues responsible for the creation of the TMA. Luten (2006) describes the various forms that TMAs generally take which include informal partnerships, semi-independent partnerships, and independent or incorporated non-profit organisations, the latter of which is the most common form of a TMA. However, large scale VTBC programs are more likely to be undertaken under the semi-independent structure with government agencies operating as discussed in the TravelSmart Households in the West application (DTEI(SA) 2009), where public entities host a TMA type program involving the private sector and community. While Luten (2006) found similarities between the urban form and culture of Australia and the countries currently using TMAs to indicate a high likelihood of transferability of the TMA concept, further research is required to determine potential success when applied to VTBC programs. Meiklejohn and Wake (2007) discuss the trial and identification of potential TMAs in Melbourne under the Victorian TravelSmart program for the purpose of facilitating workplace based TravelSmart interventions, and identify the need for further community engagement for behaviour change outside the workplace.

Formalised coordination and management will be essential as VTBC programs develop into widespread programs, and evolve from a singularly travel based approach to general sustainable behaviours.

6.5 Research Requirements

This review has identified the potential of VTBC for mitigation and adaptation to climate change in an Australian context. Several areas have been identified that require further research to improve VTBC practices for this purpose and are summarised below:

Maximising uptake through targeted deployment of VTBC

- a multi-criteria GIS based screening process could provide the means for identifying areas with a higher likelihood of success for VTBC interventions based on a variety of characteristics, including topography, alternative transport availability and demographics (Section 6.1)

Characteristics of participants and non-participants

- knowledge about the characteristics of participants and non-participants is required in order to improve VTBC instruments, increase participant uptake or develop more targeted applications
- knowledge about the reasons why people participate or do not, can also assist in identifying what barriers need to be addressed in order to increase uptake across the community

Evaluation methods

- gaps still exist in understanding the full impacts resulting from VTBC. Methods and case studies fully evaluating impacts of VTBC require development to build a more persuasive argument on the extent and breadth of impacts related to VTBC, and their value to society
- evaluation should also be further applied to determine instrument effectiveness in order to improve the VTBC toolkit
- long term monitoring is required to determine the presence and extent of a residual effect to VTBC, and the possible maintenance requirements of VTBC interventions to maintain effectiveness over time
- GPS surveys have proven to be useful in evaluation (Section 4.2.1), however they rely on supporting travel surveys to define the travel activities undertaken, or inferences based on the characteristics of the data such as speed, route, stop frequency and location. In order to develop GPS as a complete, independent evaluation method the reliability of the inferences made to describe mode and other trip characteristics need to be assessed.

Application of VTBC principles to target multiple behaviour changes

- Australian pilot studies are required to determine the effectiveness of behaviour change interventions targeting multiple behaviours
- the current VTBC toolkit requires assessment with respect to suitability for application to non-travel related behaviour to develop new tools and adapt those currently used

Best practice application of VTBC in Australia

- a framework is required to determine how behaviour change programs are to be coordinated and undertaken on a large scale across Australia to use the resources, skills, and existing community structures to their maximum potential and support consistent best practice VTBC (Section 6.1, 6.4)

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